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AUSTRALIAN MINERAL INDUSTRY QUARTERLY

In this issue:

The *Australian Mineral Industry Quarterly* reviews developments in mineral and fuel commodities in Australia, and records statistics of production, imports, and exports. Most numbers also contain a review article on a particular commodity or more general topic. A cumulative index of articles in Volumes 1-29 was published in Volume 30, No. 1.

The 'Commodity review' in No. 1 of each volume reviews developments that took place in the quarter ended 31 March of the designated year, and No. 1 of each volume is published in August of that year. The 'Commodity reviews' in Nos. 2 and 3 cover the quarters ended 30 June and 30 September, and Nos. 2 and 3 are published the following November and February. 'Commodity review' in No. 4 deals with developments for the year as a whole, and No. 4 is published the following May. Except for the Summary Tables, statistics tables in Part 2 of each volume relate to the quarters immediately preceding those covered in Part 1.

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AUSTRALIAN MINERAL INDUSTRY QUARTERLY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

and AUSTRALIAN BUREAU OF STATISTICS

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Contents

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Part 1 Quarterly Review

Bureau of Mineral Resources, Geology and Geophysics, Canberra, Australia

COMMODITY REVIEW

Mineral Economics Section, BMR

Fuels

BLACK COAL

Mine production of raw coal in the March quarter is estimated at 21.4 million tonnes (Mt), a reduction of 4 percent on the previous quarter but a 1-percent increase on the corresponding period in 1979. Saleable coal production fell 1 percent below the March 1979 quarter to an estimated 16.8 Mt. Industrial disputes in New South Wales and Queensland were responsible for the fall in raw coal production.

In New South Wales raw coal production during the quarter totalled 11.2 Mt (8.9 Mt saleable coal), a fall of 3 percent from the corresponding period in 1979. Increased production in the Singleton-North West and Western districts failed to offset reductions in the Maitland, Newcastle, Burragorang Valley, and South Coast districts. Raw coal production in Queensland is estimated by BMR at 8.8 Mt (6.6 Mt saleable coal) or 2 percent above the 1979 March quarter level. Large increases in open-cut coal production in the Mackay district offset decreases in other districts.

Higher consumption of black coal in the first quarter of 1980 for electricity generation in New South Wales and Queensland was largely responsible for the 13-percent increase in consumption to 8.6 Mt over the March 1979 quarter.

Black coal exports increased in the first quarter of 1980 to 10.9 Mt, an 11-percent rise over the first quarter of 1979. A sharp increase of 24 percent to 7.5 Mt in shipments to Japan was recorded, New South Wales supplying an estimated 3.4 Mt and Queensland an estimated 4.1 Mt.

Continuing strong demand for black coal for export and domestic consumption has resulted in a steady decrease in the level of stocks held in New South Wales. As at 22 March 1980 stocks totalled 9.9 Mt, compared with 12.4 Mt on 24 March 1979.

Several new contracts and agreements for the sale of black coal were announced during the quarter, indicating a strengthening of interest in coal as an energy source.

The Queensland Government announced in January that it intended to proceed with the development of the Curragh project north of Blackwater, central Queensland. Coal produced would be used for domestic electricity generation.

In February B.P. Australia Ltd and Millmerran Coal Pty Ltd reached agreement subject to necessary governmental approval, whereby B.P. Australia would acquire 100 percent of Millmerran Coal. On implementation of the agreement B.P. would join Amax Iron Ore Corporation and Mitsui Iron Ore Development Pty Ltd in the exploration and possible development of coals in southeast Queensland that are suitable for power generation and have conversion potential.

Central Queensland Coal Associates and Japanese steel mills concluded negotiations in February for the supply of 9.6 Mt of coking coal over an 8-year period from the Norwich Park mine.

Prospects for the development of the Oaky Creek project in Central Queensland received a boost with the announcement in March that a heads of agreement for the sale of 0.7 Mt of coking coal/year for 8 years had been signed with the Italian steel group, Finsider. Under the agreement Finsider would take a 7.5-percent interest in the project.

Bridge Oil Ltd reported in March that drilling in its Galilee Basin prospect had delineated measured in-situ reserves of 800 Mt of steaming coal.

Also in March an agreement was announced between AAR Limited and IOL Petroleum Limited that would give IOL a further 10 percent of AAR's share in the Hail Creek project. In return AAR would receive IOL's interests in the Theodore, Taroom, and Yarrabee coal prospects and other resource projects, as well as a $4.2 million cash payment. The agreement, subject to government approval, will alter ownership of the Hail Creek project to: AAR Limited 44 percent, Esso Exploration & Production Australia Inc. 25 percent, IOL Petroleum Pty Limited 25 percent, Marubeni Coal Pty Ltd 4 percent, and Sumisho Coal Development Pty Ltd 2 percent.

M. B. HULEATT

URANIUM

Uranium oxide production by Mary Kathleen Uranium Ltd in the March quarter of 1980 was 156 tonnes (132.3 tonnes U), 33 percent less than in the previous quarter but 5 percent more than in the corresponding 1979 quarter; a six-week industrial stoppage coupled with mechanical problems during the period reduced output.

On 23 January Western Mining Corporation Ltd announced the results of the first diamond-drillhole, ACD–1, on the Acropolis prospect, 25 km southwest of Olympic Dam. The hole was completed at 1098 m and encountered mineralisation over 66 m, from 924 m to 990 m, of 0.7% Cu and 0.07 lb/tonne U_3O_8. The style of mineralisation is similar to that at Olympic Dam.

On 7 February 1980, Mary Kathleen Uranium Ltd announced that it had been informed by the Minister for Trade & Resources that, following the Commonwealth's disposal of its interests in the Ranger project, he considered it appropriate that the Government should proceed to investigate the possible disposal of its interests in Mary Kathleen Uranium Ltd.

Nuclear Exchange Corporation (Nuexco) quotations of monthly exchange values per pound of U_3O_8 as reported in *American Metal Market* opened the year at US$42.40 (last changed on 15/11/79), but decreased on 4 February 1980 to US$40.00/lb and on 3 March to US$38.00/lb, at which the price remained at 31 March.

D. J. PERKIN

Metals

ALUMINIUM

Production of aluminium during the March quarter of 1980 was 71 538 tonnes, compared with 65 131 tonnes in the corresponding quarter of 1979. With exports of 6612 tonnes and imports of 750 tonnes, apparent consumption of primary aluminium during the March quarter was 65 676 tonnes.

Consumption statistics published by the Aluminium Development Council of Australia Ltd showed that estimated consumption of aluminium in Australia during 1979 was 245 697 tonnes, 17.2 percent higher than in 1978 (209 600 tonnes). The ADCA's estimate takes into account changes in some stocks (down 9719 tonnes in 1979) and estimated consumption of secondary metal, which increased from 24 360 tonnes in 1978 to 30 500 tonnes in 1979. Per-capita consumption rose to 17 kg in 1979, from 14.7 kg in the previous year.

The Australian price for primary aluminium ingot (99.5% Al) was increased by each of the three domestic producers from $1.244/kg to $1.385/kg (f.i.s. main cities) from the start of trading in January 1980. A further increase to $1.545/kg was announced in early March by Alcoa and Comalco and later by Alcan, effective from 1 April 1980. Because of continuing tight supplies on major world markets, free-market prices had been consistently higher than the Canadian export quotation, with which the Australian price had been aligned; this contributed to a very tight supply-demand situation in Australia throughout 1979 by encouraging export of secondary and scrap forms of metal which would otherwise be available to the domestic market. According to the local industry, imports to meet increased demand had to be obtained at prices in excess of current Australian domestic prices. The newly announced increases were to enable companies to recover cost increases and improve profitability to support planned new investment.

The Canadian export quotation for 99.5% ingot was increased from US$1525 to US$1750/tonne c.i.f. from 27 March 1980, so that as it stood from 1 April the Australian price was still some US$75–80 below the published international price.

Alcoa of Australia Ltd announced on 22 March that it had begun a feasibility study for a smelter in Western Australia which, including the cost of the necessary power generation plant, is likely to involve a minimum expenditure of about $350 million, and ultimately around $900 million. The company is considering a minimum economic capacity of 100 000 tonnes/year of aluminium, which could be increased to 200 000–240 000 tonnes/year. The project will depend on the availability and cost of sufficient power generating capacity, which requirement would probably be met by expansion of the coal-fired Muja power station on the Collie coalfield. Alcoa favours the Pinjarra-Wagerup–Bunbury district for location of the smelter.

Late in March, Alcoa announced also that it had agreed to supply 40 000 tonnes/year of aluminium from its Portland, Vic. smelter, now under construction, to Mitsubishi Light Metal Industries of Japan. The metal is to be supplied under contract initially over a ten-year period commencing in 1983.

Comalco Ltd will spend $28.8 million to upgrade its Bell Bay smelter in Tasmania, which will result in a 5000 tonnes/year increase in capacity to 117 000 tonnes/year by the end of 1982. The increase will result from extending the fourth potline commissioned in 1977; the original potline which was commissioned in 1955 will be shut down progressively.

According to an announcement by Comalco on 18 March, the company would cease operations immediately at its canmaking plant in Melbourne, following sale of the plant to J. Gadsden Australia Ltd. Comalco will continue to operate canmaking plant in Sydney until 30 June 1981, after which the plant will be operated by the joint purchaser of Comalco's canmaking facilities, Containers Ltd, probably at a different location. According to the Comalco announcement, the company's strategy is to concentrate its investment funds in expansion of primary metal production capacity, rather than in further development of canmaking potential, which will also require substantial investment over the next few years.

A. GOURLAY

COPPER

Mine production for the three months to March 1980 was 48 457 tonnes, 9 percent below production in the previous quarter. This was mainly accounted for by lower production at Mount Isa (down 13 percent) as well as at Mount Morgan, Tennant Creek, Mount Lyell, and Woodlawn. Increases were recorded at Cobar, Burra and Mount Gunson.

Total blister production (primary and secondary, including anode production) was 41 169 tonnes, 3 percent more than in the previous quarter but 8 percent less than in the March 1979 quarter.

Refined copper output (primary and secondary, excluding toll-charge scrap) was 39 175 tonnes, about the same as in the previous quarter.

Early in January, Western Mining Corporation Ltd announced that it was continuing to intersect good grades of copper, lead, zinc, and silver at its prospects in the Benambra district in eastern Victoria. Assays of three drill holes in the Wilga prospect yielded values in the same range as those found in previous holes. At the Currawong prospect, 4 km northeast of the Wilga deposit, hole 25 intersected a second lens of mineralisation about 200 m south of that intersected in earlier holes. Drill core from this second lens assayed 1.5% Cu, 0.6% Pb, 5.3% Zn, and 40.8 g/t Au over a 28.4-m interval.

Further drilling by WMC at its Olympic Dam prospect on Roxby Downs Station, SA, extended the limits of known mineralisation. A hole about 1 km from previously drilled areas intersected 306 m of 1.0% Cu and 0.35 lb/tonne U_3O_8 between 343 m and 649 m.

In February, final government approval was given for the development of the Teutonic Bore copper-zinc deposit in Western Australia. The mine is expected to come on stream in mid-1981, producing about 300 000 tonnes of ore/year.

In February also Conzinc Riotinto of Australia Ltd announced plans to increase copper production at the CSA mine at Cobar by 50 percent once expansion is completed. This is expected to take three years and will increase ore production to more than 750 000 tonnes/year. The possibility of expansion was enhanced by the discovery of a broad band of high-grade copper mineralisation on the QTS prospect near the main CSA mine shafts.

Immediately before the New Year, trading in the copper section of the London Metal Exchange (LME) was fairly quiet. However, despite fears of a major recession, trading surged ahead in January following military activity in Afghanistan. The price of copper wirebar was £1127/tonne on 4 January and had reached a high of £1300/tonne by 31 January. A reversal took place in February and March with prices falling back to £1236/tonne on 29 February and to £940/tonne on 31 March. The fall was in response to strengthening fears of a worldwide recession which resulted in reduced consumer demand and a build-up of LME warehouse stocks.

The US producer price followed similar trends, rising from an initial price of 112.6 US cents/lb at the beginning of January to a high of 143.4-146.2 US cents/lb in mid-February. By March 21 it had fallen below US$1/lb and it closed the quarter at 90.8–102.2 US cents/lb.

The Mount Isa Mines copper price opened for the year at $2000/tonne. It rose to a high of $2800/tonne on 21 February and fell back to $2080/tonne on 31 March.

N. KNIGHT

GOLD

Mine production of gold during the first quarter of 1980 is estimated by BMR to have been 4600 kg.

ABS figures indicate that exports of refined gold were 1576 kg, valued at $29.2 million.

Hectic trading in early January pushed the price of gold to record levels on world markets. The change in the US Treasury's gold sales practice announced in October, 1979 was a significant factor in the price boom. After opening the year at US$599.00/oz, the London Bullion Market price leapt to US$765.00 on 16 January. Two days later the price was US$825.00/oz, an increase of nearly US$100 over the previous day's quote, and on 21 January it reached an all-time high of US$843.00/oz. Nevertheless, under pressure of profit-taking and reaction to the US announcement of stringent economic measures, the price fell in late January and fluctuated below about US$700.00/oz to reach US$474.00/oz on 18 March. After a brief rally, the price closed the quarter at US$503.25/oz.

The Gold Producers' Association price to Australian buyers opened the year at $484.80/oz and, following the London price trend, jumped to $752.50/oz on 21 January. After fluctuating between about $650.00/oz and $590.00/oz, the GPA price decreased by a series of steep falls and minor recoveries to $567.77 on 27 February. From this date, the GPA ceased publishing its official daily price, as the Association had earlier changed its sales practice such that from mid-January all gold was to be sold by weekly auction. Although the auction prices are confidential, the Association continues to provide, on a daily basis, the Australian equivalent of the Hong Kong market opening quote. The price of gold published daily by the Perth Mint, which is also based on the Hong Kong price, was $574.82 on 27 February and rose to $588.13/oz on 5 March. Subsequent sharp falls followed by slight recoveries resulted in a net decrease to $450.63 on the last day of the quarter.

During the quarter, Homestake Gold Ltd, partner in Kalgoorlie Mining Associates, announced a further step-up in the redevelopment of KMA's Golden Mile leases. Production is planned to begin in 1981 and reach a rate of 2830 kg/year of gold by 1983. Whim Creek Consolidated NL announced plans to install additional equipment to increase recovery rates at its recently reopened open-cut mine and leaching operation at Haveluck, near Meekatharra.

In Victoria, Wattle Gully Gold Mines NL began construction of a new crushing mill at its Chewton underground mine; operation of the mill will increase throughput capacity to 50 000tonnes/year of ore.

CRA Exploration Ltd signed a letter of understanding with Kitchener Mining NL to complete a feasibility study of the promising Bamboo Creek leases, near Marble Bar. The joint venture will be investigating the possible use of photometric ore sorters in processing the ore.

Consolidated Resources NL (formerly Uranium Consolidated NL) announced plans to reopen the Comet mine near Cue, WA, where reserves are stated as 109 700 tonnes at an average grade of 14.7 g/t Au. Production was scheduled to begin in the second half of 1980.

In other exploration projects, WMC announced the intersection of significant gold mineralisation at three prospects, the Hunt nickel mine at Kambalda, the Lancefield mine at Windarra, and at Stawell, Victoria.

In Queensland, Placer Development Ltd reported reserves of about 25 Mt at an average grade of 2.34 g/t Au at its Kidston prospect and Samantha Exploration NL reported encouraging intersections from prospects at Mount Rawdon and Coalstoun in the Bundaberg region, and at Bimurra in the Bowen Mining District.

The International Monetary Fund continued its sales of 444 000 oz of gold on the first Wednesday of each month. Average prices realised at the sales were US$562.85/oz in January, US$712.12/oz in February, and US$641.23/oz in March. The March sale raised $US265 million, bringing the total for the series of auctions to US$4240 million.

C. MOCK

IRON ORE

Production and exports of iron ore were adversely affected by cyclones and industrial disputes during the March quarter of 1980.

Price increases negotiated for lump and fines products went some way towards offsetting rising production costs and the reduction in earnings/tonne of ore shipped which has occurred in recent years. However, the reduced competitive position of iron ore pellets was highlighted with announcements concerning closure of two major pellet plants in Western Australia.

Production of iron ore, at 21 Mt, was unchanged compared with the same period of 1979 but was more than 17 percent below the preceding, December 1979, quarter. A 15-percent increase in production at the Mount Tom Price and Paraburdoo mines to 10.5 Mt compared with the March quarter of 1979 was offset by a 28-percent decrease in output at Mount Whaleback to 5.7 Mt. Cyclone damage adversely affected production, particularly at Goldsworthy, Shay Gap, and Mount Whaleback. Reconstruction at Goldsworthy and rail line repairs between Goldsworthy and Port Hedland are being carried out at an estimated cost of $7 million.

Exports of iron ore and iron ore pellets decreased by 8 percent to 17.7 Mt. Increased shipments to Japan (up 3 percent to 13.0 Mt) only partly balanced reduced exports to Europe (down 20 percent to 2.3 Mt) and to China—excluding Taiwan Province (down 61 percent to 0.9 Mt). Exports during the March quarter of 1980 were 22 percent below those in the preceding December 1979 quarter.

The Dampier pellet plant of Hamersley Iron Pty Ltd (production capacity 3 Mt/year) was closed at the end of February. Hamersley had announced early in 1979 that it would close the plant as its 10-year contract for supply of pellets to Japanese steel mills had expired and the company was unable to renew the contract or find other markets. Closure of the pellet plant was delayed to enable deliveries disrupted by industrial disputes to be fulfilled. Demand for pellets has declined as their cost of production has increased and because steelmakers in many countries are making greater use in their blast furnaces of sinter produced from iron ore fines. Hamersley negotiated a contract for the sale of fines to Japanese mills to replace the pellet contract.

Cliffs Robe River Iron Associates announced in March that it would close its pellet plant at Cape Lambert (production capacity 5 Mt/year) for at least a year. Pellet production at Cape Lambert was stated to be uneconomic at current prices. Cliffs has reportedly negotiated contracts for the sale of iron ore fines to Japanese steel mills to replace the sale of pellets.

Australian iron ore exporters and Japanese steelmakers concluded negotiations during the quarter on prices of iron ore for delivery from April 1980. Prices of both lump and fines for delivery by major producers were increased by an average of about 20 percent above prices for 1979. Japanese reports indicate prices in some contracts have been raised to around US$17.40/dry tonne f.o.b. for fines and US$20.00 for lump ore. Increased prices of iron ore for delivery to European steelmakers in 1980 were also reported, the prices of fines being fixed at between 20 and 30 percent above those in 1979.

Further discussions were held between Japanese steel mills and Pilbara iron ore developers over proposals for mining and exporting iron ore from deposits at Marandoo, 40 km south of Wittenoom, and at Area C, midway between Newman and Tom Price. In 1979 the Goldsworthy Partners (Consolidated Gold Fields Ltd, Utah Development Company, and MIM Holdings Ltd) proposed the development of deposits at Area C at an initial mine production rate of 10 Mt/year and later 32 Mt/year. Cost of development to the first stage of production was estimated in July 1979 to be around $A440 million. A group consisting of Texasgulf Inc., Hancock Prospecting Pty Ltd, and Wright Prospecting Pty Ltd, plan to develop the Marandoo deposits. In 1976 the group proposed a project which would produce and export 18 Mt of ore/year within three years of initial production. The cost of the proposals at the time was estimated at US$1000 million.

R. PRATT

IRON AND STEEL

Domestic demand for steel products remained firm in the March quarter of 1980. Iron and steel output was more than that in the corresponding period of 1979.

Production of pig iron by The Broken Hill Pty Co. Ltd increased by 1 percent to 1.87 Mt. Coke shortages at Port Kembla caused by industrial disruptions in the coal mining industry resulted in the banking of two of the four producing blast furnaces. Operating difficulties were experienced at Whyalla in February. Production in the March 1979 quarter had also been affected by industrial disputes and technical difficulties.

Raw steel output by BHP and its subsidiaries increased by 8 percent to 2.05 Mt, despite industrial disputes and iron shortages. Production of steel increased at all centres. Output increased at Newcastle by 25 percent to 580 000 tonnes, at Whyalla by 12 percent to

323 000 tonnes, and at Port Kembla by 0.1 percent to 1 147 000 tonnes.

Production of marketable steel products by BHP decreased by 6 percent to 1.61 Mt. Domestic despatches of steel products increased by 12 percent to 1.37 Mt, but exports fell by 19 percent to 282 000 tonnes.

Exports of pig iron, which are mainly from Kwinana, increased by 10 percent in the March quarter to 153 000 tonnes valued at $19 341 000. China (97 000 tonnes), Taiwan Province (11 000 tonnes), and Japan (9 000 tonnes) were the main markets.

The Acting Minister for Special Trade Representations announced in February that Australia and the Commission of European Communities had agreed on price and access arrangements for certain Australian steel exports to the Community in 1980. As with the 1979 Arrangement, Australia will limit its exports to a total of 450 000 tonnes. Within this limit Australia may export up to 350 000 tonnes of finished steel products. In return for the Australian agreement to limit the quantity of exports, the Commission will continue to allow a penetration margin on price for Australian steel (6% for general steel and 4% for specialty steel) below the delivered price of European steel. The Commission has removed a number of special alloy steels from the pricing provisions and quota limits. In addition European temporary imports for hire-rolling will no longer be subject to the pricing provisions and quotas of the Arrangement, provided that ownership of the imported products remains unchanged.

BHP announced in March that a new coke oven battery is to be reconstructed at the Port Kembla steelworks to replace the plant's oldest battery. The project, scheduled for completion at the end of 1982, will cost $147 million and comprise 50 ovens with a production capacity of 625 000 tonnes/year of coke.

During the period European investors held talks with the Queensland government on the possibility of establishing a steel mill at Gladstone. The consortium is reportedly interested in constructing a steel mill with a production capacity of 800 000 tonnes/year, mainly for rod and wire products.

Steel output by members of the International Iron & Steel Institute in the March quarter of 1980 decreased by 1 percent to 119.3 Mt. Decreased production in EEC (down 5 percent to 32.7 Mt) and USA (down 5 percent to 29.4 Mt) was offset by increased output in Japan (up 5 percent to 28.5 Mt) and by other member countries (up 4 percent to 28.8 Mt). In Japan demand for steel was strong from most industries, especially the automobile, shipbuilding, and machinery industries. Reduced production in the EEC mainly reflected a major steel industry strike in the UK during January and February. Production in USA, despite the fall compared with the March 1979 quarter, was more than in the December quarter of 1979.

R. PRATT

LEAD AND ZINC

Australian mine production of lead in lead and mixed lead concentrates in the first quarter of 1980 totalled 90 515 tonnes, 9 percent below output in the corresponding period in 1979. Mine production of zinc and mixed zinc concentrates decreased by 7 percent to 103 295 tonnes. The decreases were caused mainly by a drop in the output of lead from Mount Isa and decreased production of both lead and zinc from the Rosebery and Hercules mines in Tasmania. Production from the West Coast mines was affected by a routine mill maintenance shut-down before Easter and by an industrial stoppage.

Production of lead in lead bullion in the first quarter of 1980 totalled 39 103 tonnes, 5 percent less than output for the same quarter in 1979. Decreases in production at Mount Isa more than offset increased production at Cockle Creek.

At Port Pirie, Broken Hill Associated Smelters Pty Ltd, the only domestic producer of primary refined lead, operated at slightly less than full capacity throughout the quarter. Australian production of refined lead, including production of secondary refined lead from all other producers, totalled 57 862 tonnes, 10 percent below the coresponding period in 1979.

All zinc smelters and refineries operated at about 85–90 percent of capacity throughout the quarter. Output of refined zinc totalled 71 628 tonnes, only slightly less than for the same quarter in 1979, but much less than the record totals achieved in the second half of 1979.

Demand for lead eased during the quarter, prices falling from the record levels of 1979. The London Metal Exchange (LME) price for lead opened for the year at £540/tonne but at the end of January it had fallen to below £450/tonne. The fall was prompted by a slump in the US automobile industry and speculations about the implications of the embargo on grain exports to USSR; large purchases by USSR had been one of the prime movers of the price rises in 1979. During February and early March there was a slight recovery, initiated by a prolonged strike at the

Britannia Lead refinery (the only lead refinery in UK) which had caused a temporary shortage. However, by the end of March news of the imminent settlement of the strike caused a sharp drop in prices which closed for the quarter at around £456/tonne. The US producers' price fell progressively throughout the quarter from 55 US cents/lb on 3 January to 50–52 US cents/lb on 7 February and finally to 48 US cents/lb on 31 March. In Australia the domestic price remained around $1050/tonne throughout the quarter.

There was a general firming in the demand for zinc during the quarter, with a progressive fall in producer stocks and a firming of prices. The European producer price, at which most of the world's zinc is traded, rose from US$780/tonne, where it had been for some months, to US$825/tonne. The US producers' price rose from its opening level of 37.5 US cents/lb to 39.5 US cents/lb at the end of February, where it remained for the rest of the quarter.

In Australia the domestic price of zinc, quoted by EZ Industries, rose from $714 tonne to $745/tonne on February 21.

In February, EZ Industries announced that it would proceed with the development of its Elura lead-zinc-silver deposit near Cobar, NSW. The whole project, including underground mine development and infrastructure, will cost around $160 million and is expected to be completed by December 1982.

Sulphide Corporation began studies to evaluate proposals for an electrolytic refinery to supplement the production capacity of the existing imperial smelting furnace at Cockle Creek, NSW. The studies are intended to determine the economics of such a development which, if feasible, would be unlikely to go ahead until after the mid-1980s.

In March, Broken Hill Associated Smelters Pty Ltd announced that work on upgrading its Port Pirie lead smelter was nearing completion and the plant, which will be capable of upgrading 20 tonnes of lead bullion/hour, should come fully on stream in June of this year. The new plant will enable BHAS to maintain output of 99.99% lead as the content of bismuth in the concentrates from Broken Hill increases, and will also enable the company to buy more material from a much wider source.

N. KNIGHT

NICKEL

Mine production of nickel decreased in the March quarter of 1980 compared with the same period of 1979 but the value of nickel exports increased substantially. Increased prices during the quarter mainly reflected rising production costs, particularly for energy.

Australian mine production of nickel decreased by 10 percent to 16 620 tonnes. A substantial increase in production of nickel in concentrates at Agnew, WA, by Western Selcast Pty Ltd and Mount Isa Mines Ltd was not sufficient to offset reduced output of nickel in ore at Greenvale, Qld (Metals Exploration Queensland Pty Ltd and Freeport Queensland Nickel Inc.) and in concentrates from the Kambalda, WA district, mainly by Western Mining Corporation Ltd. Production at the Spargoville mine by Selcast Exploration Ltd ceased with its closure in January. Though there are additional deposits in the vicinity of the mine, their development is not justified at the moment. The Spargoville mine was opened in 1975. In recent times Spargoville ore has been treated in the concentrator at Kambalda by WMC under a toll arrangement.

The value of nickel exports almost doubled to $88.9 million in the March quarter 1980 because of improved demand and, since early 1979, higher prices; the value of nickel metal in powder and unwrought form increased from $19.6 million to $27.8 million and the value of nickel matte and speiss, including nickel oxide sinter, rose from $25.4 million to $61.6 million. However, the total value of nickel exports was 20 percent less than in the December quarter of 1979.

Nickel supply and demand remained in close balance during the March quarter. However, nickel prices increased towards the end of the period, mainly in response to increased production costs. The producer price of cathode nickel increased from US3.20–3.25/lb to US$3.45–3.50/lb on 28 February.

Metals Exploration announced in February that the Queensland Cabinet had approved a plan to provide finance for a project to reduce fuel oil consumption at the Yabulu nickel refinery. The project, estimated to cost $45 million and take 2½ years to complete, involves the installation of a new coal-fired boiler, conversion of ore dryers to coal firing, and installation of coal-handling facilities. The project is expected to reduce fuel oil consumption by about half. A decision to proceed with the project is subject to formal approval of the financing plan by certain lenders and completion of negotiations over coal supplies and rail freight.

R. PRATT

TIN

Mine production of tin-in-concentrates in the March 1980 quarter, although affected by an industrial dispute, was 2519 tonnes, 10 percent more than in the corresponding quarter of 1979, when production also was affected by an industrial dispute.

Production of primary refined tin, 985 tonnes, was 19 percent less than in the corresponding 1979 quarter. In addition, over 100 tonnes of secondary tin was produced from tinplate scrap and tinplating wastes.

Consumption of primary refined tin, at 715 tonnes, was 21 percent less than in the March 1979 quarter because of greatly reduced consumption in tinplate and solder.

Exports of tin-in-concentrates increased by 38 percent on the previous corresponding quarter to 1984 tonnes, Malaysia being the main destination. Exports of refined tin, 401 tonnes, were 78 percent higher. The main destination was UK.

Refined tin imports in the March 1980 quarter were 33 tonnes, all from Malaysia. The only imports in 1979 were 5 tonnes in November.

Aberfoyle Limited began construction of a pilot-scale matte fuming plant at the Kalgoorlie nickel smelter of Western Mining Corporation Ltd. Trials will include treatment of a 4000-tonne sample of ore from the Queen Hill deposit, near Zeehan. Drilling has established about 1 000 000 tonnes of inferred mineralisation grading about 1% Sn in this deposit, but the material is fine-grained and mineralogically complex and tin recovery by normal methods is poor.

Renison Limited announced that trials on treatment of low-grade concentrates by tin fuming were scheduled to be carried out in Europe in March, using a 100-tonne sample.

The joint venture group testing the Grampians deposit, near Emmaville, announced that drilling had established the presence of 17 Mt of mineralisation averaging 0.17% Sn, 0.05% Cu, and 4.4 g/t Ag. The size and grades were expected to alter as drilling continued. Interests in the joint venture are Newmont Pty Ltd and ICI Australia Ltd (each 38.75%), Endeavour Resources Ltd (15%), and Pelsart Resources NL (7.5%, reducing to a carried interest of 5%).

Another Newmont/ICI Australia joint venture (earning 40% and 20% respectively, with Great Northern Mining Corporation NL and Oakbridge Limited together holding 40%) announced that exploration in the Baal Gammon area near Herberton, North Queensland, had outlined resources of 4.5 Mt grading 1.3% Cu, 43 g/t Ag, and 0.3% Sn and, in another body, 7 Mt of 0.25% Sn.

The Mount Bischoff joint venture (in which Metals Exploration Ltd has an interest of 85%, Comstaff Pty Ltd and Preussag Australia Pty Ltd together have 15%, and CRA is earning 25%), announced that drilling adjacent to the old Mount Bischoff workings had revealed significant intersections of tin mineralisation. The mineralisation occurs in a quartz porphyry dyke and as massive sulphides in dolomite.

The International Tin Council adjusted its buffer stock price ranges on 13 March to: floor M$1650/pikul (1 pikul = 60.48 kg); middle sector M$1815 to M$1980; ceiling M$2145. The previous points, set on 20 July 1979, were M$1500, M$1650, M$1800, and M$1950.

The Penang price for tin increased rather irregularly from about M$2100/pikul at the beginning of the year to about M$2230 in late February, when it began to rise rapidly. Consumers, especially in USA, had kept stocks at low levels, believing that releases from the US stockpile were imminent. However, as opinion grew that no tin would be available from that source for some time, consumers began buying to meet their future requirements. This culminated in a surge of demand on major markets after the US announcement, at the beginning of March, that the first offer of tin from its stockpile would not be until 1 July. Prices rose sharply, the Penang price reaching a new record of M$2471/pikul on 6 March; this price then fell, rapidly at first, to close the quarter at M$2265. Monthly averages for the Penang price were: January M$2143; February M$2218; March M$2340.

The Australian price for primary refined tin, which is based on the Penang price, rose from $15 247/tonne at the beginning of the year to a record $18 131 on 7 March, then fell back to fluctuate below $17 000 for the second half of the month.

The LME cash price for standard-grade tin, which was influenced also by availability of stocks in LME warehouses, rose from £7560/tonne to £8000 in mid-January but then fell to below £7400 until mid-February. It rose to a new record of £8455/tonne on 6 March, then fell below £8000 on 11 March, to remain below this level for the remainder of the month.

I. R. McLEOD

TUNGSTEN

Australian production of tungstic oxide in concentrates (WO_3) was 83 736 metric-tonne units (mtu) in the March quarter of 1980, about 2 percent less than in the corresponding period of 1979.

Peko-Wallsend, Australia's largest tungsten producer and one of the world's top four producers, increased output by about 10 percent compared with the 1979 March quarter; production came from its mine and artificial scheelite plant on King Island, Tasmania.

Production from the Queensland Wolfram Pty Ltd mine at Mount Carbine in northern Queensland was about 30 percent less than in the corresponding period in 1979. The only major development during the quarter was the construction of a very large tailings disposal area which involved building a 1125-megalitre dam at a cost of $250 000.

Production at the Kara scheelite mine in Tasmania increased compared with production in the previous quarter. The mine is currently the subject of a feasibility study being undertaken by the Canadian-owned McIntyre Mines (Australia) Pty Ltd. The company, which has outlined reserves of 1.14 Mt of 0.73% WO_3, is carrying out the feasibility study to determine whether development costs for a modern high-recovery treatment mill can be reduced.

Central Tasman Tungsten Ltd completed the construction of a small underground wolframite mine at Oakleigh Creek, central Tasmania, during the quarter. Commissioning trials began at the mine in January but were seriously affected by a defect in the secondary crusher. However, the crusher was expected to be operational in time to permit commissioning trials to be completed and regular production to start some time in May. Total identified ore reserves were given by the company as 148 200 tonnes of 1.09% WO_3.

Australis Mining NL installed a mobile screening plant at their tin-scheelite prospect at Mount Deans, WA, during the quarter. They also began work on the design and construction of a screening and wet extraction plant capable of treating 300 tonnes/day.

In USA, the General Services Administration (GSA) held its monthly auctions of stockpiled material. Prices realised at the auctions were at or slightly below equivalent LMB prices at the time. Despite lifting on 1 January 1980 of the duty charged on sales for domestic use, offerings were still undersubscribed, allowing the sale of greater amounts of ore for export.

The LMB quotation for standard-grade wolframite, at the beginning of the quarter ranged from US$131.00/mtu to US$135.00/mtu. By the middle of the quarter it had risen to between US$141.00 and US$147.00/mtu, and it closed the quarter at US$145.00-149.00/mtu.

The International Tungsten Indicator rose from around US$134.00/mtu in the first half of January to US$141.00/mtu in the second half of March.

Price rises are believed to be the result of several factors—a natural rebounding from a fairly depressed market in late 1979, a weakening of the US dollar and the international political situation with its attendant moves towards rearmament.

During the quarter the UNCTAD tungsten committee once again made an unsuccessful attempt to reach agreement on a tungsten price stabilisation scheme. Despite this failure the committee agreed to meet for further discussions later in the year.

N. KNIGHT

Non-metals

PHOSPHATE

With Queensland Phosphate Limited's (QPL) operation on care-and-maintenance and most of the company's stockpiles sold, Australian production of phosphate fertiliser is again based solely on imported rock. Nauru and Christmas Island continue to provide the bulk of requirements but since the depletion last year of the Ocean Island deposits, Florida, USA has also become an important source of supply. Imports of phosphate rock in the quarter ended 31 March 1980 of 708 108 tonnes (valued f.o.b. at $22.22 million), of which one-quarter was from Florida, were 31 percent higher than in the corresponding quarter of the previous year.

Production of phosphatic fertiliser in the March quarter—1.21 Mt of single superphosphate equivalent (22% P_2O_5)—was 14 percent greater than in the corresponding quarter of 1979.

The British Phosphate Commissioners (BPC) reported that consumption of imported rock in sales of manufactured fertilisers in the March 1980 quarter was 1.03 Mt, 50 percent more than for the corresponding quarter of 1979.

Listed export prices of Florida rock, f.o.b. Tampa or Jacksonville, for 1980 purchases are 17–19 percent higher than for the previous year. The increase, about US$6–7 tonne, brings the cost of 68–66% TPL rock to US$39/tonne. However, the effective increase to purchasers is about US$10/tonne because the degree to which 1979 list prices were discounted is likely to be reduced in 1980.

A. DRIESSEN

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Deep-sea manganese nodules in the Australian region — a review

H. A. Jones
(Geological Branch, BMR)

Abstract

Deep-sea manganese nodules contain significant amounts of Ni, Cu, and Co, in addition to Mn, and have been actively investigated as potential ores of these metals over the past 15 years. They are found on the sea-floor throughout the world's oceans in water depths of 4 to 6 km where rates of sediment accumulation are low. Variations in nodule abundance and composition are influenced by water depth, bottom topography, type of underlying sediment, and by other factors, but many aspects of their growth mechanism are still poorly understood.

Nodules with the highest content of economically important metals occur in the north-equatorial zone of the eastern Pacific; combined Ni+Cu values in that area commonly average about 2.5% and Mn about 30%. These figures are currently accepted as the grades necessary for a first-generation mine site. In the Australian region a manganese nodule field covering at least 1 million km^2 is known to exist southwest of the continent. Nodules from this area are relatively enriched in Ni (up to 1.15%), but are low in Cu and Mn, and overall the grades are substantially lower than those of the eastern Pacific deposits.

Elsewhere in the Australian region, the south-equatorial belt of the eastern Indian Ocean may have some potential for higher-grade nodules but as yet this area is poorly explored.

Possibly harmful effects of deep-sea mining upon the marine environment may result from disturbance of bottom sediment, but published comments on this problem are largely speculative. Legal aspects of sea-bed mining in international waters have been debated by the United Nations in the Law of the Sea Conference for several years and although considerable progress has been made, final agreement has not been reached. Attempts have been made to permit, under domestic legislation, the further development of seabed mining technology prior to the passage of a Law of the Sea Treaty.

Introduction

A comprehensive bibliography of marine manganese nodules published a few years ago (Glasby & Hubred, 1976) contains 2077 entries; the overwhelming majority of these have appeared since the mid-1960s, the time when it first became widely recognised that deep-sea manganese nodules were potentially exploitable ores of nickel (Ni), copper (Cu), cobalt (Co), and manganese (Mn). The bibliography referred to contains entries up to December, 1973; since that time the flow of articles in scientific and technical journals and the popular press has continued at a high rate because of numerous active research programs, many of them sponsored by the office for the International Decade of Ocean Exploration, involvement of powerful international mining consortia, and continued public interest in this unusual mineral resource.

Scientific interest centres on the mode of formation of nodules, on their complex mineralogy and structure, and on the reasons for the variations in their composition and distribution density. The difficulties associated with extraction of metals from the ores, the daunting engineering problems involved in the development of a viable mining technique, possible environmental hazards resulting from mining, and questions of ownership under international law, all continue to be debated and to attract wide public interest.

Information on manganese nodule fields in the Australian region, although still scanty, has been added to significantly in recent years as the result of work by BMR and Monash

University scientists, using mainly Royal Australian Navy ships. The purpose of this paper is to review the data now available on nodules in this area and to put them in the wider perspective of manganese nodules worldwide.

Origin and composition

Iron and manganese oxides are found on the sea-floor as concretionary bodies ranging from sand-size grains to extensive encrustations and massive slabs; in the deep ocean they occur most commonly as discrete nodules a few centimetres in diameter, black in colour and somewhat earthy and friable, usually more or less globular in shape, and with concentric internal structure and botryoidal surface texture. Sections through nodules sometimes reveal a nucleus of foreign material, which may be a mineral or organic fragment, and the internal growth rings may record several stages of growth, fracturing, and regrowth. Growth rates are believed to be extremely low (a few millimetres/million years), although some authors have cast doubt on the reliability of the techniques employed in the determinations. In composition they consist of very finely divided and intimately mixed poorly-crystalline iron and manganese oxides, minor quantities of other metals, and very variable amounts of organic and mineral detritus and their alteration products.

There is an extensive literature dealing with the origin of manganese nodules, and it is not intended to review the subject in detail here. They are clearly concretionary bodies grown in situ, and in the open ocean are generally restricted to areas of very slow sedimentation in deep waters below the carbonate compensation depth (i.e., the depth below which the rate of calcium carbonate solution exceeds the rate of its deposition). However, the original source of the contained metals, the roles of volcanism and interstitial waters, the factors controlling inorganic precipitation and the part played by bacteria, and the effect of variations in type and abundance of nucleating agents are all questions which have not been satisfactorily resolved. It seems clear that no single uniform group of processes is involved in nodule development, and this is likely to be the cause of the considerable variation in chemical and physical properties which they exhibit.

One particularly puzzling aspect of manganese nodules concerns the contrast between their growth rates and the overall sedimentation rates on the surrounding sea floor. How is it that they lie exposed on the sea floor and are not buried by sediment, when it appears that the rate of deposition of sediment very greatly exceeds the rate of accretion of the nodules themselves? Growth rates of nodules estimated from radiometric dating (Ku, 1977) and from the volcanic glass hydration rind technique (Morgenstein, 1973) are in the range 1-10 mm/million years, whereas the rate of accumulation of sediment in these environments is measured in millimetres/thousand years. Both estimates may be in error, but not by orders of magnitude. Nodules do occur within the sedimentary section below the sea floor, and have been recorded from depths of over 100 m in deep-sea drill cores. However, much the highest concentration of nodules is found at the sediment surface on the present day sea-floor, which has been estimated to carry as many nodules as are present in the underlying 6-7 m of sediment (Horn & others, 1972). Some mechanism must therefore exist to retain the nodules at the sediment surface; it would seem that the activity of burrowing or grazing organisms provides the most likely explanation, although no substantive evidence for this exists, and other causes, for example current activity and earth tremors, have been suggested (see reviews by Glasby & Read, 1976 and Menard, 1976).

The chemical composition of manganese nodules varies on a regional scale, with average metal values and ratios between metals showing significant differences between oceans

TABLE 1. AVERAGE COMPOSITION OF DEEP-SEA NODULES IN WORLD OCEANS (Wt %)

	PACIFIC (a)			*INDIAN (a)*		*ATLANTIC (b)*	
	NE	*SE*	*W*	*W*	*E*	*N*	*S*
Mn	22.33	19.81	16.87	13.56	15.83	13.6	11.7
Fe	9.44	10.20	13.30	15.75	11.31	17.0	13.9
Ni	1.08	0.96	0.56	0.32	0.51	0.32	0.43
Cu	0.63	0.31	0.39	0.10	0.33	0.19	0.09
Co	0.19	0.16	0.40	0.36	0.15	0.35	0.12

(a) Data from Cronan (1972): boundaries between east and west sectors are at about 160°W in the Pacific and 70°E in the Indian Ocean.
(b) Data from Mero (1965).

and between sectors of an ocean (Table 1). Composition also varies on a local scale over distances of a few kilometres, on a micro-scale over distances of metres, and within single nodules. Much of this variation cannot be easily explained on current knowledge, but an idea of the amount of variation which occurs and of its possible causes is essential to an appreciation of the difficulties inherent in resource evaluation.

The regional variations in composition display some consistency in the Pacific and Indian Oceans, where in each case the eastern sectors tend to show higher Mn:Fe ratios and higher Ni and Cu values (Cronan, 1977; Calvert, 1978). No obvious regional trends occur in the Atlantic. The positive correlation of Ni and Cu with Mn, and of Co with Fe, appears to have very wide application, as does the negative correlation of Co with water depth. The regional trends referred to are obscured by local influences such as water depth and the nature of the substrate. Thus in the vicinity of the mid-ocean ridges nodules tend to be enriched in Fe and depleted in Ni and Cu.

The relationship between nodule composition and the underlying sediment has received much attention in the literature since it was found that the nodules highly enriched with Ni and Cu in the northeast equatorial Pacific are largely confined to the areas of siliceous ooze. Ni-plus-Cu values in these regions average about 2.5%, which is twice that of nodules from the red clay areas of the eastern Pacific. Siliceous oozes occur below the carbonate compensation depth in areas of high biological productivity in the surface waters, and it has been suggested that the dissolution of abundant organic remains at depth provides the source of these metals, and that the high porosity of the siliceous ooze allows ready migration of metals to the sediment surface where they are incorporated in the nodules (Greenslate & others, 1973).

Substantial chemical variations over very small areas are common. Some reports may reflect shortcomings in analytical procedures or definition, for example analyses of whole nodules can be expected to differ significantly from analyses of outer layers and cores of nodules; in addition, differences in composition between the upper surface of a nodule and that part in contact with the sediment have been noted. Nevertheless, real differences in bulk composition do occur. Thus Glasby (1970) records analyses of 40 samples from a single dredge haul which range in Ni+Cu values between 0.39 and 1.38%, and Frazer (1979) quotes Ni+Cu values of nodules from a single box core ranging from 1.97 to 2.91%. These differences point to the uncertainties which must attach to interpretations based on analyses of single specimens.

There is evidence to suggest that there is an inverse relationship between nodule concentration and content of Ni and Cu. This may be partly because denser concentrations of nodules tend to occur on the tops and flanks of abyssal hills, where the shallower water depths and greater abundance of volcanic nuclei result in relative enrichment in Fe and Co and depletion in Mn, Ni, and Cu. It may also be partly due to the interesting relationship noted by Menard (1976) between the abundance of nodules, their composition, and the age of the underlying oceanic crust. Menard found that 10 percent of photographs of the sea floor overlying Miocene or younger crust showed nodules, and that this percentage increased with increasing age of crust to a maximum of 47 percent overlying late Cretaceous crust, declining irregularly thereafter. Content of Ni, however, showed a different, largely opposite trend with no high Ni values on very young or very old crust, and a well-defined peak of nodules enriched in Ni overlying crust of Oligo-Miocene age (Fig. 1). The data on which these observations are based were restricted to certain areas of the Pacific, and it remains to be seen if the conclusions are valid elsewhere.

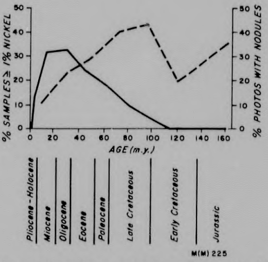

Fig. 1. Percentage of nodules with > 1% Ni (full line) and percentage of bottom photos showing nodules (broken line) plotted against magnetic age of crust. Data from the deep Pacific, excluding the north equatorial zone and areas of rapid sedimentation. After Menard (1976).

Distribution worldwide

Manganese nodules were first recovered in deep-sea dredge hauls by HMS *Challenger* in 1873, and during that voyage (1872-76) were found to be widely distributed throughout the oceans of the world. Twenty-five years later, more detailed sampling by the *Albatross* expedition broadly outlined the nodule fields of the equatorial Pacific. By 1977, the World Ocean Sediment Data Bank of Scripps Institution of Oceanography, the largest collection of publicly available data, held information on 55 000 sample stations, including 1850 nodule-sampling sites and 3800 analyses of nodules. A large amount of additional less-accessible data, mainly in the possession of ocean mining consortia, exists, but mainly relates to the potential mine site areas of the eastern Pacific.

Although manganese nodules and manganese-iron crusts occur in shallow water and high growth rates have been recorded, it has been known since the time of the *Challenger* voyage that the nodules of the deep ocean floor with high trace-metal contents develop extremely slowly. Therefore favourable accumulation areas are those with low sedimentation rates, remote from land or swept by currents, and in deep water below the carbonate compensation depth. On a worldwide basis, much the most extensive nodule fields are found in the Pacific Ocean; the Atlantic, with its higher rates of terrigenous sedimentation and significantly shallower average depth, has the lowest abundance of nodules, and the Indian Ocean has abundances intermediate between the two (Fig. 2).

Maps of nodule distribution have little meaning without data on concentration density. Closely spaced sampling and photography, and underway monitoring with towed television, have shown that density of coverage commonly changes considerably over distances of a kilometre or less. Studies of the potential mine site areas of the north-equatorial eastern Pacific indicate that highest concentrations of nodules occur on the tops and flanks of abyssal hills. Detailed surveys in this area have also shown that rough areas, with a relief of up to a few tens of metres, tend to have a denser coverage of nodules of more variable composition than nearby smooth areas (Craig, 1979); however, significant changes in abundance also sometimes occur between areas in apparently identical topographic settings. Work by the French in the eastern Pacific underlines the difficulties inherent in estimating nodule concentrations (kg. m^{-2}), even in areas directly observed in photographs or sampled by grabs; thus Bastien-Thiry (1979) concludes that abundance at any one point can be estimated by these methods with an accuracy of only about ±50 percent: sources of error include failure of the grab to recover all the nodules in its theoretical sampling area, and, in the case of photographs, failure to record nodules thinly blanketed by sediment and inability to estimate the sphericity of nodules. These uncertainties, coupled with the variations in nodule composition referred to previously, add to the problems of mine site selection.

Manganese nodules in the Australian region

Cape Leeuwin field

Cores and bottom photographs collected during seven cruises by USNS *Eltanin* between 1969 and 1973 provided the first evidence of extensive manganese nodule deposits in the southeast Indian Ocean. From a study of some hundreds of *Eltanin* photographs Kennett & Watkins (1976) outlined an area between about 95°E and 115°E centred on about 38°S which they refer to as the southeast Indian Ocean manganese pavement, and which has subsequently been termed the Cape Leeuwin manganese nodule field (Fig. 3). Within this area manganese pavements and nodules are known to be particularly densely concentrated in two regions, around 37°S, 100°E and 40°S, 112°E. Dense concentrations of unknown extent also occur outside those areas, and outside the pavement area delineated by Kennett & Watkins, and far too few data are available to allow the limits of particular fields to be defined with any confidence.

Since 1976 the *Eltanin* data have been supplemented by sampling carried out from HMA Ships *Diamantina* and *Moresby*. Figure 3 shows the position of all stations in the region where manganese nodules have been recovered and analyses are available. Some additional sampling has been carried out by mining companies, but these data have not been released. Available analyses are listed in Table 2. The average Ni+Cu content of all samples is 1.15% and the range from 1.72 to 0.38%. Omitting the two stations on the northern margin of the field close to the flanks of the Naturaliste Plateau (Diamantina 77-11 and Eltanin PL 45-95), average Ni+Cu is increased to 1.21%. Ni values of over 1% occur at eight stations and the average Ni+Cu content of nodules at these eight stations is 1.58%. Five of these stations, including the only two record-

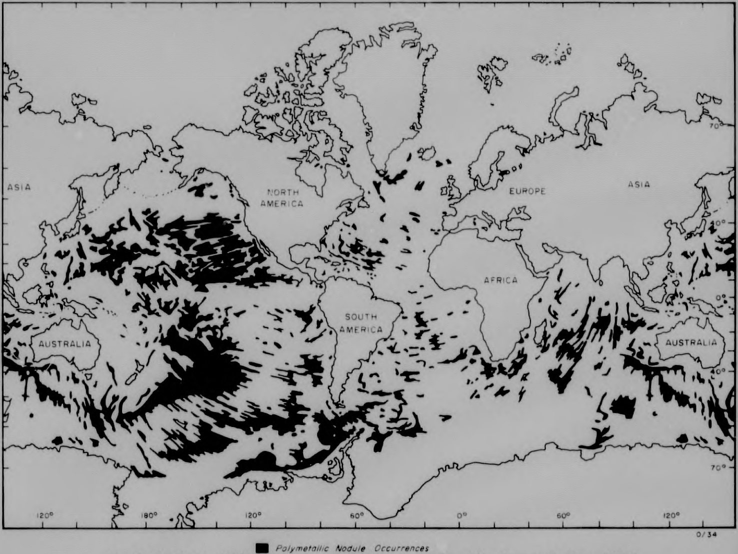

Fig. 2. Worldwide distribution of deep-sea manganese nodules. After Rawson & Ryan (1978).

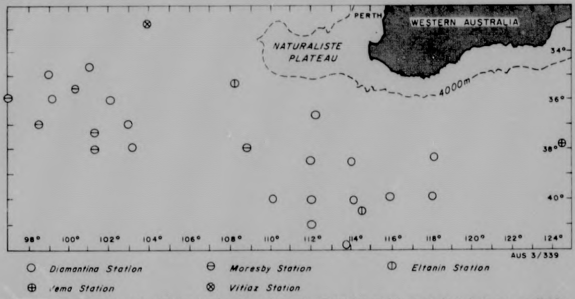

Fig. 3. Manganese nodule stations in the Cape Leeuwin Field for which analytical data are available.

ing Ni+Cu values equal to or exceeding 1.70%, occur in the western group of stations in the region of 100°E.

The best of these values do not approach those of material from the projected first-generation mine sites of the eastern Pacific, where areas with nodules averaging about 2.5% Ni+Cu have been outlined. The Cape Leeuwin field nodules are, however, relatively enriched with Ni as compared with Cu, which places them in a rather more favourable light owing to the higher value of Ni. Thus, while studies of the economics of nodule mining commonly quote a minimum average Ni+Cu content of about 2.25% as being necessary for a viable operation, and assume the two metals are present in approximately equal amounts, it has also been suggested that a more realistic measure of the grade required for mining is given by weighting the Ni figures to allow for the difference in value between the two metals (Frazer, 1977). Using the formula proposed by Frazer has the effect of lifting above the minimum average grade certain deposits which have slightly less than 2.25% Ni+Cu, but have significantly more Ni than Cu. The Cape Leeuwin field nodules are low in Cu and relatively enriched with Ni, but not sufficiently so to bring them close to the minimum acceptable grades as defined by the Frazer formula.

No mention has previously been made of Mn in relation to ore grade, although in terms of the value of contained metal Mn exceeds Ni, Cu, and Co combined in the case of eastern Pacific ores, which contain 25-35% Mn. This is much above values from the Cape Leeuwin field, which average only 20% Mn. It is uncertain whether the ore processing methods now under consideration will produce Mn; probably not if hydrometallurgical treatment is used, but production of Mn could be economically essential under a pyrometallurgical process (Agarwal & others, 1979). The relatively low Mn content of the Cape Leeuwin nodules could therefore further downgrade their resource potential.

Southern Ocean

Data on manganese nodules in the Southern Ocean to the south and southeast of Australia come mainly from USNS *Eltanin* cruises and from the research vessels *Vema* and *Robert D. Conrad* of the Lamont Doherty Geological Observatory of Columbia University. Known occurrences of nodules number 66, and a large proportion of these are photographic records only. Over the area covered by these 66 nodule stations (Fig. 4), the Scripps World Ocean Sediment Data Bank lists some 500 deep-water (>1000 m) sampling sites, not including bottom photographs. These figures show that about 12 percent of localities sampled or photographed hold nodules. However, it would be unrealistic to draw general conclusions of regional nodule distribution from such data; many of the samples were cores, which as likely as not would not recover evidence of surface nodules unless they were very densely packed, and the sampling sites themselves are unevenly, and commonly very widely spaced. The Lamont deep-sea photo-

TABLE 2. STATION DATA AND PARTIAL ANALYSES OF MANGANESE NODULES FROM THE CAPE LEEUWIN FIELD

Station		*Lat. S*	*Long. E*	*Depth (m)*	*Weight %, dry basis*					
					Mn	*Fe*	*Ni*	*Cu*	*Co*	*Ni+Cu*
Diamantina	76-2	40°03′	114°10′	4700	19.3	6.5	1.12	0.57	0.07	1.69
Diamantina	76-3	41°53′	113°57′	4300	24.6	12.3	1.05	0.43	0.08	1.48
Diamantina	76-4	37°57′	103°09′	5000	23.3	12.6	0.95	0.37	0.14	1.32
Diamantina	76-5	37°00′	102°55′	4700	24.5	11.4	1.00	0.44	0.15	1.44
Diamantina	76-6	36°00′	102°00′	4800	22.8	12.2	0.88	0.38	0.18	1.26
Diamantina	76-7	35°54′	99°03′	4300	23.0	12.8	0.93	0.36	0.19	1.29
Diamantina	76-8	34°58′	98°58′	4350	24.3	10.9	1.02	0.44	0.20	1.46
Diamantina	76-9	34°38′	101°00′	4650	20.7	14.8	0.75	0.31	0.21	1.06
Diamantina	77-1	38°26′	118°07′	5300	ND	11.2	0.76	0.38	0.14	1.14
Diamantina	77-2	39°56′	118°00′	4700	19.1	15.9	0.62	0.26	0.14	0.88
Diamantina	77-3	39°58′	115°56′	4750	13.6	6.7	0.63	0.33	0.06	0.96
Diamantina	77-5	38°38′	114°00′	4650	17.8	15.4	0.57	0.28	0.14	0.85
Diamantina	77-6	38°33′	111°59′	4600	16.7	18.6	0.34	0.16	0.20	0.50
Diamantina	77-7	40°00′	112°01′	4200	18.2	19.7	0.42	0.18	0.17	0.60
Diamantina	77-8	41°00′	112°02′	4500	18.7	9.5	0.83	0.46	0.09	1.29
Diamantina	77-9	40°02′	110°04′	4600	23.3	10.6	1.03	0.52	0.10	1.55
Diamantina	77-11	36°38′	112°16′	4100	18.6	19.5	0.34	0.13	0.41	0.47
Moresby	79-1	38°06′	108°49′	4750	22.2	13.0	0.92	0.42	0.16	1.34
Moresby	79-3	38°01′	101°18′	4600	24.9	10.8	1.11	0.47	0.15	1.58
Moresby	79-4	35°59′	97°01′	4550	24.9	8.9	1.15	0.55	0.17	1.70
Moresby	79-5	37°01′	98°26′	4550	25.4	9.1	1.12	0.60	0.16	1.72
Moresby	79-6	35°31′	100°19′	4450	22.1	15.8	0.70	0.28	0.24	0.98
Moresby	79-7	37°22′	101°16′	4600	23.6	12.6	0.94	0.38	0.18	1.32
Eltanin	PC45-88	40°33′	144°32′	4389	9.1	5.2	0.41	0.35	0.04	0.76
Eltanin	PC45-95	35°21′	108°13′	4576	14.8	14.0	0.26	0.12	0.18	0.38
[1]Vema	16-SBT29	37°50′	124°30′	5665	18.4	10.3	0.90	0.45	0.15	1.35
[2]Vitiaz	5193	32°48′	103°52′	5300	17.4	12.4	0.51	0.27	0.14	0.78

(1) Mero (1965)
(2) Bezrukov & Andrushchenko (1973);
Diamantina 1976 analyses are given in Frakes & others (1977);
Diamantina 1977 and Moresby 1979 analyses are from unpublished BMR records.
Eltanin analyses are given in Noakes & Jones (1976).

graphic records (Ewing & others, 1971) point to an area south of Tasmania, in the region of 55°S, 150°E, as having relatively dense concentrations of nodules, but too few photographs are available to allow the continuity and extent of these concentrations to be mapped.

The available chemical analyses are given in Table 3. Most values are low and in a number of samples the metal content is so low that they scarcely merit the term manganese nodule. Interest in the basin to the south of Australia as a possible source of enriched nodules derives from a single *Challenger* station, a nodule from which was reported by Goldberg (1954) to assay at 1.15% Ni and 1.81% Cu. These high values have not been reproduced by other analyses of material from this dredge haul; for example the Russian Atlas of the Indian Ocean (Udintsev, 1975) quotes 1.15% Ni and 0.75% Cu for this *Challenger* station. Considerable variability is to be expected, because the original drawing of nodules from this site in the Challenger Report (Murray & Renard, 1891) shows a very heterogeneous assemblage of material.

Tasman and Coral Seas

Data from the Tasman and Coral seas and from the Australian sector of the Indian Ocean are scarce. In the Tasman and Coral seas sedimentation rates are generally too high to favour widespread nodule development. None out of about 20 Lamont photo stations north of 40°S to the east of Australia recorded nodules, and out of a total of about 186 deep-water stations listed in the Scripps World Ocean Sediment Data Bank in the Tasman and Coral seas, nodules are present in only 11. Analyses are available from only two stations, both in the Tasman Sea (Table 4).

Material from the *Galathea* station, with 1.28% Ni, is unusually enriched for the south-west Pacific. However, the analyses were carried out on encrustations on pumice and on the earbone of a whale and therefore are by no means representative of the bulk composition. The *Kimbla* material consists of typical sub-spherical nodules without recog-

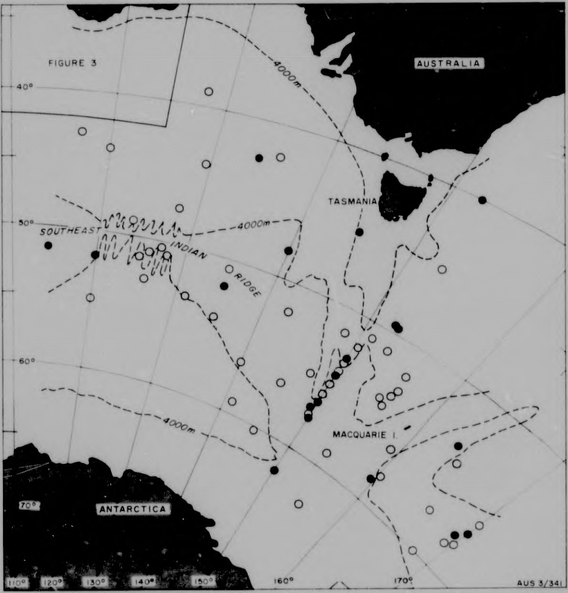

Fig. 4. Manganese nodule stations in the Australian sector of the Southern Ocean. Full circles indicate analyses available.

nisable nuclei of foreign material, but carrying abundant mineral detritus and calcareous and siliceous organic debris.

Eastern Indian Ocean

The Scripps Ocean Sediment Data Bank records 14 manganese nodule stations out of a total of 176 deep-water sampling sites in the eastern Indian Ocean (between 10° and 30°S and east of 100°E). In addition, manganese nodules and crusts have been recovered recently at about 30 sampling stations on the outer continental margin of northwest Australia in the region of the Scott, Exmouth, and Wallaby Plateaus. Available analytical data are summarised in Table 5.

No high values of Ni and Cu have beer recorded from this region and only two analyses show over 1% Ni+Cu. Both these come from the region of very slow sedimentation floored by red clay between Ninetyeast Ridge and Western Australia. There are some general similarities in sedimentation patterns and nodule compositional trends between the Pacific and Indian Oceans, and on this basis the belt of Ni+Cu-enriched nodules of the siliceous ooze zone of the east equatorial Pacific might be expected to have a counter-

TABLE 3. STATION DATA AND PARTIAL ANALYSES OF MANGANESE NODULES FROM THE SOUTHERN OCEAN SOUTH OF AUSTRALIA

Station		*Lat. S*	*Long. E*	*Depth (m)*	*Weight %, dry basis*					
					Mn	*Fe*	*Ni*	*Cu*	*Co*	*Ni+Cu*
Eltanin	PC34-2	57°00′	169°50′	5189	7.7	13.0	0.06	0.09	0.08	0.15
[1]Monsoon	85G	57°43′	169°12′	5288	10.7	19.2	0.19	0.10	0.17	0.29
Eltanin	PC44-9	53°30′	163°31′	2689	10.5	17.9	0.09	0.06	0.16	0.15
Eltanin	PC36-37	58°40′	159°31′	3876	1.5	7.5	0.04	0.04	0.01	0.08
Eltanin	PC38-15	49°40′	152°34′	4262	5.9	13.0	0.07	0.11	0.07	0.18
Eltanin	PC38-12	49°42′	152°33′	4271	6.4	12.0	0.12	0.14	0.08	0.26
Eltanin	PC38-17	39°59′	152°02′	4244	12.0	16.0	0.20	0.06	0.08	0.26
Eltanin	PC38-10	57°28′	150°28′	3255	14.0	15.0	0.39	0.18	0.29	0.57
Eltanin	PC36-15	56°35′	150°17′	3516	1.0	14.0	0.23	0.12	0.12	0.35
Eltanin	RD38-3	57°00′	150°00′	3291	13.5	12.0	0.43	0.13	0.15	0.56
Eltanin	PC36-18	53°01′	150°00′	3878	9.5	17.0	0.13	0.07	0.16	0.20
Eltanin	PC38-2	54°14′	149°58′	4060	13.5	13.0	0.63	0.17	0.13	0.80
Eltanin	RD38-2	61°53′	149°17′	3657	16.0	9.4	0.79	0.35	0.21	1.14
Eltanin	PC34-13	45°12′	145°04′	3968	7.0	19.0	0.12	0.14	0.07	0.26
Eltanin	PC36-4	48°09′	140°08′	4536	1.6	4.9	0.03	0.01	0.03	0.04
Eltanin	PC34-21	52°05′	135°06′	3367	8.5	20.0	0.19	0.18	0.05	0.37
[2]Challenger	160	42°42′	134°10′	4760	21.0	9.9	1.15	1.81	0.09	2.96
Eltanin	PC44-28	51°59′	119°38′	3905	10.7	20.0	0.08	0.07	0.11	0.15
Eltanin	TC45-66	51°30′	114°18′	3524	21.3	8.0	1.40	0.53	0.15	1.93

(1) Mero (1964), (2) Goldberg (1954); *Eltanin* analyses are reported by Noakes & Jones (1976).

TABLE 4. STATION DATA AND PARTIAL ANALYSES OF MANGANESE NODULES AND CRUSTS FROM THE TASMAN SEA

Station		*Lat. S*	*Long. E*	*Depth (m)*	*Weight %, dry basis*					
					Mn	*Fe*	*Ni*	*Cu*	*Co*	*Ni+Cu*
[1]Kimbla	5B	36°15′	155°35′	4300	5.9	15.8	0.29	0.21	0.07	0.50
[2]Galathea	574	39°45′	159°39′	4800	26.8	7.76	1.28	0.60	0.19	1.88

(1) Exon & others (1980), average of two analyses.
(2) Ahrens & others (1967), average of two analyses.

part in the siliceous ooze zone of the east equatorial Indian Ocean. The siliceous ooze belt of the eastern Indian Ocean covers a much smaller area than the corresponding zone in the eastern Pacific, and is interrupted by large areas of calcareous sediment derived from the Cocos Islands and Christmas Island rises (Fig. 5). Scripps Data Bank has records of 121 stations in the general area of the siliceous ooze belt (7-15°S, 90-108°E); very few of these provide records of manganese nodules and not a single analysis is available, which underlines the need for additional data. The oceanic crust in this region is of Mesozoic age, which somewhat downgrades its prospectivity for high-grade manganese nodule deposits if the relationship between age of crust and grade of nodules discussed in a previous section applies in the Indian Ocean.

Mining, ore processing, and environmental effects

Manganese nodules lie exposed on the sea floor and are readily amenable to sweeping or sucking into a towed or independently-mobile collecting device. Difficulties in the initial dredging process relate mainly to maintaining control over the equipment in contact with the seabed to achieve efficient coverage and to avoid obstacles. Transportation of the ore from great depths to the surface vessel poses very severe engineering problems. A simple mechanical system involving an endless chain of dredges—the Continuous Line Bucket (CLB) system—was successfully tested as long ago as 1970, but it appears that subsequent development has not fulfilled early expectations. Even when two vessels are used to improve control over the line of buckets and increase the separation between the rising and descending lines, entanglements occur and expected recovery rates have not been attained owing to the difficulty in maintaining efficient bottom contact.

Hydraulic methods involve either airlift systems, in which compressed air is injected into the pipe at various levels to raise an air-water-solid slurry to the surface, or various forms of pumping systems using either surface-mounted jet pumps or submerged pumps mounted in the dredge head or incorporated in the pipe. Each system has its own drawbacks: airlift systems require thick-walled pipe to withstand the large pressure differences, while both jet and slurry pumps are low in efficiency, and submerged pumps are vulnerable to mechanical problems and are difficult to service.

Metallurgical processing of manganese nodules has been under investigation for more than a decade without the emergence of an undisputed preferred method. The finely divided nature of the material precludes mechanical beneficiation, and the complex mixture of metals, extreme porosity, and very high water content compound the difficulties

Fig. 5. Sea-floor sediment distribution in the eastern Indian Ocean. S—siliceous ooze, C—calcareous pelagic sediments, T—mainly terrigenous sediments, RC—red clay. After Udintsev (1975).

TABLE 5. STATION DATA AND PARTIAL ANALYSES OF MANGANESE NODULES (n) AND CRUSTS(c) FROM THE EASTERN INDIAN OCEAN

Station		*Lat. S*	*Long. E*	*Depth (m)*	*Weight %, dry basis* *Mn*	*Fe*	*Ni*	*Cu*	*Co*	*Ni+Cu*
Valdivia	KD4	13°09′	120°05′	2100	21.2	18.1	0.47	0.03	0.32	0.50 (c)
Valdivia	KD3	13°06′	120°05′	2300	17.5	19.4	0.30	0.04	0.26	0.34 (c)
Valdivia	KD13	12°54′	119°52′	2100	17.5	18.3	0.38	0.06	0.35	0.44 (n)
Sonne 8	KD148	20°58′	110°34′	4800	17.0	12.7	0.47	0.28	0.20	0.75 (n)
Sonne 8	KD165	24°24′	109°43′	4400	13.5	13.8	0.29	0.18	0.24	0.47 (n)
Sonne 8	KD170	25°37′	108°36′	4600						
Sonne 8	KD167	25°31′	108°32′	5300	16.0	13.5	0.34	0.20	0.22	0.42 (n)
[1]Sonne 8		—	—	—	14.1	15.4	0.30	0.12	0.18	0.42 (c)
Dodo	60P	16°17′	106°30′	5918	14.6	13.1	0.47	1.06	0.15	1.53 (n)
Dodo	62D	16°18′	104°16′	5660	18.5	10.9	0.38	0.24	0.33	0.62 (n)
Dodo	66D(A)	19°56′	100°00′	5860	16.5	9.1	0.76	0.53	0.20	1.29 (n)
Vitiaz	4521	15°05′	111°52′	4598	17.0	14.2	0.50	0.25	0.13	0.75 (n)
Vitiaz	5186	26°50′	108°20′	5258	16.7	16.0	0.31	0.13	0.27	0.44 (n)
Vitiaz	4555	15°36′	104°49′	5810	18.2	10.7	0.31	0.21	0.16	0.52 (n)

(1) Average of 30 analyses of Fe-Mn crusts from the Exmouth and Wallaby Plateau margins, NW Australia. Sample locations between 16°34′S and 25°57′S, 108°52′E and 117°33′E. Water depths range from 2500 m to 5300 m.

Valdivia data from Hinz & others (1978). *Sonne* data from von Stackelberg & others (1980). Dodo and *Vitiaz* station data from Scripps Data Bank, analyses from Udintsev (1975).

of effective and economical metal extraction. Both hydrometallurgical and pyrometallurgical processes have been extensively tested.

As many as 70 different hydrometallurgical methods have been investigated (Agarwal & others, 1979); all involve acidic or basic leaching of metals from nodules, or combined reduction and leaching. The method favoured by the Kennecott Joint Venture consortium is a low-temperature ammoniacal leach process, with reduction by carbon monoxide, and liquid ion exchange to extract Cu and Ni, and sulphide precipitation to extract Co.

Pyrometallurgical processes, such as that favoured by the International Nickel consortium, involve high-temperature drying and reduction of the ore and therefore have an initially greater fuel requirement. However, the slag produced in this process is a relatively easily-treated manganese ore, and the recovery of manganese would significantly affect the economics of the operation.

Metallurgical processing will presumably be carried out on land, and the disposal of wastes produced poses problems shared by many existing onshore mining operations. However, large-scale dredging of deep-sea nodules has never before been attempted, and few criteria exist on which to base estimates of the effect of the mining process on the marine environment. Whatever method of nodule collection is used, destruction of bottom-dwelling life forms over the area mined is inevitable. It has been estimated that a viable mining operation would need to recover 1-2 million tonnes of nodules/year, which at a nodule density of 10 kg.m^{-2} would entail the mining of 100-200 km^{2} of sea floor each year. Little is known of the community of bottom-dwelling life forms, except that it is sparse and of limited diversity. Although reproductive rates are likely to be extremely slow, and therefore repopulation of mined-out areas of sea floor delayed, it is difficult to conceive of any significant permanent regional damage resulting from the mining itself.

The same cannot be said of the indirect effects of mining, which must involve the disturbance and putting into suspension of large quantities of sediment near the bottom and the transport of some sediment, and probably water also, from abyssal depths to the surface. Possible effects these processes may have include the release of potentially toxic trace metals held in the bottom sediments and increase in turbidity and nutrients in surface waters with resulting impact on the phytoplankton. In a comprehensive review of the environmental aspects of nodule mining, Amos & others (1977) conclude that disturbances caused by mining are likely to be insignificant compared with those brought about by natural events. However, they concede that cumulative and possibly far-reaching perturbations influencing the food web are within the bounds of possibility, and careful monitoring of the initial mining operations will be required to guard against potentially hazardous consequences.

Legal aspects of mining deep-sea manganese nodules

The law of the sea has undergone fundamental changes since the Second World War. Although there had been disagreements about the width of the Territorial Sea before then, the concept of a narrow zone offshore from the coastal state totally under national jurisdiction was universally accepted, as was the related concept of the High Seas beyond the Territorial Sea, where no state could exercise sovereignty. The first extension of jurisdiction with respect to the seabed and subsoil underlying the High Seas came with the Truman Proclamation of 1945, in which USA claimed exclusive rights to the resources of the continental shelf adjoining its coast. The legal status of the superadjacent waters remained High Seas under that proclamation. The example of USA was followed by other countries, and by the time the Convention on the Continental Shelf was signed in Geneva in 1958, many coastal states had proclaimed sovereign rights over their continental shelves.

In the definition of the continental shelf adopted by the 1958 Convention, the seaward extent of the shelf was defined as 'to a depth of 200 m, or beyond that limit to where the depth of the superadjacent waters admits of the exploitation of the natural resources of the said areas'. The open-ended nature of the exploitability criterion left the way clear for extravagant claims of sovereignty to be made. However, the judgement of the International Court of Justice in the North Sea cases in 1969, which required the continental shelf to be 'the natural prolongation of the landmass', pointed to a limit of the continental shelf, namely the continental margin.

A milestone in the development of the new ideas on offshore areas was the Maltese statement to the UN General Assembly in 1967, in which it was argued, amongst other things, that the resources of the seabed beyond national jurisdiction properly belonged to all mankind. This important principle was adopted by the United Nations in a declaration of the General Assembly in 1970, but the vital question of the limits of national jurisdiction has been under discussion in the UN since that time in the Seabed Committee and since 1973 in the Third United Nations Conference on the Law of the Sea.

Discussion of these limits has resulted in a large measure of agreement on the following:

(1) a territorial sea with a maximum breadth of twelve nautical miles;

(2) an Exclusive Economic Zone (EEZ) which extends 200 nautical miles seaward from the coastal base-lines;

(3) a continental shelf extending beyond the territorial sea throughout the natural prolongation of the coastal state's land territory to the outer edge of the continental margin or to a distance of 200 nautical miles from the base-lines where the outer edge of the continental margin does not extend out to that distance.

This legal continental shelf is, of course, quite different from the continental shelf as understood by oceanographers and geomorphologists. Protracted debates in UN Conferences in recent years have resulted in broad agreement on defining the limits of the legal continental shelf based on the principle of natural prolongation of the landmass, but combining criteria of morphology and sediment thickness with overriding distance and depth limits.

Manganese nodules occur in a number of areas which will fall under coastal state jurisdiction. This is the case off Florida, Argentina, and South Africa in the Atlantic; off Mexico and Peru in the Pacific; and off Madagascar and southwest Australia in the Indian Ocean, as well as off oceanic islands in many places. However, the main nodule fields of the world's oceans, including those likely to be exploited in the foreseeable future, lie in deep water remote from land in areas which by no stretch of imagination can be assigned to any coastal state. These, then, will be regarded as part of the common heritage of mankind and subject to some measure of control by an international agency yet to be constituted. It is likely that an important function of this international agency will be the administration of funds derived from levies imposed on profits from seabed mining ventures.

Uncertainty about the legal position and about the role of the international agency has not prevented substantial investment in research and development by mining interests during the period preceding international agreement on a Law of the Sea Treaty. Five international consortia representing American, Belgian, British, Canadian, Dutch, French, German, and Japanese companies are in existence, and considerable effort has been put into solving problems of mining, ore processing, and waste disposal, as well as into exploration and mine-site evaluation.

The United States on 28 June passed legislation on deep seabed mining to serve as an interim measure pending United States approval of an international agreement on a Law of the Sea Treaty. The legislation enables US companies to undertake non-commercial mining operations immediately but prohibits commercial recovery until 1988. It also includes provision for tax revenues to be held against future contributions required by an international controlling authority. The legislation emphasises that the USA is not asserting sovereignty over the seabed beyond national jurisdiction. Unilateral legislation ahead of agreement in the Conference has aroused some disquiet in the international community, but it remains to be seen whether it will disrupt the process of negotiation in the Conference, or will act as an incentive to progress towards a Convention, given the delay mechanism in the legislation.

Conclusion

Manganese nodules occur in deep water throughout the world's oceans where sedimentation rates are low, but their distribution is patchy and the factors controlling their abundance, and their variable composition, are not fully understood. In the Australian region dense concentrations are known to exist southwest of the continent (the Cape Leeuwin Field), and south of Tasmania, and scattered occurrences have been recorded in the Tasman Sea and eastern Indian Ocean. On existing data only the Cape Leeuwin Field has any resource potential: here nodules are distributed over an area of at least 1 million km^2, concentrations are apparently quite dense, and Ni values commonly exceed 1%. Part of the field is less than 1000 km from the industrial centres of southwestern Australia. On the debit side, the field lies in relatively high latitudes and is therefore exposed to frequent severe weather and sea conditions: more important, the Ni, Cu, and Mn contents of the nodules are significantly below the currently-accepted economic cut-off grades. As yet, samples from the field are few in number and widely spaced, and large areas of higher-grade nodules may still be discovered. If, however, the values obtained from the small number of available analyses are representative of the whole field, the potential for establishing a mine site in the area in competition with higher-grade deposits of the eastern Pacific would appear to be remote in the short to medium term.

Elsewhere in the Australian region the density of sampling of the deep sea floor is too sparse to allow any general conclusions to be drawn. On the basis of the well-established relationship between the high-grade nodule fields of the north-equatorial eastern Pacific and the equatorial siliceous ooze belt, the obvious target for future exploration is the corresponding equatorial siliceous ooze belt of the eastern Indian Ocean. No analyses are available from the siliceous ooze belt itself, and the handful of analyses from this general region are not particularly encouraging, although a Cu value exceeding 1% was recorded southeast of the Cocos Islands during the Dodo expedition. However, the region is very poorly known, and additional sampling is badly needed. In the Pacific there appears to be a relationship between the grade and abundance of nodules and the age of the underlying oceanic crust, the higher-grade nodules being found on crust formed in the mid-Tertiary. If this relationship has general validity, the potential of the eastern Indian Ocean siliceous ooze belt is downgraded because the crust there is of Mesozoic age.

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METAL, ORE, AND CONCENTRATE PRICES

compiled by R. M. Weber

(All European prices, and US prices for copper, lead, tin, and zinc, are obtained from the London *Metal Bulletin*; the remaining US prices are obtained from *Metals Week* and *American Metal Market*. Australian prices are obtained from various sources)

MONTHLY AVERAGE BASE METAL PRICES

	Copper	Tin	Zinc	Lead
Australia ($/tonne)				
January 1980	2 179.00	15 634.00	714.00	1 069.04
February 1980	2 684.00	15 217.00	724.33	1 050.00
March 1980	2 321.90	17 088.90	745.00	1 050.00
UK (LME, £/tonne)				
January 1980	1 148.00	7 514.00	341.75	493.95
February 1980	1 274.00	7 470.00	380.02	510.47
March 1980	1 046.07	7 924.76	337.09	508.66
USA (US cents/lb)				
January 1980	117.00	790.00	37.50	50.00
February 1980	132.00	804.00	38.50	51.00
March 1980	105.61	829.23	38.50	51.00

MAXIMUM AND MINIMUM BASE METAL PRICES 1 JANUARY TO 30 MARCH 1980

	Copper	Tin	Zinc	Lead
Australia ($/tonne)				
Maximum	2 800.00	18 131.00	745.00	1 150.00
Minimum	2 000.00	15 247.00	714.00	1 050.00
UK (LME, £/tonne)				
Maximum	1 375.00	8 455.00	403.00	588.00
Minimum	937.00	7 220.00	305.00	434.00
USA (US cents/lb)				
Maximum	144.00	895.00	39.50	55.00
Minimum	95.00	761.00	37.50	48.00

METAL PRICES AS AT END OF MARCH 1980

(Prices shown are for the last trading day of the month; where prices are not set daily, the date of latest change is shown. Some prices are nominal, being subject to negotiation between producer and purchaser. Commonwealth Trading Bank currency exchange (telegraphic transfer buying) rate $A1.00 = US$1.0855).

Aluminium

Australia .. **$1385/tonne** (7.1.80)
Domestic ingots 99.5% c.i.f. capital cities, lots of 10 000 kg or more

Europe **£815/tonne** (1.2.80)
UK producer, 99.5%, delivered

USA .. .. **84-85 cents/lb** (27.3.80)
Metals Week, US market

Antimony

Australia .. **$3900/tonne** (3.1.77)
1-tonne lots, delivered capital cities

Europe **£3400-3450/tonne** (24.3.80)
European free market, 99.6%, $/tonne, warehouse

USA .. .. **157-165 cents/lb** (27.3.80)
Metals Week, New York dealer, 99.5-99.6% metal, c.i.f. port

Bismuth

Australia .. **$5.59-5.99/kg** (18.2.80)
Based on LME price
$5.69-5.89/kg (27.3.80)
Based on *Metals Week*, New York dealer price

Europe .. .. **US$2.75-2.95/lb** (18.2.80)
European free market, 1-ton lots in warehouse

USA **$2.80-2.90/lb** (27.3.80)
Metals Week, New York dealer, 99.99% min.

Cadmium

Australia .. **$6.50/kg** (29.1.80)
Minimum 1-tonne lots, delivered Melbourne

Europe .. .. **US$2.85-2.95/lb** (20.3.80)
European free market, c.i.f., sticks

USA **$2.93-3.03/lb** (27.3.80)
Metals Week, New York dealer, 99.95% min.

Cobalt

Australia .. **$38.70/kg** (6.2.79)
Ceramic oxide 70% Co, delivered Melbourne

Europe .. .. **US$22.50-24.00/lb** (31.3.80)
European free market, 99.5% in warehouse

USA .. **$25.00/lb** (1.2.79)
Metals Week, shot/cathode/250 kg

Copper

Australia .. **$2080.00/tonne** (31.3.80)
Mount Isa Mines Ltd price; electrolytic wirebar basis; c.i.f. main Australian ports

Europe .. **£941.00/tonne** (31.3.80)
LME, cash, midday, electrolytic wirebar

USA .. .. **95-101 cents/lb** (17.3.80)
Cathodes, delivered

Gold

Australia .. **$450.63/troy oz. $14.48/g**
Perth Mint selling price, min.
400-oz bars

Europe .. **US$503.25/troy oz.**

USA .. .. **$490.00/troy oz**
Metals Week, Handy & Harman sellers' price, 400-oz bars, 99.95%

Lead

Australia .. **$1050/tonne** (8.1.80)
99.97-99.99% f.o.b., f.o.r., Port Pirie

Europe **£448.00/tonne** (31.3.80)
LME, cash, midday

USA .. .. **50-52 cents/lb**

Mercury

Australia .. **nominal**

Europe .. **US$395.00-410.00/flask** (24.3.80)
European free market, c.i.f., $/flask, min. 99.99%

USA **$395.00-405.00/flask** (13.3.80)
Metals Week, New York dealer, 20-plus flasks

Nickel

Australia .. **$7.00-7.10/kg**
Australian currency equivalent of *Metals Week* producer cathode price, last trading day of month

Europe .. .. **US$2.88-3.15** (31.3.80)
European free market, c.i.f., Europe

USA **$3.45-3.50/lb** (13.3.80)
Metals Week, major producer, cathode, 99.97% f.o.b.

Pig iron

- *Australia* .. **$139.00/tonne** (26.11.79)
  Foundry, c.i.f. State capital city ports
- *Europe* **£113.50/tonne** (30.12.79)
  Foundry, phosphorus 0.12-1.00% ex-basing points, UK
- *USA* .. .. **$191.00/short ton**
  f.o.b., No. 2 Foundry (Birmingham)

Platinum

- *Australia* .. **nominal**
- *Europe* .. .. **£193.00/troy oz** (24.3.80)
  UK & Empire refined, delivered
- *USA* .. .. **$420.00/troy oz** (19.12.79)
  Metals Week, major producer, f.o.b. refinery

Selenium

- *Australia* .. —
- *Europe* .. .. **US$9.25-10.75/lb** (17.3.80)
  European free market price, c.i.f.
- *USA* **$9.15-9.60/lb** (21.2.80)
  Metals Week, New York dealer price, commercial-grade 99.5% min.

Silver

- *Australia* .. **$1049.02/kg** (3.3.80)
  Minimum lots 320 kg, f.o.b., f.o.t. Port Pirie
- *Europe* .. .. **622.40 pence/troy oz** London Spot
- *USA* .. .. **1160 cents/troy oz**
  Metals Week, Handy & Harman, commercial bar form, 99.9% min.

Tin

- *Australia* .. **$16 349.00/tonne**
  Spot, minimum 1 tonne, ex-smelter
- *Europe* **£7670.00/tonne** (31.3.80)
  LME, cash, midday
- *USA* .. .. **793-806 cents/lb** (31.3.80)
  New York
- *Penang* .. **M$2265.00/pikul** (31.3.80)
  Ex-smelter

Zinc

- *Australia* .. **$745.00/tonne** (21.2.80)
  EZ Industries, Prime Western, 98.5%, 15 tonnes and over
- *Europe* **£305.00/tonne** (31.3.80)
  LME, cash, midday
- *USA* .. .. **37.50 cents/lb** (1.2.80)
  Prime Western, delivered

ORE AND CONCENTRATE PRICES AS AT END OF MARCH 1980

(Prices shown are for the last trading day of the month; where prices are not set daily, the date of latest change is shown. Some prices are nominal, being subject to negotiation between producer an' purchaser. Prices quoted will vary according to grade a.d possible impurities, and in many cases with the size of the parcel)

Antimony

- *Australia* .. **nominal**
- *Europe* .. .. **US$23.50-25.00/mtu**
  Lump sulphide ore, 60% Sb, c.i.f.
- *USA* .. .. .. —

Beryl

- *Australia* .. **nominal**
- *Europe* .. .. **US$36.00-40.00/stu**
  Cobbed lump, minimum 10% BeO, c.i.f.
- *USA* **$75.00-85.00/stu** (26.12.79)
  10-12% Be, imported c.i.f. Philadelphia

Chromite

- *Australia* .. **nominal**
- *Europe* .. .. **US$130.00-135.00/tonne**
  Turkish lumpy, minimum 48% Cr_2O_3, 3:1, f.o.b.
- *USA* .. **nominal**

Columbium (niobium)

- *Australia* .. **nominal**
- *Europe* .. .. **US$10.00-13.00/lb**
  Columbite, minimum 65% combined Nb_2O_5 + Ta_2O_5, 10:1, c.i.f., $/lb of pentoxide content
- *USA* .. .. **1000-1200 cents/lb** (8.11.79)
  10:1, Nb_2O_5:Ta_2O_5. Dealer and producer quotation priced on basis of combined pentoxide content, c.i.f. US ports

Manganese

- *Australia* .. **nominal**
- *Europe* .. .. **US$1.70-1.73/mtu**
  Metallurgical, minimum 48-50% Mn, maximum 0.1% P, c.i.f.
- *USA* **166-173/cents/ltu** (20.3.80)
  Producer selling agents and dealer quotation c.i.f. US ports, min. 48% Mn

Molybdenum

- *Australia* .. **nominal**
- *Europe* .. .. **US$10.31/lb** (28.2.80)
  Mo in MoS_2 concentrate, f.o.b. Climax, minimum 85%
- *USA* **$10.31/lb** (27.2.80)
  95% MoS_2, considered nominal, cost of container extra

Monazite

- *Australia* .. **nominal**
- *Europe* **$A350-400/tonne**
  Concentrate, minimum 60% ReO + thoria, f.o.b., f.i.d. Australia
- *USA* .. .. **nominal**

Tantalum

- *Australia* .. **nominal**
- *Europe* .. .. **US$103.00-112.00/lb**
  Ore, minimum 60% Ta_2O_5, c.i.f.
- *USA* **$105.00-110.00/lb** (5.3.80)
  Dealer quotation: about 60% combined Nb_2O_5 and Ta_2O_5, depending on grade and size of lot

Tin (cassiterite)

- *Australia* .. **$145.12/mtu**
  Concentrate, 70%, delivered Sydney
- *Europe* .. .. Returning charge/tonne:
  £205-235, 70-75% Sn (including deduction)
  £275-325, 30-65% Sn (including deduction)
  £310-360, 20-30% Sn (including deduction)
- *USA* .. .. .. —

Titanium cons—ilmenite

- *Australia* .. **nominal**
- *Europe* **$A17.00-19.00/tonne**
  Bulk concentrate, minimum TiO_2, f.o.b. Australia
- *USA* .. .. **$55.00/long ton** (26.12.79)
  54% TiO_2, imported f.o.b. Atlantic ports, shipload quantities

Titanium cons—rutile

- *Australia* .. **nominal**
- *Europe* **$A320.00-350.00/tonne**
  Concentrate, 95-97% TiO_2, bagged, f.o.b., f.i.d. Australia
  $A290.00-330.00/tonne
  Bulk conc., 95-97% TiO_2, f.o.b., f.i.d. Australia
- *USA* .. .. **$425.00-450.00/short ton** (26.12.79)
  96% TiO_2, f.o.b. cars Atlantic and Great Lakes ports

Tungsten cons—wolframite

- *Australia* .. **$133.58-137.26/mtu WO_3**
  Based on LME price, minimum 65% WO_3
- *Europe* .. .. **US$145.00-149.00/mtu WO_3**
  Wolframite, std, min. 65% WO_3, c.i.f.
- *USA* **$129.49/stu** (25.1.80)
  GSA domestic, based on units of WO_3

Tungsten cons—scheelite

Australia .. **nominal**
Europe .. .. **nominal**
USA .. .. **$129.43/stu WO_3** (25.1.80)
GSA domestic and export, based on units of WO_3

Uranium—oxide

Australia .. —
Europe .. .. **US$37.00-42.00/lb** (13.7.79)
Concentrate, contract basis, f.o.b. mine
USA **$38.00/lb** (2.1.80)
American Metal Market—Nuexco, immed. delivery, US

Uranium—hexafluoride

Australia .. —
Europe .. .. **US$38.00-43.00/lb** (13.7.79)
USA .. .. —

Zircon

Australia .. **nominal**
Europe **$A50.00-60.00/tonne**
Sand, 66-67% ZrO_2, standard, f.o.b., f.i.d. Australia
$A75.00-85.00/tonne
Premium, maximum 0.1% TiO_2, f.o.b., f.i.d. Australia
USA .. .. **$150.00/short ton** (26.12.79)
Ore, Australia, 65% ZrO_2, bulk, c.i.f. Atlantic ports

Copper ore (Australia)

The price paid for ores is related to the market price for copper, less charges listed below. The basis of price determination is variable: details are obtainable from the two smelters—The Electrolytic Refining & Smelting Company of Australia Pty Ltd, Port Kembla, NSW, and Mount Isa Mines Ltd, Mount Isa, Qld.

	ERS	*Mount Isa*
Metal deduction or copper content deduction	**1.3 units of copper**/tonne of ore (a)	**1.3 units of copper**/dry tonne of ore
Receiving, sampling, assaying, smelting charge/tonne	**$30.00** (material natural state)	**$11.30** (dry ore)
Converting, refining, realising charge/unit of copper paid for	**$2.50**	**$1.70**
Gold refining charge/gram of gold paid for	**8 cents** (b)	**5 cents** (c)
Silver refining charge/gram of silver paid for	**2 cents** (d)	**1.45 cents** (e)

(a) Payment at 96% of the ERS refined copper price, after metal deduction.

(b) ERS gold deduction: 0.002 kg gold/dry tonne of material, and 2.5% of the balance of gold metal contained in material.

(c) Mount Isa gold deduction: from the gold content of each parcel of ore delivered, 2 g gold/tonne of ore will be deducted; payment for 97.5% of the excess is based on the Australian Gold Producers monthly average price.

(d) ERS silver deduction: 0.03 kg silver/tonne of material and 8% of the balance of silver metal contained in material.

(e) Mount Isa silver deduction: from the silver content of each parcel of ore delivered, 60 g silver/tonne of ore will be deducted; payment for excess is based on average London Bullion Brokers cash price for silver.

Part 2 Quarterly Statistics

Australian Bureau of Statistics, Canberra, Australia

PREFACE

by R. J. Cameron

Australian Statistician

Statistics included in this Part relate to Australian production of and overseas trade in minerals and mineral products. In the main, the data relating to mineral production consist of official statistics of Mines Departments (and equivalents) of the several States and the Northern Territory Department of Mines & Energy. These statistics have been supplemented as necessary by data obtained from the Energy Economics Branch of the Department of National Development & Energy and from the Bureau of Mineral Resources, including information collected by BMR from mines and treatment plants.

The presentation of data in this Part is arranged to assemble under the one heading all statistics in respect of each particular mineral. Summary tables showing production of selected major minerals and metals are shown on page 53 and include details where available for the March quarter 1980.

The fundamental concept of Australian mineral production statistics is that quantities and values of individual minerals are reported in terms of the products in the form in which they are despatched from the locality of each mine. This involves the inclusion in the mining industry of ore-dressing and certain elementary smelting of metallic minerals (e.g., in the case of gold) and miscellaneous treatment of non-metallic minerals where these operations are carried out in an associated plant at or near the mine. For example, in the case of a metal mine, the output is recorded as ore when no treatment is undertaken at the mine or as a concentrate where ore-dressing operations are carried out in an associated plant in the locality of the mine.

The particulars of quantities of minerals produced have been compiled on this basis as far as practicable. This has involved some rearrangement of official statistics published by Mines Departments (and equivalents) for certain States. Actual output of the mineral product (as defined in the preceding paragraph) has generally been reported, but in some cases it has been necessary to include despatches from the mine (or reported sales) as distinct from production in deriving the total for Australia. In addition to the basic quantity data, particulars of contents of metallic minerals are shown and in general represent total contents (as determined by assay) for each metal which is a 'pay metal' or 'refiners' prize' when present in the particular mineral.

The data exclude construction materials (sand, gravel, building stone, etc.) and some particulars for non-metallic minerals which are not at present available.

Quarterly values of output statistics are not available because of delays in realisation of values of several important minerals. Calendar-year statistics of the value of output of individual minerals are published each year in the *Australian Mineral Industry Annual Review.* Fiscal-year statistics are published by the Australian Bureau of Statistics in the Bulletin *Mineral Production* (Catalogue No. 8405.0).

I extend my thanks to State Departments of Mines and their equivalents, Statisticians of the several States, and the Department of National Development & Energy who have supplied information used in the preparation of these tables.

Index

Metric units and conversion factors

Imperial Unit	*Metric Unit*	*Conversion factors* — *Imperial to Metric: multiply by*	*Metric to Imperial: multiply by*
Mass			
troy (fine) ounce	kilogram	0.0311035	32.1507
pound	kilogram	0.453592	2.20462
short ton	tonne	0.907185	1.10231
long ton	tonne	1.01605	0.984207
long ton unit	metric ton unit	1.01605	0.984207
Volume			
cubic foot	cubic metre	0.0283168	35.3147
barrel	cubic metre	0.158987	6.28981

Terms and symbols

tonne: metric ton (2204.6 lb)
unit: metric ton unit (22.046 lb)

*: subject to revision

—: nil
. .: less than half the unit shown
n.a.: not available
n.a.p.: not available for publication
n.e.i.: not elsewhere included
n.y.a.: not yet available

Statistics of smelter and refinery production exclude secondary metal (i.e. metal recovered from scrap) unless otherwise specified.

All import and export values are expressed in Australian currency and are generally f.o.b. port of shipment. A more detailed description of the method of valuation is quoted in the *Overseas Trade Bulletin*, Catalogue No. 5409.0.

Any discrepancies between totals and sums of components in the tables are due to rounding.

Note Enquiries concerning the mineral statistics contained in Part 2 may be made by telephoning Mr Les Wright, Canberra (062) 49 9556.

ALUMINIUM

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Bauxite	tonne	24 292 511	27 585 039	6 601 913	6 483 592	7 063 791	7 435 743
Alumina (Al_2O_3) content	,,	*10 392 851*	*11 785 251*	*2 767 536*	*2 762 289*	*3 038 009*	*3 217 417*
Production: States (Al_2O_3 content)							
New South Wales	,,	1 465	1 249	239	307	353	350
Victoria	,,	1 077	1 562	—	990	—	572
Queensland	,,	4 442 239	5 171 550	1 134 710	1 210 494	1 316 247	1 510 099
Western Australia	,,	3 692 528	4 281 679	1 105 039	1 019 200	1 060 480	1 096 960
Northern Territory	,,	2 255 542	2 329 211	527 548	531 298	660 929	609 436
Total contained alumina	,,	**10 392 851**	**11 785 251**	**2 767 536**	**2 762 289**	**3 038 009**	**3 217 417**
Smelter and refinery production							
Alumina	,,	6 775 675	7 414 606	1 792 196	1 817 845	1 911 047	1 893 518
Refined aluminium	,,	263 361	269 575	65 131	66 053	68 103	70 288
IMPORTS							
Bauxite	tonne	6 515	16 036	3 117	8 226	3 716	977
Value	$'000	700	1 673	204	1 117	282	70
Alumina	tonne	3 524	4 210	986	946	969	1 309
Value	$'000	1 866	2 148	476	506	434	732
Aluminium and aluminium-base alloys							
Unworked shapes	tonne	344	4 330	975	2 176	537	642
New Zealand	,,	*1*	*3 314*	*924*	*2 001*	*302*	*87*
U.K.	,,	*339*	*249*	*18*	*129*	*77*	*25*
U.S.A.	,,	*1*	*628*	*25*	*26*	*61*	*516*
Other	,,	*3*	*139*	*8*	*20*	*97*	*14*
Value	$'000	710	6 046	1 186	2 960	900	1 000
Plates, sheets, strips and circles	tonne	933	2 030	285	453	710	582
Value	$'000	2 576	5 945	759	1 369	1 955	1 862
Pipes and tubes	tonne	76	220	63	46	13	98
Value	$'000	294	1 703	275	225	715	488
Bars, rods and angles	tonne	1 048	2 849	427	385	409	1 628
Value	$'000	1 861	4 972	821	610	724	2 817
Foil	tonne	1 588	2 505	1 092	419	416	578
Value	$'000	4 922	5 683	1 012	1 319	1 462	1 890
Powder	tonne	450	901	246	168	223	264
Value	$'000	759	1 583	356	302	431	494
Wire, single-strand, uncovered	tonne	102	1 079	40	115	169	755
Value	$'000	308	1 943	137	301	256	1 249
Scrap (including re-melt)	tonne	1 337	1 463	319	219	427	498
Value	$'000	1 388	2 001	313	248	859	581
EXPORTS *(a)*							
Alumina *(b)*	'000 tonnes	6 250	6 476	1 488	1 654	1 670	1 664
Value	$'000	671 306	775 396	167 925	200 403	200 976	206 092
Aluminium and aluminium-base alloys							
Unworked shapes	tonne	80 019	75 999	25 891	11 761	20 068	18 279
Hong Kong	,,	*905*	*2 187*	*611*	*571*	*568*	*437*
Japan	,,	*57 410*	*38 990*	*12 927*	*6 570*	*10 787*	*8 706*
Philippines	,,	*7 136*	*8 875*	*1 387*	*2 672*	*2 247*	*2 569*
Thailand	,,	*3 343*	*2 327*	*888*	*606*	*268*	*565*
Other	,,	*11 225*	*23 621*	*10 078*	*1 342*	*6 199*	*6 002*
Value	$'000	74 876	85 947	27 467	13 203	23 734	21 543
Plates, sheets, strips and circles	tonne	2 830	9 987	926	2 692	1 819	4 550
Value	$'000	4 703	17 788	1 560	4 455	3 740	7 933
Pipes and tubes	tonne	159	434	143	125	160	6
Value	$'000	392	988	325	254	384	25
Bars, rods and angles	tonne	156	1 316	190	469	425	232
Value	$'000	313	2 103	412	681	601	409
Foil	tonne	1 470	2 534	398	781	681	674
Value	$'000	2 220	4 101	581	1 222	1 120	1 178
Powder	tonne	98	310	62	77	109	62
Value	$'000	202	388	70	77	156	85
Wire, single-strand, uncovered	tonne	33	774	3	752	11	8
Value	$'000	96	1 114	15	1 047	18	34
Scrap (including re-melt)	tonne	8 002	10 481	2 640	3 030	2 263	2 194
Value	$'000	5 017	8 180	1 780	2 440	2 041	1 919

(a) Details of exports of bauxite are not available for publication. *(b)* Country details not available for publication.

ANTIMONY

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Antimony ore	tonne	231	—	—	—	—	—
Antimony content	,,	*36*	—	—	—	—	—
Antimony concentrate	,,	(a)1 428	1 411	378	342	357	334
Antimony content	,,	*(a)964*	*960*	*261*	*228*	*242*	*229*
Antimony content of minerals produced							
Antimony ore	tonne	36	—	—	—	—	—
Antimony concentrate	,,	(a)964	960	261	228	242	229
Lead concentrate	,,	519	598	146	167	150	135
New South Wales	,,	1 495	1 558	407	395	392	364
Victoria	,,	24	—	—	—	—	—
Western Australia	,,	n.a.p.	—	—	—	—	—
Total contained antimony	,,	**(a)1 519**	**1 558**	**407**	**395**	**392**	**364**
IMPORTS							
Antimony metal	tonne	87	51	7	5	20	19
Value	$'000	100	138	14	13	58	53
EXPORTS*(b)*							
Antimony ores and cons	tonne	3 040	3 041	1 968	371	490	212
Value	$'000	2 653	2 827	1 577	426	547	277

(a) Excludes antimony concentrates produced in Western Australia. (b) Exports of antimonial lead alloy are shown on page 40.

ASBESTOS

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Chrysotile	tonne	62 744	79 121	13 444	15 980	22 463	27 234
New South Wales	,,	*62 744*	*79 121*	*13 444*	*15 980*	*22 463*	*27 234*
IMPORTS							
Chrysotile	tonne	30 107	16 683	3 552	4 192	5 467	3 472
Canada	,,	*28 459*	*16 284*	*3 534*	*3 991*	*5 369*	*3 390*
Others	,,	*1 646*	*399*	*18*	*201*	*98*	*82*
Value	$'000	14 363	8 036	1 293	2 154	2 838	1 751
Amosite	tonne	8 490	5 205	1 568	729	1 035	1 873
South Africa	,,	*8 490*	*5 205*	*1 568*	*729*	*1 035*	*1 873*
Others	,,	—	—	—	—	—	—
Value	$'000	3 543	2 347	668	308	488	883
Other types	tonne	3 464	1 054	58	1	135	860
Value	$'000	1 472	430	20	2	25	383
EXPORTS							
All types and grades	tonne	37 094	49 756	10 075	7 751	12 550	19 380
Value	$'000	16 829	15 844	3 501	3 050	3 466	5 827

CADMIUM

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Cadmium content of minerals produced							
Lead concentrate	tonne	69	99	17	19	30	33
Zinc concentrate	,,	1 459	1 695	344	418	477	456
New South Wales	,,	914	1 177	225	289	353	310
Queensland	,,	426	429	92	104	105	128
Tasmania	,,	188	188	44	44	49	51
Total contained cadmium	,,	**1 528**	**1 794**	**361**	**437**	**507**	**489**
Refinery production							
Refined cadmium	,,	747	804	201	202	166	235
EXPORTS							
Cadmium and cadmium alloys—							
Unwrought	tonne	641	524	120	187	80	137
Value	$'000	2 359	2 657	499	1 064	449	645
Worked shapes and sections	tonne	10	34	16	5	13	
Value	$'000	36	159	66	29	62	2
Waste and scrap etc.	tonne	93	67	62	2	1	2
Value	$'000	50	82	32	15	15	20

COAL

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Black coal							
Bituminous	'000 tonnes	74 094	76 774	17 839	19 507	19 053	20 375
Sub-bituminous	,,	5 733	6 367	1 431	1 498	1 697	1 741
New South Wales	,,	50 679	50 867	11 524	12 425	12 949	13 969
Queensland *(a)*	,,	24 936	27 626	6 775	7 470	6 560	6 821
South Australia	,,	1 585	1 677	404	351	437	485
Western Australia	,,	2 404	2 735	516	699	743	777
Tasmania	,,	224	238	52	61	61	64
Underground	,,	42 203	42 102	9 724	10 627	10 581	11 170
Open cut	,,	37 624	41 041	9 547	10 379	10 169	10 946
Total	,,	**79 827**	**83 142**	**19 270**	**21 005**	**20 750**	**22 116**
Brown coal (lignite)	,,	**32 860**	**32 597**	**6 975**	**8 465**	**9 465**	**7 692**
Victoria	,,	32 860	32 597	6 975	8 465	9 465	7 692
Coal products							
Metallurgical coke	,,	5 003	8 140	2 026	2 006	2 082	2 026
Brown coal briquettes	,,	1 129	1 157	234	289	324	310
IMPORTS							
Coal	tonne	22 696	16 016	3 913	503	10 812	788
Value	$'000	1 105	1 606	247	147	1 033	179
Coke (incl. petroleum coke)	tonne	126 415	148 124	39 536	46 227	24 109	38 252
Value	$'000	13 114	15 193	4 335	4 127	2 756	3 975
EXPORTS							
Black coal	'000 tonnes	37 538	40 452	9 325	10;514	9 527	11 086
Japan	,,	*24 890*	*26 803*	*5 678*	*7 575*	*6 514*	*7 036*
Other	,,	*12 648*	*13 651*	*3 648*	*2 939*	*3 014*	*4 050*
Value	$'000	1 465 635	1 590 324	366 301	419 042	371 049	433 932
Brown coal (lignite)	tonne	24 465	50 909	22	37	34 412	16 438
Japan	,,	*22 916*	*50 279*	—	—	*34 261*	*16 018*
Other	,,	*1 549*	*628*	*22*	*37*	*149*	*420*
Value	$'000	532	2 024	4	14	1 477	529
Coke	tonne	211 744	96 305	43 202	1 855	26 539	24 709
Value	$'000	6 153	3 081	1 428	142	845	666

(a) Saleable coal; excludes washery rejects.

COPPER

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Copper ore (a)	tonne	30 085	11 765	10 895	290	290	290
Copper content	,,	*3 575*	*1 228*	*1 138*	*30*	*30*	*30*
Silver content	*kilogram*	*16 407*	*5 501*	*5 336*	*55*	*55*	*55*
Copper concentrate	tonne	754 441	837 841	204 665	222 525	208 863	201 788
Copper content	*tonne*	*203 502*	*218 961*	*54 998*	*58 517*	*53 747*	*51 699*
Gold content	*kilogram*	*1 547*	*1 359*	*271*	*352*	*352*	*363*
Silver content	,,	*26 742*	*35 664*	*7 611*	*9 637*	*9 493*	*8 923*
Lead content	*tonne*	*527*	*2 314*	*56*	*611*	*966*	*681*
Zinc content	,,	*1 217*	*3 291*	*341*	*986*	*1 207*	*757*
Copper precipitate	tonne	51	—	—	—	—	—
Copper content	,,	*37*	—	—	—	—	—
Copper content of minerals produced							
Bismuth concentrate	tonne	706	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Copper ore (a)	,,	3 575	1 228	1 138	30	30	30
Copper concentrate	,,	203 502	218 961	54 998	58 517	53 747	51 699
Copper precipitate	,,	37	—	—	—	—	—
Copper-tin concentrate	,,	451	446	97	96	81	172
Lead concentrate	,,	4 321	4 512	735	1 269	1 290	1 218
Lead-copper concentrate	,,	3 530	3 369	895	837	771	866
Nickel concentrate	,,	4 782	3 094	725	737	828	804
Silver concentrate	,,	14	—	—	—	—	—
Zinc concentrate	,,	1 193	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
New South Wales	,,	14 258	17 781	3 719	4 322	4 823	4 917
Queensland	,,	162 701	171 985	44 303	47 152	42 918	37 612
South Australia	,,	12 631	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Western Australia	,,	4 782	3 094	725	737	828	804
Tasmania	,,	23 908	22 485	5 889	5 637	4 125	6 834
Northern Territory	,,	3 831	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Total contained copper	,,	**222 111**	**234 735**	**59 103**	**62 382**	**57 815**	**55 435**
Smelter and refinery production							
Blister copper (b)	,,	164 395	167 146	43 253	44 228	41 651	38 014
Refined copper	,,	152 621	138 249	33 292	33 458	38 071	33 428

		1978	1979*	1979* March	June	September	December
IMPORTS							
Copper—							
Unrefined copper	tonne	1	..	—	—	—	
Value	$'000	1	3	—	—	1	2
Refinery shapes	tonne	10	228	..	..	1	227
U.K.	,,	*6*	..	..	..	—	—
Others	,,	*4*	*228*	—	..	1	227
Value	$'000	20	103	..	..	3	100
Bars, rods, angles and tees	tonne	51	107	37	60	4	6
Value	$'000	130	249	56	164	11	18
Plates, sheets and strips	tonne	48	60	3	3	19	35
Value	$'000	89	148	9	8	46	85
Pipes and tubes	tonne	424	365	131	49	73	112
Value	$'000	534	845	60	192	226	367
Wire	tonne	30	76	10	9	55	2
Value	$'000	150	220	65	97	42	16
Powder	tonne	189	167	41	45	45	36
Value	$'000	481	521	114	142	120	145
Scrap	tonne	442	377	118	77	61	121
Value	$'000	278	294	58	67	33	136
Copper-base alloys—							
Pigs, ingots and blocks	tonne	120	283	26	18	39	200
Value	$'000	98	389	28	18	58	285

		1978	1979*	1979* March	June	September	December
IMPORTS *(continued)*							
Copper-base alloys—*continued*							
Rolled, drawn and extruded shapes	tonne	2 505	5 505	979	867	1 814	1 845
Value	$'000	4 349	7 698	2 127	2 064	1 591	1 916
Wire	tonne	377	361	80	62	96	123
Value	$'000	984	1 343	252	245	426	420
Scrap	tonne	427	732	153	129	86	364
Value	$'000	269	690	114	80	61	435
EXPORTS							
Copper—							
Copper concentrate	tonne	108 316	150 499	45 849	30 496	22 960	51 194
Japan	,,	*102 723*	*129 360*	*31 635*	*29 312*	*21 631*	*46 782*
Other	,,	*5 593*	*21 139*	*14 214*	*1 184*	*1 329*	*4 412*
Value	$'000	30 983	64 901	14 235	12 420	11 746	26 500
Copper matte	tonne	4 504	6 886	2 376	—	1 508	3 002
Netherlands	,,	*500*	—	—	—	—	—
Other	,,	*4 004*	*6 886*	*2 376*	—	*1 508*	*3 002*
Value	$'000	1 867	5 347	1 640	—	739	2 968
Copper-lead dross	tonne	5 002	2 665	936	974	367	388
Value	$'000	3 108	4 265	680	1 350	1 086	1 149
Slags and residues	tonne	—	267	—	—	140	127
Value	$'000	—	238	—	—	79	159
Blister copper	tonne	4 144	28 756	711	8 257	4 796	14 992
Germany, F.R.	,,	*4 144*	*303*	—	—	*303*	—
Japan	,,	—	*4 871*	*711*	*1 265*	*1 493*	*1 402*
Other	,,	—	*23 582*	—	*6 992*	*3 000*	*13 590*
Value	$'000	8 786	51 527	1 950	17 648	3 856	28 073
Refinery shapes	tonne	60 065	46 978	8 445	16 684	10 775	11 074
E.E.C. (c)	,,	*33 951*	*23 455*	*4 300*	*9 125*	*4 300*	*5 730*
U.K.	,,	*19 367*	*14 159*	*2 502*	*4 504*	*3 402*	*3 751*
Other	,,	*6 747*	*9 364*	*1 643*	*3 055*	*3 073*	*1 593*
Value	$'000	68 480	81 193	12 142	30 176	18 336	20 539
Bars and rods	tonne	14 973	24 130	6 156	6 116	4 758	7 100
Value	$'000	18 961	40 645	9 043	11 048	8 629	11 925
Angles, shapes and sections	tonne	5 056	74	16	17	15	26
Value	$'000	5 866	215	42	46	49	78
Plates, sheets and strips	tonne	2 736	2 199	269	574	491	865
Value	$'000	4 498	5 115	595	1 367	1 162	1 991
Tubes and pipes	tonne	2 094	2 902	697	602	690	913
Value	$'000	3 953	6 905	1 573	1 380	1 699	2 253
Wire	tonne	175	1 030	147	144	337	402
Value	$'000	273	1 973	233	299	639	802
Scrap	tonne	139	12	—	12	—	
Value	$'000	106	28	—	22	—	6
Copper-base alloys—							
Refinery shapes	tonne	158	435	41	213	75	106
Value	$'000	262	679	73	281	127	198
Bars and rods	tonne	3 027	3 480	1 482	615	599	784
Value	$'000	3 826	6 089	2 931	988	958	1 212
Angles, shapes and sections	tonne	85	95	21	42	10	22
Value	$'000	154	193	39	82	26	46
Plates, sheets and strips	tonne	268	589	79	156	135	219
Value	$'000	546	1 284	183	369	334	393
Tubes and pipes	tonne	144	254	76	65	43	70
Value	$'000	338	629	104	185	140	200
Wire	tonne	104	151	44	64	17	26
Value	$'000	185	407	93	179	51	84
Scrap	tonne	209	336	57	44	80	155
Value	$'000	195	628	196	55	135	242
Copper and copper-base alloys—							
Foil	tonne		1		—		1
Value	$'000	3	6	1	—	1	4
Powders and flakes	tonne	97	543	37			506
Value	$'000	119	850	48	2	3	797
Copper content of concentrates, matte, etc. exported (d)	*tonne*	*41 418*	*49 155*	*13 171*	*8 439*	*8 919*	*18 626*

(a) Includes cupreous ore for fertiliser. (b) Total production for refining in Australia and overseas. (c) Excludes U.K. (d) Excludes copper in blister

GEMS

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Opals	$'000	51 285					
New South Wales	,,	*15 427*					
Queensland	,,	*857*					
South Australia	,,	*35 000*					
Western Australia	,,	—					
Sapphires	,,	23 731					
New South Wales	,,	*3 719*	n.y.a.	n.a.	n.a.	n.a.	n.a.
Queensland	,,	*20 012*					
Other gems	,,	337					
New South Wales	,,	*6*					
Queensland	,,	*301*					
South Australia	,,	*14*					
Western Australia	,,	*17*					
IMPORTS							
Diamonds, gem	metric carat	76 046	68 402	15 943	17 495	13 925	21 039
Value	$'000	34 180	32 097	8 075	8 111	5 336	10 575
EXPORTS							
Opals—							
Rough, not cut or polished	$'000	7 606	6 711	1 475	2 399	1 508	1 329
Cut and polished (a)	,,	19 085	18 283	4 066	5 192	4 083	4 942
Sapphires—							
Rough, not cut or polished	,,	8 164	15 032	3 191	4 156	4 324	3 361
Other	,,	2 144	2 139	303	442	1 038	356

(a) Includes black opals.

GOLD

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Gold ore	tonne	117	21	4	4	5	8
Gold content	*kilogram*	*81*	*94*	*25*	*28*	*16*	*25*
Gold bullion	,,	20 084	n.a.	n.a.	n.a.	n.a.	n.a.
Gold content	,,	*16 545*	*14 987*	*3 780*	*3 877*	*3 661*	*3 669*
Silver content	,,	*1 488*	*1 819*	*333*	*412*	*380*	*694*
Gold content of minerals produced							
Bismuth concentrate	,,	128	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Copper concentrate	,,	1 547	1 359	271	373	352	363
Copper ore	,,		—	—	—	—	—
Gold ore	,,	81	94	25	28	16	25
Gold bullion	,,	16 545	14 987	3 780	3 877	3 661	3 669
Lead concentrate	,,	303	326	74	75	91	86
Lead-copper concentrate	,,	1 214	1 133	319	235	269	310
Nickel concentrate	,,	64	—	—	—	—	—
Zinc concentrate	,,	261	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
New South Wales	,,	422	443	96	109	112	126
Victoria	,,	12	17	—	5	6	6
Queensland	,,	607	487	81	109	163	134
South Australia	,,	1	—	—	—	—	—
Western Australia	,,	13 332	11 464	3 297	2 436	2 757	2 974
Tasmania	,,	1 892	1 833	513	392	411	517
Northern Territory	,,	3 876	4 052	582	1 635	1 039	796
Total contained gold	,,	**20 142**	**18 295**	**4 568**	**4 687**	**4 487**	**4 553**
Refinery production							
Newly-won gold							
Australian origin	,,	16 645	14 987	4 238	3 001	3 978	3 770
Overseas origin	,,	1 343	1 616	427	300	353	536
Scrap							
Australian origin	,,	3 090	4 210	954	710	1 231	1 315
Overseas origin	,,	29	32	4	1	19	8
Total	,,	**21 109**	**20 844**	**5 624**	**4 012**	**5 580**	**5 628**

GOLD

		1978	1979*	1979* March	June	September	December
IMPORTS							
Gold							
Refined forms (excl. specie, leaf and foil)	kilogram	37	1	1		—	—
Value	$'000	269	16	15	1	—	—
Unrefined bullion (gold content)	kilogram	783	405	2	3	398	2
Fiji	..	*561*	—	—	—	—	—
Papua New Guinea	..	*81*	—	—	—	—	—
Other	..	*140*	*405*	*2*	*3*	*398*	*2*
Value	$'000	3 674	56	13	8	16	19
EXPORTS							
Refined forms (excl. specie, leaf and foil)	kilogram	3 636	7 274	3 143	2 917	526	688
Hong Kong	..	*2 770*	*6 273*	*3 125*	*2 047*	*439*	*662*
Japan	..	*299*	*371*	—	*299*	*72*	—
Singapore	..	*1*	*2*	*2*	—	—	—
New Zealand	..	*113*	*14*	*5*	*3*	*3*	*3*
U.K.	..	*407*	*1*		—		*1*
Other	..	*43*	*610*	*10*	*568*	*11*	*21*
Value	$'000	19 732	58 570	20 797	21 832	7 163	8 778
Gold content of concentrates, blister copper, etc. exported	*kilogram*	*2 435*	*3 148*	*221*	*1 421*	*476*	*1 030*

GYPSUM

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production	**tonne**	**939 884**	**1 159 324**	**288 263**	**230 890**	**360 729**	**279 442**
New South Wales	..	18 034	26 956	4 512	6 840	8 520	7 084
Victoria	..	107 359	131 003	41 442	39 000	24 955	25 606
South Australia	..	648 146	782 298	199 218	141 084	248 583	193 413
Western Australia	..	166 345	219 067	43 091	43 966	78 671	53 339
EXPORTS							
Gypsum and anhydrite	tonne	181 040	424 678	89 676	106 392	158 736	69 874
Indonesia	..	*29 707*	*148 153*	*19 642*	*33 360*	*46 454*	*48 697*
Malaysia	..	*595*	*41 783*	*78*	*41*	*41 483*	*181*
New Zealand	..	*84 501*	*63 742*	*5 730*	*36 809*	*15 443*	*5 760*
Singapore	..	*16 200*	*51 281*	*11 285*	*11 431*	*18 905*	*9 660*
Other	..	*50 037*	*103 975*	*37 197*	*24 751*	*36 451*	*5 576*
Value	$'000	1 696	3 328	786	861	1 059	622

IRON

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Iron ore and concentrate (*a*) (*b*)	'000 tonnes	83 134	91 709	22 214	18 255	24 667	26 573
Iron content	,,	*52 825*	*58 013*	*14 119*	*11 595*	*15 421*	*16 878*
Production: States, iron content							
South Australia	,,	1 506	1 640	360	446	423	411
Western Australia	,,	49 873	54 844	13 336	10 806	14 653	16 049
Tasmania	,,	1 446	1 529	423	343	345	418
Total contained iron	,,	**53 825**	**58 013**	**14 119**	**11 595**	**15 421**	**16 878**
Iron and steel							
Iron ore pellets	,,	9 471	9 403	2 384	2 460	2 246	2 313
Pig iron	,,	7 337	7 811	1 866	1 916	1 984	2 045
Raw steel (*c*)	,,	7 589	8 125	1 898	1 973	2 097	2 157
Blooms and slabs	,,	6 646	6 680	1 651	1 609	1 708	1 712
Tinplate	,,	329	363	88	76	91	108
IMPORTS							
Iron							
Iron ore	tonne	30 731	26 400	10 105	16 293	2	..
Canada	,,	*30 721*	*24 894*	*10 105*	*14 789*	—	—
Philippines	,,	—	*1 500*	—	*1 500*	—	—
Other	,,	*10*	*5*	..	*3*	*2*	..
Value	$'000	697	678	222	454	1	1
Iron and steel							
Ferroalloys (excl. powders)							
Ferrochromium	tonne	18 730	13 835	976	237	7 689	4 933
Value	$'000	7 568	6 507	514	186	3 406	2 401
Ferromanganese	tonne	5 033	15 758	358	2 242	8 438	4 720
Value	$'000	2 629	7 694	306	203	3 944	3 241
Ferromolybdenum	tonne	191	220	36	22	83	79
Value	$'000	1 499	3 956	319	330	1 860	1 447
Ferronickel	tonne	—	55	—	—	—	55
Value	$'000	—	74	—	—	—	74
Ferrosilicon	tonne	6 363	7 149	1 887	489	2 270	2 503
Value	$'000	2 894	3 649	825	299	963	1 562
Other	tonne	1 889	4 868	551	865	2 042	1 410
Value	$'000	2 375	5 561	685	1 295	1 505	2 076
Tinplate (*d*)	tonne	1 290	388	251	..	53	84
Value	$'000	497	185	118	..	25	42
EXPORTS							
Iron							
Iron ore and pellets	'0000 tonnes	75 101	78 286	19 253	19 872	16 387	22 774
Japan	,,	*51 813*	*54 473*	*12 664*	*13 517*	*12 591*	*15 701*
Other	,,	*23 288*	*23 813*	*6 589*	*6 355*	*3 796*	*7 073*
Value	$'000	906 025	1 008 434	231 213	260 401	221 148	295 672
Iron and steel							
Pig iron	tonne	685 431	641 536	138 611	161 012	134 101	207 812
China (excl. Taiwan Province)	,,	*533 568*	*416 451*	*62 993*	*95 738*	*126 720*	*131 000*
Japan	,,	*72 585*	*116 688*	*50 432*	*39 338*	*781*	*26 137*
New Zealand	,,	*664*	*918*	*254*	*156*	*201*	*307*
Romania	,,	*32 603*	—	—	—	—	—
U.S.A.	,,	*14 567*	—	—	—	—	—
Other	,,	*31 444*	*107 479*	*24 932*	*25 780*	*6 399*	*50 368*
Value	$'000	56 982	71 992	13 340	17 461	16 740	24 451
Ingots, blooms and slabs	tonne	1 013 467	604 604	171 981	160 237	139 866	132 520
Value	$'000	132 873	104 340	26 244	26 735	23 989	27 372
Scrap	tonne	484 327	577 297	143 732	174 744	115 236	143 585
Value	$'000	30 040	50 265	10 522	13 689	12 354	13 700
Tinplate, excl. waste	tonne	52 401	37 131	3 789	5 769	21 730	5 843
Value	$'000	20 161	19 134	2 102	3 353	10 285	3 394
Tinplate waste	tonne	31 477	33 054	7 096	9 330	9 762	6 866
Value	$'000	8 848	13 367	2 583	3 479	4 543	2 762
Iron content of iron ore and pellets exported	*'000 tonnes*	*47 415*	*49 407*	*12 170*	*12 522*	*10 346*	*14 369*

(*a*) Iron oxide for metal extraction. (*b*) Includes iron ore for pelletising. (*c*) Includes recovery from scrap. (*d*) Includes terneplate.

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Lead ore (a)	tonne	3 694	5 340	1 632	1 272	1 299	1 137
Lead content	,,	*422*	*706*	*262*	*151*	*172*	*121*
Silver content	*kilogram*	*1 041*	*1 509*	*641*	*294*	*331*	*243*
Lead concentrate	tonne	613 845	665 531	161 076	171 892	166 698	165 865
Lead content	,,	*373 588*	*388 172*	*92 992*	*102 404*	*98 897*	*93 879*
Silver content	*kilogram*	*623 294*	*674 073*	*176 638*	*185 274*	*157 107*	*155 054*
Antimony content	*tonne*	*519*	*598*	*146*	*167*	*150*	*135*
Cadmium content	,,	*69*	*99*	*17*	*19*	*30*	*33*
Copper content	,,	*4 321*	*4 512*	*735*	*1 269*	*1 290*	*1 218*
Gold content	*kilogram*	*303*	*326*	*74*	*75*	*91*	*86*
Zinc content	*tonne*	*34 827*	*42 542*	*10 067*	*11 300*	*10 157*	*11 018*
Sulphur content	,,	*52 749*	*60 662*	*13 402*	*15 255*	*15 760*	*16 245*
Lead-copper concentrate	,,	27 812	24 902	7 042	5 843	5 363	6 654
Lead content	,,	*6 766*	*5 340*	*1 453*	*1 261*	*1 121*	*1 505*
Copper content	,,	*3 530*	*3 369*	*895*	*837*	*771*	*866*
Silver content	*kilogram*	*55 294*	*47 227*	*12 211*	*12 434*	*10 924*	*11 658*
Gold content	,,	*1 214*	*1 133*	*319*	*235*	*269*	*310*
Zinc content	*tonne*	*2 834*	*2 817*	*747*	*618*	*624*	*828*
Sulphur content	,,	*8 196*	*7 552*	*2 193*	*1 769*	*1 611*	*1 979*
Lead content of minerals produced							
Copper concentrate	,,	527	2 314	56	611	966	681
Copper-lead-zinc ore	,,	998	223	223	—	—	—
Lead ore (a)	,,	422	706	262	151	172	121
Lead concentrate	,,	373 588	388 172	92 992	102 404	98 897	93 879
Lead-copper concentrate	,,	6 766	5 340	1 453	1 261	1 121	1 505
Silver concentrate	,,	80	—	—	—	—	—
Zinc ore	,,	—	—	—	—	—	—
Zinc concentrate	,,	17 910	20 730	4 668	4 668	6 330	5 064
New South Wales	,,	230 574	240 973	53 636	63 081	65 897	58 359
Queensland	,,	146 928	154 321	40 622	40 947	35 912	36 840
South Australia	,,	24	7	—	7	—	—
Tasmania	,,	22 754	22 184	5 396	5 060	5 677	6 051
Northern Territory	,,	11	—	—	—	—	—
Total contained lead	,,	**400 291**	**417 485**	**99 654**	**109 095**	**107 486**	**101 250**
Smelter and refinery production							
Refined lead (c)	,,	204 022	215 734	55 492	54 606	51 820	53 816
Lead content of lead bullion for export	,,	151 964	169 469	41 023	44 357	44 416	39 673

EXPORTS

		1978	1979*	1979* March	June	September	December
Lead concentrate	tonne	140 960	63 530	16 947	1 340	22 851	22 392
Belgium-Luxembourg	,,	*44 410*	*9 971*	*963*	—	*4 583*	*4 425*
Japan	,,	*23 912*	*6 271*	—	—	*6 111*	*160*
U.S.A.	,,	*24 233*	*12 563*	*8 403*	*1 340*	*1 353*	*1 467*
Other	,,	*48 405*	*24 437*	*7 581*	—	*10 804*	*6 052*
Value	$'000	47 670	38 834	10 907	941	12 476	14 510

LEAD *(continued)*

		1978	1979*	1979* March	June	September	December
EXPORTS *(continued)*							
Lead bullion	tonne	148 423	166 248	33 771	36 873	53 729	41 875
Germany, F.R.	,,	*5 000*	*4 500*	—	*1 000*	*1 500*	*2 000*
Netherlands	,,	*15 546*	*7 873*	*1 250*	*1 623*	*3 750*	*1 250*
U.K.	,,	*117 890*	*143 184*	*31 271*	*33 000*	*46 529*	*32 384*
Other	,,	*9 987*	*10 691*	*1 250*	*1 250*	*1 950*	*6 241*
Value	$'000	112 339	245 001	31 108	49 799	83 026	81 068
Refined lead, unworked (incl. antimonial lead) *(d)*	tonne	158 268	163 589	40 202	41 368	36 514	45 505
Asia—China	,,		*17 988*	—	*8 993*	*4 498*	*4 497*
Other	,,		*24 975*	*5 766*	*6 257*	*6 532*	*6 420*
Europe excl. U.K.	,,		*19 694*	*6 504*	*4 437*	*4 945*	*3 808*
India	,,		*37 674*	*8 428*	*10 295*	*9 801*	*9 150*
Japan	,,		*8 075*	*2 399*	*1 395*	*2 888*	*1 393*
Middle East	,,		*12 809*	*4 856*	—	—	*7 953*
New Zealand	,,		*6 516*	*1 486*	*1 861*	*1 854*	*1 315*
U.K.	,,		*14 501*	*2 601*	*3 098*	*5 996*	*2 806*
U.S.A.	,,		*21 357*	*8 162*	*5 032*	—	*8 163*
Value	$'000	83 750	153 466	29 016	39 008	34 431	51 011
Rolled and extruded shapes	tonne	2 259	2 181	554	758	346	523
Value	$'000	1 514	2 332	396	780	298	858
Scrap	tonne	9 757	7 316	942	589	2 765	3 020
Value	$'000	2 535	4 292	328	274	1 539	2 151
Slags and residues	tonne	18 133	5 446	647	1 418	1 612	1 769
Value	$'000	1 863	3 704	280	950	1 278	1 196
Lead content of concentrates, residues, etc., exported	*tonne*	*95 091*	*38 847*	*9 924*	*2 786*	*13 318*	*12 819*
Lead content of lead bullion exported	,,	*147 101*	*141 243*	*33 540*	*45 662*	*53 062*	*8 979*

(a) Includes lead-silver ores. (b) Product of dump re-treatment. (c) Includes lead content of lead alloys from primary sources. (d) Time series prior to 1979 is on a different basis.

LIMESTONE

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production *(a) (b)*	**'000 tonnes**	**10 924**	(b)10 197	**2 402**	**2 560**	**2 625**	**2 611**
New South Wales	,,	2 903	3 280	776	726	914	865
Victoria	,,	2 245	2 179	514	508	601	556
Queensland	,,	1 802	1 800	450	450	450	450
South Australia	,,	1 890	2 130	466	603	494	567
Western Australia	,,	1 365	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Tasmania	,,	718	808	196	273	166	172
Cement, Portland	,,	**4 993**	5 243	**1 205**	**1 302**	**1 377**	**1 359**
IMPORTS							
Limestone and calcareous stone	tonne	1 320 216	1 317 225	321 597	346 680	368 344	280 604
Japan	,,	*1 272 471*	*1 269 274*	*321 590*	*322 660*	*344 457*	*280 567*
Other	,,	*47 745*	*47 951*	*7*	*24 020*	*23 887*	*37*
Value	$'000	6 743	6 522	1 784	1 718	1 780	1 240
Calcium carbide	tonne	3 080	8 353	473	102	5 684	2 094
Philippines	,,	*3 078*	*5 777*	*473*	*102*	*4 272*	*930*
Other	,,	*2*	*2 576*	..	..	*1 412*	*1 164*
Value	$'000	639	2 167	94	24	1 464	585
Cement, Portland grey	,,	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Cement, Portland white	tonne	17 406	14 063	3 858	3 109	3 358	3 738
Denmark	,,	*2 062*	*2 100*	*590*	*377*	*698*	*435*
Japan	,,	*12 230*	*9 249*	*2 064*	*2 368*	*2 187*	*2 630*
U.K.	,,	*1 016*	*804*	*183*	*237*	*110*	*274*
Other	,,	*2 098*	*1 910*	*1 021*	*127*	*363*	*399*
Value	$'000	1 291	1 125	328	243	267	287
Cement, Portland, other	tonne	1 725	2 177	39	36	139	1 963
Value	$'000	169	295	5	7	70	213
EXPORTS							
Cement, constructional	tonne	36 417	205 238	59 281	6 105	74 214	65 638
Value	$'000	1 611	5 420	1 305	370	2 023	1 722

(a) Including shell and coral. (b) Excludes Western Australia.

MAGNESITE

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production	**tonne**	**21 350**	**28 136**	**6 425**	**7 590**	**7 514**	**6 607**
New South Wales	"	20 280	28 136	6 425	7 590	7 514	6 607
Queensland	"	897	—	—	—	—	—
South Australia	"	173	—	—	—	—	—
IMPORTS							
Magnesite calcined, deadburned	tonne	9 790	15 477	7 250	6 218	—	2 009
Value	$'000	1 811	3 072	1 449	1 225	—	398
Magnesite calcined, other	tonne	(a)					
Value	$'000	(a)	(a)	(a)	(a)	(a)	(a)
Magnesite, other	tonne	(a)					
Value	$'000	(a)					
Magnesium oxide (b)—							
Electrically fused	tonne	2 912	604	95	164	163	182
Value	$'000	715	684	103	187	175	219
Other	tonne	12 605	6 049	1 634	43	68	4 304
Value	$'000	2 754	1 439	396	33	71	939
EXPORTS							
Magnesite and magnesium oxide	tonne	63 808	4 228	679	1 022	1 891	636
Value	$'000	8 195	876	127	212	393	144

(a) Not available separately—included with 'Magnesium oxide—other'.
(b) Predominantly seawater magnesite and seawater deadburned magnesite.

MANGANESE

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Metallurgical-grade	tonne	1 248 922	1 666 275	490 204	311 299	287 076	577 696
Manganese content	"	*608 438*	*793 336*	*235 095*	*146 986*	*138 397*	*272 858*
Manganese content of minerals produced							
Metallurgical-grade ore	"	608 438	793 336	235 095	146 986	138 397	272 858
Other grade ore	"	8 332	—	—	—	—	—
Zinc concentrate	"	5 385	6 432	1 412	1 811	1 748	1 461
Total contained manganese	"	**622 155**	**799 768**	**236 507**	**148 797**	**140 145**	**274 319**
Production, States: metallurgical-grade ore:							
Northern Territory	"	1 248 000	1 666 275	490 204	311 299	287 076	577 696
Western Australia	"	922	—	—	—	—	—
Total	"	**1 248 922**	**1 666 275**	**490 204**	**311 299**	**287 076**	**577 696**
IMPORTS *(a) (b)*							
Battery grade ore	tonne	2 962	—	—	—	—	—
Value	$'000	376	—	—	—	—	—
Other grade ore	tonne	..	119	68	17		34
Value	$'000		28	15	4		9
Unalloyed powders and flakes	tonne	1 209	957	123	259	257	318
Value	$'000	1 064	892	108	236	249	299

(a) Imports of ferromanganese are shown on page 38. (b) Details of exports of manganese ore are not available for publication.

MONAZITE

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Monazite concentrate	tonne	14 992	16 206	4 814	3 447	4 265	3 680
Monazite content	,,	*13 938*	*14 584*	*4 333*	*3 103*	*3 838*	*3 310*
Production: States, monazite content:							
New South Wales (a)	,,	210	1 570	114	114	1 173	169
Western Australia	,,	13 728	13 014	4 219	2 989	2 665	3 141
Total contained monazite	,,	**13 938**	**14 584**	**4 333**	**3 103**	**3 838**	**3 310**
EXPORTS							
Monazite concentrate	tonne	11 600	13 154	2 794	5 488	2 300	2 572
France	,,	*6 643*	*8 433*	*1 132*	*3 527*	*1 714*	*2 060*
U.K.	,,	*4 244*	*802*	*105*	*145*	*252*	*300*
Other	,,	*713*	*3 919*	*1 557*	*1 816*	*334*	*212*
Value	$'000	2 376	3 084	612	1 311	549	612

(a) Despatches.

NICKEL

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Nickel ore	tonne	1 805 933	2 081 501	612 661	435 534	547 560	485 746
Nickel content	,,	*28 895*	*33 305*	*9 803*	*6 969*	*8 761*	*7 772*
Cobalt content	,,	*2 077*	*2 498*	*735*	*523*	*657*	*583*
Nickel concentrate	,,	480 118	331 553	74 273	78 746	92 009	86 525
Nickel content	,,	*56 973*	*40 018*	*8 608*	*9 596*	*11 313*	*10 501*
Cobalt content	,,	*1 125*	*762*	*170*	*181*	*212*	*199*
Copper content	,,	*4 700*	*3 094*	*725*	*737*	*828*	*804*
Total contained nickel	,,	**85 868**	**73 323**	**18 411**	**16 565**	**20 074**	**18 273**
IMPORTS *(a)*							
Pigs, ingots and blocks	tonne	2 998	695	187	17	378	113
Value	$'000	11 719	3 375	713	85	1 940	637
Pellets, shot granulated	tonne	67	57	17	—	16	24
Value	$'000	274	281	64	—	87	130
Electroplating anodes	tonne	7	34	—	11	23	..
Value	$'000	57	201	—	65	136	
Bars, rods, angles, shapes and sections	tonne	56	74	29	45		
Value	$'000	365	491	173	308	4	6
Plates, sheets and strips	tonne	1	20	1	12		7
Value	$'000	15	98	11	53	2	32
Pipes and tubes	tonne	3	1		1		
Value	$'000	49	49	10	24	2	13
Wire	tonne	40	23	5	6	1	11
Value	$'000	279	126	13	46	13	54
Powder	tonne	52	11	1	10		
Value	$'000	248	78	23	45	6	4
Nickel-base alloys—							
Unworked shapes	tonne	172	98	3	4	20	71
Value	$'000	711	332	13	23	98	198
Bars, rods, angles, shapes and sections	tonne	118	286	63	122	46	55
Value	$'000	777	1 367	418	168	342	439
Plates, sheets and strips	tonne	471	3 373	49	100	99	3 125
Value	$'000	2 368	2 412	408	777	619	608
Pipes and tubes	tonne	49	239	11	9	5	214
Value	$'000	518	492	150	141	64	137
Wire	tonne	106	3 270	961	2 088	76	145
Value	$'000	872	1 764	141	723	613	287
Powder	tonne	323	42	4	12	10	16
Value	$'000	1 027	386	43	115	89	139
EXPORTS *(b)*							
Nickel—							
Concentrate	$'000	4 537	—	—	—	—	—
Metal, unwrought	,,	57 544	102 494	18 540	24 222	32 604	27 128
Matte and speiss	,,	143 991	221 077	25 409	37 155	71 815	86 698
Powder	,,	14 142	3 134	1 016	560	907	651

(a) Imports of ferronickel are shown on page 38. (b) Details of the quantities exported of nickel concentrate, nickel metal unwrought, nickel matte and speiss, and nickel powder are not available for publication.

		1978	1979*	1979* March	June	September	December
PRODUCTION *(Source: Energy Economics Branch, Department of National Development & Energy)*							
Petroleum production							
Crude oil	'000 m^3	25 187	25 368	5 969	6 389	6 525	6 485
Natural gas	'000 000 m^3	7 320	8 382	1 661	2 205	2 464	2 052
Refinery operations							
Input of feedstock	'000 m^3	35 995	36 850	8 592	8 914	9 957	9 387
Products							
Refinery gas (a) (b) (c)	,,	106	60	25	13	9	13
Liquefied petroleum gas	,,	657	642	151	150	175	166
Aviation gasoline	,,	56	68	9	19	20	20
Motor spirit	,,	13 825	14 020	3 200	3 627	3 570	3 623
Power kerosene	,,	18	22	6	5	6	5
Aviation turbine fuel	,,	2 215	2 319	586	531	560	642
Lighting kerosene	,,	242	243	48	85	79	31
Heating oil	,,	725	551	89	177	229	56
Automotive distillate	,,	6 881	7 641	1 760	1 768	2 087	2 026
Industrial diesel fuel	,,	1 458	1 190	248	276	323	343
Furnace fuel (b)	,,	4 569	4 605	1 211	1 028	1 177	1 189
Solvents	,,	219	220	54	44	61	61
Lubricating oil base stock	,,	591	591	154	124	140	173
Bitumen	,,	479	522	141	123	114	144
Other marketable products	,,	1 076	878	255	244	194	185
Refinery fuel—							
Liquid	,,	500	446	102	124	110	110
Gas and coke (a)	,,	1 972	1 938	513	474	493	458
IMPORTS							
Natural crude	'000 m^3	6 427	6 137	1 422	1 044	2 017	1 654
Value	$'000	448 325	594 423	104 790	90 122	207 229	192 282
Enriched crude and other refinery stock	'000 m^3	4 700	4 567	1 509	955	1 219	884
Value	$'000	336 061	422 104	109 277	83 398	114 928	114 501
Gasoline, solvents and other petroleum spirits	'000 m^3	609	918	314	228	231	145
Value	$'000	75 927	134 976	39 397	31 103	36 327	28 149
Kerosene and aviation turbine fuel	'000 m^3	57	179	40	13	54	72
Value	$'000	6 869	25 948	5 025	1 539	8 370	11 014
Automotive distillate, industrial and marine diesel fuels and heavy distillates, n.e.i.	'000 m^3	803	707	183	157	146	221
Value	$'000	72 574	96 665	17 113	17 043	21 589	40 920
Residual oils	'000 m^3	2 134	2 669	607	757	723	582
Value	$'000	136 720	224 558	37 942	53 310	68 688	64 618
Lubricating oil	'000 m^3	43	46	7	20	15	4
Value	$'000	9 191	11 484	1 811	3 982	3 716	1 975
EXPORTS							
Natural crude	'000 m^3	..	113	6	53	53	1
Value	$'000		24 237	744	9 010	7 342	7 141
Partly refined petroleum	'000 m^3	288	222	74	78	43	27
Value	$'000	21 690	29 628	6 206	12 517	6 545	4 360
Gasoline, solvents and other petroleum spirits	'000 m^3	515	278	9	66	78	125
Value	$'000	55 764	68 507	12 518	10 447	14 681	30 861
Kerosene and aviation turbine fuel	'000 m^3	302	393	125	124	77	67
Value	$'000	30 606	53 453	12 865	15 729	12 994	11 865
Automotive distillate, industrial and marine diesel fuels and heavy distillates, n.e.i.	'000 m^3	947	741	224	219	142	156
Value	$'000	67 072	110 874	22 178	32 841	25 719	30 136
Residual oils	'000 m^3	244	439	132	6	33	268
Value	$'000	17 220	49 461	9 158	592	3 198	36 513
Lubricating oils	'000 m^3	237	260	40	102	61	57
Value	$'000	41 656	57 257	8 080	18 690	14 323	16 164

(a) Fuel-oil equivalent. *(b)* Excludes refinery fuel. *(c)* For sale as fuel.

PHOSPHATE

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Phosphate rock	tonne	248 328	6 999	—	3 073	—	3 926
Queensland	,,	*238 332*	—	—	—	—	—
South Australia	,,	*9 996*	*6 999*	—	*3 073*	—	*3 926*
Production of superphosphate (a)	**'000 tonnes**	**3 481**	**3 983**	**1 063**	**1 123**	**645**	**1 152**
IMPORTS							
Phosphate rock	'000 tonnes	2 052	2 388	540	739	477	632
Christmas Island (Indian Ocean)	,,	*606*	*673*	*175*	*160*	*177*	*161*
Nauru	,,	*1 112*	*1 277*	*206*	*421*	*286*	*364*
Other	,,	*334*	*967*	*159*	*158*	*15*	*107*
Value	$'000	70 662	89 026	20 825	28 202	17 169	22 830

(a) Includes double and triple superphosphate and ammonium phosphate expressed in terms of single superphosphate, i.e. 22% P_2O_5 equivalent.

SALT

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production (a)	**'000 tonnes**	**5 766**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
Victoria	,,	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Queensland	,,	150	n.a.	n.a.	n.a.	n.a.	n.a.
South Australia	,,	679	n.a.	n.a.	n.a.	n.a.	n.a.
Western Australia	,,	4 938	4 328	809	1 304	983	1 232
IMPORTS							
Salt, common	tonne	19 444	19 620	13 440	2 427	1 658	2 095
Value	$'000	536	581	170	161	112	138
EXPORTS							
Salt	'000 tonnes	4 653	4 544	824	1 235	1 357	1 128
Value	$'000	32 639	33 069	5 699	9 033	9 917	8 420

(a) Excludes Victoria.

SILLIMANITE *(a)*

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production	**tonne**	**568**	**568**	**128**	**194**	**136**	**110**
South Australia	,,	568	568	128	194	136	110

(a) Imports not available separately—included under clays.

SILVER

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Silver content of minerals produced							
Bismuth concentrate	kilogram	120	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Copper ore	,,	16 407	5 501	5 336	55	55	55
Copper concentrate	,,	26 742	35 664	7 611	9 637	9 493	8 923
Gold bullion	,,	1 488	1 819	333	412	380	694
Silver-gold concentrate	,,	13	13	4	4	2	3
Lead ore (a)	,,	1 041	1 509	641	294	331	243
Lead concentrate	,,	623 294	674 073	176 638	185 274	157 107	155 054
Lead-copper concentrate	,,	55 294	47 227	12 211	12 434	10 924	11 658
Nickel concentrate	,,	191	—	—	—	—	—
Silver concentrate	,,	27 283	1 595	1 595	—	—	—
Zinc concentrate	,,	60 651	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
New South Wales	,,	306 936	298,439	70 394	74 433	80 438	73 174
Queensland	,,	417 377	456 317	126 453	128 565	99 865	101 434
South Australia	,,	—	429	—	429	—	—
Western Australia	,,	1 678	1 819	333	412	380	694
Tasmania	,,	86 192	76 597	19 869	19 621	18 318	18 789
Northern Territory	,,	341	460	81	84	145	150
Total contained silver	,,	**812 524**	**834 061**	**27 130**	**223 544**	**199 146**	**194 241**
Refinery production							
Refined silver	,,	298 561	294 914	72 603	77 423	73 603	71 285

IMPORTS

		1978	1979*	1979* March	June	September	December
Silver							
Silver and alloys	kilogram	1 115	404	126	109	41	128
Fiji	,,	*151*	—	—	—	—	—
New Zealand	,,	*71*	*48*		—	*28*	*20*
U.K.	,,	*199*	*39*	*12*	*2*	*9*	*16*
U.S.A.	,,	*134*	*185*	*68*	*107*		*10*
Other	,,	*559*	*131*	*46*		*3*	*92*
Value	$'000	312	176	39	35	17	85

EXPORTS

		1978	1979*	1979* March	June	September	December
Silver, refined							
Mint bullion	kilogram	76 339	44 943	20 928	8 049	6 808	8 982
Value	$'000	9 917	10 451	3 021	1 820	1 683	3 927
Refined, other	kilogram	9 157	38 265	21 009	7 906	6 137	3 213
Value	$'000	1 530	10 106	4 929	1 609	1 739	1 829
Silver content of concentrate, matte, etc. exported	*kilogram*	*166 102*	*147 940*	*16 489*	*12 157*	*31 514*	*87 780*
Silver content of lead bullion exported	,,	*290 207*	*286 168*	*75 022*	*81 129*	*110 625*	*19 392*

(a) Includes lead-silver ores.

SULPHUR

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Pyrite concentrate (a)	tonne	204 724	44 910	22 840	12 707	9 363	—
Sulphur content	"	*92 714*	*21 799*	*11 127*	*6 121*	*4 551*	—
Sulphur content of minerals produced							
Lead concentrate	"	52 749	60 662	13 402	15 255	15 760	16 245
Lead-copper concentrate	"	8 196	7 552	2 193	1 769	1 611	1 979
Pyrite concentrate	"	92 714	21 799	11 127	6 121	4 551	—
Zinc concentrate	"	266 517	292 245	61 917	75 343	76 009	78 976
New South Wales	"	203 813	236 451	49 387	62 858	62 473	61 733
Queensland	"	67 397	68 641	14 693	16 671	16 829	20 448
Tasmania	"	148 966	77 166	24 559	18 959	18 629	15 019
Total contained sulphur	"	**420 176**	**382 258**	**88 639**	**98 488**	**97 931**	**97 200**
Sulphuric acid production	**'000 tonnes**	**1 870**	**2 074**	**533**	**543**	**438**	**560**
IMPORTS							
Sulphur, elemental	tonne	496 804	436 220	86 975	79 910	118 097	151 238
Canada	"	*470 376*	*336 996*	*86 961*	*69 810*	*78 927*	*101 298*
Iran	"	*26 134*	—	—	—	—	—
U.S.A.	"	*109*	*99 038*	—	*10 047*	*39 051*	*49 940*
Other	"	*186*	*186*	*14*	*53*	*119*	—
Value	$'000	15 548	19 805	2 954	3 333	5 443	8 075

(a) Gold content not recorded separately; included in gold content of gold bullion.

TALC *(a)*

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production	**tonne**	**146 954**	**156 870**	**29 064**	**39 166**	**30 158**	**58 482**
New South Wales	"	9 506	18 754	1 390	4 942	8 055	4 367
South Australia	"	14 070	15 565	3 404	4 598	3 146	4 417
Western Australia	"	123 378	122 551	24 270	29 626	18 957	49 698
IMPORTS							
Talc	tonne	527	420	114	26	89	191
China (excl. Taiwan Province)	"	*201*	*161*	*60*	—	—	*101*
U.S.A.	"	*236*	*168*	*29*	*15*	*79*	*45*
Other	"	*90*	*92*	*26*	*10*	*11*	*45*
Value	$'000	103	85	18	7	25	35
EXPORTS							
Talc	tonne	106 177	107 849	24 126	30 809	18 015	34 899
Japan	"	*90 577*	*85 511*	*16 988*	*26 223*	*11 235*	*31 065*
Netherlands	"	*11 291*	*12 868*	*3 091*	*3 729*	*3 000*	*3 048*
Other	"	*4 309*	*9 470*	*4 047*	*857*	*3 780*	*786*
Value	$'000	5 338	6 330	1 393	1 890	1 051	1 996

(a) Includes steatite, chlorite and pyrophyllite.

TIN

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Copper-tin concentrate	tonne	1 894	1 983	395	433	387	768
Copper content	,,	*451*	*446*	*97*	*96*	*81*	*172*
Tin content	,,	*47*	*47*	*11*	*9*	*9*	*18*
Tin concentrate	,,	22 898	21 874	4 587	6 160	5 536	5 591
Tin content	,,	*11 817*	*11 456*	*2 282*	*3 267*	*2 866*	*3 041*
Production: States, tin content							
New South Wales	,,	2 312	2 699	624	772	748	555
Victoria	,,	1		—		—	
Queensland	,,	1 775	1 771	292	353	383	743
Western Australia	,,	497	397	109	82	111	95
Tasmania	,,	7 270	6 628	1 266	2 067	1 631	1 664
Northern Territory	,,	9	8	2	2	2	2
Total contained tin	,,	**11 864**	**11 503**	**2 293**	**3 276**	**2 875**	**3 059**
Smelter and refinery production							
Refined tin	,,	5 129	5 423	1 220	1 293	1 386	1 524
IMPORTS *(a)*							
Refined tin	tonne	204	5				5
Value	$'000	2 701	69				69
EXPORTS *(a)*							
Tin concentrate	tonne	15 109	13 177	2 957	3 646	3 605	2 969
Value	$'000	67 841	83 114	14 760	28 527	21 800	18 027
Tin, unworked—							
Refined	tonne	2 079	1 621	228	174	620	599
Value	$'000	21 524	22 041	3 191	2 266	8 222	8 362
Alloys	tonne	67	125	105	6	8	6
Value	$'000	443	1 473	1 325	53	52	43
Tin content of all concentrates, slags, residues, etc. exported	*tonne*	*6 992*	*6 467*	*1 442*	*1 646*	*1 869*	*1 510*

(a) Production and overseas trade details for tinplate are shown on page 38.

TITANIUM

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Ilmenite concentrate	tonne	1 254 994	1 150 465	299 126	269 145	297 563	284 631
Titanium dioxide content	,,	*716 755*	*647 082*	*170 537*	*150 110*	*166 891*	*159 544*
Leucoxene concentrate	,,	16 103	21 773	4 411	3 956	6 071	7 335
Titanium dioxide content	,,	*14 650*	*19 441*	*3 969*	*3 516*	*5 406*	*6 550*
Rutile concentrate	,,	257 075	278 901	69 194	70 021	74 512	65 174
Titanium dioxide content	,,	*246 915*	*267 708*	*66 437*	*67 220*	*71 514*	*62 537*
Titanium dioxide content of minerals produced							
Titanium dioxide contained in:							
Ilmenite concentrate	,,	716 755	647 082	170 537	150 110	166 891	159 544
Leucoxene concentrate	,,	14 650	19 441	3 969	3 516	5 406	6 550
Rutile concentrate	,,	246 915	267 708	66 437	67 220	71 514	62 537
Total contained titanium dioxide	,,	**978 320**	**934 231**	**240 943**	**220 846**	**243 811**	**228 631**
Production: States (titanium dioxide content)							
Ilmenite concentrate (a)							
New South Wales	,,	30 484	10 842	3 650	3 732	1 936	1 524
Queensland	,,	25 020	1 343	396	357	216	374
Western Australia	,,	675 901	654 338	170 460	149 537	170 145	164 196
Total	,,	**731 405**	**666 523**	**174 506**	**153 626**	**172 297**	**166 094**
Rutile concentrate							
New South Wales	,,	100 400	81 401	24 741	22 505	21 030	13 125
Queensland	,,	50 408	89 227	19 290	22 516	23 773	23 648
Western Australia	,,	96 107	97 080	22 406	22 199	26 711	25 764
Total	,,	**246 915**	**267 708**	**66 437**	**67 220**	**71 514**	**62 537**

TITANIUM *(continued)*

		1978	1979*	1979* March	June	September	December
IMPORTS							
Titanium oxide—							
Anatase	tonne	45	7		2		5
Value	$'000	36	12		3	2	7
Rutile	tonne	1 002	645	212	91	89	253
Value	$'000	671	567	158	83	79	247
Titanium white pigment	tonne	115	131		61		70
Value	$'000	121	262	1	84	31	146
EXPORTS							
Ilmenite concentrate (a)	tonne	1 000 152	911 325	174 433	243 273	229 086	264 533
Brazil	..	*46 578*	*56 437*	*28 130*	—	—	*28 307*
France	..	*155 825*	*82 292*	*28 152*	*17 825*	*36 315*	—
Japan	..	*73 775*	*53 004*	*2 209*	*13 788*	*5 555*	*31 452*
U.K.	..	*226 732*	*200 854*	*43 367*	*58 380*	*52 660*	*46 447*
U.S.A.	..	*266 298*	*165 738*	*41 886*	*44 178*	*74 165*	*5 509*
Other	..	*230 944*	*353 000*	*30 689*	*109 102*	*60 391*	*152 818*
Value	$'000	16 752	18 859	3 895	4 714	5 377	4 873
Rutile concentrate	tonne	371 268	317 780	85 544	75 314	73 454	83 468
Canada	..	*10 827*	*351*	*18*	*62*	*54*	*217*
Japan	..	*25 648*	*26 879*	*3 692*	*11 240*	*4 823*	*7 124*
Netherlands	..	*27 710*	*22 088*	*7 141*	*4 526*	*7 423*	*2 998*
U.K.	..	*47 596*	*81 422*	*26 180*	*10 079*	*20 055*	*25 108*
U.S.A.	..	*195 004*	*121 123*	*28 429*	*34 639*	*31 082*	*26 973*
Other	..	*64 483*	*65 917*	*20 084*	*14 768*	*10 017*	*21 048*
Value	$'000	69 142	69 342	16 252	15 405	17 794	19 891

(a) Includes leucoxene concentrate.

TUNGSTEN

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Scheelite concentrate	tonne	3 437	3 416	640	940	880	956
Tungstic oxide (WO) content	*unit*	*249 000*	*249 994*	*47 076*	*68 977*	*64 289*	*69 652*
Wolfram concentrate	tonne	1 363	2 146	561	512	573	500
Tungstic oxide (WO) content	*unit*	*92 400*	*149 447*	*38 609*	*36 175*	*39 762*	*34 901*
Tungstic oxide (WO) content of minerals produced							
Scheelite concentrate							
Queensland	unit	—	3 217	100	835	1 308	974
Western Australia	..	—	—	—	—	—	—
Tasmania	..	249 000	246 777	46 976	68 142	62 981	68 678
Northern Territory	..	—	—	—	—	—	—
Total contained in scheelite	..	**249 000**	**249 994**	**47 076**	**68 977**	**64 289**	**69 652**
Wolfram concentrate							
New South Wales	..	—	—	—	—	—	—
Queensland	..	78 400	137 266	36 023	33 004	36 374	31 865
Tasmania	..	14 000	12 181	2 586	3 171	3 388	3 036
Northern Territory	..	—	—	—	—	—	—
Total contained in wolfram	..	**92 400**	**149 447**	**38 609**	**36 175**	**39 762**	**34 901**
Total contained in tungsten minerals	..	**341 400**	**399 441**	**85 685**	**105 152**	**104 051**	**104 553**
EXPORTS							
Scheelite concentrate	tonne	3 936	3 442	935	934	736	837
Value	$'000	40 014	32 255	8 796	8 729	7 230	7 500
Wolfram concentrate	tonne	827	1 690	467	502	364	357
Value	$'000	6 642	19 010	3 338	3 766	3 304	8 602
Tungstic oxide (WO) content of concentrates exported	*unit*	*349 772*	*358 994*	*90 070*	*106 767*	*77 520*	*84 637*
In scheelite concentrate	..	275 027	243 813	68 323	65 565	50 684	59 241
In wolfram concentrate	..	74 745	115 181	21 747	41 202	26 836	25 396

URANIUM

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Uranium oxide (U_3O_8)	tonne	607	832	148	215	235	234
Uranium content	..	515	707	*126*	*182*	*200*	*199*
EXPORTS							
Uranium oxide (U_3O_8)	tonne	1 114	1 317	486	223	226	382
Value	$'000	66 908	102 275	37 432	16 484	17 164	31 195

ZINC

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Zinc concentrate	tonne	841 869	943 187	196 467	239 374	260 648	246 698
Zinc content	..	*433 578*	*482 886*	*99 793*	*123 264*	*132 487*	*127 342*
Lead content	..	*17 910*	*20 730*	*4 668*	*4 668*	*6 330*	*5 064*
Silver content	*kilogram*	*60 651*	*n.a.p.*	*n.a.p.*	*n.a.p.*	*n.a.p.*	*n.a.p.*
Gold content	..	*261*	*n.a.p.*	*n.a.p.*	*n.a.p.*	*n.a.p.*	*n.a.p.*
Cadmium content	*tonne*	*1 459*	*1 695*	*344*	*418*	*477*	*456*
Cobalt content	..	*93*	*97*	*22*	*29*	*25*	*21*
Copper content	..	*1 193*	*n.a.p.*	*n.a.p.*	*n.a.p.*	*n.a.p.*	*n.a.p.*
Manganese content	..	*5 385*	*6 432*	*1 412*	*1 811*	*1 748*	*1 461*
Sulphur content	..	*266 517*	*292 245*	*61 917*	*75 343*	*76 009*	*78 976*
Zinc content of minerals produced							
Copper concentrate	..	1 217	3 291	341	986	1 207	757
Copper-lead-zinc ore	..	803	233	233	—	—	—
Lead concentrate	..	34 827	42 542	10 067	11 300	10 157	11 018
Lead-copper concentrate	..	2 834	2 817	747	618	624	828
Silver concentrate	..	34	—	—	—	—	—
Zinc concentrate	..	433 578	482 886	99 793	123 264	132 487	127 342
New South Wales	..	267 925	327 744	65 022	87 226	93 704	81 792
Queensland	..	127 980	128 789	28 402	31 267	31 544	37 576
South Australia	..	—	—	—	—	—	—
Tasmania	..	77 388	75 236	17 757	17 675	19 227	20 577
Total contained zinc	..	**473 293**	**531 769**	**111 181**	**136 168**	**144 475**	**139 945**
Smelter and refinery production							
Refined zinc	..	290 066	305 394	73 591	76 000	77 783	78 020
EXPORTS							
Zinc concentrate	tonne	467 718	376 806	119 152	77 602	101 297	78 755
Belgium-Luxembourg	..	*4 823*	*22 384*	*8 361*	*7 455*	*2 804*	*3 764*
Bulgaria	..	*21 906*	—	—	—	—	—
India	..	*30 942*	*19 013*	*10 590*	—	*130*	*8 293*
Japan	..	*200 069*	*228 852*	*63 036*	*46 495*	*83 992*	*35 329*
Netherlands	..	*87 952*	*13 165*	*13 165*	—	—	—
U.K.	..	*51 492*	*43 174*	*13 049*	—	*5 301*	*24 824*
Other	..	*70 534*	*80 516*	*10 951*	*53 950*	*9 070*	*6 545*
Value	$'000	47 661	59 349	16 269	13 309	17 293	12 478

ZINC *(continued)*

		1978	1979*	1979* March	June	September	December
EXPORTS *(continued)*							
Refinery-type shapes	tonne	215 368	160 988	38 140	44 661	40 966	37 221
China (excl. Taiwan Province)	,,	—	—	—	—	—	—
China (Taiwan Province only)	,,	*36 108*	*22 089*	*7 068*	*7 637*	*3 147*	*4 237*
India	,,	*10 858*	*18 496*	*3 803*	*4 318*	*6 432*	*3 943*
Indonesia	,,	*34 502*	*21 597*	*6 737*	*3 927*	*6 027*	*4 906*
New Zealand	,,	*11 876*	*15 011*	*1 740*	*4 568*	*4 092*	*4 611*
Thailand	,,	*21 585*	*19 706*	*6 158*	*4 277*	*3 226*	*6 045*
U.K.	,,	*3 705*	*2 534*	*1 135*	*136*	*957*	*306*
U.S.A.	,,	*38 068*	*27 014*	*3 482*	*10 253*	*9 611*	*3 668*
Other	,,	*58 666*	*34 541*	*8 017*	*9 545*	*7 474*	*9 505*
Value	$'000	107 237	105 571	23 379	31 089	26 562	24 541
Plates, circles and strips	tonne	49	38	1	5	15	17
Value	$'000	80	72	3	14	27	28
Slags and residues	tonne	5 454	3 523	513	1 075	988	947
Value	$'000	1 486	1 627	266	464	450	447
Zinc content of ores and concentrates, slags, residues, etc. exported	*tonne*	*251 622*	*189 836*	*63 624*	*40 042*	*54 234*	*31 936*

ZIRCONIUM

		1978	1979*	1979* March	June	September	December
PRODUCTION							
Mine production							
Minerals produced							
Zircon concentrate	tonne	391 606	446 980	115 213	115 138	111 386	105 243
Zircon content	,,	*386 724*	*440 119*	*113 785*	*113 731*	*109 216*	*103 387*
Production. States, zircon content							
New South Wales	,,	108 823	95 921	27 554	31 642	22 221	14 504
Queensland	,,	62 148	78 942	17 361	20 123	21 829	19 629
Western Australia	,,	215 753	265 256	68 870	61 966	65 166	69 254
Total contained zircon	,,	**386 724**	**440 119**	**113 785**	**113 731**	**109 216**	**103 387**
EXPORTS							
Zircon concentrate	tonne	391 276	479 115	114 126	137 385	124 206	103 398
Belgium-Luxembourg	,,	*13 915*	*8 122*	—	—	*8 104*	*18*
Canada	,,	*16 520*	*16 719*	*202*	*16 066*	*36*	*415*
France	,,	*24 501*	*21 793*	*4 505*	*2 274*	*4 916*	*10 098*
Italy	,,	*40 348*	*64 774*	*19 872*	*16 522*	*13 566*	*14 814*
Japan	,,	*109 364*	*188 080*	*48 137*	*48 689*	*47 039*	*44 215*
Netherlands	,,	*39 185*	*35 237*	*15 855*	*6 847*	*7 877*	*4 658*
U.K.	,,	*29 020*	*20 455*	*5 590*	*2 177*	*3 547*	*9 141*
U.S.A.	,,	*56 614*	*49 117*	*5 280*	*20 218*	*19 455*	*4 164*
Other	,,	*61 808*	*74 818*	*14 685*	*24 592*	*19 666*	*15 875*
Value	$'000	29 365	33 115	8 149	9 282	8 396	7 288

MINOR MINERALS

		1978	1979*	1979* March	June	September	December
BARITE							
Mine production	tonne	10 844	10 825	1 991	2 952	2 935	2 947
Imports (including witherite)	,,	541	1 171	201	200	119	651
Value	$'000	72	89	21	22	9	37
Exports	tonne	969	1 232	345	282	413	192
Value	$'000	113	205	112	33	33	27

MINOR MINERALS

		1978	1979*	1979* March	June	September	December
BISMUTH							
Mine production							
Bismuth concentrate	tonne	3 900	n.a.p.	n.a.p.	n.a.p.	n.a.p.	n.a.p.
Bismuth content	,,	*1 054*					
Gold content	*kilogram*	*128*					
Copper content	*tonne*	*706*					
Selenium content	*unit*	—					
Silver content	*kilogram*	*120*					
Bismuth content of minerals produced							
Bismuth concentrate	tonne	1 054					
Copper concentrate	,,	—					
Total contained bismuth	,,	**1 054**					
Imports							
Bismuth metal	tonne	22	13	3	10		
Value	$'000	135	81	15	41		25
CLAYS							
Mine production							
Brick clay and shale	'000 tonnes	8 563	8 969	1 940	2 230	2 429	2 370
Imports							
Andalusite, mullite, Dinas earth, kyanite and sillimanite	tonne	385	3 033	2 149	213	361	310
Value	$'000	39	236	132	21	43	40
Bentonite and bentonitic clay	tonne	30 355	57 241	19 145	3 050	11 773	23 273
Value	$'000	1 375	2 028	588	552	243	645
Clay, ball	tonne	1 571	560	210	208	74	68
Value	$'000	153	57	15	26	11	5
Clays and earths, activated	tonne	3 786	42 147	1 368	958	1 415	38 406
Value	$'000	649	1 144	242	239	397	266
China clay, incl. kaolin	tonne	10 202	6 193	499	226	228	5 240
Value	$'000	597	479	56	48	37	338
Fireclay	tonne	301	223	39	32	112	40
Value	$'000	44	39	4	6	23	6
Clays, n.e.l.	tonne	27 217	45 636	13 022	11 667	9 836	11 111
Value	$'000	2 457	3 842	881	1 174	667	1 120
Exports							
Clays (except activated)	tonne	13 408	6 092	2 516	1 672	786	1 118
Value	$'000	1 054	525	211	176	54	84
COBALT							
Mine production							
Cobalt content of minerals produced							
Nickel ore	tonne	2 418	2 498	735	523	657	583
Nickel concentrate	,,	882	762	170	181	212	199
Zinc concentrate	,,	93	97	22	29	25	21
Total contained cobalt	,,	**3 393**	**3 357**	**927**	**733**	**894**	**803**
Imports							
Cobalt oxide and hydroxide	tonne	13	16	2	3	5	6
Value	$'000	186	627	52	97	219	259
Cobalt and cobalt-base metal alloys (excl. powder)	tonne	14	18	2	7	7	2
Value	$'000	257	880	84	377	361	58
CRYOLITE, NATURAL							
Imports (including chiolite)	tonne	175	112	28	44	31	9
Value	$'000	80	63	15	25	18	5
DIAMONDS, INDUSTRIAL							
Imports	metric carat	892 220	1 139 237	373 669	352 146	229 712	183 647
Value	$'000	5 921	7 330	978	1 505	2 254	2 593
Exports (a)	metric carat	200 593	247 861	30 750	102 991	51 962	62 158
Value	$'000	1 474	1 949	298	532	471	648

(a) Excludes powder and dust.

MINOR MINERALS

				1979*			
		1978	1979*	March	June	September	December
DIATOMITE							
Mine production	tonne	2 821	588	102	143	83	260
Imports	,,	13 707	7 532	2 910	2 080	680	1 862
Value	$'000	1 740	1 759	433	352	283	691
DOLOMITE							
Mine production	tonne	638 422	726 004	164 647	197 141	177 172	187 044
FELSPAR							
Mine production	tonne	3 185	4 340	116	1 185	872	2 167
FLUORSPAR							
Imports	tonne	32 711	27 012	10 653	5 550	8 621	2 188
Value	$'000	1 637	1 604	674	304	497	129
MERCURY							
Refinery production	kilogram	—	—	—	—	—	—
Imports	,,	75 941	47 990	10 115	10 722	21 609	5 544
China (excl. Taiwan Province)	,,	*52 406*	*17 423*	*2 415*	—	*13 628*	*1 380*
Japan	,,	—	*18 285*	—	*6 900*	*7 935*	*3 450*
Spain	,,	*17 940*	*11 385*	*7 590*	*3 795*	—	—
U.S.A.	,,	*321*	*174*	*110*	*15*	*36*	*13*
Other	,,	*5 274*	*723*	..	*12*	*10*	*701*
Value	$'000	260	308	33	75	160	40
MICA							
Imports							
Ground or pulverised	tonne	277	335	20	67	77	171
Value	$'000	54	67	8	19	14	26
Other	tonne	203	292	21	66	70	135
Value	$'000	111	97	19	36	13	29
PEAT							
Mine production *(b)*	tonne	2 877	4 075	1 157	564	974	1 380
Imports	,,	12 005	26 066	1 147	7 688	10 754	6 477
Value	$'000	1 087	1 122	177	428	269	248
PLATINUM AND PLATINUM-GROUP METALS							
Imports							
Ingots, blocks, pigs, etc.	kilogram	4 542	1 333	333	156	213	631
Value	$'000	2 196	3 060	876	810	683	691
Powder	kilogram	42	2 703	6	124	1 056	1 517
Value	$'000	96	197	6	67	53	71
Wire	kilogram	86	120	6	26	37	51
Value	$'000	284	569	63	222	156	128
POTASSIUM							
Imports							
Potassium chloride (fertiliser grade)	tonne	164 286	158 064	35 936	20 950	67 846	33 332
Value	$'000	8 277	9 384	1 928	1 166	3 897	2 393
Potassium sulphate (fertiliser grade)	tonne	5 711	8 546	5 128	656	328	2 434
Value	$'000	741	1 194	616	84	45	449
TANTALUM AND COLUMBIUM (NIOBIUM) *(a)*							
Exports							
Tantalite-columbite concentrate	tonne	125	312	39	49	167	57
Value	$'000	2 243	5 950	900	1 598	1 051	2 402

(a) Details of mine production are not available for publication. *(b)* Excludes Western Australia.

Summary Tables

MINE PRODUCTION OF PRINCIPAL MINERALS: AUSTRALIA

Mineral	Unit of Quantity	1978	1979*	1979* June	1979* September	1979* December	1980* March
Bauxite	'000 tonnes	24 293	27 585	6 484	7 064	7 436	6 579
Black coal	,,	79 827	83 142	21 005	20 750	22 116	18 703
Brown coal	,,	32 860	32 597	8 465	9 465	7 692	7 134
Copper (a)	tonne	222 111	234 735	62 382	57 815	55 435	48 457
Gold (a)	kilogram	20 142	18 295	4 687	4 487	4 553	4 763
Iron ore and concentrate (b)	'000 tonnes	83 134	91 709	18 255	24 667	26 573	21 579
Lead (a)	tonne	400 291	417 485	109 095	107 486	101 250	90 515
Manganese ore, metallurgical	,,	1 248 922	1 666 275	311 299	287 076	577 696	686 819
Nickel (a)	,,	85 868	73 323	16 565	20 074	18 273	16 609
Petroleum—							
Crude oil	'000 m^3	25 187	25 368	6 389	6 525	6 485	5 593
Natural gas	'000 000 m^3	7 320	8 382	2 205	2 464	2 052	1 977
Silver (a)	kilogram	812 524	834 061	223 544	199 146	194 241	180 690
Tin (a)	tonne	11 864	11 503	3 276	2 875	3 059	2 535
Titanium—							
Ilmenite concentrate (c)	,,	1 254 994	1 150 465	269 145	297 563	284 631	291 420
Rutile concentrate	,,	257 075	278 901	70 021	74 512	65 174	69 358
Tungsten concentrate (d)	unit	341 400	399 441	105 152	104 051	104 553	85 107
Zinc (a)	tonne	473 293	531 769	136 168	144 475	139 945	10[illegible] 295
Zircon concentrate	,,	391 606	446 980	115 138	111 386	105 243	108 437

(a) Total metallic content of minerals produced. (b) Excludes iron oxide not intended for metal extraction. (c) Excludes leucoxene. (d) Tungstic oxide content.

SMELTER AND REFINERY PRODUCTION OF PRINCIPAL METALS: AUSTRALIA

Mineral	Unit of Quantity	1978	1979*	1979* June	1979* September	1979* December	1980* March
Alumina	tonne	6 775 675	7 414 606	1 817 845	1 911 047	1 893 518	1 837 388
Aluminium (refined)	,,	263 361	269 575	66 053	68 103	70 288	71 538
Cadmium (refined)	,,	747	804	202	166	235	244
Copper (blister) (a)	,,	164 395	167 146	44 228	41 651	38 014	39 489
Copper (refined)	,,	152 621	138 249	33 458	38 071	33 428	33 535
Gold (refined) (b)—							
Australian origin	kilogram	16 645	14 987	3 001	3 978	3 770	3 779
Total	,,	17 988	16 603	3 301	4 331	4 306	4 131
Lead—							
Refined (c)	tonne	204 022	215 734	54 606	51 820	53 816	49 019
Lead content of lead bullion for export	,,	151 964	169 469	44 357	44 416	39 673	39 103
Pig iron	'000 tonnes	7 337	7 811	1 916	1 984	2 045	1 885
Raw steel (d)	,,	7 589	8 125	1 973	2 097	2 157	2 049
Silver (refined)	kilogram	298 561	294 914	77 423	73 603	71 285	73 136
Tin (refined)	tonne	5 129	5 423	1 293	1 386	1 524	985
Zinc (refined)	,,	290 066	305 394	76 000	77 783	78 020	71 628

(a) Total production for refining in Australia and overseas. (b) Newly-won gold. (c) Includes lead content of lead alloys from primary sources. (d) Includes recovery from scrap.

Note: Particulars of crude oil and natural gas were collected by Energy Economics Branch, Department of National Development & Energy; particulars of refined aluminium, cadmium, copper, gold, lead, silver, tin and zinc were collected by the Bureau of Mineral Resources.

books and maps, and information on prices, may be obtained from: Publications Sales, Bureau of Mineral Resources, Cnr of Constitution Avenue and Anzac Parade, Parkes, ACT (PO Box 378, Canberra City, ACT 2601) or phone (062) 49 9519. Back issues of the *AMI Annual Review* and *Quarterly* are available in limited numbers.

Coloured geological maps cost $6.00 and $12.00 per sheet, depending on scale, and geophysical and preliminary geological maps $4.00/sheet. Other publications are priced individually; prices are given in the *Catalogue of Publications* and in the *Quarterly List of Publications*, but are subject to change.

Enquiries about geographic, topographic, and resource maps, and air photographs and related topics should be directed to the Division of National Mapping, PO Box 548, Queanbeyan 2620, or phone (062) 97 4022.

A reference set of BMR publications and 1:250 000 scale geological maps and Explanatory Notes is available for inspection at the NATMAP sales office in Sydney (Australian Government Centre, Chifley Square—phone (02) 239 0433). This office has order forms for all BMR maps and publications and will accept pre-paid orders for forwarding to Canberra.

Orders for publications must be accompanied by payment in advance. Prices charged include postage by surface mail. An additional charge is made for special delivery, e.g. airmail, airfreight. Cheques, postal orders etc., should be made payable to Receiver of Public Moneys, Department of National Development. Payment from abroad should be made by bank draft or international money order.

Lists of publications, lists of Records available on open file, and further information on the availability of preliminary data may be obtained from Information Section, Bureau of Mineral Resources, P.O. Box 378, Canberra City, ACT 2601, or phone (062) 49 9620.

GOVERNMENT PRINTER COPY SERVICE

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Other publications of the Australian Bureau of Statistics relating to the Australian mineral industry

Catalogue No.

8404.0	*Minerals and Mineral Products* (Monthly)
8407.0	*Mineral Exploration* (Annually)
5317.0	*Foreign Control in the Mining Industry, 1976-77*
8405.0	*Mineral Production* (Annually)
8402.0	*Mining Establishments (Details of Operations)* (Annually)
8401.0	*Mining Establishments (Summary of Operations, Australia)* (Preliminary) (Annually)
8408.0	*Mineral Exploration (other than for petroleum): Expenditure by Principal Enterprises* (Quarterly)
8409.0	*Petroleum Exploration* (Quarterly)

Enquiries about these publications (all of which are free or charge) should be made to: **Australian Bureau of Statistics, P.O. Box 10, Belconnen, A.C.T. 2616.**

Other BMR publications

AUSTRALIAN MINERAL INDUSTRY ANNUAL REVIEW 1978

The *Australian Mineral Industry Annual Review 1978* is due to be published in September 1980. The volume provides a record of the growth of the Australian mineral industry in 1978, and reports production, consumption, treatment, trade, prices, new developments, exploration, and resources for all mineral commodities including fuels, and summarises equivalent developments abroad.

BULLETINS AND REPORTS

The full results of most BMR surveys and other research projects are published individually as *Bulletins* and *Reports*. Reports are published in microfiche. Two recent Bulletins: *Geology of the Granites-Tanami Region, NT and WA* (Bulletin 189), and *Geology and Geochemistry of the Tantangara and Brindabella area, NSW and ACT* (Bulletin 204). Two recent Reports: *Geological Branch Summary of Activities 1979* (Report 222, Microform MF119) and *Geophysical Branch Summary of Activities 1979* (Report 223, Microform MF120).

MINERAL RESOURCES REPORTS

Mineral Resources Reports are an occasional series: each summarises the geology and production statistics of deposits of a particular mineral commodity in Australia. *Australian Tin Deposits* MRR 7, 77 pp.) was issued in 1977, *Australian Antimony Deposits* (MRR 8, 15 pp.) in 1978, and *Australian Molybdenum Deposits* (MRR 9, 46 pp) in 1979.

BMR JOURNAL OF AUSTRALIAN GEOLOGY AND GEOPHYSICS (quarterly)

Volume 5, No. 2 was issued in June 1980, No. 3 in September 1980. Some recent papers: *TEM model studies of the Elura deposit, Cobar, NSW*, 5(2); *Shallow structure and Late Cainozoic geological history of western Bass Strait and the west Tasmanian Shelf*, 5(2); *The early geological history of the Proterozoic Mount Isa Inlier, northwestern Queensland: An alternative interpretation*, 5(3); *Some aspects of interstitial water movements in simulated sedimentary systems*, 5(3).

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