RECORD 1982/12

ABSTRACTS

PETROLEUM AND MINERALS REVIEW CONFERENCE CANBERRA, 1-2 JULY 1982

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Mineral industry overview and outlook

I.R. McLeod

The mineral industry has made an important contribution to the Australian economy since the mid-1800s. Until about 20 years ago the industry was based on lead, zinc, copper, silver, gold, and coal; however, the rapid expansion which began in the mid-1960s was accompanied by diversification, and iron ore, bauxite, nickel, mineral sands, tin, uranium and others have been added to the list of major mineral products.

Mineral exports have grown commensurately, increasing from $187 million in 1961 to $7 034 million in 1981, and now account for about 37 percent of total merchandise exports. Imports increased from $198 million in 1961 to $2 372 million in 1981, crude oil remaining the predominant import. The industry has become increasingly dependent on exports and consequently its health depends on a strong world economy and its ability to compete with other mineral exporting countries.

The industry's growth slowed in the late 1970s as world economic conditions worsened and in 1981 the only major commodities whose production increased were black coal, uranium, and zinc. Production of bauxite, copper, iron ore, manganese, mineral sands, and silver fell substantially. The deterioration continued into 1982 and indeeed has been accentuated for many mineral commodities. Prices of nearly all commodities have fallen in real terms if not in current dollar terms.

Although forecasts generally are for a rapid recovery in many commodities once the world economy begins to improve, the timing of such improvement is not clear at present.

Australia's demonstrated economic resources of some commodities, such as iron ore, bauxite, and probably coal are clearly sufficient for many years at projected production rates. Currently known economic resources of tin will be largely depleted in the next 10 years and those of nickel and rutile will be exhausted about the turn of the century. However, resources in extensions to known tin deposits and in poorly tested deposits are large and additional deposits of all three commodities would become economic with increases in prices.

Mineral exploration expenditure in constant dollar terms has more than doubled in the last five years, and several potentially important deposits have been discovered in this period. However, with the current depressed economic conditions and reduced demand and prices for minerals, exploration expenditure is likely to fall. A decrease in exploration expenditure and effort is expected to continue until mineral commodity prices and industry profitability improve substantially.

Petroleum exploration and production in Australia

J.A.W. White & E.R. Smith

The presence of petroleum in Australia was first noted as long ago as 1839. Discoveries of natural gas at Roma, Qld, in 1900, and of crude oil at Rough Range, WA, in 1953, proved to be only minor accumulations and non-commercial.

A number of minor, but important, gas discoveries were made in the Roma area in 1960, but the most important event in the history of petroleum exploration in Australia occurred in 1961 with the discovery of the Moonie oil field in southeast Queensland. The encouragement given by this discovery led to an upsurge of exploration activity resulting in many discoveries in the next ten years or so: Barrow Island oil field in Western Australia, Gidgealpa and Moomba gas fields and Tirrawarra oil field in South Australia, Mereenie oil field and Palm Valley gas field in the Northern Territory, North Rankin gas field offshore Western Australia, and Barracouta and Marlin gas fields and Halibut and Kingfish oil fields in Bass Strait, offshore Victoria.

Exploration activity decreased substantially in the period 1972 to 1977; this was brought about by a combination of factors, including the relative lack of follow-up success from the discoveries of the decade before.

Increased prices, an attractive pricing policy, the adoption of improved geophysical techniques, and a better understanding of the geological factors governing petroleum accumulation have led to a dramatic increase in exploration activity since 1977, the last two years in particular demonstrating a sharp rise in exploration effort.

Onshore, only Tasmania has failed to attract an increase in petroleum exploration activity; all other States and the Northern Territory have seen a substantial increase in effort, and about thirty drilling units are currently operating.

Offshore, a similar picture emerges, with only New South Wales and Queensland not seeing drilling activity during the last several years. Discoveries in Bass Strait offshore Victoria, and offshore Western Australia, over the last year or so have provided further encouragement, whilst appraisal drilling in the Joseph Bonaparte Gulf (Northern Territory and Western Australia) and in other areas offshore Western Australia have increased known recoverable reserves of oil and gas.

The first sustained commercial production of oil was from Moonie, Queensland in 1964 and since that time, a further 10 onshore and 7 offshore oil fields have been brought into production. There are plans for several other oil fields to be connected to production facilities over the next year or so. Commercial production of gas commenced in the Roma area in 1961 and there are now a total of 32 onshore gas fields and 3 offshore gas fields, with others to be connected shortly to existing or new gas pipelines.

The current level of geophysical activity, and the announced plans to develop the Blina oil field in Western Australia and the Cooper Basin liquids scheme in South Australia, tend to add support to the supposition that the current higher level of petroleum exploration and development is not transient in nature, but reflects a more mature phase in the development of Australia's petroleum resources.

Although there are some short-term problems due to the current economic downturn and consequent shortage of exploration funds, there is good reason to believe that the increased level of activity can be sustained as long as the discovery rate is maintained. The discovery of a major new oil province would constitute a further impetus to activity and such a discovery is probably essential if the level of activity is to be increased further.

Australia's prospects for future discovery and supply of petroleum

D.J. Forman

According to an assessment prepared at BMR, there is an 80 percent chance of finding more than 950 million barrels of oil, but only a 20 percent chance of finding more than 3800 million barrels of recoverable oil in the foreseeable future. The average or mean value of this assessment is 2600 million barrels, which compares with the 3350 million barrels of recoverable oil which have already been identified.

The age distribution of Australia's identified and undiscovered petroleum resources as estimated by BMR is indicated in the following table.

	Identified		Undiscovered (mean value)	
	oil (MMB)*	gas (TCF)+	oil (MMB)	gas (TCF)
Upper Triassic to Cainozoic	3230	16	1730	13.6
Upper Carboniferous to Triassic	50	17	540	13.8
Devonian to Carboniferous	-	<0.1	170	1
Cambrian to Ordovician	65	1	160	1.1
TOTAL	3345	34	2600	29

Maps of Australia have been prepared showing the distribution of vitrinite reflectance values in sedimentary sequences belonging to each of the age subdivisions shown in the table. Using standard methods of interpretation, these maps can be used to determine the thermal maturity of the sediments for oil and gas generation and a number of conclusions can be drawn when this interpretation is viewed in conjunction with the resource data.

The best prospects for further oil discoveries are considered to be in Upper Triassic to Cainozoic sequences in the Bonaparte Gulf, Gippsland, Eromanga, and Carnarvon Basins and the Exmouth Plateau, although all oil-mature sediments of this age must be regarded as prospective. These oil-mature sediments occur offshore in parts of the marginal basins adjacent to western and southern Australia, and onshore in those parts of the intra-cratonic basins that have thick sediments or a high geothermal gradient.

The Upper Carboniferous to Triassic sedimentary rocks appear to be gas prone and therefore are thought to have less oil potential, even though extensive areas of oil and gas-mature sediments occur both onshore and offshore.

The Cambrian to Ordovician and Devonian to Carboniferous sediments are believed to have some oil potential, although a high proportion of these sediments is mature to overmature.

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* Million barrels

\+ Trillion (10^{12}) cubic feet

There is no major change in our understanding of the prospects for future supply of oil and gas from that reported by the National Energy Advisory Committee in 1981. Many of the oil discoveries in recent years have been made in structures that were already known to contain hydrocarbons and most of them were made in known hydrocarbon plays. Only one oil discovery has been of really significant size, and, excluding this, annual discoveries have been far below annual production. New discoveries in oil producing areas should allow production to remain at present levels until late in this decade or possibly early in the next. However, the assessment assumes that new discoveries will also be made in new areas and these will be needed to extend this level of production into the 1990's.

Australia's coal resources and their development

M.B. Huleatt

From a modest beginning in 1799 the Australian black coal industry has become one of the most advanced in the world. In 1981 Australia was among the top ten producers and was the largest exporter after the USA. Raw coal production was 111 million tonnes, which yielded 92 million tonnes of saleable product; consumption by Australian industry was 37 million tonnes and exports totalled 51 million tonnes valued at $2 300 million. Various forecasts suggest that by 1990 exports may well exceed 100 million tonnes per year and domestic use 75 million tonnes per year.

Production from long-established coal mining areas, e.g. Ipswich, Newcastle, and Collie, has been supplemented in recent years by development of new mines in the Bowen Basin and the Hunter Valley in particular. These two areas are still the focal points for mine development. Outside the established areas there is potential for future development of other coal resources such as in the Galilee, Arkaringa, and Perth Basins, as demand warrants. Exploration has developed rapidly over the past few years, private expenditure more than doubling between 1978-79 and 1979-80 and increasing by a further 59 percent in 1980-81 to $76 million. In addition, substantial exploration programs are being undertaken by the Queensland and New South Wales governments.

Australia's demonstrated resources of black coal currently stand at 51.5×10^9 tonnes in-situ, of which about 29.5×10^9 tonnes is regarded as being economically recoverable. Because much of the coal mined is subsequently washed there is a loss of material which has amounted to about 18 percent of the mined tonnage in recent years. Taking this factor into account, less than half the known 'in-situ' resources may ultimately be used. Any advances in mining or utilisation technologies that will improve this situation will be most important in the efficient exploitation of Australia's coal resources.

Trends within the industry indicate that we can expect improved recovery and utilisation in the future. The application of longwall mining methods underground and the pre-stripping of overburden in open-cut mines should ensure increased recovery which may well be supplemented in the longer term by the introduction of techniques for thick seam mining. Application of fluidised bed combustion techniques will permit more efficient combustion of coal but more importantly will allow the use, as a fuel, of washery reject material which is now discarded.

Australia's demonstrated resources of brown coal total 39.3×10^9 tonnes in-situ. Most of these resources are in Victoria but recent exploration has resulted in the discovery of significant new deposits in Western Australia and the delineation of further resources in South Australia. At present brown coal is mined only in Victoria and annual production is about 33 million tonnes. This coal is used almost exclusively for electricity generation and future development of Australia's brown coal resources will depend on the demand for electricity and the possible establishment in the future of a synfuels industry based on the use of brown coal.

The current improved oil supply and pricing position provides a 'breathing space' in which advances made in the coal industry in recent years may be consolidated. Research into synfuels production from various feedstocks will continue and the accumulated data will allow a fully considered decision regarding the path to be followed should it be decided to move in this direction.

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The expectations of the industry have suffered some setbacks in recent months that may result in a revision of the industry's forward projections. The setbacks have been the result of economic factors including the reduced demand for coal by the major importing countries. Australia has abundant resources of coal to meet expected demand in the foreseeable future. The rate of development of these resources is likely to be determined by economic and/or other external factors rather than any significant technological difficulties or problems associated with mining or preparation to meet market specifications.

Oil shale resources and development

B.G. Elliott & D.L. Gibson

Oil shale is a fine-grained sedimentary rock containing an appreciable amount of solid organic matter which breaks down irreversibly to an organic petroleum-like liquid (shale oil) when heated in a retort at about 500°C.

A shale oil industry operated in New South Wales between 1865 and 1952, but production was very small. Many countries had oil shale industries early this century, but only those of the USSR and China have operated recently, and that of China is being scaled down.

In Australia, major oil shale deposits occur in Queensland. Exploration for these has been centred on the generally small but thick Tertiary basins near the coast between Townsville and Brisbane, and in the Great Artesian Basin where oil shale occurs in the Toolebuc Formation.

The successful development of large-scale shale oil projects is subject to financial, technological, and developmental barriers and to marketing and environmental constraints which may affect their viability. Such projects will require very substantial capital investment and could involve high risk. Several projects are being considered for, or are under, development overseas. Of these, Union Oil's project at Long Ridge, Colorado appears to be at the most advanced stage of development and the company plans to commission a commercial-scale retort within the next 18 months.

In Australia, the outlook is for project research and evaluation to continue at Condor, Julia Creek, Rundle, and Yaamba. There are still good prospects for additions to existing resources and for new discoveries, particularly in eastern Queensland.

Uranium resources and supply

G. Battey

In Australia significant exploration for uranium did not commence until 1944 and by 1967 the nation's reserves were estimated to be 6200 tonnes of uranium. A number of major new discoveries have been made since 1967 and it is currently estimated that Australia has 294 000 tonnes of uranium in the Reasonably Assured Resources (RAR) category recoverable at a cost of less than US\$30/lb U_3O_8. Mine production of uranium oxide commenced in 1954 and to the end of 1981 production totalled 14 143 tonnes of contained uranium.

It is estimated that the Western World's uranium resources in the Reasonably Assured category recoverable at a cost of less than US\$50/lb U_3O_8 have decreased by 11% in the past two years as a result of increasing capital and production costs and of increased production. Current resources are considered to be adequate to meet any likely level of demand for the next twenty years. Exploration is decreasing from the record level of 1979, with the largest decrease in the USA.

World production capacity currently exceeds demand, and production capabilities are planned to increase from 49 000 tonnes of uranium in 1981 to 78 000 in 1986. If these planned facilities are built many of them will not operate at full capacity in the absence of increased market demand.

Because of the sluggish growth of nuclear power in recent years, relative to predictions made in the 1970s, and the increased supply capability and production of the major producing countries an oversupply situation has developed and uranium prices in real terms have fallen. Although this situation is not expected to continue in the mid and long term, numerous producers, particularly in the USA, have heavily curtailed or ceased mining. The large, lower-cost projects in Canada and Australia are in a good position to exploit the expanding demand that will arise in the late 1980s and 1990s. The recent developments in the market have given rise to concern that current investment in exploration and development may fall short of the levels required to ensure timely availability to meet future requirements.

Based on statistics covering the period to the end of 1980, expenditure on uranium exploration in Australia has shown a steady increase in recent years. This is in contrast to most other countries and is no doubt due in part to the very high success rate in this country where the cost of discovery per unit uranium has been relatively low.

Australian uranium production has increased in recent years; production commenced at Nabarlek in June 1980 and at Ranger in August 1981. However, production at the Mary Kathleen mine is expected to cease in December 1982 because the remaining resources would be uneconomic at current prices.

Work is currently proceeding on several potential new uranium mines in Australia. A metallurgical plant has been constructed at Kalgoorlie to establish the treatment process for Yeelirrie ore and, despite the recent withdrawal by one of the joint venturers in the project, the operators are continuing with plans to commence production in 1986. Government approvals have recently been granted for the development of the Lake Way and Honeymoon deposits and for the joint venturers at Jabiluka to proceed to secure sales contracts. Work is also proceeding towards obtaining Government approvals for the development of the Koongarra, Beverley, and Ben Lomond deposits. Drilling is continuing to further define the copper and uranium resources at the Olympic Dam deposit and a shaft is being sunk to obtain geological and engineering data and samples for metallurgical testing.

Tin - a changing commodity

I.R. McLeod

Australian mine production of tin, after falling to about 1500 t in the mid-1950s, increased to level off over the past 10 years generally around 11 000 t/year. Three mines together supply about three-quarters of the total production.

Twenty years ago, production was mainly from alluvial or quartz lode deposits, which allowed good recovery of cassiterite in a clean high-grade concentrate. The major Australian smelter was originally designed to handle such material. Most production now is from sulphide-bearing lodes; high recovery from these is difficult, and concentrate grades are low.

Although mine production has increased, production of refined tin has not; currently over half our mine production is exported, mainly as concentrates.

Australian consumption of refined tin has decreased markedly over the past five years, largely because of reduced consumption in tinplate (the major end-use) resulting from thinner tin coatings.

Australian demonstrated economic resources of contained tin have increased from 28 000 t in 1960 (of which about 50% was in lode deposits) to 216 000 t in 1982 (96% lode). The increase reflects mainly increases in reserves at Renison, which now represent 85 percent of demonstrated econmic resources. Reserves in other deposits are sufficient for only a few years. However, deposits now the subject of detailed feasibility studies could have an aggregate production of over 4000 t/year. In addition, resources in tailings are large, and technical advances are making re-treatment of these feasible; technical advances such as matte fuming could also make deposits with metallurgically difficult ores economic.

Production from new sources requires an adequate tin price. Recent production has substantially exceeded demand, and the price is now heavily supported by the International Tin Council at the lower end of its price range by buffer stock buying and export controls.

Further, three major non-mine sources overhang the market: the US stockpile, the ITC's holdings, and the tin acquired by the interests that supported the price in 1981.

Because of these factors, the tin price is unlikely to increase markedly for a few years, and Australian production is unlikely to increase much for some time. Beyond then, a real price increase, which could eventuate as lower-cost deposits elsewhere in the world are exhausted, is likely to see higher Australian production and Australia increase its share of total world production.

Mineral sands - the industry in a world context

J. Ward

Australia became the world's leading producer and exporter of zircon and rutile concentrates in the late 1940s and early 1950s, of alluvial ilmenite in the 1960s, and of monazite concentrates in the 1970s. It is now the main world supplier of all four commodities as well as the world's chief exporter of so-called synthetic rutile. Australia is expected to continue in this role for the foreseeable future. However, whereas in former years Australia had a virtual monopoly of world markets in rutile and zircon, this position is now being challenged by the emergence of new sources of alluvial rutile and zircon, as well as by the availability of new forms of 'sythetic' high-titania feed.

This paper examines the development of Australia's pre-eminence as the world supplier of mineral-sand concentrates, considers Australia's current competitive position vis-a-vis other world producers, and suggests some possible future trends. The conclusion is reached that to maintain its competitive position in a world context, Australia will need to

- expand its resource base to assure long-term continuity of supply,
- continue R & D particularly in the fields of mining and extraction of mineral from low-grade, disseminated, aeolian deposits, and
- extend the spectrum of the industry to include a substantial content of mineral processing.

Non-metallic minerals - a profile of the industry

A. Driessen

Although the non-metallics sector of the mineral industry is not as ~~'viable'~~ 'visible' as its counterpart metal and energy-mineral sectors, it is, nevertheless, important both as an area of economic activity and because of its direct contribution to our standard of living: non-metallic minerals are used in a very wide variety of products and processes.

The non-metallic minerals, for the purpose of this paper, are divided into five groups:

(a) Minerals for the building/construction industry, including sand, gravel, crushed rock, brick clay, limestone, gypsum, and asbestos.

(b) Refractories, including dolomite, fire clay, magnesite, pyrophyllite, and sillimanite.

(c) Minerals for the fertiliser and chemical industries, including phosphate rock, potash, sulphur, fluorspar, and salt.

(d) Other non-metallics, including barite, bentonite, diatomite, kaolin, and talc.

(e) Gem and semi-precious stones.

The ex-mine value of production of non-metallic minerals in Australia is about $670 million; this is overshadowed by metals (about $3000 million) and energy minerals (about $3100 million). However, production of metals and energy minerals is largely for export markets.

Comparing the sectors by apparent domestic consumption (again measured in terms of ex-mine values) brings metals (about $750 million) and non-metals (still about $670 million) closer together. Apparent consumption of energy minerals remains high (about $2570 million) because exports (coal) are largely offset by imports (oil). If mineral supply balances are reckoned in ex-mine values for production and f.o.b. values for imports and exports, then the non-metallics sector is a net-import sector.

Non-metallic minerals tend to be used in-toto rather than to be extracted from an ore, as are metals. Consequently physical and chemical specifications become most important in assessing commercial viability of exploitation; for non-metallics quality is not always synonymous with grade. Because the ex-mine value of non-metallics generally is much lower than that of metals, the economics of transport also have a particular bearing on determining viability. These considerations, plus the fact that quantitative and qualitative data of known deposits are scarce as well as little-publicised, make it difficult to compile comprehensive information on resources of non-metallic minerals at a national level.

Although many non-metallic minerals are characterised less by physical scarcity than by the previously mentioned factors affecting viability, some deficiencies are obvious - notably trona (naturally occurring sodium carbonate) and potash.

Chromium in Australia

R. Pratt

Chromium is used widely in the metallurgical, chemical, and refractory industries. Its major use is in metallurgy, particularly in stainless steel production where it is used mainly in the form of ferrochromium. Other important uses for chromium and its compounds include alloy steels, pigments, plating, leather tanning, and catalysts.

Chromium supplies are of considerable strategic importance; historically, disruptions in supply to the major industrial consuming nations have resulted from the concentration of resources and production in only a relatively few countries.

Chromite is the only mineral from which chromium can be extracted commercially. A recent assessment conducted by BMR has indicated that Australia's chromite resources are much larger than previously believed. However, although some Australian deposits have potential for economic development, further exploration and solution of mining and processing problems are needed, and the development of known deposits cannot be economically justified at current prices.

Chromite has been mined intermittently on a small scale in Australia since 1882. However, like most industrialised countries we import nearly all our chromite. Additionally we are almost wholly dependent on imports for our supplies of ferrochromium and chromium chemicals. The value of these imports has increased considerably in recent years.

Approximately 60 percent of chromium consumed in Australia is contained in ferrochromium, 25 percent in refractories and foundry sands, and 15 percent in chemicals. Recent improvements in techniques for the manufacture of stainless and other alloy steels has enabled greater use of lower-grade, lower-cost ferrochromium. Chromite consumption in refractories has decreased in recent years as open-hearth steelmaking, the most substantial user of chromite refractories, has been replaced by basic oxygen steelmaking which requries dolomite or magnesite refractories. Australia's chromite requirements for refractories will diminish substantially when open-hearth steelmaking plant at Port Kembla is closed shortly. Consumption of ferrochromium, and of chromium chemicals, used principally in Australia in pigment manufacture and in leather tanning preparations, is expected to continue to increase with Australian economic expansion.

Reduced steel output over the last two years has caused world ferrochromium consumption to fall considerably. Major Western world users have reduced ferrochromium output partly by closing higher-cost production facilities. During this time major chromite producers have reportedly increased their ferrochromium production capacity, continuing the trend for ferrochromium production capacity to shift from the major industrialised consuming countries to the chromite-producing nations.

Recent price decreases reflect substantially reduced demand for chromite on world markets. With the current downturn in the steel industry likely to continue for some time, demand for chromite and ferrochromium products is expected to remain depressed for at least the remainder of 1982.

In recent years consideration has been given to the installation of plant to produce ferrochromium with other steelmaking alloys in Australia, and the possibility of producing ferrochromium chemicals from chromite has been investigated. Though Australian requirements are expanding, the availability of imports at competitive prices is seen as a deterrent to resuming production of these products in the immediate future.