Characteristics of Mining in Australia

By

Impact Project Research Centre

University of Melbourne

Marco Bin and Peter J. Wicken

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Impact
The paper provides an overview of the general characteristics of the mining industry in Australia, with particular emphasis on minerals that are important. It includes a description of the methods of their extraction and the activities of federal and state governments related to mining.


INTRODUCTION

Marco Bini and Peter L. Willcox

CHARACTERISTICS OF MINING IN AUSTRALIA

6 REFERENCES
Finally, although Australia is a major world mineral producer, it is not as important in mineral processing; many minerals are exported raw or in partially processed form. Iron ore, for example, is merely crushed and sized before shipping. Similarly, most tin is exported in the form of concentrate. One important exception is bauxite, almost all of which is processed at least to the intermediate stage of alumina before export. In addition, three minerals are exported principally in metallic form: gold, copper and nickel.

2. DESCRIPTION OF MINERALS

Table 1 presents a summary of 1987 data on thirteen of Australia’s most important mineral industries. Each row gives statistics for a particular mineral in a particular form. The figures shown in the columns are as follows. Column one gives the unit in which quantities of each mineral are measured: tonnes (t), kilotonnes (kt), or megatonnes (Mt). Column two gives the quantity of domestic output. With the exception of bauxite and alumina, for ores and intermediate products the value shown is the weight of the contained mineral, not the weight of the ore or product itself. Column three gives the Bureau of Mineral Resources (BMR) estimate of “demonstrated economic” reserves of the mineral. The BMR classifies a given deposit as “demonstrated” when it is well established that the deposit actually exists. Of demonstrated reserves, the deposits that the BMR believes might be worth mining at current prices and wages are said to be “economic”.

5. SUMMARY

As discussed above, many minerals are mined in Australia and a wide variety of mining techniques are used. However, only a few minerals are important exports, namely gold, iron ore, bauxite, and coal. The principal methods used to mine these minerals are highly capital-intensive, involving expensive specialized machinery. The government plays an active part in the mining industry through the imposition of taxes and royalties, but does not, on the whole, involve itself with actual mineral production. The only notable exception to this is the production of brown coal in Victoria.
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**Table:** Statistics on Student Enrollment by Grade

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**Chart:** Intended Salary by Grade
demonstrated economic reserves of the mineral would last at current rates of extraction. Column five gives the quantity of exports; comparing this to total production shows the proportion of the mineral that is exported. Column six gives the value of exports in millions of dollars at f.o.b. prices. Finally, column seven shows Australian output as a per cent of world production.

Several interesting facts are apparent from the table. First, Australia has enormous reserves of several minerals. Bauxite, black and brown coal, copper, iron ore and uranium are all in sufficient supply to support current production for many decades. A number of other minerals are also relatively abundant: lead, silver, tin, rutile and ilmenite, zinc and zircon all have known supplies that will last thirty years or more at current prices and technology. Moreover, new discoveries, improvements in mining methods, and changes in mineral prices are likely to keep most of these industries operating for many years beyond what is shown in the table.

The second important fact shown in the table is that for a few minerals Australia is one of the world's largest producers. Over a third of the world's bauxite comes from Australia, as well as half the world's rutile and zircon, and a quarter of its ilmenite. In addition, Australia produces a fifth of the world's supply of lead.

Finally, an additional fact evident from the table is that four of the minerals are particularly important exports: alumina/aluminium, black coal, gold and iron ore each account for well over a billion dollars of foreign trade. The remainder of this section presents detailed descriptions of each of those industries, followed by somewhat shorter descriptions of the other nine major mining sectors.
...
2.1.1 Black Coal

Australia is the world’s largest exporter of black coal, accounting for 30 per cent of world trade. The second largest exporter is the United States, which supplies 21 per cent of total trade, while South Africa ranks third with 12 per cent. Many countries, including China, the United States and the Soviet Union, produce vast amounts of black coal for domestic use, so in terms of production (rather than exports) Australia ranks only seventh and accounts for but 4 per cent of world output. Exported Australian black coal is used both for coking (in iron and steelmaking) and for steam power and heat generation. Coking coal made up 54 per cent of exports in 1987, while steam coal accounted for the remaining 46 per cent. About half of total exports are sent to Japan. Seventy-one per cent of domestic coal production is exported; the remainder is used for power generation (22 per cent), iron and steel making (4 per cent), and other purposes (3 per cent).

 Virtually all Australian black coal (and all of the exports of it) is produced in Queensland or New South Wales. In 1987, Queensland produced 88.1 megatonnes (Mt) of raw black coal (49 per cent of the total) of which 5.2 Mt came from underground mines. New South Wales produced another 83.6 Mt (47 per cent), of which 49.6 Mt came from underground mines and 34.0 Mt came from open-cut operations. Thus, in Queensland and New South Wales together, 32 per cent of the black coal produced came from underground mining while 68 per cent of it came from open-cut. South Australia and Western Australia together produced about 4 per cent of total coal output and used it almost entirely for generating electric power. A very small amount of black coal was produced in Tasmania and used in cement and paper production.

Coal mining methods have changed dramatically in the last thirty years. Most noticeably, there has been enormous growth in open-cut mining. In 1960, open-cut

A typical continuous miner is electrically powered, mounted on caterpillar tracks, weighs about 65 tonnes, and is 11 metres long and 4 metres wide.78 Once extracted, the coal is transferred to the rear of the machine where it is loaded into an electric shuttle car. The shuttle then carries the coal to a nearby conveyor belt which takes it out of the mine. It is usual for 2 such shuttlecars to be used in this type of operation.

In general, operating these machines requires a crew of seven: two men to drive the shuttlecars, two to operate the mining machinery, two assistants, and one man to handle miscellaneous tasks.79 In any given shift (6-8 hours), a crew can produce up to 500 tonnes of coal. Other persons such as an electrician, a mechanical fitter and the mine supervisor may be required from time to time. A typical mine may operate seven or more crews per shift. Usually, one of the crews is assigned to roof support, since continuous miners eliminate the need for drilling and shooting, but not for supporting the roof.

Increasingly, however, longwall mining is being used for underground coal extraction. In longwall mining, a long narrow tunnel is dug along the side of the seam to be extracted.80 A second tunnel, perpendicular to the first and much shorter, is dug into the seam at the far end. Then, a special longwall mining machine is installed in the transverse tunnel. Longwall machines have two key features: a cutting head that moves back and forth along the transverse tunnel, and a set of hydraulic supports which hold up the tunnel’s roof. The cutting head moves down the transverse tunnel ripping the coal from the seam. The extracted coal falls onto a conveyor which carries it from the mine. When the cutting head reaches the end of the transverse tunnel, the

78. See, for example, Western Australia School of Mines: 85 Years, pp. 27-36.
79. This paragraph is based on a telephone conversation with Richard Pinchen of the Great Gold Mine in the Hunter Valley, New South Wales.
80. These tunnels can be up to two kilometres long.
units are planned for Dusseldorf and New South Wales. 10

South and open cut mines: excavators 9

cold production or complex plant, this comes to 1.3 keros and 3.5% comes for under-

year 1957-89. In example, open cut mine produced 6.7 keros per cold production used

Figure 4: Drilling and Shootin

from (1982), p. 66.
2.1.2 Brown Coal

Brown coal is inferior to black coal in several respects. It has a relatively high moisture content and produces less heat per kilogram when burned than black coal. In addition, it is high in volatile hydrocarbons, so it deteriorates rapidly and can ignite spontaneously. Thus, inventories must be kept to a minimum. All of Australia's known economic reserves of brown coal occur in Victoria's Latrobe Valley. There, however, the seams are quite thick (60-125 metres) and are overlain by only a thin layer of sandy clay (10-15 metres).

In spite of its disadvantages, a large amount of brown coal is mined in Victoria and used to fuel electric power stations. To overcome the problem of volatility, the coal is moved by conveyor directly from the mines to nearby power stations for immediate use. Since each power station must receive a continuous supply of coal at all times, the State Electricity Commission of Victoria itself operates the mines. In 1987, it accounted for 97 per cent of all domestic brown coal production (42.22 Mt). Most of the remaining brown coal was produced by Alcoa, which has a small mine (1.25 Mt) at Anglesea which it uses to fuel an aluminium smelter at Point Henry. AMCOR Ltd operates the only other mine, a very small one (.04 Mt) near Baccus Marsh which fuels a steam plant. All of these mines are open-cut.

After mining, fillings is required to achieve the uranium oxide (uranium dioxide) process. The process begins with the extraction of uranium from the ore, followed by the separation of uranium from its ore.

The extraction of uranium from the ore is achieved through various methods, including chemical processes and physical processes. The process involves the following steps:

1. **Extraction**: The ore is first crushed and ground to a fine powder. This is done to increase the surface area of the ore, making it easier to extract the uranium.

2. **Leaching**: The ground ore is then treated with a leaching solution, which dissolves the uranium from the ore. This solution is typically a mixture of acids or bases, depending on the type of ore.

3. **Isolation**: The uranium-bearing solution is then subjected to isolation processes to separate the uranium from other elements. This can be done through ion exchange, solvent extraction, or precipitation methods.

4. **Refining**: The isolated uranium is then refined to remove impurities and other elements. This process can involve chemical or physical methods.

5. **Concentration**: The refined uranium is then concentrated to achieve the desired purity level, typically 99.9%.

6. **Fabrication**: The concentrated uranium is then fabricated into various forms, such as fuel rods, ingots, or other forms, depending on the application.

Today, however, the filling of stations is not often used. Instead, modern techniques are employed to achieve the desired thorium level.

### References

remove impurities and water from the bauxite. Then, metallic aluminium is produced from alumina by electrolytic smelting. In this step, a carbon anode is used to feed electric current (DC) through vats of molten alumina. The oxygen in the alumina combines with carbon in the anode to produce carbon monoxide and carbon dioxide. What remains is pure aluminium, which settles to the bottom of the vat and is drawn off periodically. An enormous amount of electricity is used -- typically 15-20 kwh per kg of aluminium. Refining alumina and producing aluminium are very capital intensive, with capital costs per tonne of capacity ranging from three to seven times that required for steel making.

Australia is by far the world's leading producer of bauxite, accounting for 37 per cent of world output in 1987. The second largest producer, Guinea, supplies about 16 per cent of world output, while the third largest producer, Jamaica, generates only 8 per cent. Sixty-one per cent of Australian bauxite comes from the Darling Range in Western Australia (near Perth), where it is mined by two companies, Alcoa of Australia Ltd and Worsley Alumina Pty Ltd. Another 23 per cent comes from Weipa, at the north end of Cape York in Queensland, where it is mined by Comalco Ltd. The remaining 16 per cent is produced by Nabalco Pty Ltd at Gove in northeastern Arnhem Land in the Northern Territory.

Most bauxite mined in Australia is refined at least to the stage of alumina before exporting. This is largely due to transportation costs: it takes two or three tonnes of

18. A complete description of the Bayer process is given in Brubaker (1967).
19. A single smelting pot uses 70,000 to 100,000 amps of current at 5 volts. A complete smelter will have 150 or more of these pots connected in series. For a detailed description of aluminium smelting, see Brubaker (1967), pp. 90-94.
21. In 1987, for example, alumina accounted for 84 per cent of the total bauxite used to produce exports. In the same year, primary aluminium accounted for 14 per cent, while shipments of raw bauxite accounted for only 2 per cent.
There are also six aluminium smelters in Queensland, two in New South Wales, two in Victoria, and one in Tasmania. The two Victorian smelters, New South Wales, and Queensland, produce more aluminium than the other two states.

City for several years.

Situated in New South Wales, located on Great Stewards, is one of the single

aluminium plants. In 1987, the aluminium production was equal to that of Queensland and Western Australia.

In 1987, the area was above the national capacity of Western Australia. In 1987, it produced 9.8% of Queensland's production. While Queensland's production was equal to that of Western Australia, its production was equal to that of Queensland's.

The data collected from the mine, plant, and the mineral seam in a particular area has been

published in technical journals. The results from these studies are critical in the development

of new mineral seams and the expansion of existing ones. This process is known as

4.2 Dependence

is little to no oxygenation. The method is sometimes known as "greening." When the deposit is entirely at the surface (this is when there

is oxygen present in the mineral seam and water uptake.

is limited by physical and geological activity. In addition, it's possible to make

show in Figure 1.2. A diagram of deep mining operations. The use of deep mining

area. The other side, called the spillage, is used for rock waste. These features are

Table 1.1 (9809) pp 281
four smelters process alumina from Gove and Gladstone. Unlike the alumina refineries, these smelters generally have some excess capacity.

Finally, it is important to realize that the world aluminium market is dominated by only six firms: Alcan (Canadian), Alcoa (US), Reynolds (US), Kaiser (US), Pechiney Ugine Kuhlmann (French) and Alusuisse (Swiss). Before World War II, the aluminium industry was definitely not competitive, but that is less evident today.

2.3 Gold

Gold is Australia’s third most important mineral export, following black coal and alumina/aluminium. In 1987, it generated over $1600 million in export earnings. About 78 per cent of Australian gold production is exported, almost all of it in the form of refined bullion.

Over the last decade, the Australian gold industry has boomed. In 1987 alone, production rose 47 per cent and 29 new mines were commissioned. Increases of that magnitude have not been unusual: production rose by 45 per cent in 1985 and 29 per cent in 1986. In fact, total production has increased sixfold since 1981. During the 1960’s and early 1970’s, however, the industry shrank by about thirty per cent. Currently, there are nearly 200 gold mines operating in Australia, with at least a few in every state. Western Australia, however, accounts for about 70 per cent of total gold production.

25. Refined bullion is at least 99.95 per cent pure.
three companies in the Pilbara: Hamersley Iron (38 per cent), Mount Newman Joint Venture (34 per cent), and Robe River Iron Associates (16 per cent). All three firms operate in remote areas and must transport their ore hundreds of kilometres by rail to reach the nearest port. The remaining 12 per cent of total iron ore production came from much smaller mines in Western Australia, South Australia and Tasmania. All iron ore mines, including those of the three largest producers, use the conventional drill/blasting/loading open-cut mining method. 30 Virtually all of the ore is treated to some extent before being exported or sold to domestic customers. At a minimum, it is crushed and sorted by size. 31 In addition, a small amount of ore is made into pellets and some low-grade ores are concentrated. 32 All Western Australian ore, and virtually all of that mined elsewhere, is ultimately used for making iron or steel. Iron oxide produced for other purposes is less than 0.1 per cent of total output.

2.5 Copper

The world’s largest copper producers are Chile and the United States, which together account for 41 per cent of total output. Australia is the world’s seventh largest producer of copper, but it produces less than 4 per cent of the world’s output. About three quarters of all Australian copper comes from Mount Isa in Queensland. 33 Another 12 per cent comes from Tasmania, mostly from the Mount Lyell mine operated by Renison Goldfields. Two mines in New South Wales and one in Western Australia produce most of the remainder, although a number of other mines produce

31. This process is known as “screening”.
33. The ore deposit at Mount Isa is enormous; the mine has been in operation for more than 40 years and has enough reserves to continue operating for another 40 at current rates of production. Deans (1983), p. 24.

the High Court and include, among other things, refining. 68 Other deductions available under Section 122 of the act include expenditure on plant, and the costs of accommodation of employees. Section 23 (c) and 23C prohibit taxes on gold, but have sunset clauses expiring on 1 January 1991.

Division 10AAA deals with transportation of minerals, and allows deductions for the costs of railroads, pipelines and other methods of transport. Division 10AA deals with the mining of petroleum and allows similar deductions to those in Division 10. 69 Finally, mining is subject to capital gains tax and there are also specific anti-avoidance provisions relating to the carrying out of prescribed mining activities. 70

4. EXTRACTION METHODS

The mineral industry uses a wide variety of extraction techniques, even for a single mineral such as black coal. Roughly speaking, however, most methods can be classified according to two important characteristics: whether they are used on the surface or underground, and whether they are continuous or cyclical. The following subsections describe the principal features of surface and underground mining and highlight the difference between continuous and cyclical techniques. A final section briefly discusses dredging, which is used for mining mineral sands.

68. Cyprus Mines v FCT 9 ATR 33.
69. See Section 124AA.
70. Section 160ZZE, Section 160 ZZF, Section 160 ZZG. These provisions attempt to prevent avoidance of tax by mining companies in particular.
restrictive practices in the vitamin industry have been very broadly covered by
Section 19A, 19AA, 19AB, and 19AC of the Trade Practices Act. In particular, the
enforcement of the Australian Competition and Consumer Act (ACCA) is

Australia's large export of lead makes it a major producer of lead, accounting for 17% of the
world market. Australia is the world's largest producer of lead, accounting for 17% of the world
market.

The Osmotherpa Chan peef, a nutrient from China, is major producer of copper.

The production of copper in China is produced by the CCCA under a program in New South Wales.
90% of the copper is produced by the CCCA under a program in New South Wales. Although 75% of the
production of copper is produced in China, 90% of the production of copper is produced in China.

...small amounts of copper are produced in other countries.

...section 19A of the Trade Practices Act.
as refined metal. Thus, Australia is only the seventh largest producer of primary refined lead. By value, lead exports are 62 per cent bullion, 15 per cent ore and concentrate, and 23 per cent refined lead.

The single largest Australian producer of lead is Mount Isa, which accounts for 42 per cent of domestic output. Another 31 per cent is contributed by three mines at Broken Hill, while the remainder comes from a number of smaller mines in New South Wales, the Northern Territory and Tasmania. Almost all of Australia's lead reserves are contained in zinc-lead-silver sulphide deposits. The Mount Isa and Broken Hill areas contain about three-quarters of domestic demonstrated economic reserves.

Lead bullion is produced by two smelters: one at Mount Isa, and the other at Cockle Creek, New South Wales. All output of both plants is exported. The only domestic producer of primary refined lead is the Broken Hill Associated Smelters (BHAS) plant at Port Pirie, South Australia. About 75 per cent of the lead produced by Port Pirie is exported. Of the remainder, over half is used to produce lead-acid batteries.

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38. Lead bullion is less pure than primary refined lead and contains substantial amounts of silver and other minerals.

39. Mount Isa is among the largest lead producers in the world (see Deans (1983), p. 43). Lead, silver and zinc usually occur together, so mine producing one of them often produce the others as well.

40. The Cockle Creek plant is subsidiary of CRA; see Deans (1983), p. 141.

41. The BHAS plant is also a subsidiary of CRA; see Deans (1983), pp. 174-175.

42. The importance of batteries to the lead industry cannot be overstated. In the United States, the world's largest consumer of lead, automobile batteries account for almost 80 per cent of all lead consumption. With the increased use of engines designed to run on unleaded fuel, the use of lead as an additive to petrol has declined.

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High Court at present is that an excise duty is a tax on goods at any stage of production, manufacture, sale or distribution. Thus, the states can only impose royalties on mineral production, since a royalty is not a tax but rather a payment for the right to enter land for the purpose of extracting a mineral. Royalties are, however, calculated according to the quantity or value of the mineral removed.

The fact that mineral reserves generally fall under state jurisdiction means royalty rates are not uniform throughout the country. Moreover, the basis on which royalties are charged also varies from state to state: some states impose flat fees per tonne, while others impose ad valorem charges. Roughly speaking, however, most states use ad valorem royalties in the range of 2-5 per cent for most minerals. Tin, rutile and ilmenite, for example, are subject to ad valorem royalties in all states and the Northern Territory. Similarly, silver, lead and zinc also have ad valorem royalties levied in all states, although some mines in New South Wales and Queensland receive special treatment. Copper bears an ad valorem royalty in all states except Queensland, which again treats some mines in a special way. In addition, gold is generally subject to an ad valorem charge, although no royalties are charged in Western Australia or Victoria.

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62. Stanton v Federal Commissioner for Taxation 1955 92 CLR 630. A royalty involves some sort of property right, whereas a tax does not. Unfortunately, these distinctions are somewhat arbitrary.


64. New South Wales uses special formulae to calculate the royalty rate charged for mines at Broken Hill. These formulae depend on the grade and depth of the ore. All other mines are subject to a 4 per cent ad valorem fee. In Queensland, mines at Mount Isa are charged special royalties that depend on the ratio of current production to that of 1973-74. See the Australian Mining Industry Review 1987, p. 302.

65. In particular, copper mined at Mount Isa is treated in the same way as silver, lead and zinc.
2.8 Silver

In Australia silver is produced almost exclusively as a byproduct of mining for other minerals. Most domestic silver comes from lead and zinc mining, but some comes from copper and gold mining as well. The largest domestic producer by far is Mount Isa, which produces almost half of all Australian silver. The remainder comes primarily from other major lead mines. Mount Isa’s silver is contained in lead bullion, most of which is shipped to a subsidiary in the United Kingdom for refining.

Of total silver production, 19 per cent is consumed domestically, 65 per cent is exported in lead bullion or various concentrates, and 16 per cent is exported as refined silver.46 Most of the refined silver (over 60 per cent) is produced by the BHAS smelter at Port Pirie. The remainder is produced by smaller smelters at Port Kembla and Hobart (Electrolytic Zinc’s Risdon refinery), and by the Perth Mint. Worldwide, photographic film accounts for about half of the use of refined silver. Much of the remainder is used in minting commemorative coins.

2.9 Tin

Australia produces around 5 per cent of world tin output. Most of that (85 per cent) comes from Renison Bell, an underground mine in Tasmania owned by Renison Goldfields Consolidated. The remaining 15 per cent of domestic tin production comes from much smaller mines in Queensland and Western Australia.

All of Renison’s output is exported to Malaysia in the form of concentrate. There are, however, two domestic tin smelters which process some of the output of the

46. These percentages are based on tonnes of silver contained in the different products.

To use Victoria as an example, under the Victorian Mines Act and regulations made by the minister, three major types of licence are available: exploration licences, mining leases, and miner’s claims.59 Each of these confers various rights upon its holder. They differ in the tenure and size of mining operations permitted, and according to how much is known about the mineral seam.

Exploration licences authorize exploration for crown-owned minerals and permit feasibility studies to determine whether commercial mining is viable. These licences are subject to a number of restrictions, including a minimum annual expenditure per square kilometre of land leased which increases the longer the licence is held. In addition, a bond must be posted to ensure that the area is satisfactorily restored. Licences are issued for one or two years, with the possibility of extensions up to a total of five years.

A miner’s claim, which is best suited to small mining operations, entitles the owner to a number of exclusive rights. The most important of these is the right to possession of any minerals found. A claim also grants other rights, including the right of residence, the right to erect buildings, and the right to use machinery and explosives on the claim. The initial term of a claim is five years, but it can be renewed. In January 1990, the cost of a claim was $20. In addition, a bond of up to $500 was required, although the bond would be returned upon satisfactory restoration of the mining claim after working.

59. See the publications issued by the Victorian Department of Industry, Technology and Resources listed in the Reference section.
4. The Utilities Commission is based on natural gas and electricity regulations. The

Regulation is an important aspect of utility operations, and in smaller.

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Regulation is an important aspect of utility operations, and in smaller.
The ITC’s price control efforts have largely been taken over by a newer organization, the Association of Tin Producing Countries (ATPC). The ATPC was formed in 1983 with essentially the goal of a textbook cartel: achieving high earnings for its members. Together, members of the ATPC control over 65 per cent of world tin production. Two major producers, Brazil and China, are not members but cooperate with the ATPC to some extent. Including them brings the ATPC share of world tin production to 90 per cent.

Following the collapse of tin prices in 1985, the ATPC decided to restrict production and exports of tin beginning in 1987 in order to reduce world inventories. These inventories were considerable: the United States Government alone had stocks exceeding a year’s worth of total world tin production. Australia implemented the ATPC export restrictions by issuing production quotas to producers.\(^n\) In addition, the federal and various state governments adopted programs intended to encourage small producers (those with annual production under 100 t) to leave the industry. These programs, together with the fall in tin prices, have reduced the number of tin mining companies in Australia from 106 in 1983 to 15 in 1987.

2.10 Titanium

Three titanium-bearing minerals are mined in Australia: rutile, ilmenite and leucoxene. All three are obtained from deposits of mineral sands and are valued for the substantial amounts of titanium dioxide \((TiO_2)\) they contain. Titanium dioxide is used principally as an ingredient in white pigment.

54. Commonwealth v Tasmania (The Dam Case), 1983 46 ALR 625.
55. See R v Federal Court of Australia: Ex Parte WAFL 1979 143 CLR 190, State Superannuation Board v Trade Practices Commission 1982 150 CLR 282 and Fencott v Muller 1983 152 CLR 570. A shelf company is literally a company which can be bought “off the shelf” from a solicitor. It usually takes five weeks or more to comply with the formalities necessary to incorporate a company, so solicitors often create a stock of incorporated dummy companies. These can later be converted into real companies easily by changing the directors and shareholders.
56. Commonwealth v Tasmania (The Dam Case) ibid. For example, there was support in the High Court for the view that the building of a dam which would be used in the generation of electricity was a non-trading activity for the purpose of trade.
The exercise of property power is governed by the Constitution and the law. The law defines the limits of property power and includes provisions that protect the rights of individuals and the public. The Constitution also recognizes the importance of property power in promoting economic development and social welfare. However, the exercise of property power must be balanced with the protection of individual rights and public interests. The right to property is a fundamental right that is protected by the Constitution, and any interference with this right must be justified by a compelling public interest.
far is Canada, which alone accounts for about one-third of the world’s output.

There are three uranium mines in Australia: Ranger, Nabarlek and Olympic Dam. Ranger and Nabarlek are both in Arnhem Land in the Northern Territory, while Olympic Dam is in South Australia. All three produce uranium oxide ($U_3O_8$), the principal form of uranium in world trade. Over 85 per cent of domestic uranium production is exported, mostly under long-term contracts negotiated with individual overseas companies (between 80 and 85 per cent of all world uranium production is sold under long-term contract). Uranium not exported is used domestically for medical and scientific purposes.

From 1965 to 1985, world uranium production exceeded consumption, resulting in large stockpiles. Since 1985, however, production has been below consumption.

2.12 Zinc

Australia is the world’s second largest mine producer of zinc (13 per cent) and the fourth largest producer of refined metal (6 per cent). It is also the second largest exporter, after Canada, and supplies about 20 per cent of western world trade. About half of domestic zinc production is exported in the form of concentrate, while another third is refined to metallic zinc and then exported. The remaining sixth is used domestically, principally for galvanizing. Refined zinc is about 60 per cent of the value of total zinc exports.

Zinc and lead are usually found together and, as was the case with lead, Mount Isa is easily Australia’s largest producer. Together with the small nearby Hilton mine, Mount Isa accounts for one-third of all Australian zinc production. Mines at Broken Hill and adjacent areas of New South Wales contributed another 52 per cent of total output, while smaller mines in Tasmania, South Australia and the Northern Territory made up the remaining 16 per cent. Two-thirds of domestic demonstrated reserves of zinc are found at Mount Isa or Broken Hill. Most of the rest is in other parts of New South Wales or Tasmania.

Refined zinc is produced by three plants. Electrolytic Zinc’s Risdon refinery in Tasmania accounts for about two-thirds of total output, a refinery at Cockle Creek in New South Wales produces another 23 per cent, and the remainder comes from the BHAS smelter at Port Pirie. The Risdon refinery is one of the largest in the world and uses concentrate from Mount Isa and Broken Hill, as well as from Tasmania.

2.13 Zircon

Zircon ($ZrSiO_4$) is a byproduct of mineral sands mining for rutile and ilmenite (see titanium). It is the principal commercial form of the element zirconium. Australia produces about 55 per cent of the world’s supply of zircon, and has produced more than fifty per cent for many years. About 70 per cent of Australian zircon comes from Western Australia; the remainder comes from Queensland and New South Wales. Virtually all of it (96 per cent) is exported.

Zircon is used for a number of purposes and is not usually refined into metallic zirconium. Metallic zirconium, the principal use of which is in the construction of nuclear reactors, is not produced in Australia at all.