The Sustainability of Mining in Australia : Key Production Trends and Their Environmental Implications for the Future

RESEARCH REPORT

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Executive Summary

The sustainability of mining is not a simple concept – at first glance it would appear to be an obvious oxymoron, a paradox. Yet in reality, most mineral production is sometimes two or three orders of magnitude higher than a century ago, commonly from mines which dwarf their previous generation. There are clearly numerous aspects and issues involved in assessing the sustainability of mining, and the emphasis will largely vary according to whether one is adopting a mining industry, government or independent civic perspective.

In the past few decades the mining industry in Australia has moved to improve its environmental management, and in the past decade has been prominently involved in the global debate about sustainability and the need to incorporate sustainable development into mine operations as well as corporate policy.

There remains, however, no previous study which has examined long-term trends in mining which are critical in understanding sustainability and mining. The principal issues include increasing production, declining ore grades (or quality), increased open cut mining and associated waste rock or overburden and remaining economic resources. Combined, these aspects are critical in quantifying the scale or footprint of mining, and also underpins the sustainability of mining.

This report presents the first ever such study which has compiled master data sets on the above issues for almost all sectors of the Australian mining industry, namely black and brown coal, uranium, iron ore, bauxite, manganese, mineral sands, copper, gold, lead-zinc-silver, nickel and diamonds (tin and tungsten being excluded). The report contains data essentially from the start of each sector studied, sometimes back as far as 1829.

The unique study illustrates a number of key aspects concerning mining and sustainability :

- **Production** : *gradually or exponentially increasing*, which is likely to continue for some time;
- **Ore Grades** : *gradually declining*, unlikely to ever increase in the future with some metals likely to decrease by about half in the near future (eg. gold);
- **Open Cut Mining** : *now widespread*, likely to be sustained in the future though the long-term is hard to predict as new mineral deposits are likely to be deeper;
- **Waste Rock / Overburden** : *increasing rapidly*, likely to be sustained in the future and closely linked to open cut mining (especially for coal and base metals);
- **Economic Resources** : *commonly increasing but some remain stable or gradually declining*, future linked closely to exploration, technology and economics;

From a sustainability perspective, these trends point to the scale of mines and the associated footprint gradually increasing in the future. This is due to the increased solid wastes (tailings and waste rock) per unit mineral / metal production caused by declining ore grades and increased waste rock and open cut mining.

In terms of economic resources, this study demonstrates that for most minerals resources have actually increased over time despite increasing production (e.g copper, gold, nickel, mineral sands), but for some minerals rapidly increasing production is putting pressure on known economic resources (eg. iron ore).

All of these combined trends have important social, environmental and economic implications for mining. They give hope to some but cause for concern for others.

Ultimately, the sustainability of the mining industry continues to hang in the balance.

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Common Acronyms & Abbreviations

NSW	State of New South Wales	NT	State of Northern Territory
QLD	State of Queensland	SA	State of South Australia
TAS	State of Tasmania	VIC	State of Victoria
WA	State of Western Australia		

ABARE	Australian Bureau of Agricultural & Resource Economics (Commonwealth Agency)
AGSO	Australian Geological Survey Organisation (Commonwealth Agency, replaced BMR)
AusIMM	Australasian Institute of Mining & Metallurgy
AWAC	Alcoa World Alumina & Chemicals, Alcoa Ltd (60%) and Alumina Ltd (40%) Joint Venture
BHP	Broken Hill Proprietary Company Ltd
BHPB	BHP Billiton Ltd (formerly BHP)
BHS	Broken Hill South Silver Mining Company Ltd
BMR	Bureau of Geology, Geophysics & Mineral Resources (Commonwealth Agency)
CIP	Carbon-in-Pulp (cyanide milling technology for gold)
CRA	Conzinc Riotinto Australia Ltd (now Rio Tinto Ltd)
DM's	State Department of Mines (eg. Annual Reports, Bulletins, Mineral Resource studies, etc)
EZ	Electrolytic Zinc Company of Australasia Ltd
GA	Geoscience Australia (Commonwealth Agency, replaced AGSO)
GEMCO	Groote Eylandt Mining Company Pty Ltd (former BHP subsidiary)
JV	Joint Venture
MIM	Mt Isa Mines Ltd (now part of Xstrata Ltd)
MRT	Mineral Resources Tasmania
NBH	North Broken Hill Ltd (now part of Rio Tinto Ltd)
NSWCIP	New South Wales Coal Industry Profile
NSWDM	New South Wales Department of Mines
NSWDMR	New South Wales Department of Mineral Resources
NSWMIR	New South Wales Mineral Industry Review
PIRSA	Primary Industries & Resources South Australia
QDM	Queensland Department of Mines
SADM	South Australian Department of Mines (now PIRSA)
SECV	State of Electricity Commission of Victoria
TDM	Tasmanian Department of Mines (now MRT)
VDM	Victorian Department of Mines (now VDPI)
WADM	Western Australian Department of Mines (now WADoIR)
WADMPR	Western Australian Department of Minerals & Petroleum Resources (now WADoIR)
WADoIR	Western Australian Department of Industry & Resources
WR	Waste Rock
ZC	Zinc Corporation

Common Element & Mineral Symbols

Ag	Silver	Co	Cobalt	Mn	Manganese	U	Uranium
Al	Aluminium	Cu	Copper	Sb	Antimony	W	Wolfram
Au	Gold	Fe	Iron	Sn	Tin	Zn	Zinc
As	Arsenic	Pb	Lead	Ti	Titanium	Zr	Zirconium

Project and Associated Publications to Date

Most papers below are available from the personal staff website of the author :
http://civil.eng.monash.edu.au/about/staff/muddpersonal/
If they are not (for copyright reasons), please email and request them.

Peer-Reviewed Journal Papers :

Mudd, G M, 2007, *Global Trends in Gold Mining : Towards Quantifying Environmental and Resource Sustainability ?* **Resources Policy**, 32 (1-2), pp 42-56.

Mudd, G M, 2007, *Gold Mining in Australia : Linking Historical Trends and Environmental and Resource Sustainability*. **Environmental Science and Policy**, doi:10.1016/j.envsci.2007.04.006.

Mudd, G M, 2007, *An Analysis of Historic Production Trends in Australian Base Metal Mining*. **Ore Geology Reviews**, 32 (1-2), pp 227-261.

Mudd, G M, 2007, *An Assessment of the Sustainability of the Mining Industry in Australia*. **Australian Journal of Multi-Disciplinary Engineering**, 5 (1), pp 1-12.

Peer-Reviewed Conference Papers & Presentations :

Mudd, G M, 2007, *Resource Consumption Intensity and the Sustainability of Gold Mining*. Proc. "2nd International Conference on Sustainability Engineering and Science : Talking and Walking Sustainability", Auckland, New Zealand, February 2007.

Mudd, G M & Diesendorf, M, 2007, *Sustainability Aspects of Uranium Mining : Towards Accurate Accounting ?* Proc. "2nd International Conference on Sustainability Engineering and Science : Talking and Walking Sustainability", Auckland, New Zealand, February 2007.

Valero, A, Valero, A, Martinez, A, Mudd, G M, 2006, *A Physical Way to Assess the Decrease of Mineral Capital Through Exergy : The Australian Case*. Proc. "9th Biennial Conf on the International Society for Ecological Economics (ISEE) : Ecological Sustainability and Human Well-Being", New Delhi, India, 15-18 December 2006.

Mudd, G M, 2005, *An Assessment of the Sustainability of the Mining Industry in Australia*. Proc. "National Conference on Environmental Engineering : EES 2005 - Creating Sustainable Solutions", Sydney, Australia, July 2005, 6 p.

Mudd, G M, 2005, *Accounting for Increasing Mine Wastes in the Australian Mining Industry*. Proc. "1st International Conference on Engineering for Waste Treatment", Albi, France, May 2005, 8 p.

Mudd, G M, 2004, Sustainable Mining : An Evaluation of Changing Ore Grades and Waste Volumes. Proc. "1st International Conference on Sustainability Engineering & Science", Auckland, New Zealand, 6-9 July 2004.

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The primary companies and organisations include :

Mining Companies :

- Argyle Diamond Mines
- BHP Billiton Ltd (BHPB)
- Dominion Mining Ltd
- International Power Hazelwood Ltd (IPH)
- Loy Yang Power Ltd (LYP)
- MPI Mines Ltd
- Newcrest Mining Ltd
- Newmont Mining Corporation
- NRG Flinders Ltd
- Oxiana Ltd
- Perseverance Corporation
- Queensland Nickel International Ltd (QNI)
- Rio Tinto Ltd
- Xstrata Ltd
- Yallourn Energy Ltd

State Departments / Agencies :

- Mineral Resources Tasmania (MRT)
- Northern Territory Department of Business, Industry & Resource Development (NTDBIRD, now NTDPIFM)
- Primary Industries & Resources South Australia (PIRSA)
- Queensland Department of Natural Resource & Mines (QNRM, now QNRW)
- Western Australian Department of Industry & Resources (WADoIR)

Commonwealth Departments / Agencies :

- Geoscience Australia (GA)

Industry Associations & Consultants :

- Australian Coal Association (ACA)
- Barlow Jonker Pty Ltd
- Intierra Ltd (formerly Minmet Pty Ltd)

There were, of course, many other companies and organisations whose public information available via the internet, databases, reports and/or library collections proved infinitely valuable.

It is hoped that the scale of data sets compiled within this project and final report demonstrate what really is available, and how this can be synthesized into a clear view of modern trends in mining and associated sustainability issues.

These data sets could be used for a variety of purposes – they are compiled for research and education only. No commercial use is intended.

Accordingly, if the data is used, a kind acknowledgement would be much appreciated.

The Sustainability of Mining in Australia : Key Production Trends and Their Environmental Implications for the Future

1. Introduction : Defining 'Sustainable Mining'

The phrase "sustainable mining" appears, at first glance, to be a simple oxymoron – an obvious paradox. After all, numerous famous mines have long since closed due to a finite quantity of ore able to be economically (or technologically) mined and processed at that given period of history. Yet in reality there are mines in operation today that dwarf the productive output of previous generations of mines – an apparent paradox.

In recent years there has been a renewed public debate about mining and its sustainability, due to strong public sentiment on environmental and social issues surrounding the mining industry in Australia and globally. This debate, however, is not new and indeed dates back many centuries. For example, the famous German scholar of mining and metallurgy, Georgius Agricola, stated in his 1556 treatise "De Re Metallica" that :

> "… **the strongest argument of the detractors is that the fields are devastated by mining operations** … Also they argue that **the woods and groves are cut down**, for there is need of an endless amount of wood for timbers, machines, and the smelting of metals. And when the woods and groves are felled, **then are exterminated the beasts and birds**, very many of which furnish a pleasant and agreeable food for man. Further, **when the ores are washed, the water which has been used poisons the brooks and streams**, and either destroys the fish or drives them away. Therefore the inhabitants of these regions, on account of the devastation of their fields, woods, groves, brooks and rivers, find great difficulty in procuring the necessaries of life … **Thus it is said, it is clear to all that there is greater detriment from mining than the value of the metals which the mining produces.**" (emphasis added) (pp 8) (Agricola, 1556)

Agricola, despite acknowledging the legitimate concerns of critics, argued passionately that the benefits from mining far outweighed localised impacts and that mining was a core part of the foundation of modern society. The contemporary debate is essentially the same as that outlined by Agricola – social and environmental impacts of mining and the use of minerals for military purposes versus the economic and social benefits from mining and the broad-based need for minerals in modern technology.

The past decade has seen an increasingly focused debate on the need to shift modern mining to a more sustainable framework. The approach to describing what is "sustainable mining" varies considerably, largely dependent on whether the view is from industry, government or civic groups. Some of the key issues often raised include :

- declining ore grades
- available economic resources
- economic parity and sharing of risks and benefits
- impurities (eg. arsenic, mercury)
- environmental and social impacts during and after mining
- the increasingly large scale of mining, especially the use of major open cuts and the significant volumes of waste rock/overburden produced

Thus, although Agricola raised many of these issues in the context of European mining in the sixteenth century, the current debate is on a truly global scale and the inextricable links between the substantively larger scale of present mining and the associated environmental-social impacts and benefits.

To address these issues, the following hypotheses are investigated :

- *ore grades are in gradual but permanent decline,*
- *scale of individual mines is generally increasing,*
- *solid waste burden (waste rock/overburden and tailings) per unit mineral is increasing,*
- *continually expanding production continues to put pressure on economic resources,*
- *more complex ores are now being developed, often with significant impurities.*

These hypotheses give rise to questions such as :

- *is the environmental burden per unit metal/mineral increasing ?*
- *do these trends increase the potential for short and long-term environmental and social impacts ?*
- *can mining ever truly be a sustainable human endeavour ?*

The first question is quantifiable, and this report aims to provide substantive data to help in this regard. The latter questions are, without doubt, contentious and quite subjective and are not readily quantifiable – although they are at the heart of a future mining industry which can rightly (or wrongly) ascribe itself as sustainable.

The continuing debate on incorporating sustainable development into the mining industry, however, lacks systematic data analysis of current and historical mining activities. Data for aspects such as economic resources, ore grades and solid waste burden, is fundamental evidence in any assessment or quantification of sustainability for mining.

This report will briefly examine the perspectives and aspects of "sustainable mining", followed by a detailed compilation and analysis of the history of mining and mineral production in Australia over the last century or more. The review of sustainable mining is not intended to be extensive but is necessary to establish the conceptual basis for the need to provide quantitative data on mining and mineral production to underpin the debate on sustainable mining. The term minerals is applied broadly and is intended to encompass all metals as well as other minerals which are non-metals (eg. coal, diamonds).

This report does not seek to develop a new model of sustainability for the minerals industry, rather, it quantifies the principal trends of modern mining and places these within the context of the current debate on sustainable mining, thereby providing fundamental data for quantifying the sustainability of mining. A discussion of the key Australian trends and the merits of different perspectives will then be presented, leading to some recommendations for improved reporting by the mining industry to allow a better understanding and quantification of sustainable mining. The report is the first truly systematic quantification of these trends and issues in the Australian mining industry.

2. Approach & Methodology

In order to establish the context for this report, some of the principal issues on mining and the environment, or 'sustainable mining', are presented and briefly reviewed. This section is not intended to be a thorough analysis and critique of this debate. It is intended, however, to lay the foundation for the subsequent sections of the report; that is, the need to systematically quantify the key trends in modern mining and mineral production.

In order to assess the sustainability of Australian mining, a detailed compilation of the production history of mining and milling across all states and territories[1] in Australia has been undertaken, with a view towards establishing the extent of the changes in ore grades for various minerals and metals as well as quantifying the production of wastes (where possible). The extent of economic resources has also been collected for most commodities, though this is only reported as 'economically demonstrated resources' according to industry standards (eg. the JORC code[2]). Limited data on mine site rehabilitation has been collected.

There are a number of periodic or regular reports published on the Australian mining industry. These include the "Annual Mineral Industry Review" by the former Commonwealth Bureau of Mineral Resources (or 'BMR') (BMR, var.), various industry statistical publications (eg. ABARE, var.-a, var.-b; LP & Minmet, var.; Riddell, var.; RIU, var.), State Department of Mines[3] reports, annual reports of state and federal agencies and mining companies, as well as the older series "The Mineral Industry : Its Statistics, Technology and Trade" on the global mining industry (1892-1940) (Anonymous, var.). For some specific minerals (eg. coal, aluminium), industry associations and consultants also compile annual data over time. All primary data sources are listed in detail within each section as well as appendices.

For total mineral production, the principal references include :

- BMR, Annual Mineral Industry Review annual series (1948 to 1987) (BMR, var.);
- BMR 1964 Australian Mineral Production & Trade Study (Kalix *et al.*, 1966);
- NSW and QLD Coal Industry Reports (annual) (eg. NSWDMR, var.-a; QNRM, var.-a);
- State Department of Mines Annual Reports (MB-NTA, var.; NSWDM, var.; NTDME, var.; QDM, var.; SADM, var.-b; TDM, var.; VDM, var.; WADM, var.) and Industry Statistical Reports (eg. NSWDMR, var.-b; QNRME, var.; VDPI, var.; WADMPR, var.; WADoIR, var.);
- ABARE, Australian Mineral Statistics quarterly journal (ABARE, var.-a);
- ABARE, Australian Commodity Statistics annual series (ABARE, var.-b);
- AME 1982 Gold Study, "Gold : World Supply and Demand" (Govett & Harrowell, 1982);
- Coal data courtesy of Barlow-Jonker Pty Ltd (consultants); and
- Australian Aluminium Council, industry statistical data (from website) (AAC, 2004).

For individual mine data, including mining and milling data, additional references include :

- Company Annual Reports and announcements (numerous);
- McGraw Hill's "The Mineral Industry : Its Statistics, Technology and Trade" (Anonymous, var.);
- Register of Australian Mining (RIU, var.);
- Australian Mines Handbook (annual) (LP & Minmet, var.);
- Jobson's Mining Year Book (annual) (Riddell, var.); and
- Minmet Australia Pty Ltd, quarterly gold statistics (subscriber service)[4];
- State Geological Survey technical reports (eg. Bulletins, Reports, Memoirs, etc).

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[1] The term "states" is used throughout this report to denote both states and territories inclusively.
[2] JORC – The Joint Ore Reserves Committee is the formal industry standard / code for quantifying and reporting ore reserves and resources; see (AusIMM *et al.*, 2004).
[3] Most states now name their Department of Mines differently, such as 'Mines & Energy', 'Mineral Resources' or it is housed within the broad Primary Industries portfolio (eg. PIRSA).
[4] Minmet Australia Pty Ltd : **www.minmet.com.au** (now part of Intierra Pty Ltd)

The extent of Australian economic base metal resources is published by Geoscience Australia (GA, var.) and includes data from 1975-2006 for most minerals. All pre-1975 resources data is obtained by collating individual mines (see references in Appendix). It should be noted that the formal basis for reporting ore resources has changed considerably over time, say 1900 to 2006 (eg. the Joint Ore Reserves Code or 'JORC'; AusIMM *et al.*, 2004). However, given the generally small number of major mines reporting resources prior to 1975, it is considered useful to compare the different data to assess the magnitude of changes in economic reserves over this period.

The following rules were applied in assessing and compiling reported data :

- company data takes precedence over other sources;
- calendar year was adopted where possible, otherwise financial year data was applied in the year it was reported (eg. 1987/88 would be recorded in 1988; considered sufficient for overall timescale trends of decades);
- assayed ore grade was sought, with yield data corrected for recovery (where known);
- all data was converted to SI units (eg. tonnes and kilograms; this is a key challenge in converting the considerable extent of historic data, especially dating back to the 1800's). Standard prefixes have also been used through, including 'M' for 10^6 and 'k' for 10^3 (eg. Mt, kt);
- alluvial mining has generally not been included (due to the difficulty of data equivalence, except in diamonds), or is presented and discussed separately;
- co-product or by-product mines with significant production have been incorporated into each specific commodity (eg. a Cu-Au mine would be included in both sectors);
- where sources conflicted, the data considered closest to or most consistent with a company source was adopted (requiring some degree of judgement).

Although the inclusion of co-products and by-products into each commodity does introduce a degree of double accounting, it was considered important to do this to assess the true extent of ore processed to produce the specific metal or mineral. In general, it is clear that a mine should be included (eg. Mt Lyell in Cu and Au), while for others it is somewhat subjective (eg. Rosebery and Au; Kambalda and Cu; Broken Hill and Cu). If the by/co-product represented significant annual production (eg. >100 kg gold), then it was included in that commodity. The inclusion or otherwise of by/co-products is detailed within each relevant commodity section.

In order to assess the degree to which the data set represents its specific sector, the calculated production is graphed as a percentage of reported production. The 'calculated production' is derived by the summation of all individual mine production from the compiled data set. The reported production is the official annual production of that metal. Thus, for each metal a value of >90% would suggest that the data presented effectively covers that metal sector for that given year. Given the variable data sources, it is possible that the proportion of production could be >100%. This could be due to a variety of factors, including errors in individual mine production, rounding errors, financial versus calendar year, and/or incorrect reported Australian production.

The extent of and quality of data varies considerably across all of the above publications, with inevitable gaps for some years. The reporting of data is not always consistent, such as mineral yield versus assayed ore grade, concentrate versus ore, plus discrepancies for the same data between publications. For much of the historical gold and base metals data of the 1800's, a key issue is that not all production was reported to State Mines' Departments (despite the urging to report such data for posterity). For other aspects, there is often no compilation nor public reporting of key overall data (eg. rehabilitation).

Overall, there is a minor degree of uncertainty in the assembled data sets. When different data sources for specific mines are compared, the correlations are very close. The net effect on trends in the data is therefore considered to be negligible. For examining trends over temporal scales up to two centuries, this uncertainty is not significant as the overall trends show larger change than the uncertainty in the data (eg. Cu ore was ~15-25% Cu in the mid-1800's but is presently 0.2-3% Cu). For most of the time period presented, the compiled data represents more than 90% of base metal production in Australia.

The commodities for which data is complete to the full extent available includes aluminium, iron ore, black and brown coal, diamonds, mineral sands, nickel and uranium. For the remaining metals, the metal production is added from all individual mines to create an estimate of total mine production. This 'calculated' value is then compared to the reported Australian production as a percentage. For the commodities with incomplete data sets, the data generally represents some 80-95% of the production (mostly >90%), and includes copper, gold, lead, zinc, silver. Values >100% represent errors in either the mine production estimate (eg. due to calendar versus financial year data) or the reported Australian production (possibly due to different data sets or sources being utilised rather than individual mines).

To allow interpretation of each major commodity, a brief history is presented outlining the main developments over time. This provides a reasonable foundation to interpret much of the variability in the many production and other graphs.

Finally, a detailed analysis of key trends is presented, based on statistical regressions and extrapolations of the numerous graphs within various sections. This brings together the evidence for the extent of declining ore grades, solid waste burden and remaining economic resources. These trends are then discussed within the context of sustainable mining for the Australian mining industry.

The remaining structure of this report is therefore :

- *Defining Sustainable Mining*
- *Results : Total Mineral Production*
- *Results : Energy Commodities*
- *Results : Bulk Commodities*
- *Results : Base-Precious Metals and Diamonds*
- *Analysis : Key Trends*

All master data sets, as compiled, are given in the various appendices, including a detailed listing of all references used to produce this data set.

3. Defining Sustainable Mining

3.1 The Mining Cycle

The extraction of useful materials from the earth is indeed an ancient practice that has evolved over the millennia to the present day where the scale is considerable. The modern mining industry moves from exploration and deposit discovery to evaluation through development to operation and finally followed by rehabilitation. This is often known as the 'mining cycle'. It is this continually evolving cycle of the deposits discovered and developed versus the known prospects/resources remaining which is a key issue surrounding resource depletion/availability.

The principal methods of physically extracting minerals include alluvial, underground, open cut and solution mining. In general, underground and open cut mining are the pre-dominant forms of mining, while alluvial and solution mining are often used for particular minerals or types of mineral deposits, such as alluvial techniques for mineral sands or in situ solution mining for sulphur, salts and certain metals (eg. copper, uranium). After mining, the ore is milled to liberate the mineral or element of economic interest. There are a wide variety of milling methods, often including or combining grinding, gravity separation, physical flotation, chemical leaching, product purification, refining and/or smelting. A diagrammatic view of a typical modern mine site is shown in Figure 1.

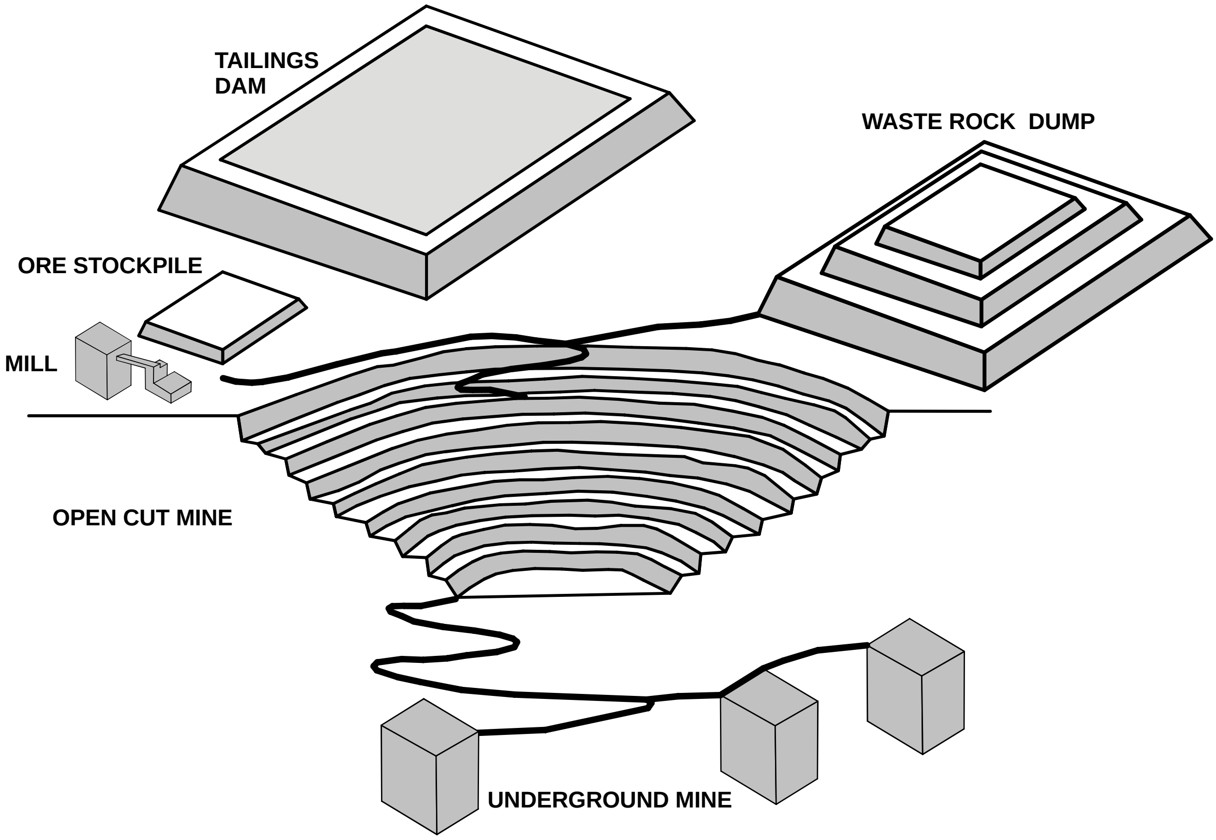


Figure 1 – Diagrammatic View of a Typical Modern Mining-Milling Complex

3.2 Perspectives of Sustainable Mining

3.2.1 Key Definitions, Concepts and Themes

In the context of this report, sustainable development will be defined based on the World Commission on Environment and Development (WCED, 1990). That is, the ability of current generations to meet their needs without compromising the ability of future generations to meet their needs. In the context of mining, this is taken to include the availability of resources and a productive environment at former mining or milling sites.

It is clear that mining operations need to consider sustainable development, especially since the legacy of mining can resonate for some hundreds of years (Azcue, 1999; Barrett, 2000; IIED & WBCSD, 2002; Lottermoser, 2003). The definitions of sustainable mining vary widely, however, generally along the lines of whether a civic, environmental, government or industry perspective is advocated. The concepts of sustainable mining often focus on two key themes – resource depletion/availability and environmental/social impacts.

The known or available resources theme is most commonly raised by civic, academic and some government groups (eg. Meadows *et al.*, 1972; Young, 1992). The argument asserts that resources of a particular mineral, say coal, iron ore or copper, are a finite quantity and that continual production will eventually deplete this resource as they are non-renewable. If increasing production is taken into account, this points to exhaustion occurring earlier than if production was held constant. The mining of a non-renewable finite resource is therefore argued as clearly unsustainable.

In contrast, the mining industry has argued that mining is a cyclical activity – involving exploration through mining to rehabilitation and back to exploration (eg. Hore-Lacy, 1986; Tilton, 2003). It is argued that this process is inextricably linked to economics and social issues (eg. land use), giving rise to more exploration as prices rise due to perceptions of potential supply shortages as demand grows. Commonly, the view that mineral resources are finite is rejected by the mining industry due to this continuing cycle of the discovery of new deposits, new technology and and the like to continue to meet rising demand.

Overall, there is less debate on the extent of economically recoverable resources at present, with the primary focus being on the environmental and social impacts of the extraction and recovery of various minerals and metals (ESDWG, 1991; WCED, 1990).

The potential environmental and social impacts of mining are relatively well documented and understood in general, though debateable on a site-specific basis (eg. Da Rosa *et al.*, 1997; IIED & WBCSD, 2002). There are numerous aspects to these issues, and the scale of environmental and social impacts are intimately linked. The most commonly raised components include :

- ***Land Use Management*** – especially potentially competing uses such as conservation through national parks and mining; associated legislative, planning and democratic issues (eg. ESDWG, 1991; IIED & WBCSD, 2002; Zuckerman *et al.*, 1972).
- ***Environmental Impact Assessment and Permitting*** – legislation in Australia at both state and federal level requires environmental assessment before any legal authority to develop a mine can be issued. This is viewed as a major component in ensuring the best engineering design and minimal environmental impacts for a proposed mining project, as well as providing for public consultation.
- ***Environmental Impacts During Operations*** – This includes solid and liquid waste management (tailings and waste rock/overburden), mine site water management, hazardous wastes (eg. cyanide), pollutant emissions – especially greenhouse gases (CO_2), as well as incidents involving spills and leaks.

- ***Post-Mining Rehabilitation*** – the effectiveness of the rehabilitation techniques applied to a former mine site is a critical issue for both the mining sector as well as local communities. This is a widely acknowledged issue but there is very little in the way of both qualitative or quantitative measures to address 'sustainable' rehabilitation. There is also very little reporting of data on rehabilitation.
- ***Environmental Costs of Raw Minerals versus Secondary Sources*** – For some minerals, the environmental costs of primary supply are significant, such as energy and water consumption and land required, especially when compared to that required for recycling or re-use of some metals (eg. aluminium) (noted by, amongst numerous others, IIED & WBCSD, 2002; Meadows *et al.*, 1972; WCED, 1990; Young, 1992). The concept of "virtual water" is now being applied to mineral commodities as a way to quantify the relative water costs of mineral supplies (eg. Allan, 1993; Hoekstra & Hung, 2005).
- ***Economic Parity*** – The benefits from mining, such as monetary profits, are not always distributed fairly between a mining company, governments and local affected communities. As such, there can be a common perception that the risks and benefits are skewed, with the communities who will commonly have to bear the long term risks not sharing sufficiently in the benefits during and after mining.
- ***Increasing Scale*** – The increasing scale of modern mining is argued as a major barrier to a more 'sustainable' raw materials sector (Young, 1992). The substantive size of numerous open cut mines, tailings storage facilities, waste rock or overburden dumps, and the like, as well as the volume of material inputs to process and produce metals from progressively lower grade deposits, is pointing to potential upper limits on modern mining.

All of these broad themes or aspects could be further expanded upon, and in reality are major issues of their own. However, a major weakness throughout all major works on the sustainability of mining this is the lack of thorough historical data on mining and mineral production. To address many of the above issues and provide a sound foundation to inform the various perspectives of sustainable mining, this data is absolutely fundamental.

3.2.2 Synthesis of Major Issues

As can be seen, the concept and scope of sustainable mining varies widely, but generally includes social, environmental and economic aspects. In general, the question of resource scarcity is not considered as urgent in the current debate though the issue of environmental/social impacts remains pivotal (ESDWG, 1991; Young, 1992).

These thematic issues of resources-technology-environment-social aspects are inextricably linked due to the increasing scale of modern mining which exploits lower grade but larger orebodies, often through sizeable open cut mines. The volume of wastes generated is now some orders of magnitude higher than a century ago, which in extreme cases can lead to severe impacts for long distances from mine sites (Azcue, 1999; Lottermoser, 2003).

In recent years, there has been an increasing focus on techniques such as "Life Cycle Assessment" (LCA) to assess the total costs to produce a unit quantity of a particular metal. LCA includes a basis for accounting for water and energy consumption, toxicity, and the effects of recycling. Reviews of LCA analyses for aluminium, copper, iron, lead, zinc and nickel are given by Lunt *et al.* (2002), Norgate & Rankin (2002a, 2002b). Ultimately, it is the proportion of a given metal supplied by primary (mined) versus secondary (recycled) sources and their respective environmental costs which will largely govern a metal's sustainability. The data used for LCA analyses is still improving, and this report aims to help improve this further by providing as-mined data as potential inputs into LCA models.

In order to predict the future sustainability of the mining industry, it is therefore critical to examine the trends of ore grades, the amount of waste materials mined for a given mineral production and the extent and success of rehabilitation. This can be used to inform public policy, provide more accurate data for Life Cycle Assessment, and allow better accounting of the environmental costs of mineral production and supply. This report is the first stage in compiling and presenting this data for Australia.

4. Results : Total Mineral Production

The references listed previously have been used to compile master data sets for the historical production of major mineral commodities in Australia, ranging from the earliest data to the most recent production to 2006. These data sets are provided in the Appendices. Black and brown coal mining data is presented separately in Section 5.

The annual production history for major metals and mineral commodities are shown in Figures 2 and 3, clearly illustrating the principal historical events for the Australian mining industry. This includes the discovery and/or development of :

- copper north of Adelaide from the late 1840's (eg. Kapunda, Burra, Moonta-Wallaroo), Cobar in central New South Wales from the 1870's, Mt Lyell in the late 1890's, Mt Isa's copper from the mid-1950's and the more recent boom dominated by Olympic Dam, Northparkes, Ernest Henry and others;
- gold in New South Wales and Victoria in 1851, followed soon after by Queensland and other states (eg. Western Australia from the 1890's);
- lead-zinc-silver at Broken Hill in western New South Wales in 1883 (though zinc was not able to be recovered economically until some 20 years later);
- manganese at Groote Eylandt in the 1950's;
- nickel at Kambalda, south of Kalgoorlie, Western Australia, in 1966;
- tin at Mt Bischoff in Tasmania in 1871, and subsequently along the east coast of the mainland;
- uranium at Rum Jungle, Northern Territory, in 1949, and Mary Kathleen, Queensland in 1954, and its resurgence from the late 1970's;
- iron ore in the Middleback Ranges near Whyalla, South Australia, in the 1890's, followed by the opening up of the Pilbara from the 1960's;
- bauxite in Weipa (Queensland), Gove/Nhulunbuy (Northern Territory) and the Darling Ranges (Western Australia) in the 1960's;
- the Argyle diamond deposit in 1979.

As such, a series of mineral booms are a clear and important part of Australia's history, with the most recent booms of the last few decades providing significant economic returns (as evidenced by strongly accelerating production trends over these decades). The minor variations in annual production can generally be related to economic conditions (eg. a recession), or the closure of major mines significantly reducing production capacity (eg. tin, uranium). In the case of some commodities, social unrest (eg. strikes) can also be a cause of reduced production (eg. lead-zinc-silver, coal).

Australia, as a nation with strong mineral endowment, is continuing to increase production of virtually all mineral commodities.

The cumulative production over time are shown in Figures 4 and 5 and total production by state and Australia to 2006 compiled in Table 1.

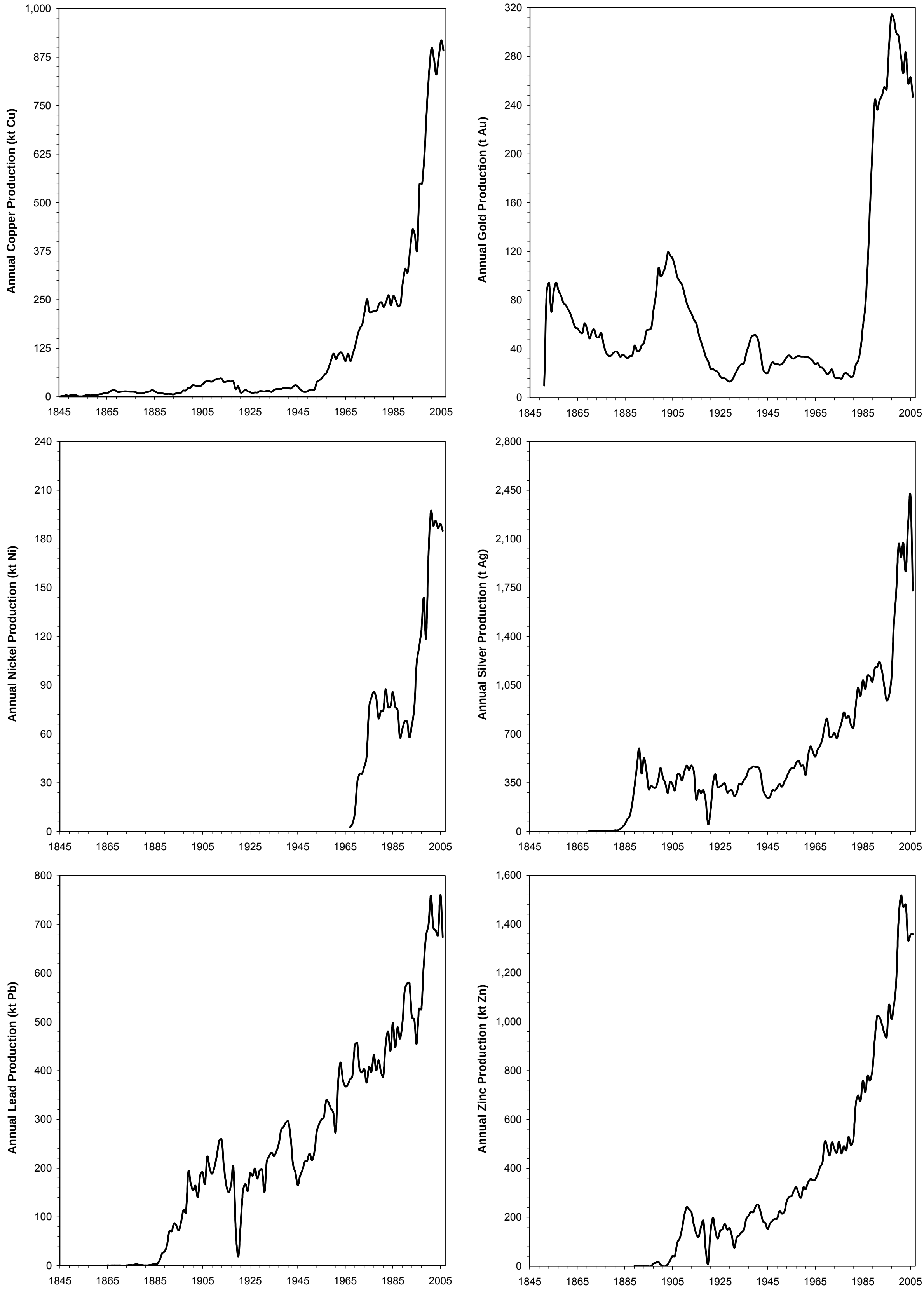


Figure 2 – Annual Mine Production : Copper, Gold, Nickel, Silver, Lead and Zinc

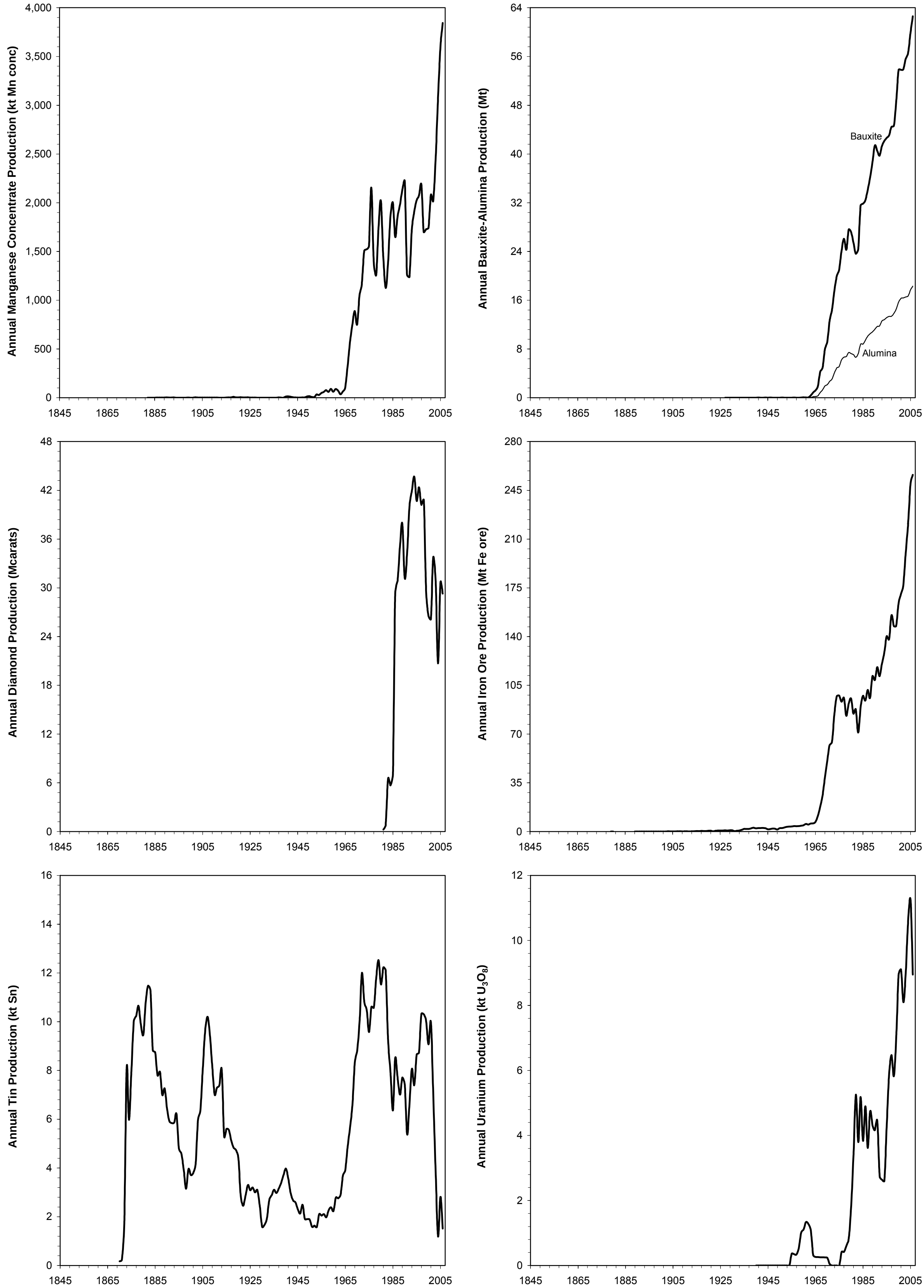


Figure 3 – Annual Mine Production : Manganese, Bauxite-Alumina, Diamonds, Iron Ore, Tin and Uranium

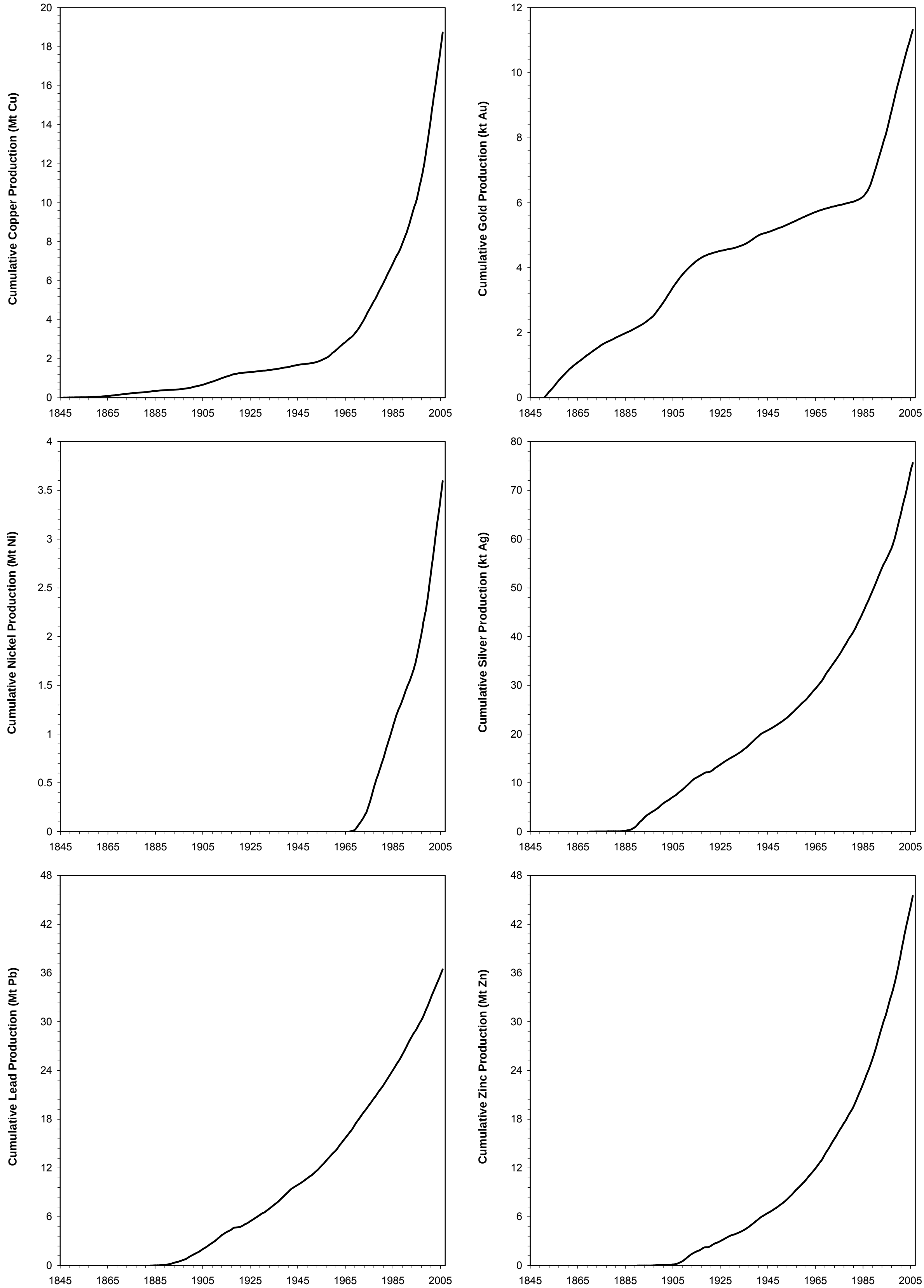


Figure 4 – Cumulative Mine Production : Copper, Gold, Nickel, Silver, Lead and Zinc

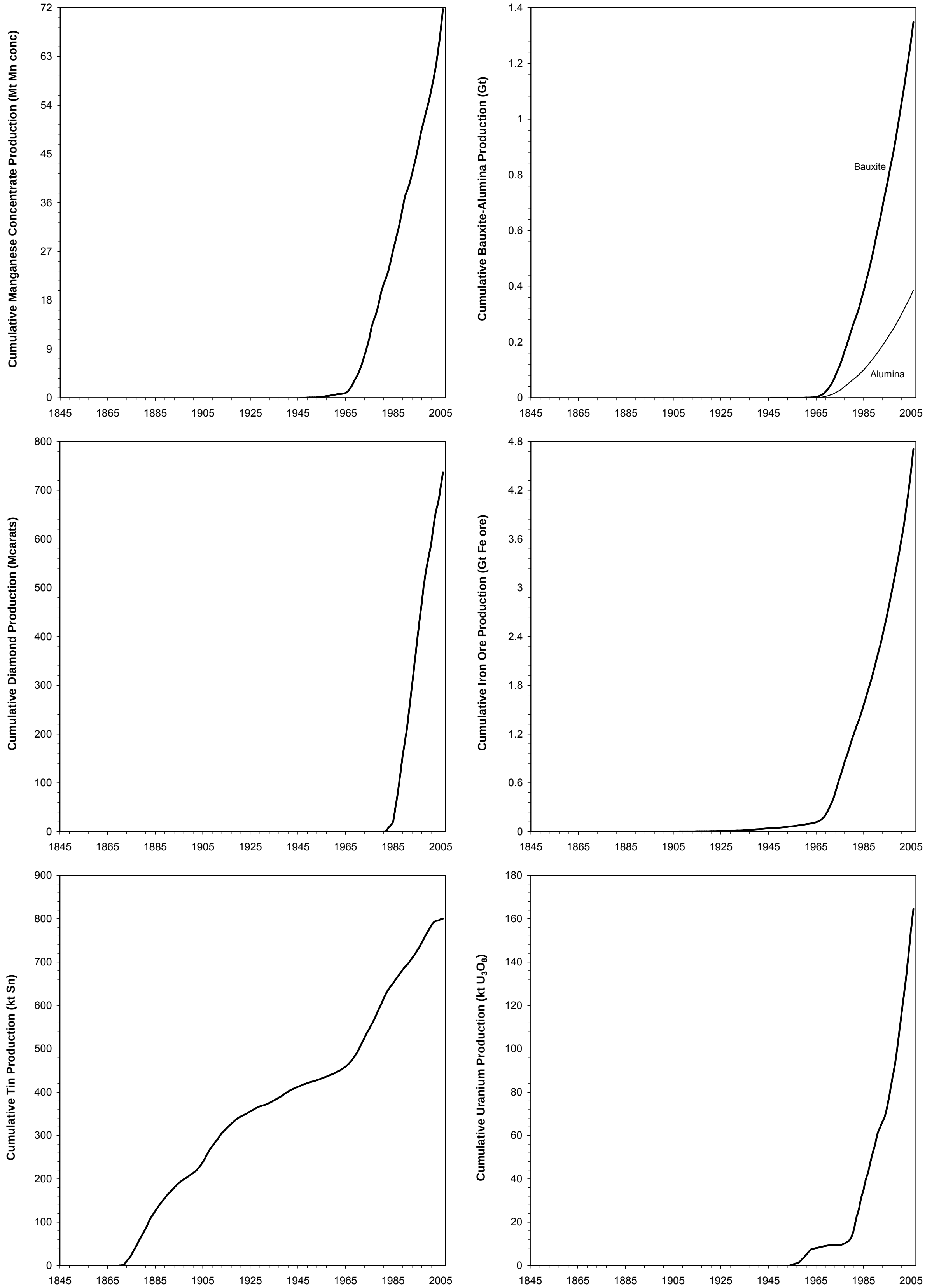


Figure 5 – Cumulative Mine Production : Manganese, Bauxite-Alumina, Diamonds, Iron Ore, Tin and Uranium

Table 1 – Total Mineral Production by State and Australia

	Units	VIC	NSW	QLD	TAS	SA	NT	WA	Aust	Period[P]
Bauxite	Mt	0.217	0.235	370.0	0	0	~186.6	~791	~1,349	1927-2006
Black Coal (raw)	Mt	22.7	4,162.2	3,577.9	26.3	110.5	0	194.4	8,299	1829-2006
Brown Coal (raw)	Mt	2,061	-	-	-	-	-	-	2,061	1889-2006
Copper	kt	15.4	2,590	10,402	1,677	2,802	367	848	18,732	1842-2006
Diamonds	Mcarats	-	~0.2	-	-	-	~0.52	~730.0	~731	1867-2006
Gold	t	2,377.4	819.0	1,336.6	196.2	55.8	514.4	6,021.4	11,321	1851-2006
Ilmenite	kt conc	102	~1,104[#]	~4,116[#]	0.6	1	-	~39,570[#]	~59,999	1934-2006
Iron Ore	Mt	0.041	4.843	0.668	76.75	236.9	6.884	4,386.5	4,713	1889-2006
Lead	kt	0.4	22,478	~10,632[#]	2,220	18.1	569.5	760.9	~36,453	1850-2006
Manganese Ore	kt	0.44	76.4	158.4	0.76	62.7	63,354	8,238	71,890	1946-2006
Monazite	kt	0	~22[#]	~5.5[#]	0	0	0	~220	~251	1947-2006
Nickel	kt	0	0	327.4	~0.6	0	0	~3,267[#]	~3,594	1967-2006
Rutile	kt conc	66.8	~4,643[#]	~4,194[#]	39.8	1.7	-	2,951	11,897	1934-2006
Synthetic Rutile[§]	kt	-	-	-	-	-	-	»8,530	»8,530	1934-2005[§]
Silver	t	~55	~33,942	~32,066	~5,573	~288	~799	~1,911	~75,618	1870-2006
Tin	kt	13.68	~182.3	~176.1	~392.3	<0.1	6.0	~37.7	~800	1870-2006
Uranium	t U_3O_8	0	0	8,893	0	50,466	105,209	~11.5	164,580	1906-2006
Zircon	kt	20.8	~4,819[#]	~3,317[#]	38.5	0.37	<0.5	10,557	~18,588	1934-2006
Zinc	kt	~19.5	~22,694[#]	~12,212[#]	~5,351[#]	415	~2,062	2,667	~45,489	1883-2006

[#] / ~ Data incomplete / approximate; » Much greater than. [P] 2006 production data is preliminary only. [§] Synthetic rutile data for WA only from 1980 (production started in the late 1960's). All data sources listed in detail in appendix, with state and Australian totals being approximate only and based on the best available data set.

5. Results : Energy Commodities

5.1 Black Coal

5.1.1 Brief History

> ***"if a good understanding between the miners and mine owners is maintained and if there survive in us the spirit of industry and enterprise … the region of the Lower Hunter [Newcastle] will be one of the chief centres of industry within the British Empire for many hundreds of years to come."*** T W Edgeworth David[5] (pp 310) (David, 1907) (also pp 295, McElroy & Rose, 1990)

Black coal has been a prominent feature of the mining industry in Australia for more than two centuries, a situation which is likely to continue for some time. The presence of black coal in Australia was noted and confirmed throughout the 1790's, principally around Newcastle and Wollongong close to Sydney, NSW, but also along the southern and eastern Tasmanian coast (Andrews, 1928; Martin *et al.*, 1993). In 1799 the first mineral exports from Australia – black coal – were collected and shipped to Bengal, India (Raggatt, 1968).

Further details on the history of black coal mining across Australia are given by Griffiths (1998), King (1975), Martin *et al.* (1993) and Raggatt (1968), numerous chapters and papers dedicated to coal in Traves & King (1975a) and Glasson & Rattigan (1990) as well as numerous papers within Woodcock (1980) and Woodcock & Hamilton (1993). For this report, only total black coal is considered, that is, both metallurgical and thermal coals.

By the turn of 1800, mining at Newcastle was producing about 4,000 t per year, including some destined for export (Martin *et al.*, 1993; McLeod, 1998). The difficult ground conditions along with the inexperienced convicts used for labour often hampered production. The NSW Government privatised the coal mines in the 1820's, and from 1830 the output of Newcastle black coal began a steady and well-sustained rise – and a great future seemed assured, as predicted by geologist T W Edgeworth David (see quote above).

Following the success of New South Wales, other states offered rewards for workable coal mines, eventually leading to major coal fields being discovered at :

- Cape Patterson in south-west Gippsland in Victoria in 1826 and nearby Wonthaggi in 1858;
- Ipswich west of Brisbane, Queensland, in 1825, and later followed by the discovery inland of the Bowen Basin stretching north-west from Brisbane and inland;
- the Collie Basin in Western Australia, south of Perth, in 1883;
- Leigh Creek in South Australia, about 600 km north of Adelaide, in 1888.

The pace of development of black coal mining in states other than New South Wales was generally slow. The impetus often came from growing urban centres, especially capitals, or other industries requiring significant coal supplies (eg. mining, railways and ships). By 1889, NSW coal exports reached 1.1 Mt from a total production of around 3.6 Mt.

The Newcastle coalfield was the dominant coal supplier to Australia throughout the 1800's, with industrial disputes and strikes often causing major interruptions in other states due to coal shortages. By the time of Australia's federation in 1901, NSW was supplying 6 Mt of coal annually, with Queensland starting to expand at about 0.5 Mt. Minor production of about 0.2, 0.1 and 0.05 Mt was being raised in VIC, WA and TAS, respectively, at this time also.

[5] T W Edgeworth David was one of Australia's most pre-eminent geologists of the early 1900's.

The tyranny of distance, periods of industrial unrest by Newcastle miners and the gradual realisation of major local black coal resources combined with industry demand led to significant mining in Queensland, Victoria and Western Australia by the early 1900's. By the 1920's, sustained capacities of about 1.1, 0.6, 0.5 and 0.1 Mt/year were being achieved in Queensland, Victoria, Western Australia and Tasmania, respectively.

For South Australia, their reliance on Newcastle coal continued until the late 1940's when the Leigh Creek field was finally developed by the state government. The production of black coal in Victoria was soon to decline, however, due to the emerging strength of the SECV and brown coal mining for power supply, with black coal mining eventually ceasing in 1971.

Another major change in the black coal industry in the late 1930's was the start of large-scale open cut mining. The practice was trialled in 1932 at Lidsdale in the Lithgow district of New South Wales (Gourlay, 1955) and in 1937 at Blair Athol in central Queensland (Dew, 1965). The development of large scale open cuts began in earnest in the 1940's in both New South Wales and Queensland, with Western Australia and South Australia also joining the trend. In 1949 Prime Minister Robert Menzies even encouraged the development of open cut mines to help address critical coal supply problems (Griffiths, 1998).

By the mid-1960's the total value of coal produced in Australia exceeded that of any other mineral, with coal exports second only to those of lead (Raggatt, 1968). For the past two decades, based on ABARE export data, coal has been the single most valuable export commodity for Australia, surging from $5.93 billion in 1989/90 to $24.41 billion in 2005/06 (Table 37, pp 38, 2006 Edition) (ABARE, var.-b).

The rapid industrialisation of major countries around the Asia-Pacific rim from the 1960's onwards provided a considerable boost to the black coal industries of New South Wales and Queensland. A wave of new mines were opened, with Queensland expanding particularly rapidly. Black coal exports (NSW only), which reached a peak of 3.4 Mt in 1908, had waned to about 0.3 Mt in 1946.

From 1961 to 2006, total exports grew exponentially from 1.9 Mt to 237 Mt, respectively, based largely on exports to Japan and across Asia (see ABARE, var.-a, var.-b). This same period has also seen the change from pre-dominantly underground mining to now mainly open cut mining.

The past decade has seen Australia in a difficult position with respect to its coal industry due to major global concern over human-induced climate change due to the use of fossil fuels. The future for the coal industry remains highly uncertain, despite the availability of potentially economic resources still thought to be mineable.

5.1.2 Major Provinces

To date, the most important provinces are the Hunter Valley-Newcastle and Illawarra-Wollongong provinces of New South Wales (mining the Sydney Basin coal measures), the Bowen and Surat Basins in Queensland, with locally significant centres including the Collie Basin in Western Australia and Leigh Creek field in South Australia, as shown in Figure 6.

Figure 6 – Principal Black Coal Provinces of Australia (adapted from ABARE, 2005)

5.1.3 Production

There is annual production data available for all states, including as far back as 1829 for New South Wales. The data set and references of annual production data for each state, including resources, underground/open cut mining and overburden (discussed in detail below), is given in the Appendix.

For Queensland, there is some recent as well as some historical data for overburden from open cut mining. For the Bowen Basin of central Queensland, it was noted by McLeod (1965a) that the black coal reserves with an overburden:coal ratio less than 6:1 were about 70 Mt (pp 131). A limited amount of data is provided by QDM (var.) for the years 1946-1954, primarily for the Blair Athol, Bowen and Callide mines in the Bowen Basin. Average overburden:coal (raw) ratios for the individual mines ranged from 0.5 to 2.1 m^3/t with the Bowen mine under development giving a ratio of 7.1 m^3/t. More recent data for the years 1992/93 to 2004/05 (but missing 1994/95 and 1995/96) is provided by QNRM (var.-a), giving average ratios of between 5.1 to 6.8 m^3/t. This increasing overburden ratio was also noted by Wentworth (1980), who observed that the overburden depth for open cut mines was increasing from 60 m to over 100 m around 1980. Over this same period, given the growth in open cut coal production, overburden production has expanded considerably from about 605 Mm^3 to 1,316 Mm^3 (which is about 70% of all overburden produced by open cut black coal mines across Australia).

According to McGiddy (1993), for open cut mines in NSW operating around 1990, the annual overburden production ranged from 0.8 to 23.9 Mm^3 with the overburden:coal (raw) ratio ranging from 2.0 to 7.1 m^3/t (pp 1524). The production-weighted average ratio can be calculated as 3.8 m^3/t, with total overburden being approximately 163.5 Mm^3. For some years since this time, overburden:coal ratios have increased slightly to around 4.4 to 5.1 m^3/t. Data prior to about 1990 has not been able to be sourced, and was not reported by NSWDMR (var.-a).

There has been very limited use of open cut mining in Tasmania, with data provided by TDM (var.). The first open cut was developed at Blackwood over 1986-87, primarily to facilitate further underground mines in the area. Open cut production moved from about 20-30 kt/year at this time and peaked in the mid-1990's at 0.27 Mt/year in 1995/96, since declining to 40-70 kt/year over 2001-2004. The average overburden:coal ratios have generally ranged from 4.7 to 7.1 m^3/t.

The overburden data for the Leigh Creek field in South Australia has been compiled from three main sources, namely from half-yearly and cumulative data reported from 1944 to 1972 by SADM (var.-a), for 1952/53 to 1962/63 by Andrew (1965) and data provided courtesy of NRG Flinders Ltd[6] for 1994/95 to 2003/04. Over the period 1944 to 1972, coal mined grew from 0.387 to 1.494 Mt while overburden removal (ignoring rehandling) grew from 0.774 to 2.528 m^3, giving waste:coal ratios of 2.00 to 1.69 m^3/t (averaging 2.17 m^3/t over the decade but generally being 2.5 to 3 in the latter years). The more recent data from 1994/95 to 2003/04 shows that average overburden:coal ratios have increased to around 4.5 to 5.9 m^3/t.

The historical overburden data for the Collie Basin field in Western Australia has been sourced for 1963 to 1971 from WADM (var.), though it does not represent all open cut production[7]. The principal open cut during this time was the Muja operation, with the smaller Western mine also (for which data was often not reported). Several small open cuts were also developed, though they were generally short-lived (see Stedman, 1988). The average overburden:coal ratios of this period ranged from 2.7 to 3.7 m^3/t. Underground mining of the Collie Basin ceased around 1994. According to Pitts (1993), average production and overburden:coal ratios around 1990 for the various open cut mines in Collie were :

- Western 5H open cut – 0.8 Mt/year coal, 3 Mm^3/year overburden, giving about 3.8 m^3/t;
- Western 5 open cut – 1.3 Mt/year coal, 8 Mm^3/year overburden, giving about 6.2 m^3/t;
- Muja open cut – 2.1 Mt/year coal, 10-13 Mm^3/year overburden, giving about 5.5 m^3/t;
- Chicken Creek open cut – 0.3 Mt/year coal, 2 Mm^3/year overburden, giving about 6.7 m^3/t;

The majority of coal mines now include a washery / colliery (or beneficiation) plant used to remove some of the impurities present either from the coal or derived from the mining process and produce a more consistent high grade coal product (eg. NSWDMR, var.-a). The ratio of raw (as-mined) to saleable (beneficiated) coal is therefore also very important in terms of solid wastes in coal mining, especially given the increasingly tight specifications for coal quality in export contracts (eg. low ash, low sulphur).

The various figures for black coal mining, including annual production, exports, overburden (as reported), proportion of open cut mining, cumulative production, state production by fraction, overburden-to-coal and raw-to-saleable coal ratios are shown in Figures 7 to 11.

[6] G Betteridge, NRG Flinders, Email 31 May 2005.
[7] The extent of coal production from various open cuts is also detailed by (Stedman, 1988), though no overburden data is stated.

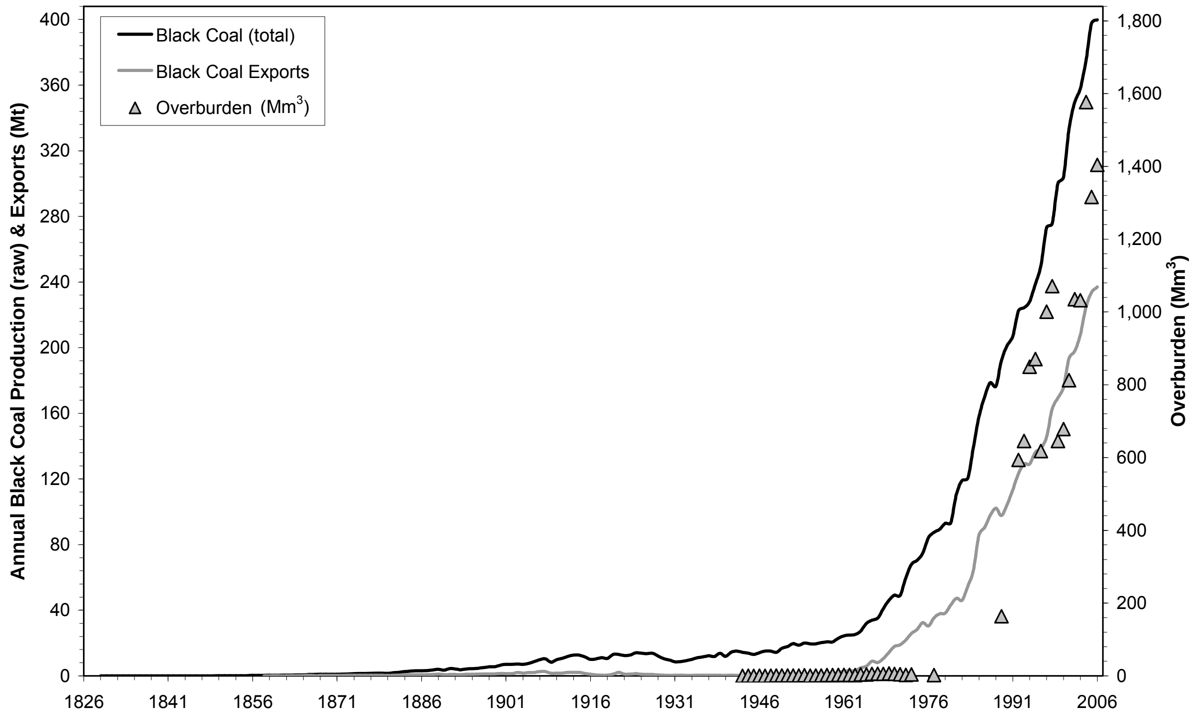
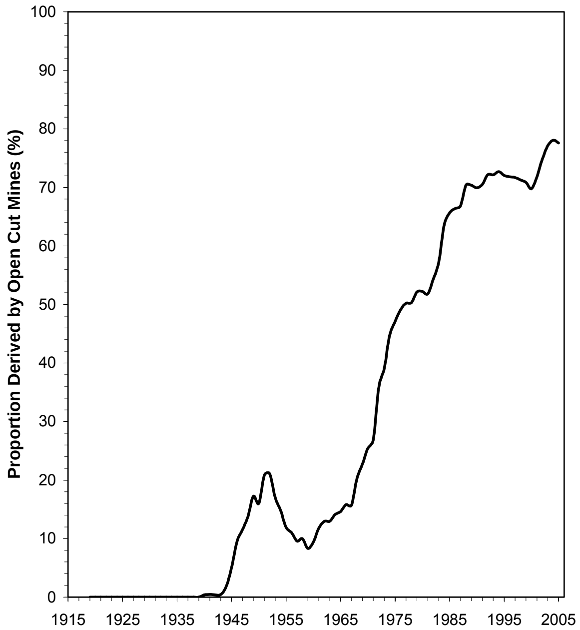


Figure 7 – Annual Black Coal Production, Exports and Available Overburden Data



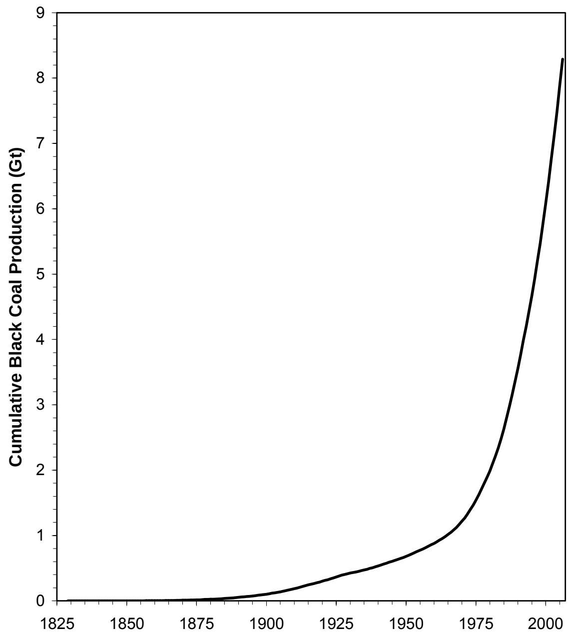


Figure 8 – Open Cut Mining (left); Cumulative Black Coal Production (right)

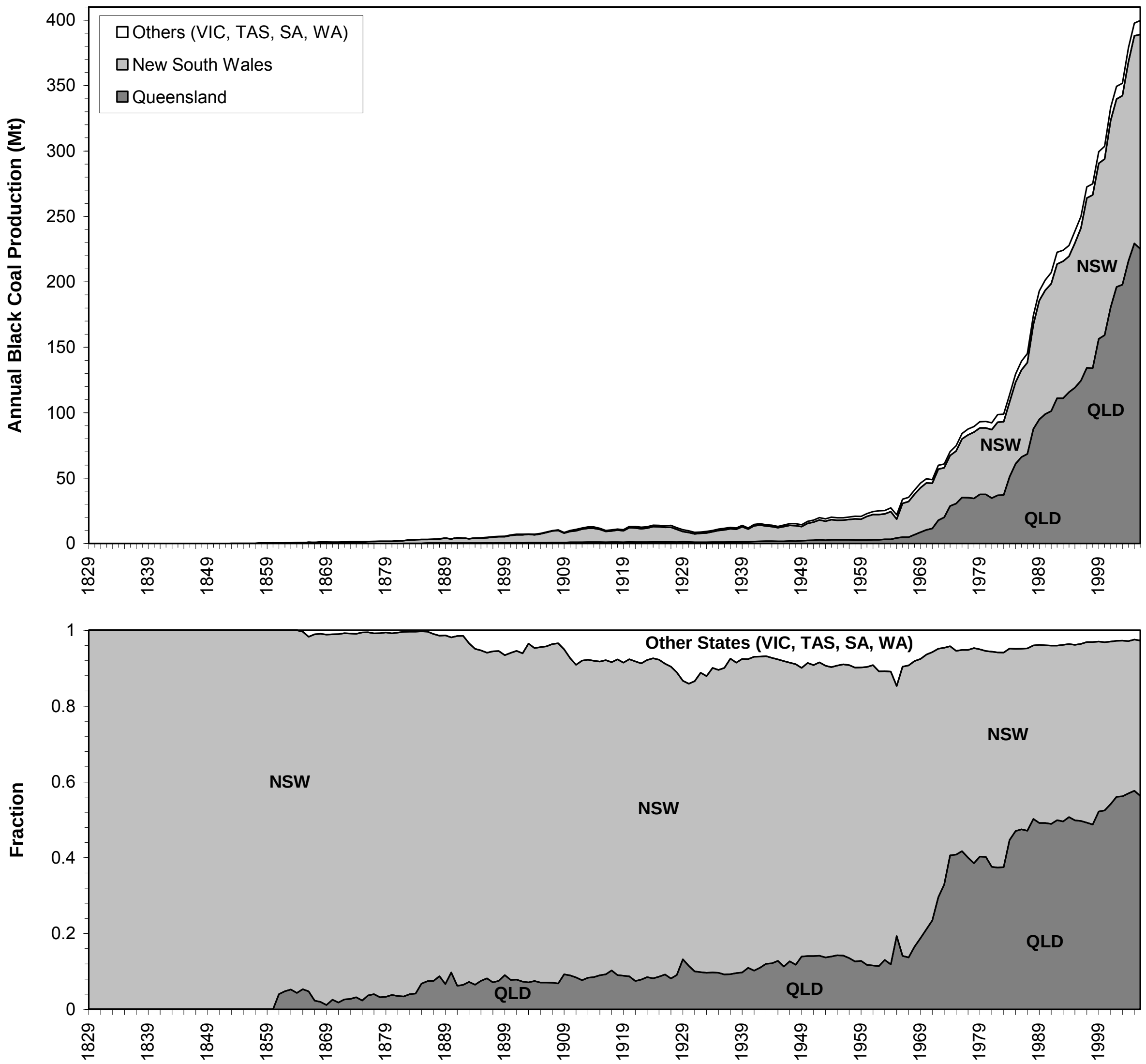


Figure 9 – Annual Black Coal Production by State : Annual and Proportional for NSW, QLD and Others (VIC, TAS, SA, WA)

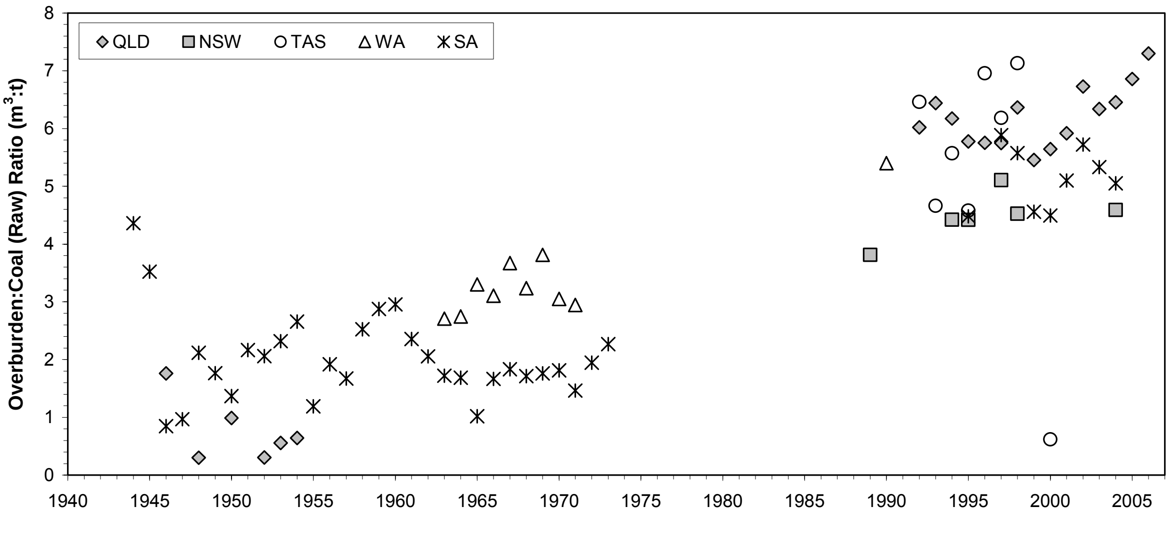


Figure 10 – Overburden:Coal Ratios for Various States

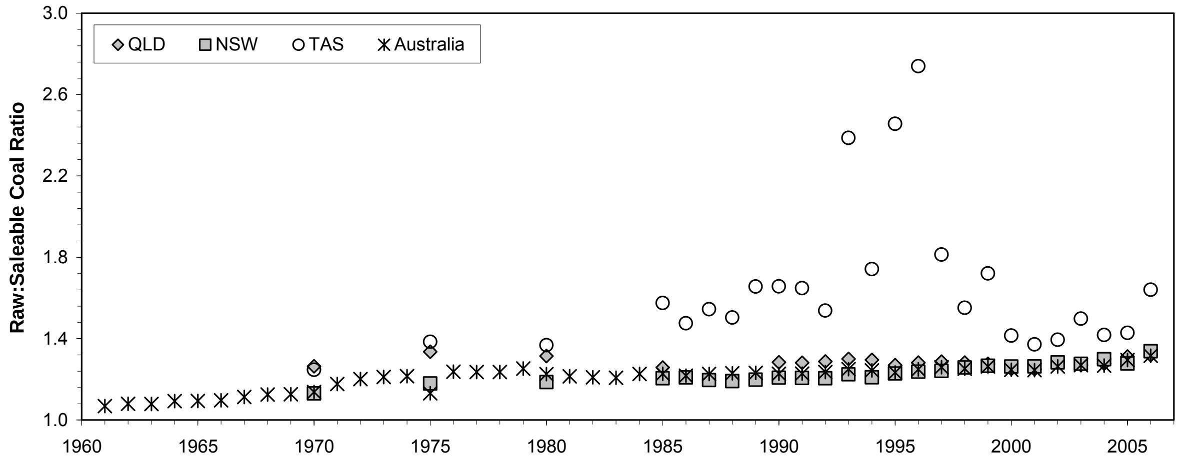


Figure 11 – Raw:Saleable Coal Ratios for QLD, NSW, TAS and Australia

5.1.4 Resources

The geological endowment of black coal in Australia has long been known to be extensive (as noted previously by David) but the economic potential of and ability to mine these resources remains a major point of conjecture, especially with the current debate over climate change. The key issue is the extent of coal 'recoverable' as opposed to the extent of coal which may be geologically estimated to be present. The definitions of 'recoverable coal' over time have changed, with more formal processes now established through the JORC code (AusIMM *et al.*, 2004) and recent guidelines written specifically for coal (CGCNSW & QMC, 2001). Under these guidelines, 'recoverable coal' is defined as coal which is "economically mineable" and includes coal only in the Proven and Probable Reserves category (that is, studies demonstrate that this coal could be economically mined). This commonly means the coal within existing mine and exploration leases where at least conceptual mine planning has been undertaken (eg. NSWDMR, var.-a).

Additionally, a new category introduced by the 2001 coal guidelines was that of 'Coal In Situ' – defined as "any occurrence of coal in the earth's crust that can be estimated and reported, irrespective of thickness, depth, quality, mineability or economic potential" (pp 3) (CGCNSW & QMC, 2001). This category broadly corresponds to historic estimates of potential coal present in various basins such as the Bowen Basin and Hunter Valley.

The earliest estimates of potential coal resources in each state vary by an order of magnitude. Despite the optimism, however, systematic resource data, even allowing for the approximate calculation techniques of the time, are not common. A review of each state is given below, followed by more recent formal national assessments of economically recoverable coal resources and 'coal in situ'.

The known economic coal resources in Queensland have increased significantly over recent decades, as further drilling and exploration has refined estimates as well as evolving technology in open cut mining making deeper deposits feasible to mine.

- 1962 (June) – the quantified resources in existing mines was estimated to be 863 Mt (pp 129) (McLeod, 1965a);
- 1965 – the quantified resources in existing mines was estimated to be 888.5 Mt, although the potential resources were considered to be in excess of 2,000 Mt (pp 259) (Andrew, 1965);
- 1974 – total measured and indicated resources, to a maximum depth of 600 m only, was 12,110 Mt (pp 66) (Traves, 1975);

- 1994 – total measured and indicated resources of 34,232 Mt, split into 2,564 / 10,608 Mt of coking coal and 10,853 / 10,207 Mt of thermal coal mineable by open cut / underground, respectively (pp 6.14) (QEPA, 1999);
- 2003 – total measured and indicated resources of 32,729 Mt, split into 4,114 / 7,126 Mt of coking coal and 13,833 / 7,656 Mt of thermal coal mineable by open cut / underground, respectively (pp 15, 2002/03 Edition) (QNRM, var.-a).

The extent of economic coal resources in New South Wales has long been a difficult issue to quantify accurately. There have been a wide range of values published at various times for NSW coal resources, sometimes varying by more than an order of magnitude. For example :

- 1907 – for the Hunter Valley region, total resources of 5,400 Mt while recoverable resources were 3,600 Mt; further speculation suggested at least 100,000 Mt of exploitable coal could be present in NSW (pp 309) (Atkinson, 1918; David, 1907);
- 1912 – to a maximum depth of 1,200 m, coal resources were about 117,200 Mt (Pittman, 1912);
- 1925 – proven and probable reserves, after allowing for mining losses, were estimated at 12,200 Mt, though in situ reserves were 20,400 Mt; speculation suggested a further 100,000 Mt could be geologically present (Andrews, 1925);
- 1940 – 'actual' and 'probable' reserves of 5,000 and 8,500 Mt, respectively, with a "very much greater tonnage of Potential Reserves" (pp 3) (Jones, 1940);
- 1962 – the measured and indicated resources were estimated to be some 3,000 Mt, with inferred resources coarsely estimated to be greater than 30,000 Mt (pp 135) (McLeod, 1965a);
- 1973 – total 'in situ' resources, to a maximum depth of 600 m only, was 100,800 Mt, of which some 8,800 Mt was conceivably recoverable by mining (pp 156) (Traves & King, 1975b);
- 1979 – total 'in situ' resources estimated by the Joint Coal Board was 500,000 Mt of which only 22,000 Mt or 5% was classified as a measured or indicated resource (pp 71, 1983 Edition) (NSWDMR, var.-a);
- 1980 – the extent of open cut mineable coal resources to a maximum depth of 200 m and a maximum overburden:coal ratio 10:1 were estimated at 7,500 Mt, within earlier estimates of 15,000-20,000 Mt (pp 806) (Ewan, 1980);
- 1993 – coal resources are "more than 80,000 Mt" (pp 19, 1993 Edition) (NSWDMR, var.-b);
- 1996 – recoverable coal resources are 10,830 Mt (pp 25, 1996 Edition) (NSWDMR, var.-a).

While Tasmania is not a major coal producer, its coal resources are locally significant. Estimates over time include :

- 1962 – measured and indicated economic resources were very small but inferred resources were 137 Mt (pp 93, 1962 Edition) (BMR, var.);
- 1965 – indicated and inferred resources were estimated at about 143 Mt (pp 267) (Andrew, 1965), pp 142 (McLeod, 1965a);
- 1991 – measured and indicated economic resources totalled 520 Mt with inferred resources of the order of several thousand Mt (pp 152) (Bacon, 1991).

Due to the current monopoly of brown coal in Victoria, there is little known about the true extent of economic black coal resources. In 1962, it was estimated that measured and indicated economic resources were of the order of 20 Mt with a further 10 Mt of inferred resources (pp 93, 1962 Edition) (BMR, var.). According to Knight (1975c), reserves for the Wonthaggi and nearby regions were about 9.5 Mt (pp 337). More recently, it is argued that the remaining coal resources of the Wonthaggi area are uneconomic (Buckley, 2003).

For South Australia, coal resources have always been minor though locally important for the state in terms of electricity generation. The estimates for the Leigh Creek Field include :

- 1962 – measured and indicated economically recoverable resources of 130 Mt (pp 93, 1962 Edition) (BMR, var.);

- 1965 – economically recoverable resources of 56 Mt, although the field was only explored to a sufficient extent to ensure a long-term coal supply for the life of the Playford power station at Port Augusta (pp 263) (Andrew, 1965);
- 1975 – proved resources of 51.85 Mt with inferred resources of 320 Mt (pp 304) (Johns, 1975);
- 2004 – mineable resources of the order 100 Mt, with inferred resources approximately 500 Mt (though increasing depth makes this uneconomic at present) .

Additionally, coal is found in other geologic basins across central South Australia, although often at significant depth and/or of low quality. These include (PIRSA, 2004) :

- Arckaringa Basin (sub-bituminous coal) – coarse estimate of 10,000 Mt (depth to the top of coal ranges from 104 to 300 m);
- Lake Phillipson (sub-bituminous coal) – coarse estimate of 5,000 Mt (depth to the top of coal ranges from 50 to 143 m);
- Lock – coarse estimate of 320 Mt;
- Lock (lignite coal) – estimate of 3,076 Mt in the Bowman's, Lochiel, Kingston, Sedan and Moorlands deposits (depth to the top of coal ranges from about 20 to 100 m);
- Cooper Basin (bituminous to anthracite coal) – claimed resources "in the order of hundreds of billions of tonnes, [which] dwarf's all other known deposits in Australia" (pp 2) although the depth to the coal ranged from 1.3 to 4 km depth.

In total, PIRSA (2004) claims South Australia's measured and indicated resources of coal are 6,000 Mt with a further 14,000 Mt of inferred resources. Given the generally low grade nature and/or significant depth of these coal resources, however, the extent of economically mineable resources is highly uncertain.

The extent of coal resources in Western Australia has always been considered to be small in comparison to the eastern states (NSW, QLD). The principal field remains the Collie Basin, south of Perth, though minor fields also occur north of Perth. Various estimates of the Collie Basin coal resources include :

- about 1903 for the Collie Proprietary mine suggested some 220 Mt of coal were present (pp 129) (Clark, 1904);
- 1912 – estimated resources in six coal seams of about 316 Mt (Maitland & Montgomery, 1912);
- 1956 – measured, indicated and inferred resources totalling 1,877 Mt, while economically recoverable resources of 113.2 Mt (pp 149) (McLeod, 1965a);
- 1962 – measured and indicated economic resources of 274 Mt and inferred resources of 1,603 Mt (pp 93, 1962 Edition) (BMR, var.);
- 1965 – economically recoverable resources of 113.2 Mt (pp 274) (Andrew, 1965);
- 1975 – economically recoverable resources of 282 Mt (pp 276) (Lord, 1975);
- 1990 – economically recoverable resources of 482 Mt within in situ resources of 1,330 Mt (pp 4) (GSWA, 1990).

There are several additional low grade coals identified in other geologic basins in Western Australia. The Perth Basin north of Perth contains the Hill River, Green Head, Talisker and Bookara coal resources, while the Vasse River field south of Perth contains coal measures equivalent to those at Collie.

A slightly different source of in situ coal resources data is that promoted by the Australian Coal Association[8] (ACA). The ACA estimates for in situ coal resources are shown in Table 2. Although the ACA data is based on Geoscience Australia data, there is some difference presumably due to the category of 'in situ' as opposed to economically recoverable. There are often significant differences with state estimates cited above.

[8] Australian Coal Association is the peak industry body representing black coal miners and consumers : **www.australiancoal.com.au**

Table 2 – In Situ Coal Resources in Australia (Mt) (December 2005) (ACA, 2007)

State	Underground	Open Cut	Total
New South Wales	20,490	13,820	34,310
Queensland	13,830	16,720	30,550
South Australia	2,450	3,100	5,550
Western Australia	890	1,300	2,190
Tasmania	500	20	520
Total	**38,160**	**34,960**	**73,120**

There are further estimates of recoverable coal resources over time, such as the Joint Coal Board (JCB), which are not included above (except where they were the cited data by the BMR). The data collated, however, gives a reasonable indication of the changes in coal resource estimates over time.

Based on GA (var.), the 2005 estimate of Australia's recoverable economic black coal resources is 39.2 Gt within an additional 67.9 Gt of sub-economic and inferred resources (2006 Edition). Of the recoverable economic resources, QLD has 55.0% or 21.6 Gt with NSW 40.8% or 16.0 Gt (pp 19, 2006 Edition) (GA, var.) (2006 data by state not yet available). This compares with economic world resources of 739 Gt with the USA (28%), Russia (20%), China (12%), India (12%) and South Africa (7%) (pp 21, 2006 Edition) (GA, var.).

The estimated economic resources of black coal in Australia are shown in Figure 12, including the resources-to-production (R-P) ratio in years.

Figure 12 – Australian 'Recoverable' Economic Black Coal Resources & Resources-to-Production Ratio (Years)

5.2 Brown Coal

5.2.1 Brief History

> ***"For half a century brown coal in Victoria has been waiting, like a huge fortune in Chancery, for the rightful heir to its riches and benefits, though more than once a claimant has failed to establish his case."*** (Herman, 1922) (from pp 45, Drucker, 1984)

The mining of brown coal in Australia, generally the lowest quality coal used for electricity production, has been mostly confined to the Latrobe Valley region of Victoria about 200 km east of Melbourne. Smaller mines also presently operate to the west and south-west of Melbourne at Bacchus Marsh and Anglesea, respectively. Until the late 1990's the Latrobe Valley mines were operated by the government-owned State Electricity Commission of Victoria (SECV), from which time the individual projects were progressively privatised.

Further detail on the brown coal mining history of the Latrobe Valley are given by Henderson (1953), Drucker (1984) and Martin *et al.* (1993), including Yallourn by Harvey (1993), McKay (1950) and Loy Yang by Vines (1997).

By 1900, brown coal mining had only been occurring at a slow rate in Victoria, mainly at the Great Morwell Coal Mine[9] north of Morwell in the Latrobe Valley. There was strong private interest in developing the local coal industry to break the reliance on imports from the Newcastle coalfields of NSW, an objective shared by the Victorian Government. Despite the optimism, however, the scale remained small. This continued until about 1920, when the Victorian Government became intimately involvement in the mining of brown coal on a large scale to rationalise the electricity supply system for Melbourne and across Victoria. At 1920, a total of some 468,000 t of brown coal had been mined in Victoria, of which 421,000 t was from the Great Morwell Coal Mine (with 90% of this by the Victorian Department of Mines between 1916 to 1920 during a major Newcastle strike). The Altona mine in Melbourne's western suburbs produced about 27,500 t between 1911 to 1919.

The Victorian Government formally established the State Electricity Commission of Victoria in 1921 to mine Latrobe Valley brown coal to supply onsite power stations. The Commissioners had been appointed earlier in 1919, with work beginning on a new mine and power station complex at Yallourn in earnest in 1920 to the west of the Great Morwell mine.

The SECV bought the Yallourn power station on-line in 1924, and from that point forward continued to expand production to meet growing electricity and briquette demand. The major Morwell-Hazelwood[10] project was approved in July 1948, and began electricity and briquette production in November 1958. A further series of open cuts were planned throughout the 1950's to 1960's, principally at the Loy Yang area south of Traralgon in the central Latrobe Valley. The Loy Yang project was finally approved by the Victorian Government in November 1976 and first electricity was generated in December 1983.

To Melbourne's west and south-west, smaller scale private projects have also been developed. The Maddingley mine near Bacchus Marsh began in about 1943 to supply coal to fuel the Broadford and Fairfield pulp mills owned by Australian Paper Manufacturers (APM) as well as other industry users and hospitals. Since the late 1960's, due to the onset of Bass Strait gas supplies and the lack of demand for solid boiler fuel, Maddingley has progressively declined in output and is now only a very small producer, even utilising part of its former open cut voids as an inert industrial waste landfill (McLeod, 1993).

[9] The Great Morwell Coal Mine was soon renamed the Old Morwell Coal Mine after works began to the west at Yallourn, and was later renamed the Yallourn North mine.
[10] Originally called the Maryvale South project, and now simply Hazelwood.

The construction of the Point Henry aluminium smelter near Geelong in the 1960's led to the major development of the Anglesea brown coal mine and power station complex to provide the electricity. The Anglesea complex is operated privately by Alcoa World Alumina and Chemicals (AWAC)[11] and is presently a moderate producer.

As of 2006, there were three open cut brown coal mines in the Latrobe Valley at Yallourn, Hazelwood and Loy Yang, supplying four major adjacent power stations (with two of these at Loy Yang) as well as the Angelsea and Maddingley mines.

5.2.2 Major Provinces

The Latrobe Valley in the Gippsland is the principal province of brown coal, though smaller basins exist at Angelsea and Bacchus Marsh south-west and west of Melbourne, respectively. Other smaller provinces of brown coal also occur across Australia though they are of poor quality and unlikely to be of economic interest. Minor brown coal resources are known at Scadden in the Bremer Basin and at Balladonia on the southern edges of Western Australia. The main Victorian locations are shown in Figure 13.

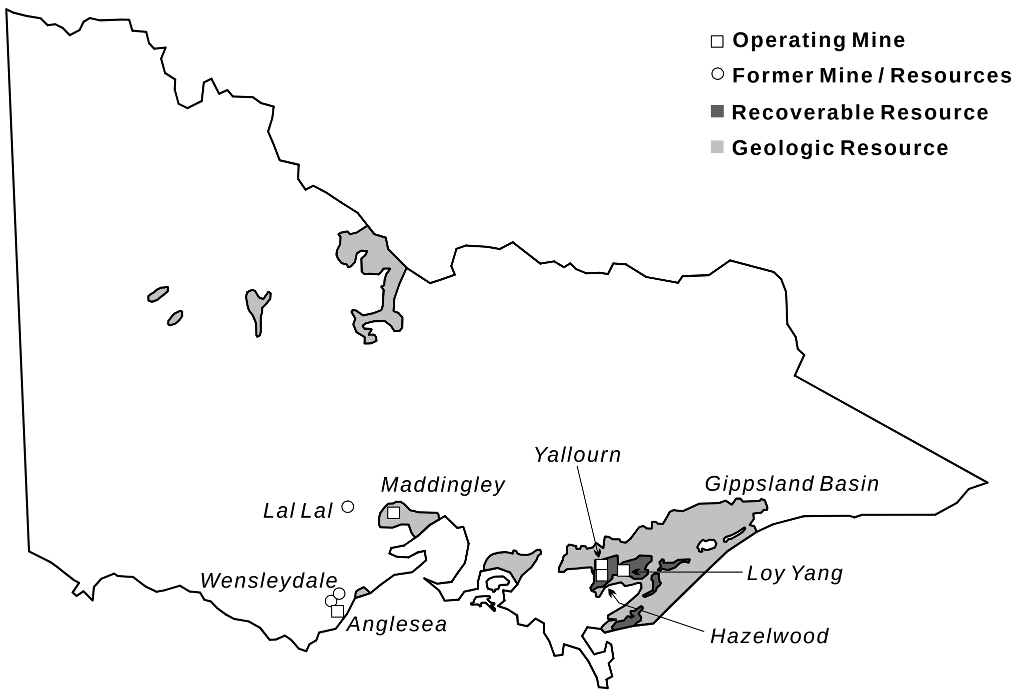


Figure 13 – Victorian Brown Coal Provinces and Mines

[11] Alcoa World Alumina & Chemicals (AWAC) is a joint venture of Alcoa of Australia Ltd (60%) and Alumina Ltd (40%) (formerly part of Western Mining Corporation, WMC).

5.2.3 Production

The production of brown coal in Victoria started in earnest in 1919, with the development of the Yallourn field for electricity production. The production data for the various mines is detailed in the appendix. Brown coal mining has been almost entirely by open cut methods (except for the Star Colliery and Wensleydale), and this is unlikely to change for the forseeable future. Annual production in shown in Figure 14, while cumulative production data for Victorian brown coal mines is given in Table 3.

Table 3 – Major Brown Coal Mines : Total Production to 2006

Mine &/or Power Station	**Operating Period**	**Brown Coal** (Mt)	**Overburden** (Mm^3)	**OB:Coal Ratio** (m^3/t)	**Reference**
Yallourn / Yallourn North	1919-2006#	~810	~257	~0.32	(see appendix)
Hazelwood-Morwell	1956-2006#	602.8	~150.9	0.25	(see appendix)
Loy Yang	1983-2006#	495.4	108.6	0.219	(see appendix)
Anglesea	Present rate 1969-2006#	~1.1/yr **~30**	~1.8/yr »40	~1.6 -	(see appendix)
Maddingley	1944-2006#,§	11.72	»2.3	-	(see appendix)
Star Colliery	1946-1972	1.433	no data	-	(Knight, 1975b)
Wensleydale	1923-1932 1943-1959	0.017 2.945	no data	-	(Knight, 1975b)
	Total	**~1,939**	**~560**	**~0.29**	

Still operating at end 2006.

§ The Maddingley mine has been operating at a gradually declining rate of production since the mid-1960's when it was producing about 400 kt/year brown coal but now only produces some 20 kt/year.

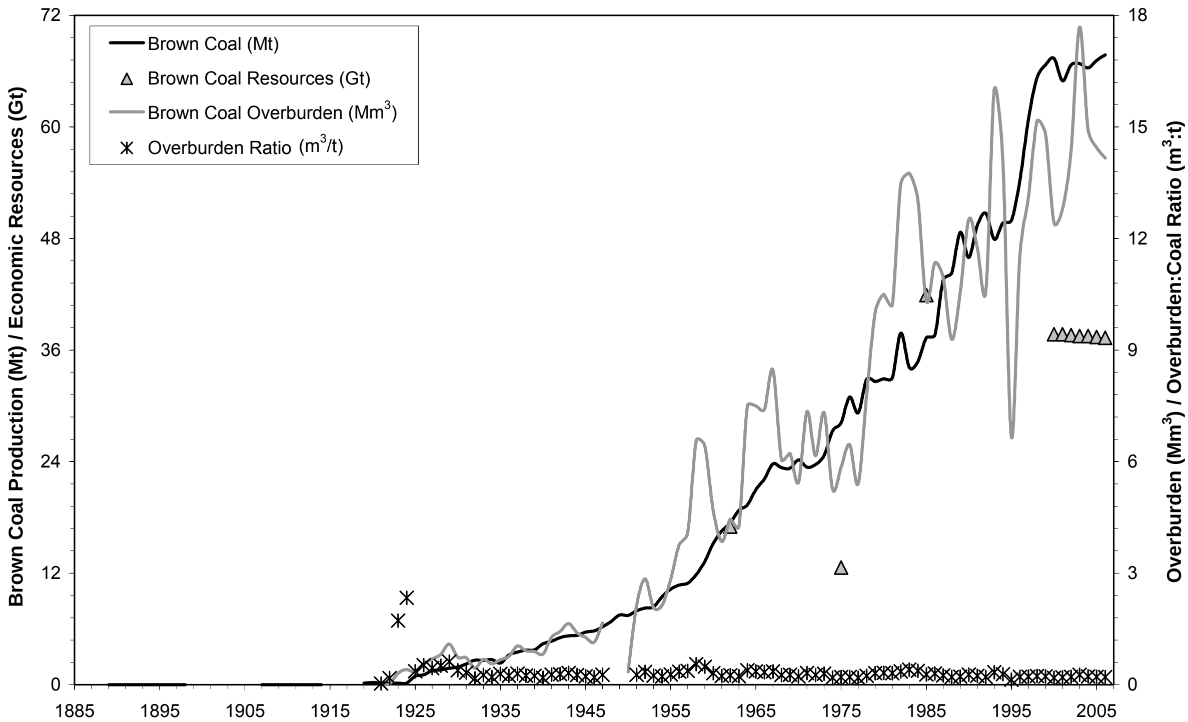


Figure 14 – Brown Coal Production, Overburden, Economic Resources and Overburden:Coal Ratio

5.2.4 Resources

The extent of economically mineable brown coal resources has been a matter of debate for some decades in Victoria, essentially focussed on the Latrobe Valley resources. Some estimates include :

- 1960 – Latrobe Valley geologic resources totalling 85,000 Mt, with economically recoverable resources of 17,000 Mt (pp 158) (McLeod, 1965a);
- 1975 – Latrobe Valley economically recoverable resources totalling 12,600 Mt (McLeod, 1998);
- 1979 – Latrobe Valley geologic resources totalling 107,847 Mt, with economically recoverable resources of 11,630 Mt (pp 837) (Holmes, 1980);
- 1982 – Latrobe Valley economically recoverable resources by open cut were 54,000 Mt, although allowing for exclusion of certain areas (eg. towns) a 'readily available' resource of 31,000 Mt was estimated for policy purposes (VBCC, 1982);
- 1985 – Latrobe Valley economically recoverable resources totalling 41,900 Mt (McLeod, 1998);
- 1986 – total brown coal resources in Victoria of 221,400 Mt, including 158,026 Mt in the Latrobe Valley (Stanley, 1986).

According to GA data, recoverable brown coal resources in Australia was 37.3 Gt in 2006, essentially unchanged from 37.7 Gt in 2000, as well as an additional 61.5 and 112 Gt of sub-economic and inferred resources, respectively (2007 Edition) (GA, var.). Approximately 89% of the economic resources (some 33.2 Gt) are contained in the Latrobe Valley. Resources over time were included in Figure 14.

5.3 Uranium

5.3.1 Brief History

> ***"On the frontiers of jungles and rugged ranges tough men are still battling against nature, to win fabulous fortunes, as our forbears did in the gold rush days of a century ago. Uranium is the modern 'Midas' mineral which lures the adventurous diggers of today, as gold lured their grandfathers."*** Frank Clune (Clune, 1957)

The uranium industry in Australia has had a variable past. It started with somewhat humble but optimistic beginnings in the early 1900's, with the main emphasis being on the alleged medicinal benefits of the radioactive radium associated with uranium. The second stage occurred at the height of the Cold War during the 1950's to 1960's, followed by the third and most successful stage of large scale production from the late 1970's onwards.

Several publications detail the history of the uranium mining industry in Australia, with the principal works being Broinowski (2003), Cawte (1992), Dunn *et al.* (1990), Griffiths (1998), Harding (1992), Hardy (1999) and Mudd (2005).

The first major uranium deposit was discovered in north-east South Australia in May 1906, to become known as Radium Hill. This was followed shortly after in 1910 at Mt Painter in the Gammon Ranges of north-east South Australia (to the north-west of Radium Hill). Despite determined efforts to produce radium, with a small quantity of uranium by-product, the intermittent operations were not economic and had completely ceased by the mid-1930's.

Following the unprecedented American nuclear attacks on Hiroshima and Nagasaki in Japan in August 1945, the post-World War II landscape of the world changed materially and uranium became a key strategic mineral of national interest.

The Commonwealth Government together with the State Mines' Departments energetically promoted uranium prospecting across Australia. The effort was rewarded with new uranium deposits being discovered across the realm of northern Australia near Darwin in the Northern Territory and between Mt Isa and Cloncurry in western Queensland. In South Australia, the State Government had conducted detailed assessment work on the old Radium Hill deposit, and began preparations for a modern mining-milling project. By the late 1950's major new mines were operating at Rum Jungle (NT), the Upper South Alligator Valley (NT), Mary Kathleen (QLD) and Radium Hill (SA). A minor quantity of copper was also produced at Rum Jungle. Following the slow down of uranium procurement by the United States of America (USA) and United Kingdom (UK) in the mid-1960's, most mines closed with Mary Kathleen placed on care and maintenance and Rum Jungle milling stockpiled ore until 1971.

With the resurgence of interest in nuclear power in the early 1970's, major exploration programs by many mining houses and exploration companies led to several new significant deposits being discovered across Australia, namely Ranger, Koongarra, Nabarlek, Jabiluka and Yeelirrie between 1970 to 1973. The large Olympic Dam polymetallic deposit, containing copper, uranium, gold and silver, was discovered in July 1975. This period also saw increased public controversy, with many protests and lobbying against uranium mining and Australia's broad involvement in the nuclear industry, as well as support for conservation through national parks over mining and Aboriginal land rights. Acknowledging this public concern, the Whitlam Commonwealth Government established the Ranger Uranium Environmental Inquiry to investigate the complex issues surrounding the potential development of the Alligator Rivers Region uranium deposits (Ranger, Nabarlek, Jabiluka and Koongarra) as well as Kakadu National Park and Aboriginal land rights. Meanwhile, the mothballed Mary Kathleen was recommissioned and began producing again. After two cautious Ranger Inquiry reports, the Fraser Commonwealth Government approved the new proposals, as well as land rights and the creation of Kakadu National Park.

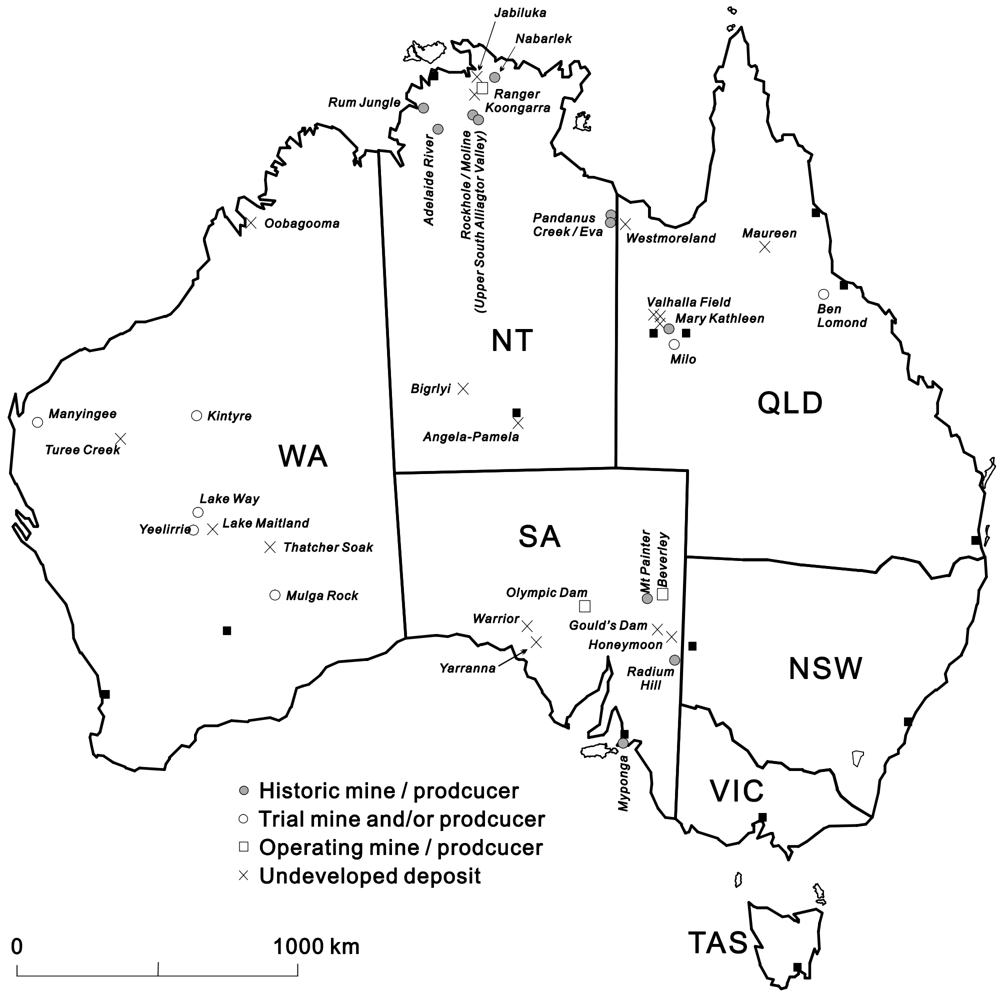


Figure 15 – Australian Uranium Mines-Mills and Deposits

By 1981, the Mary Kathleen was close to permanently ceasing operations with the exhaustion of economic reserves, the Nabarlek mill was operating at full capacity and the controversial Ranger project had been bought into full production.

After extended political controversy the Olympic Dam project was finally commissioned in August 1988, producing copper, uranium, gold and silver. The Beverley acid in situ leach project, or solution mine, was underway by early 2001. The Jabiluka project, despite significant effort and interim construction works, remains stalled and is closed for the forseeable future.

A location map of major uranium mines and deposits is shown in Figure 15.

5.3.2 Major Mines

To date there has been a total of 22 individual commercial mines and a further 15 pilot scale mines producing ore which have supported 11 processing mills (including pilot mills). The principal past producers are Radium Hill, Mary Kathleen, Rum Jungle, Nabarlek and the South Alligator Valley group of mines. A number of small-scale pilot mining and/or milling projects have also been undertaken, often for exploration and evaluation purposes (see Mudd, 2007). At present, three projects continue to operate, namely Ranger, Olympic Dam and Beverley. Given Australia's significant uranium resources, the uranium industry is always looking to develop new projects, however, uranium remains a controversial mineral in contemporary Australian society.

5.3.3 Production

As noted, Australian uranium has been produced from a total of 11 mills supported by numerous adjacent or nearby mines. A significant amount of data has been found for historical uranium production in Australia, with the principal reference being Mudd (2007). This report in turn relies on BMR, State and Commonwealth report series, company reports and announcements as well as other works to a minor extent. Overall, there are only minor gaps in the compiled data sets (especially annual data for Radium Hill), which do not impact on the overall trends. The full data set for uranium production is included in the appendices. For comparison to world production, a major source is OECD-NEA & IAEA (var.), also known as the 'Red Book' of the world uranium industry.

A compilation of production from individual projects is given in Table 4, with the production by project over time in Figure 16 and annual ore milled, ore grade and low grade ore plus waste rock in Figure 17. The proportion of uranium oxide or ore by open cut mining is shown in Figure 18. For comparison, Australian and world uranium production is shown in Figure 19.

Table 4 – Production from Major Uranium Projects to December 2006

Project	Period	Ore Milled	Grade	Production	Waste Rock & Low Grade Ore [†]
		t	%U_3O_8	t U_3O_8	t
Ranger	1981-2006[#]	32,845,000	0.29	89,868	~131,000,000
Olympic Dam[‡]	1988-2006[#]	94,481,312	0.067	44,629	»11,000,000
Nabarlek	1980-1988	597,957[M] 157,000[HL]	1.84 0.05	10,955	2,330,000
Beverley	2001-2006[#]	153 ML[P,ISL] ~40,500 ML[ISL]	-	33.27[P] 4,895	2.686 ML[P] ~703 ML
Honeymoon	1998-2000[§]	??[ISL]	-	>29.4[P]	41.194 ML[P]
Mary Kathleen	1976-1982 1958-1963	6,200,000 2,668,094	0.10 0.172	4,801 4,091.76	17,571,000 5,103,718
Trial Mines (pilot)	1970's-1980's	(no data)		» 12	»150,000
Moline	1956-1964	135,444	0.46	716.0	??
Rockhole	1959-1962	13,155	1.11	139.7	??
Radium Hill / Port Pirie	1954-1961	975,090 → ~152,400	0.119 ~0.7	852.3	??
Rum Jungle	1954-1971	~1,500,000	0.35	3,530	18,027,300
Trial Mines (pilot)	1950's-1960's	9,224.9 [RJ]	0.92	- [RJ]	??
Mt Painter	1910-1932	~933 t	~2.1	~3 t ??	??
Radium Hill	1906-1932	~2,150 t	~1.4 ?	up to 7 t ?	
	Total	139.6 Mt	0.134	159,593	»165,000,000

[M] Ore milled; [HL] low grade ore heap leached; [P] pilot plant only. [ISL] in situ leach mining (ISL) involves chemical solutions only and no physical extraction of ore. » is much greater than. [RJ] Ore milled at Rum Jungle ('RJ'), not included in sub-totals; [§] 1998-2000 Pilot project only; [#] Still operating at end of 2006.

[†] Low Grade Ore contains uranium mineralisation, generally >0.02% U_3O_8, but uneconomic for milling.
[‡] Additionally, ore assayed 2.62% Cu, 5.9 g/t Ag and 0.55 g/t Au for production of 1,957,510 t Cu, 253,444 kg Ag and 25,196 kg Au.

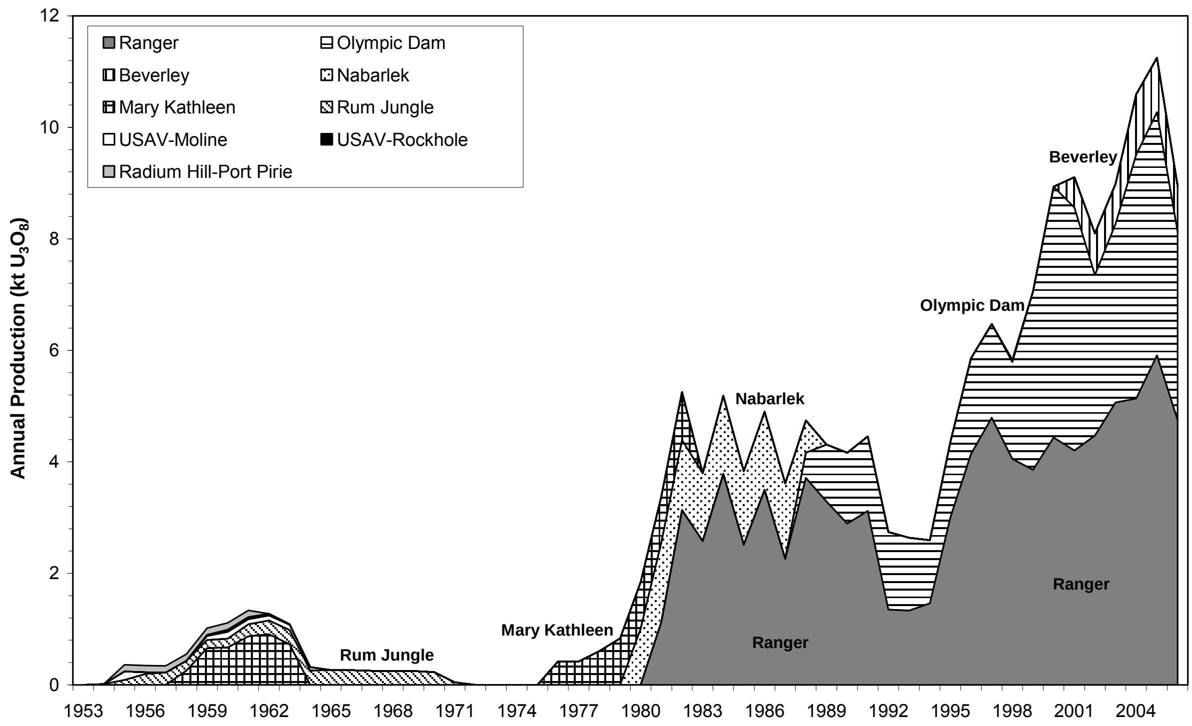


Figure 16 – Australian Uranium Production by Project Over Time

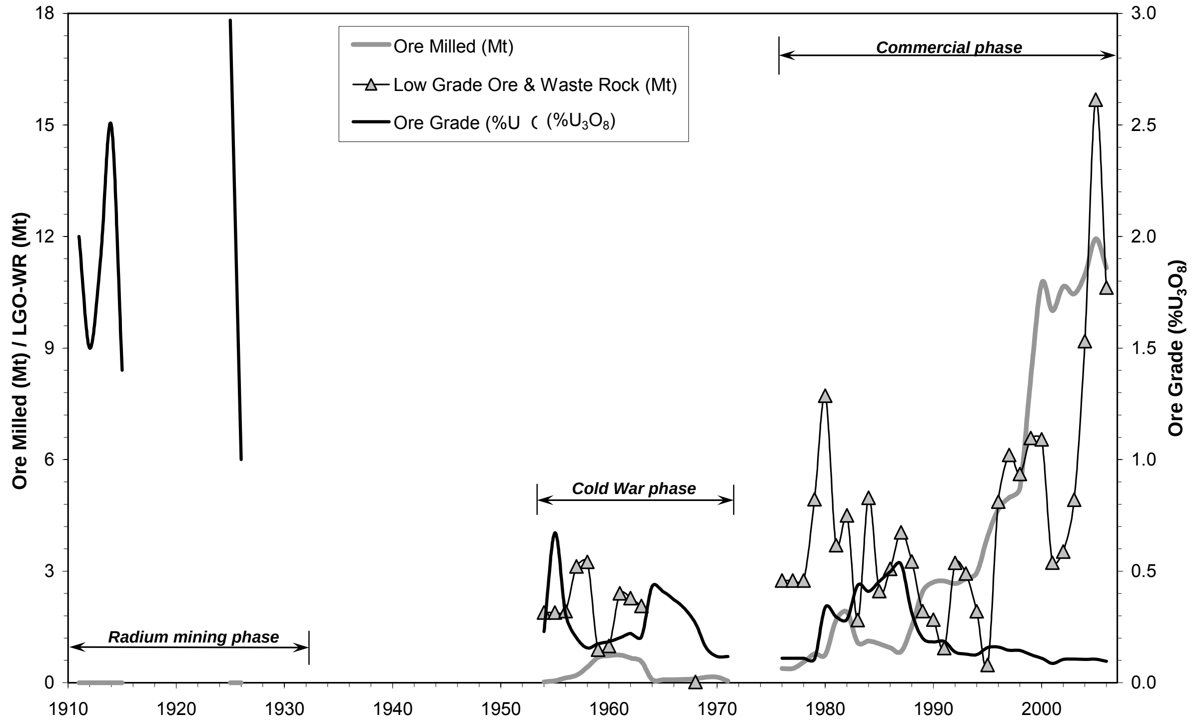


Figure 17 – Annual Uranium Ore Milled, Low Grade Ore plus Waste Rock and Ore Grade

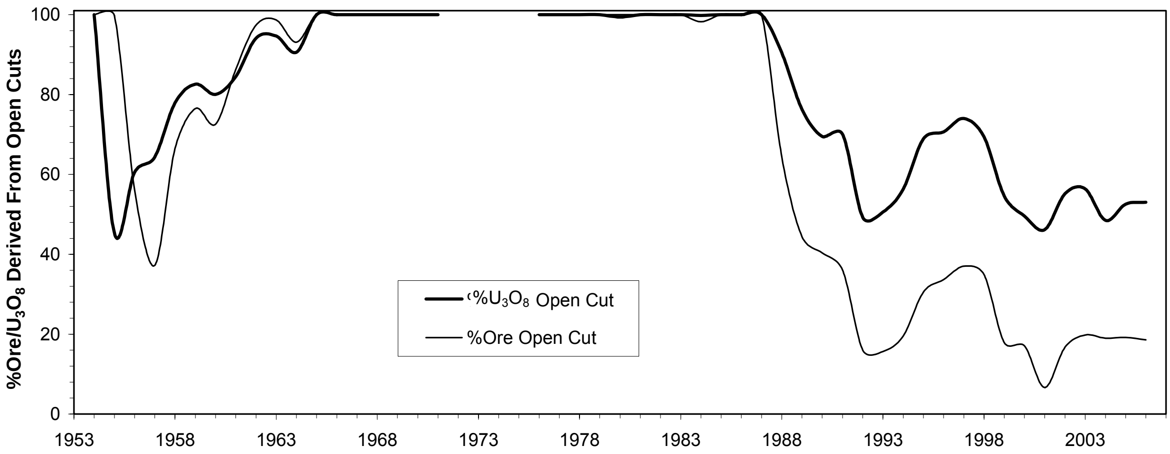


Figure 18 – Australian Uranium Ore/U_3O_8 Production by Open Cut Mining

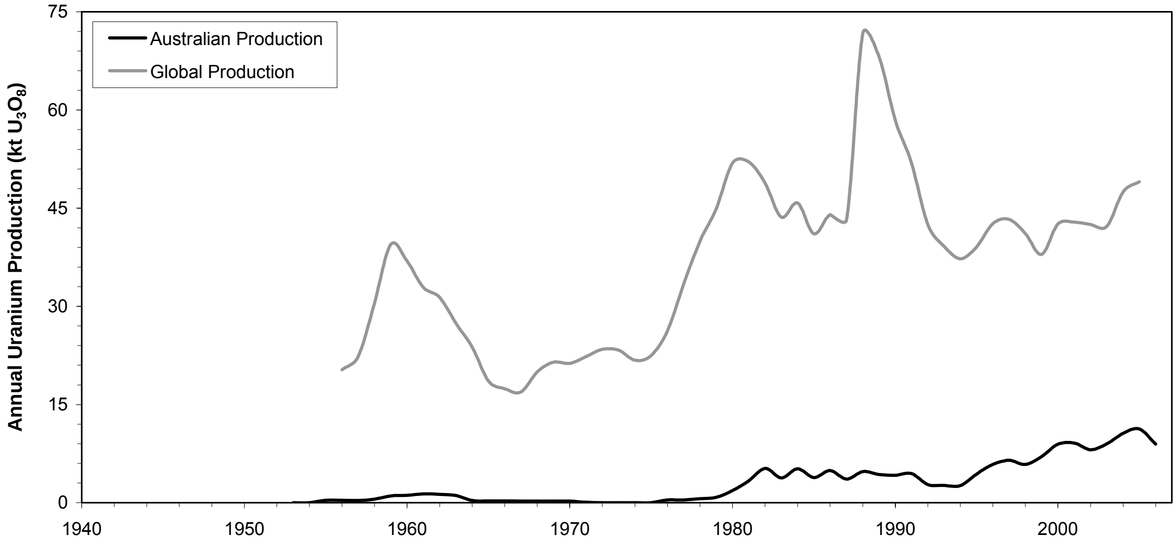


Figure 19 – Australian and Global Uranium Production

5.3.4 Resources

Due to the success of exploration in the 1970's, Australia is now recognised as having the highest quantity of economic uranium resources in the world. Based on OECD data and methodology, this is about 1.348 Mt U_3O_8 (2005 Edition, pp 15-16) (OECD-NEA & IAEA, var.). World resources are estimated at 5.592 Mt U_3O_8. The bi-annual data for Australian resources is compiled from OECD-NEA & IAEA (var.), with the data for 1945 from Dickinson (1945), 1952 based on Rum Jungle and Radium Hill contracts (eg. Cawte, 1992; Mudd, 2007) and 1963 from Stewart (1965).

A compilation of Australian uranium deposits was given by Battey *et al.* (1987) and recently updated by McKay & Miezitis (2001). Based on these studies, Mudd (2007), and more recently company announced resources, the major Australian uranium deposits are compiled in Table 5. Due to differences in methodology between Australian industry practice and the OECD, the data do not correspond precisely but do give a good comparative basis for different deposits. Clearly, the vast majority of Australia's uranium is contained within the Olympic Dam Cu-U-Ag-Au deposit, plus major resources at Ranger and Jabiluka.

As with coal, the extent of the economically recoverable resources at Olympic Dam, as well as other deposits such as Ranger and Jabiluka, remains open to conjecture due to the highly controversial nature of nuclear power and volatile nature of the uranium market. The economic uranium resources of Australia and the world are shown in Figure 20.

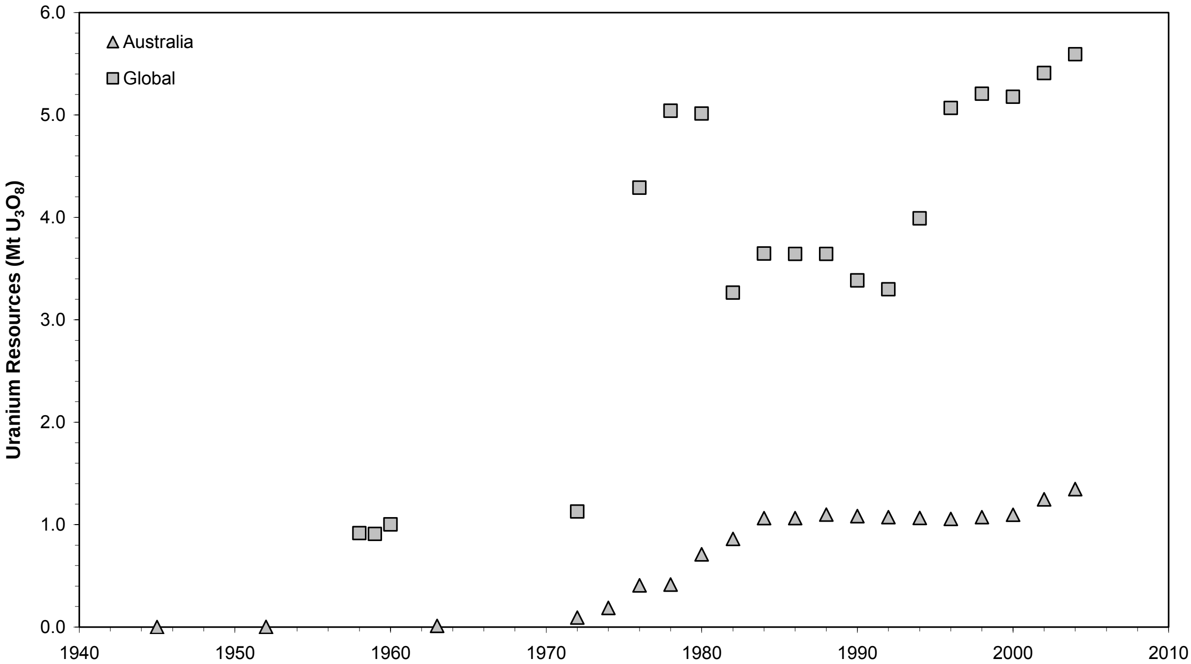


Figure 20 – Australian and Global Economic Uranium Resources

Table 5 – Principal Australian Uranium Deposits and Prospects

Deposit / Resource	**Ore** Mt	**Grade** %U_3O_8	**Cutoff** %U_3O_8	**Uranium** t U_3O_8	**Date**	**Reference**
Olympic Dam[#,†]	4,430	~0.04	-	~1,650,000	June 2006	BHPB (var.)
Ranger[#,†]	67.41	0.14	0.08	94,900	Dec. 2006	ERA (var.)
Beverley[#]	12	0.18	0.03	21,400	1997	HR (1998)
Jabiluka 2[†]	33.89	0.48	0.2	163,000	Dec. 2006	ERA (var.)
Koongarra 1	3.453	0.44	0.02	15,200	~1990	Snelling (1990)
Koongarra 2	***~0.8***	~0.3		~2,000	~1990	McKay & Miezitis (2001)
Honeymoon-East Kalkaroo	4.0	~0.11	0.01	4,210	2004	SCR (var.)
Westmoreland	17.4	0.12	-	20,900	~1997	Rheinberger *et al.* (1998)
Valhalla Field[†,§]	27.63	0.127	-	35,000	~2001	Summit (2005)
Yeelirrie	35.2	0.15	0.05	53,000	~1990	Cameron (1990)
Kintyre	***~14***	0.15-0.4	-	36,000	~1990	Jackson & Andrew (1990)
Mulga Rock	10.8	0.12	0.03	13,000	~1990	Fulwood & Barwick (1990)
Manyingee	12.1	0.08		10,890	2005	Paladin (2005)
Total	**4,194**	**~0.05**		**~2,052,500**		

[#] Does not include production to end 2006; see previous tables (including Olympic Dam table in appendix).
[†] Includes reported reserves and resources.
[§] Includes reported reserves and resources at the Valhalla, Skal and Anderson's prospects.

5.4 Energy Resources : Key Trends & Issues

5.4.1 Overview

The energy resources of Australia are extensive, and when estimated per capita, certainly place Australia in an advantageous position compared to many nations around the world. It is also one of the few OECD countries which is actually a net energy exporter rather than importer (ABARE, 2005). The current and future mix of resources mined for energy supply, as well as the role Australia plays internationally in the export of black coal and uranium, are increasingly divisive and controversial issues – especially with respect to climate change.

At present, the primary supplies of energy for Australia are derived fossil fuels including black coal, brown coal and oil and gas (the latter two of which are outside the scope of this report). Only a minor proportion of energy is derived from renewable sources, including hydro-electricity, wind and solar. The debate over the environmental impacts of the various forms of energy is outside the scope of this report, however, a statistical analysis of production, resources and overburden-to-coal ratios is presented herein to inform this debate.

5.4.2 Extrapolating Resources and Production

As noted in the various sections on black and brown coal and uranium, there has been considerable conjecture and debate over the extent of resources of these energy minerals, especially with regards to 'economically recoverable' resources. For coals the in situ geologic resources are often considerably larger than economically mineable reserves while for uranium, as a metal, the extent of economically mineable reserves is perhaps better quantified but needs to be considered in conjunction with other factors such as exploration, social and environmental issues as well as traditional market economics.

It is often claimed that Australia has hundred's of years left for coal. For example, the Australian Coal Association claims that Australia has sufficient coal to "… last over 200 years at current rates of production" (ACA, 2007). A value of more than 100 years is often quoted. Yet analyses of the available data, especially using formal standards such as JORC and associated coal resource guidelines, is rarely presented. Leaving aside the question of the various impacts of coal and uranium mining, and purely examining the question of 'finite' resources of coal and uranium, it is possible to prepare statistical correlations for annual production rates over time, project this for the future and compare this to present economic resources. Such graphs are presented in Figures 21 to 23 for black coal, brown coal and uranium, respectively. All graphs are based on linear regressions of the most recent time period using Excel with the equations and correlation coefficients shown in each graph.

These statistical predictions are based on the assumption that time is the only variable which contributes to production, which for all three energy minerals is clearly not the case. Numerous other factors are critical in understanding the evolution of production for each commodity – including economics, technology, social issues (eg. strikes), supply problems and the like. Given the relatively uniform production trends for black and brown coal, however, they are a reasonable basis on which to assess the resources-to-production (R-P) ratio – and therefore the claim of hundreds of years of resources remaining. As shown previously, the black coal R-P ratio has been in decline since 1988, and is now 98.6 years. Although not shown for brown coal, the R-P ratio has remained somewhat constant at around 560 years for the past decade and possibly longer. The historically variable production for uranium, assuming production increases over time as shown, shows a slightly lower correlation, but follows a similar pattern.

For all three commodities, assuming constant production growth over time, the point at which cumulative production reaches current economic resources is shown. For black coal this point is just over 50 years away, it is some 200 years hence for brown coal and just under 100 years for uranium.

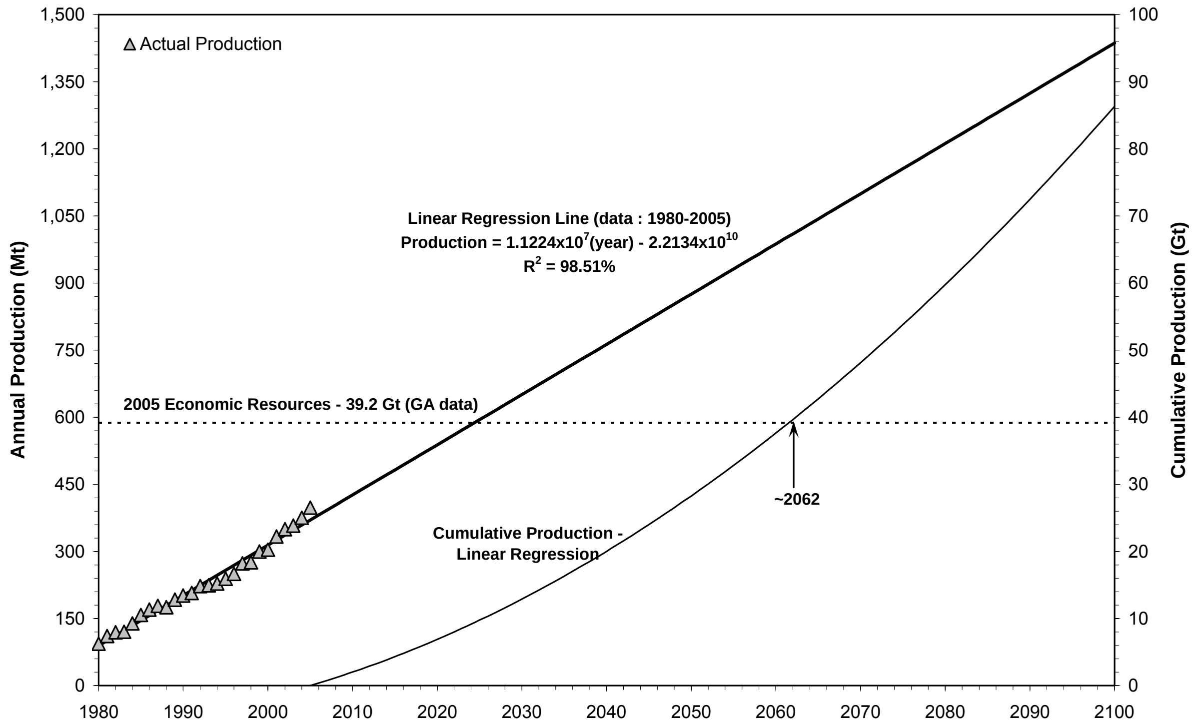


Figure 21 – Black Coal : Linear Extrapolation for Annual and Cumulative Production

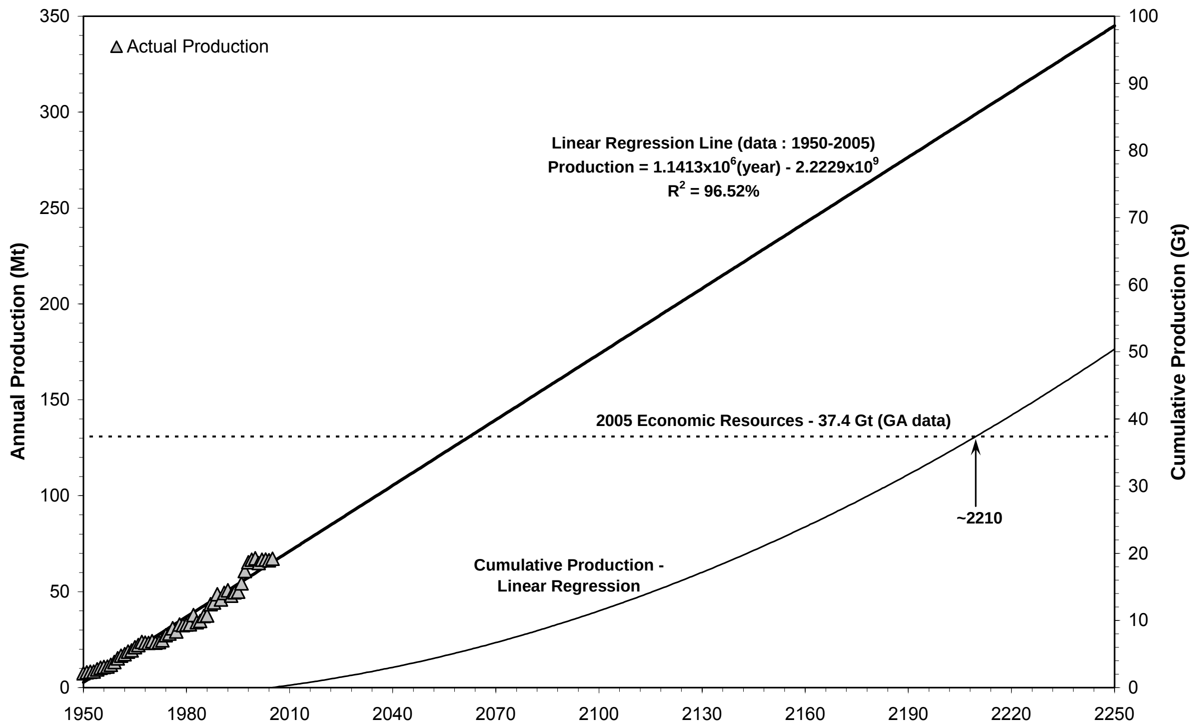


Figure 22 – Brown Coal : Linear Extrapolation for Annual and Cumulative Production

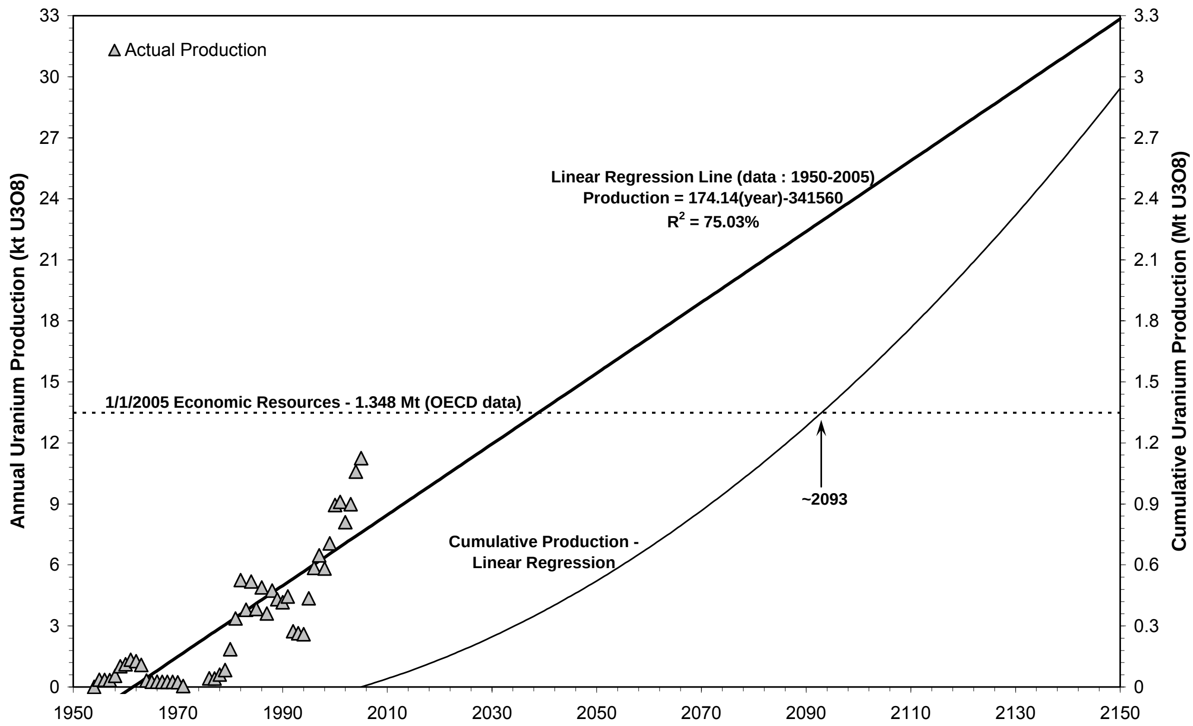


Figure 23 – Uranium : Linear Extrapolation for Annual and Cumulative Production

There is clearly significant room for changes in the classification of geologic resources to economically mineable resources, especially for coals but for new discoveries of uranium deposits. Factors which must be considered in this regard include additional mineral exploration, new technologies (exploration, mining, consumption, etc), economics, social issues as well as environmental constraints. All of these factors can lead to significant positive and negative changes to quantified economic resources.

Based on the data presented, there is evidence to suggest that demand for energy minerals has ensured that sufficient exploration has continued (albeit often in periodic phases) to maintain economically mineable resources, mainly for uranium and brown coal.

For black coal the past two decades has seen economic black coal resources stagnant and decline since 1998. The 2006 estimate of economic black coal resources, 39.6 Gt, is still an order of magnitude lower than various estimates over time – eg. 500 Gt in situ resources in NSW in 1979. For the regression in Figure 21, if data is used from 1995 only (rather than the data from 1980-2005), a steeper predicted production growth results and cumulative black coal production by 2100 is close to three times the present 39.2 Gt figure. At some point before the next 100 years we will therefore begin to reach the geologic limits of black coal resources – irrespective of social, technological economic and environmental constraints.

With respect to brown coal, we are clearly some centuries away from approaching the geologic limits of known resources. The key question in considering this has to be the environmental, economic and social costs of this degree of ultimate coal extraction.

As noted previously, a critical aspect which is poorly recognised in this debate is that of waste rock/overburden. There is evidence for technological progress making deeper and larger scale open cuts viable. A similar linear regression of the overburden:coal ratio is shown in Figure 24, including the ratio of raw:saleable coal. Both show trends of a gradual increase over time – with significant implications for total waste volumes mined.

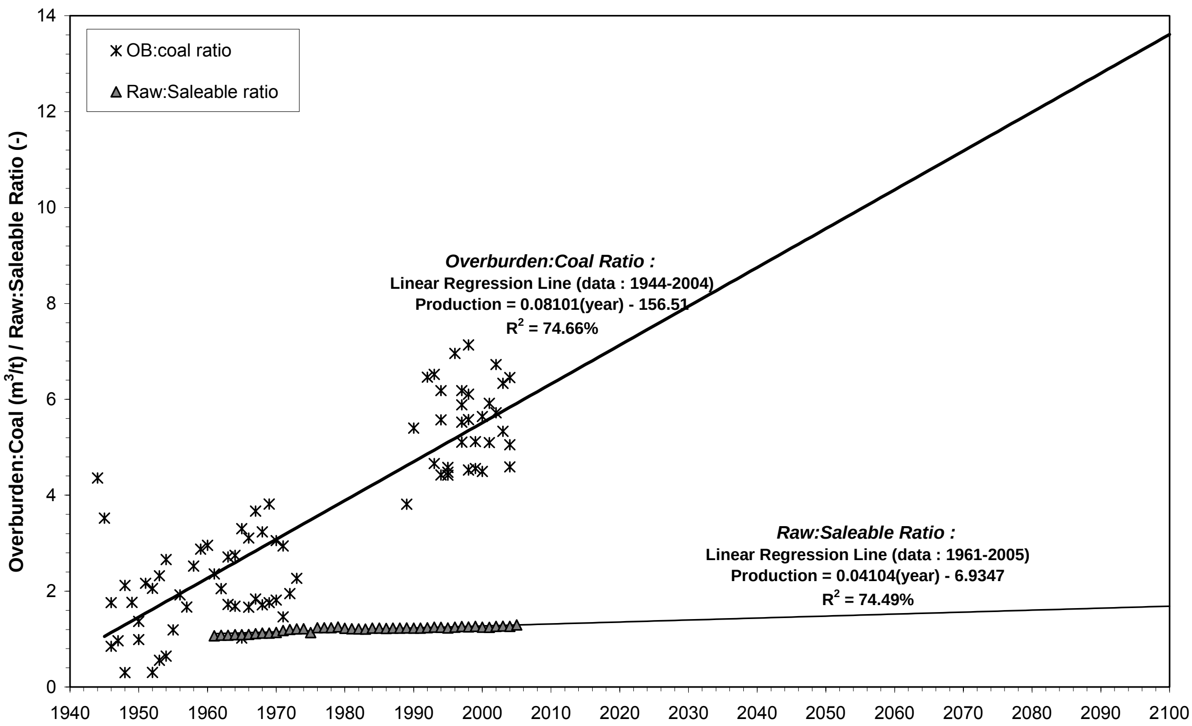


Figure 24 – Overburden:Coal Ratios and Raw:Saleable Coal Ratios : Statistical Extrapolations

Although this possible future extent of overburden:coal and raw:saleable coal ratios may be economically as well as technologically possible, it is highly contentious whether this is environmentally and socially sustainable. It is critical that further attention be given to overburden production in black and brown coal mining – by government, industry as well as the community.

The extent of economically mineable uranium resources remains open to conjecture, since as a metal it has a very different resource profile to coal resources. The vast majority of Australia's uranium is found at Olympic Dam, with a handful of other major resources known. There is great debate about the potential for discovering new uranium resources in Australia, with literally dozens of exploration companies presenting themselves as uranium explorers to the financial markets. Given the relative youth of the uranium sector compared to coal, as well as other mineral commodities, this faith by some explorers may be justified, and it may not. There is a long history of controversy over the use of uranium as an energy resource – dating back to it's first public use in nuclear weapons against Japan in August 1945 and the myriad of complex issues since this time. This fiery debate is outside the scope of this report, however, it is clear that uranium, like coal is a finite resource and based on present patterns we are likely to approach the geologic limit sometime within the next century (which is of course highly dependant on the outcome of the current nuclear debate).

6. Results : Bulk Commodities

6.1 Iron Ore

6.1.1 Brief History

> ***"There are untold millions of iron ore in the Pilbara deposits. I think this is one of the most massive orebodies in the world. There are mountains of ore there … it is just staggering. It is like trying to calculate how much air there is."*** Tom Price, Vice-President of Kaiser Corporation (1960's) (pp 16) (Sykes, 1995)

Despite a somewhat delayed start, the iron ore and steel industry in Australia now ranks as one of our largest integrated industrial sectors and provides a significant proportion of the world iron ore export market. Further details on the history of the iron ore and steel industry are widely available, but for iron ore specifically, the works of Hughes (1964), Canavan (1965), Edmonds & Stenlake (1965), Raggatt (1968), Trendall (1979), Madigan (1980), Blockley *et al.* (1990), O'Leary (1993) and Griffiths (1998) are of particular note.

The first blast furnace for processing iron ore into steel was built in New South Wales at Mittagong around 1850, although this was a small and eventually uneconomic venture (Harper, 1928). Several further attempts to produce steel locally in Australia on a reasonable scale were made but were always unsuccessful, including New South Wales and Tasmania.

The Broken Hill Proprietary Company Ltd (BHP), bravely looking to its future beyond Broken Hill, established the first large scale steel works at Newcastle, NSW, commencing production in 1915. The iron ore supply was mined from the Middleback Ranges of South Australia, where BHP had commenced mining in 1903 to supply the ironstone flux required for lead smelting at Port Pirie, SA (Jack, 1922). The start of production during World War 1 was indeed timely, and BHP's Newcastle steel works emerged after the war very efficient and producing some 200,000 t of steel per year (Raggatt, 1968).

The mining of iron ore remained largely dominated by South Australia – no other significant iron ore resources capable of supporting a sustained steel industry were known around Australia. The 1920's saw difficult times for the steel industry, which only worsened during the depression of the early 1930's. Another growing steel producer, Hoskins Iron and Steel Ltd, moved their steel works to Port Kembla adjacent to the coking coal mined from the Illawarra coal field as well as a major shipping port. Hoskins then merged with three British steel companies to form Australian Iron and Steel Ltd (AIS). In 1935, BHP achieved a complete monopoly on the Australian steel industry by merging with AIS (which became a subsidiary of BHP). It was not until BHP merged with Billiton in 2002 that this monopoly was broken through the subsequent spin offs of OneSteel and BHP Steel (now BlueScope Steel).

In November 1935, British firm H A Brassert and Company Ltd acquired leases over iron ore deposits on Koolan Island in the Yampi Sound of the northern Kimberley region of Western Australia. Brassert proposed to mine the iron ore and smelt it into pig iron for export to Japan (the Nippon Mining Company of Japan was also financing the project). At the time Robert Menzies (later to be Prime Minister) approved of the project – earning him the nickname of "Pig Iron Bob", a title to which he was apparently very sensitive (Griffiths, 1998). Menzies had expressed his approval of the export despite growing Australian (and global) concern at Japan's military capacity and build-up and what many felt was the inevitable march towards war breaking out with Japan.

Shortly after this controversial issue, the Australian government became concerned at the extent of Australia's iron ore resources. A review was conducted by geologist P B Nye in 1937 of the various states and it was concluded that although reserves were adequate for immediate requirements, longer term supplies were by no means assured (Raggatt, 1968).

A more detailed survey was then requested from Commonwealth Geological Adviser Dr W G Woolnough, and the states were asked not to grant mining leases pending the outcome of this review. In the midst of this work Menzies had said he could see no justification to interfere with the Yampi Sound project (Raggatt, 1968).

A preliminary report was produced by Dr Woolnough in April 1938, stating that unless resources were conserved Australia would become an importer of iron ore and steel in less than a generation (Raggatt, 1968). In May 1938 Prime Minister J A Lyons announced that an export embargo would be enacted for iron ore to protect Australian industry and requirements. The ban came into force on 1 July 1938, despite vehement protest from Western Australia and fiery political debate. It is argued by Blockley *et al.* (1990) that, given the open public disquiet over the iron ore exports to Japan, the embargo was probably more related to politics than rational assessment of mineral resources and economics (pp 265).

The final Woolnough report was completed in 1939, and estimated that Australia's resources of high-grade iron ore capable of direct shipping were approximately 259 Mt (Blockley *et al.*, 1990). During the late 1930's BHP continued to mine some 1.9-2.4 Mt of iron ore annually in South Australia (see production data).

The expansion of the iron ore and steel industry after World War 2 was somewhat slow. There could be various explanations for this, such as the export embargo and/or perceived limited iron ore resources, but it is hard to fully understand given the major developments from 1961 onwards. Raggatt (1968) implies that there had been attempts to modify the embargo but that "successive Governments were reluctant" to do this (pp 108).

The Commonwealth Bureau of Mineral Resources (BMR) as well as BHP undertook numerous exploration programs across various parts of Australia to identify further mineable resources of high-grade iron ore through the 1950's. The difficult work was proving rewarding – new deposits were discovered at Constance Range in north-west Queensland, at Roper Bar in the Northern Territory, as well as more positive resource assessments of previously sub-economic prospects at Savage River in Tasmania and Mt Goldsworthy, Tallering Peak and Koolyanobbing in Western Australia. Another issue was the promising results in the use of beneficiation techniques on low-grade iron ores, especially for the Middleback Ranges. By late 1959 a more positive view of the extent of Australia's economic iron ore resources led to an estimate of some 368 Mt (Blockley *et al.*, 1990). At this time the Commonwealth's advisers recommended a partial lifting of the export embargo. In December 1960 the ban on exports was partially relaxed, allowing export from new deposits under strict conditions (eg. no more than 50% of a deposit could be exported, and at no more than 1 Mt/yr).

The effect of the change in export policy was immediate. In Western Australia, geologist J A Dunn had previously undertaken extensive comparisons of Western Australia's Pilbara province with the iron ore mines in India, suggesting that the area was highly prospective for large iron ore deposits. In 1961, following a consequent change in WA Government policy in response to the partial relaxing of the Commonwealth's export embargo, the flood gates were opened for intensive exploration.

Between 1961 to 1964, a large number of mining and exploration companies were engaged in exhaustive exploration through the Pilbara and other parts of Australia. The Hamersley Range iron ore province was 'discovered', although it was most likely discovered earlier in the 1950's but kept confidential due to the export embargo. The massive new deposits – amongst some of the largest in the world – included Mt Tom Price, Mt Whaleback, Mt Newman and Robe River. Further prospects which led to significant iron ore projects developing include Savage River in Tasmania, Mt Bundey and Frances Creek in the Northern Territory, and Koolanooka in central Western Australia. By November 1962 Pilbara reserves alone were estimated at ~8,000 Mt of ore (pp 1474, 1962 Edition) (USBoM, var.).

In June 1963, in light of the Pilbara, the Commonwealth relaxed iron ore export conditions further, effectively removing the last of the most restrictive conditions (though still retaining some powers for the Commonwealth to set specific limits in some specified circumstances).

By 1965 Australia's iron ore resources had reached a staggering potential of some tens of billions of tonnes, due principally to the Pilbara (eg. Canavan, 1965; Edmonds & Stenlake, 1965). There had been rapid progress made towards development in the Pilbara, and by November 1966 four major iron ore projects were either operating or under construction at :

- Mt Goldsworthy by a joint venture between Consolidated Goldfields (UK), Cyprus Mines Corporation (Los Angeles, USA) and Utah Mining and Construction Company (San Francisco, USA);
- Mt Tom Price by Hamersley Iron Pty Ltd as a joint venture between CRA Ltd (60%) and Kaiser Steel Corporation of California (USA) (40%);
- Mt Newman by a joint venture between CSR Ltd, BHP, Amax Iron Ore Corporation (a subsidiary of American Metal Climax Inc, USA), Mitsui Itoh Iron Pty Ltd (Japan) and Seltrust Iron Ore Ltd (UK) (BHP later took over CSR's interest);
- Robe River by Cliffs Western Australia Pty Ltd (later taken over by North Broken Hill).

Throughout the 1960's the known economic iron ore resources of Australia grew almost exponentially with iron ore production between 1960 to 1970 surging from 4.45 Mt to 51.22 Mt, respectively (see production data). The construction and development of these large scale projects often tested the very limits of the technical and financial resources of the companies involved, which mostly rose successfully to the challenges involved. The various projects included new towns to service the mines, large railway infrastructure as well as new port shipping facilities (eg. Port Hedland).

The difficult market conditions of the 1970's allowed consolidation and some degree of stabilisation within the iron ore industry, especially in the Pilbara, with production varying slightly around 100 Mt per year until the late 1980's. By this time the province was now controlled by three major Australian mining companies – CRA (through subsidiary Hamersley Iron), BHP and North Ltd (through 52%-owned Robe River Iron Associates).

The iron ore industry entered the 1990's with further expansion underway. The Pilbara saw the development of several new mines, including West Angelas by North Ltd, BHP's Area C project near Mt Newman, Yandicoogina by Rio Tinto as well as expansions at the smaller at Koolyanobbing project in central WA. Rio Tinto completed a hostile takeover of North Ltd in the latter half of 2000, thereby reducing the iron ore industry in the Pilbara to two dominant players – Rio Tinto and BHP. In 1997 the future of the Savage River mine in Tasmania was given a new lease on life, securing both a new owner and future export contracts. Depending on the economics at the time, Savage River could take the highly unusual step of shifting to an underground mine in the near future beyond current contracts which expire in 2009.

The year 2006 saw a record of some 275 Mt of iron ore and pellets produced in Australia, leading to about 40% of the global export market (see appendix). Given the current pace and intensity of the expansion of existing mines and infrastructure as well as the development of new projects, it would appear that the iron ore industry in Australia is destined for some decades of productivity to come.

6.1.2 Major Provinces

The Pilbara of northern Western Australia still maintains its position as Australia's premier iron ore province. The two other most significant regions include the Middleback Ranges of South Australia and the Savage River project in Tasmania. Minor production also comes from the Koolyanobbing field in central Western Australia. These fields or projects are shown in Figure 25.

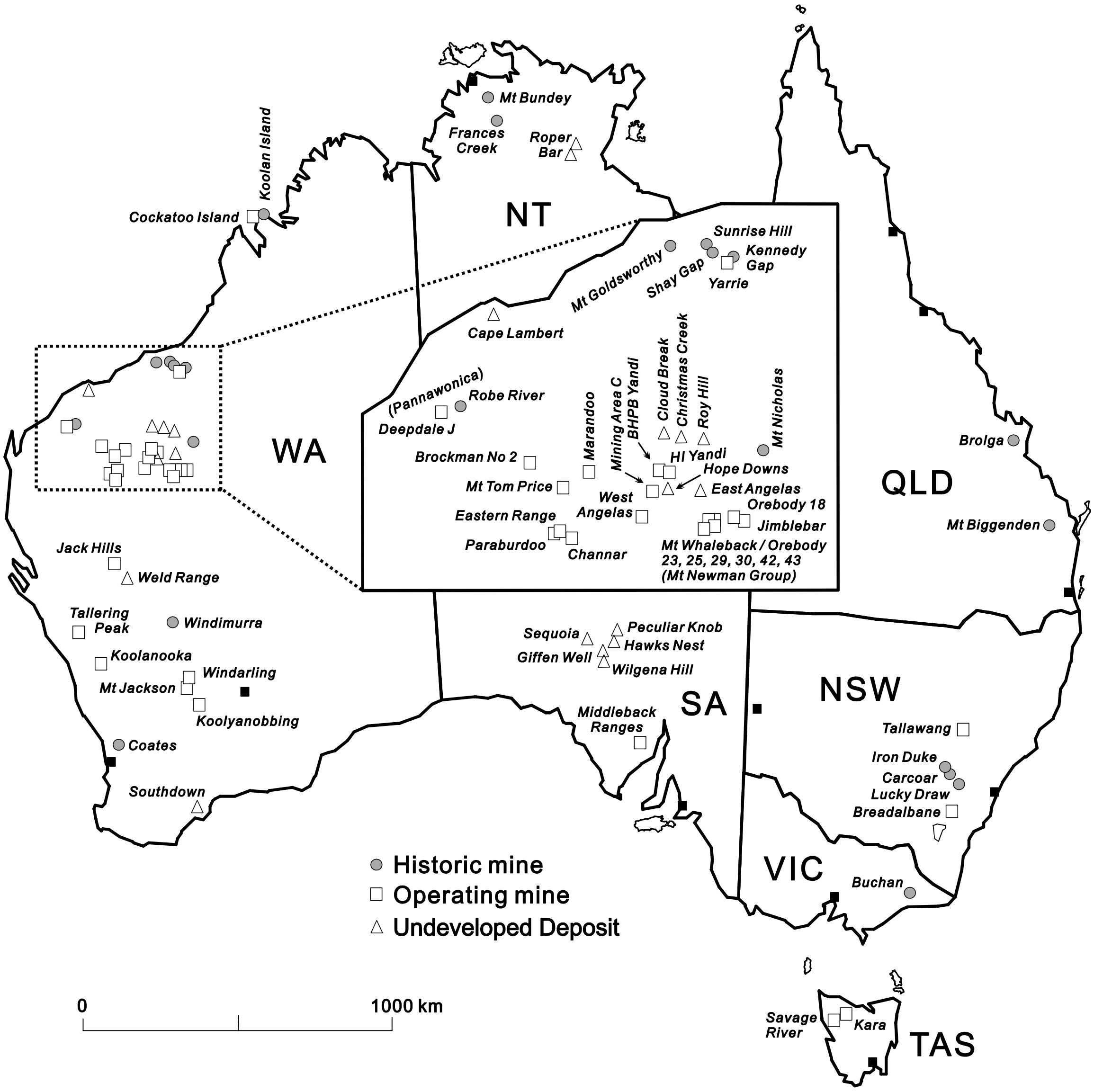


Figure 25 – Australian Iron Ore Provinces and Mines

6.1.3 Production

The total Australian production of iron ore and iron oxides was shown previously in Figure 3. The historical quantities of production by state are readily accessible (see Table 1), though data on the iron grade, waste rock and, more importantly, the impurities and smelting characteristics is less widespread or, commonly, not reported. A recent series with additional data and information on the Australian (and global) steel industry is DITR (var.).

The bulk iron grade can be estimated from data within ABARE (var.-a), BMR (var.), NSWDM (var.). A major challenge with this data is that it is often 'as shipped' production. Most iron ore projects now include a crushing, beneficiation and/or concentration plant to ensure a continuous physical and chemical quality of ore for smelting purposes (eg. to maintain high iron grades as well as minimise or remove impurities deleterious to smelting and steel production) (see Bensley *et al.*, 1993a; Bensley *et al.*, 1993b; Langenberg, 1993; Madigan, 1980; Tan & Jackson, 1993).

The iron grade data in the above references is therefore not representative of as-mined ore, with all companies generally reporting shipped production. For example, Cockatoo Island has processed ore and recovered between 80-98% in 'as-shipped' ore between 2002 to 2005 (pp 6, 2005 Edition) (Portman, var.). During the 1970's the beneficiation/product capacities of Hamersley Iron and Mt Newman was 13/10.8 and 6.8/5.2 Mt/yr (Langridge, 1980) / (Lloyd, 1980), respectively. There has been no systematic data obtained for waste rock/overburden production, though isolated data exists (discussed below). The principal data sets for iron ore are given in the appendices.

As noted previously, Australia's production of iron ore was on a small local scale until the development of the Middleback Ranges in central South Australia by BHP in 1903. Between 1903 and 1915, about 725 kt of iron ore was mined and used for fluxing purposes in lead smelting at Port Pirie. From 1915 to 1969, BHP mined 118 Mt of iron ore from the Middleback Ranges for steel production at Newcastle. By 1969, minor production had also occurred in New South Wales of some 4.44 Mt, Queensland of 0.67 Mt and Western Australia of 79.5 Mt, of which 75.2 Mt had been mined from 1961-69.

By 1970 the Pilbara had been opened up Western Australian production had grown from 0.94 Mt in 1960 to 40.3 Mt in 1970. Tasmania's moderate but significant iron ore resources were also in production with Savage River commencing at about 2 Mt ore per year in 1969. The peak production of SA was also reached in 1970 with production of 7.7 Mt iron ore.

Although the rate of expansion for iron ore production slowed during the late 1970's to mid-1980's, there has been an almost continual expansion since this time. Over the past decade to 2003, total Australian production has grown from 120.5 Mt in 1993 to 275 Mt in 2006.

As noted, there is generally only scant data on overburden or waste rock data for iron ore mining. Some specific examples include :

- **Savage River, TAS** – annual data 1975, 1977-1983 (BMR, var.) gives a waste:concentrate[12] ratio of around 3.5-4.6; the 1970's waste:ore ratio was ~1.9 (Hortie, 1980); 1987/88-2002/03 (TDM, var.) gives an ore:concentrate ratio between 2.2-2.9 and a waste:ore ratio of around 1.2-1.9 to 1995, increasing to 3.1-4.9 since the 1997 re-development (waste:concentrate ratios are 6.9-12.2); a waste:ore ratio of 5.3 was predicted for the 1990's (pp 262) (Povey, 1993);
- **Middleback Ranges, SA** – in early 1970's, the Iron Knob/Monarch mines had waste:ore ratio of 3.3 with the Iron Prince/Baron mines having a waste:ore ratio of 4 (pp 11) (Thomson, 1974); from the 1970's to early 1990's the waste:ore ratio was 3 for Iron Knob (pp 245) (Reid, 1993),

[12] Savage River produces an iron ore concentrate from a low grade ore. Raw 'as-mined' ore averages some 30-40% Fe while beneficiated concentrate averages some 65% Fe (see data in (Hortie, 1980; TDM, var.). Waste ratios are often reported in terms of "waste:concentrate" or "waste:ore", depending on the data available.

(pp 60) (Carmichael, 1980) and for the Iron Prince/Baron/Queen mines in the 1970's the waste:ore ratio was about 1.9 (pp 60) (Carmichael, 1980);

- **Koolan Island, WA** – in the 1970's the waste:ore ratio was about 3.5 (pp 61) (Baohm, 1980);
- **Cockatoo Island, WA** – in 1978 waste rock was "minor" relative to ore production of 1 Mt (pp 62) (Baohm, 1980); reported waste rock for 2004 was 0.40 Mm^3 (~1.0 Mt) with 0.65 Mt (wet) of ore, giving a waste:ore ratio of about 1.5 (Portman, var.);
- **Mt Newman, WA** – in the 1970's the waste:ore ratio was about 2.5, total movement by April 1979 was 240 Mt ore and 310 Mt waste rock (pp 69) (Grieve, 1980); in the mid-1980's high grade ore (direct shipping) was 35 Mt/year, low grade ore at 7 Mt/year beneficiated to 5 Mt/year product with waste rock of 63 Mt/year, giving a waste:ore ratio of 1.5 (pp 35) (Woodcock, 1986);
- **Mt Whaleback, WA** – between 1967 to June 1991, total ore production was 530 Mt with 1,028 Mt waste rock; as of late 1991, annual mining rates were 30 Mt ore and 75 Mt waste with a remaining waste:ore ratio of 2 (pp 238) (Ashby *et al.*, 1993). Recent estimates of the life-of-mine waste-ore totals are 1,700 Mt ore and 4,000 Mt waste rock (Porterfield *et al.*, 2003);
- **Yandicoogina ('Yandi'), WA** – mine started in 1992 with an annual capacity of 5.0 Mt ore with an overall life-of-mine waste:ore ratio of 0.3 (pp 242) (Ashby *et al.*, 1993);
- **Orebody 29, WA** – between 1980 to October 1991, total ore production was 19 Mt with 11 Mt waste rock; as of late 1991, annual mining rates were 4.0 Mt ore with an overall life-of-mine waste:ore ratio of 1.2 (pp 241) (Ashby *et al.*, 1993);
- **Channar, WA** – ore/waste mined in 1990 and 1991 was 3.182/2.354 Mt and 8.620/9.022 Mt, respectively (pp 250) (Birkett *et al.*, 1993); alternate data for 1991 gives 5.591 Mt ore and 7.142 Mt waste rock for a waste:ore ratio of 1.28 (pp 252) (Tan & Jackson, 1993);
- **Mt Tom Price, WA** – ore/waste mined in 1991 was 31.58/24.41 Mt waste for a waste:ore ratio of 0.77 (pp 252) (Tan & Jackson, 1993);
- **Paraburdoo, WA** – ore/waste mined in 1991 was 16.264/13.898 Mt waste for a waste:ore ratio of 0.85 (pp 252) (Tan & Jackson, 1993);
- **Koolyanobbing, WA** – reported waste rock for 2004 was 5.64 Mm^3 (~11.3 Mt) with 5.19 Mt (wet) of ore, giving a waste:ore ratio of about 2.2 (Portman, var.);
- **Tallering Peak, WA** – started in February 2004, with reported waste rock for 2004 and 2005 of 3.45 and 3.92 Mm^3 (~9.0 and ~10.2 Mt) with 1.43 and 2.02 Mt (wet) of ore, giving a waste:ore ratio of about 6.3 and 5.1, respectively (MGIL, var.).

On the basis of the above data for beneficiation/concentration and associated waste rock, it is therefore likely that the total material movement for iron ore production is at least twice that of saleable iron ore and possibly higher.

The data on the iron content of ores mined is available from 1972 onwards, mainly from ABARE (var.-a) and BMR (var.), with sparse data available only before this time. Based on the ABARE and BMR data, iron grades were about 64.3% Fe in 1972 and have averaged around 62.0% Fe since 1991. Based on the available data for NSW (NSWDM, var.), the iron content of NSW iron ores mined sporadically until about 1945 ranged from 31.2% to 67.4% Fe, generally averaging 58.7% Fe. For SA, no annual data has been found, however, according to Jack (1922), the ore mined up to 1914 averaged 68.5% Fe (pp 33). Additional analyses within Jack (1922) suggest an average of about 64.3% Fe (pp 53).

For iron ores, the more important issue than iron content is the impurities and overall smelting characteristics of the ore for steel production (eg. Ferenczi, 2001; Jack, 1922; Woodcock, 1980; Woodcock & Hamilton, 1993). In steel production, the levels of silica (SiO_2), phosphorous, alumina (Al_2O_3) and sulphur are critical aspects of achieving high quality steel. BHP favoured the Middleback Ranges iron ores in 1915 due to their low impurities and excellent smelting characteristics (Raggatt, 1953). It is uncommon for iron ore companies to report impurities although some companies have (eg. Portman Mining). It is likely that almost all future iron ore projects will continue to rely on beneficiation and/or concentration and possibly also greater degrees of processing to achieve high iron grades in saleable products as well as to minimise impurities (eg. Fortescue Metals proposed mines).

The production by state is shown in Figures 26 and 27, with world production versus world and Australian exports shown in Figure 28.

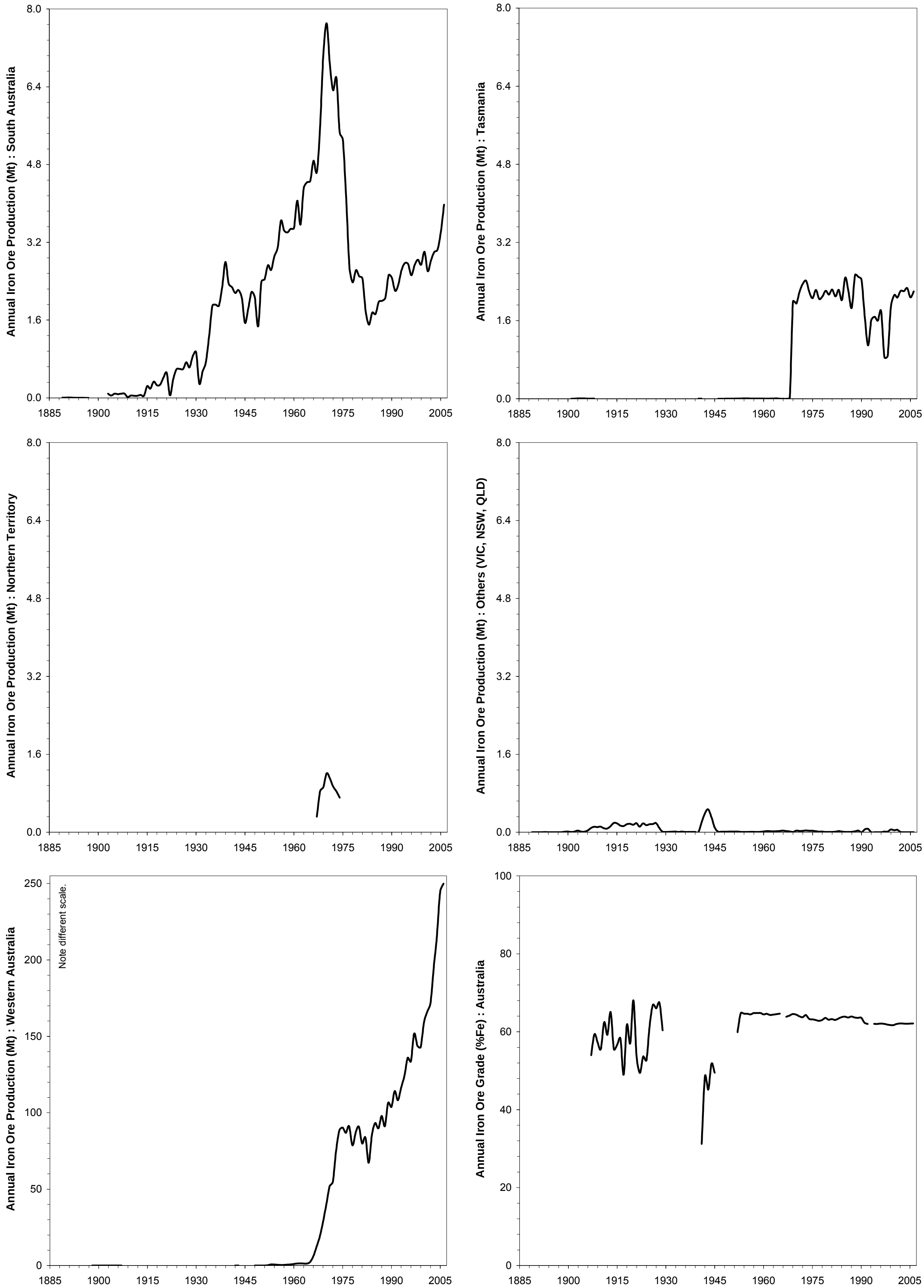


Figure 26 – Annual Iron Ore Production by State and Iron Grade (%Fe)
Note : Iron Grade from 1907 to 1945 is **NSW only** (see also text for further discussion of iron grade).

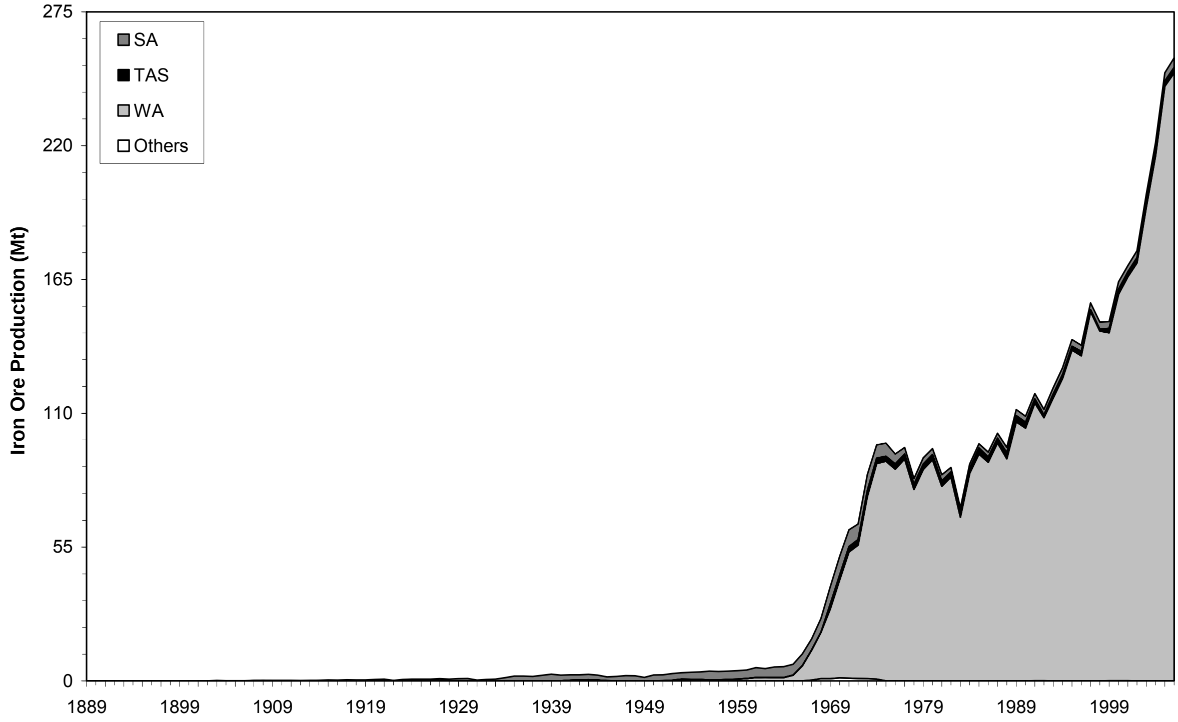


Figure 27 – Annual Iron Ore Production by State

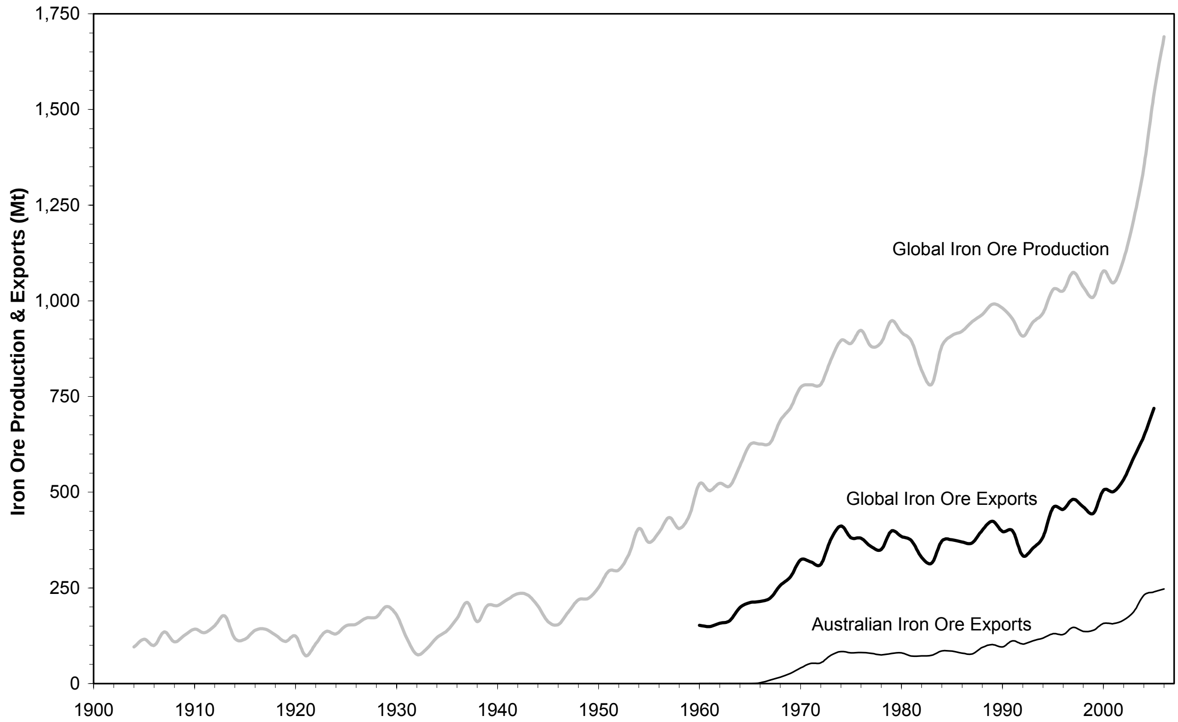


Figure 28 – Iron Ore : Australian Exports Versus World Production and Exports

6.1.4 Resources

Australia's resources of iron ore are extensive and among the largest and highest quality in the world. As noted previously, it was the development of the Pilbara province in northern Western Australia which has propelled Australia to a leading position in the world iron ore market, principally through exports to Asian nations.

The data set for Australia's iron ore resources is provided in the appendix. The compiled GA and earlier data for iron ore resources is shown in Figure 29, including the resources-to-production ratio in years. Recent formal company estimates of iron ore resources including 2005 production are provided in Table 6. Although there are differences between the company and GA data sources, mainly due to different methodologies for classifying resources, they do provide an important overview of potentially economic iron ore resources within Australia. Importantly, ongoing exploration and investigation work, especially in the Pilbara is continuing to suggest that further substantial ore resources are present though the grade is likely to be significantly lower (eg. Cane River/Balmoral South project in the Pilbara).

Overall, Australia's 2006 (and rapidly expanding) production was about 275 Mt, with known potentially economic iron ore resources of about 30,253 Mt (Table 6) providing well over 100 years at current mining rates. Curiously, the resources-to-production ratio has been declining significantly from 1992 as production rises and is now below the level which caused considerable political controversy in the 1930's with regards to the extent of resources that are perceived to be required to safeguard Australia's long-term economic interests.

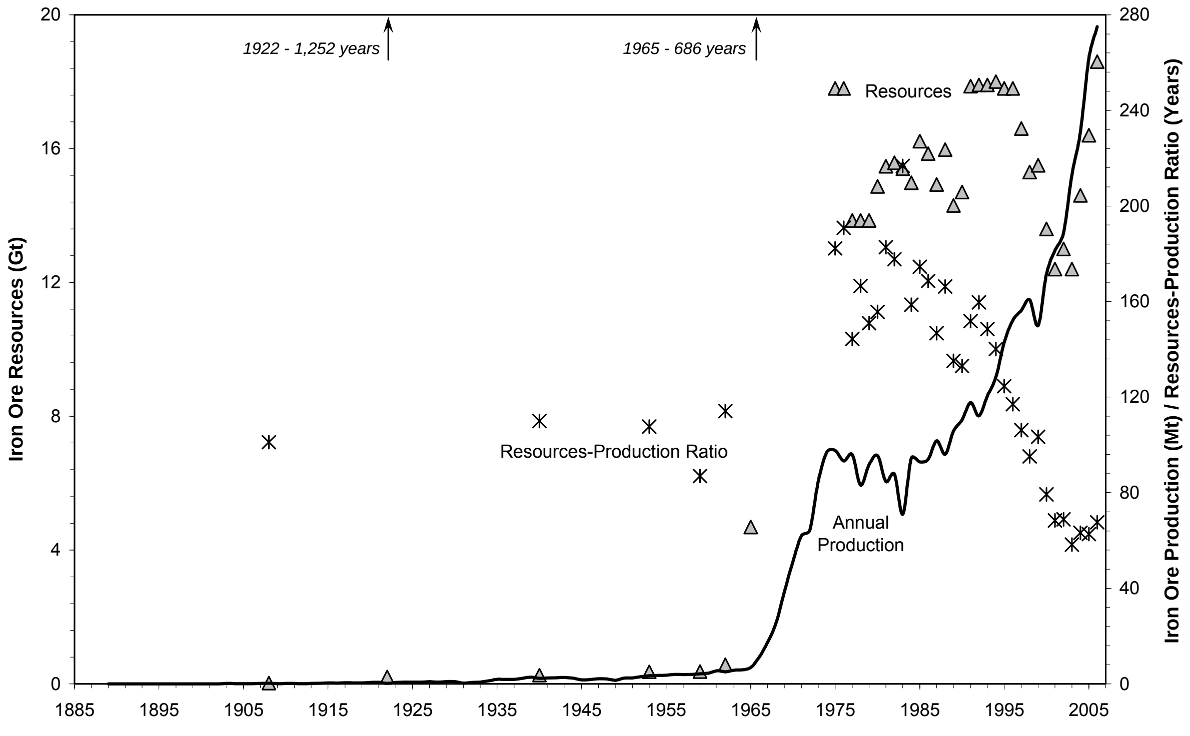


Figure 29 – Australian Iron Ore Resources Versus Production
Note : Two values off-chart for resources-production ratio.

Table 6 – Australian Iron Ore 2005 Production and Resources by Principal Company

Major Project / Deposit	2005	Resources[a]		Date	Principal Operating Company
	Mt prod	Mt ore	%Fe		
Channar	8.644	154	63.1	Dec 2005	Rio Tinto (60%)
Eastern Range	6.559	164	62.6	Dec 2005	Rio Tinto (54%)
Hamersley Iron[b]	74.387	9,970	61.5	Dec 2005	Rio Tinto (100%)
Pannawonica / Deepdale J	30.981	2,090	58.0	Dec 2005	Rio Tinto (53%)[†]
West Angelas	21.403	924	62.0	Dec 2005	Rio Tinto (53%)[†]
Mt Newman JV[§]	25.368[wet]	2,439[wet]	61.1	June 2005	BHP Billiton (85%)[§]
Jimblebar[§]	6.034[wet]	1,139[wet]	61.3	June 2005	BHP Billiton (100%)[§]
Mt Goldsworthy Northern Areas[§]	5.672[wet]	164[wet]	61.8	June 2005	BHP Billiton (85%)[§]
Mt Goldsworthy Area C[§]	18.519[wet]	1,023[wet]	61.6	June 2005	BHP Billiton (85%)[§]
Yandi JV[§]	34.437[wet]	1,479[wet]	57.9	June 2005	BHP Billiton (85%)[§]
Middleback Ranges	3.395	605.6	43.5	June 2004	OneSteel (100%)
Koolyanobbing Field[§]	5.190[wet]	152	62.01	Dec 2005	Portman (100%)
Cockatoo Island	0.617	3.5	68.14	Dec 2005	Portman : HWE (50:50%)
Savage River[‡]	2.1[‡]	245.6	49.0	June 2005	Ivanhoe Mines (100%)
Tallering Peak[c,§]	1.43[wet]	18.6	63.75	Aug 2005	Mt Gibson (100%)
BHP Minerals / Coal[§,d]	-	734[wet]	60.7	June 2005	BHP Billiton (100%)
Hope Downs	-	1,313	61.3	Dec 2002	Hancock-Rio Tinto (50:50)
East Angelas	-	900	61.5	May 2006	Hancock Prosp (100%)
Fortescue[e]	-	2,266	~58.7	March 2006	Fortescue Metals (100%)
Cape Lambert	-	2,489	29.8	July 2005	Cape Lambert (100%)
Koolan Island	-	24.9	66.9	June 2003	Aztec Resources (100%)
Southdown	-	426.2	35.9	Sept 2005	Grange Resources (100%)
Koolanooka	-	437	35.4	Dec 2005	Midwest-Sinosteel (50:50)[f]
Weld Range	-	132.1	55.6	Dec 2005	Midwest-Sinosteel (50:50)
Frances Creek	-	6.8	60.6	Aug 2006	Territory Iron (100%)
Northern Gawler Craton[g]	-	552.7	36.9	April 2002	SA Steel & Energy (100%)[g]
Roper Bar	-	~400	~30-50	mid-1960's	(not known)[h]
Totals	**244.74[#]**	**30,253**	**~56.3**		

Note : Numerous smaller prospects of iron ore with partially quantified resources not to JORC standard are not included above. Many of these prospects, such as Constance Range (QLD), Eyre Peninsula (SA), Mulga Downs (WA), Bungalbin (WA), and others, could contain tens to hundreds of millions of tonnes of additional iron ore.

[§] Production and/or resources on a 'wet tonnes' basis, hence [wet].
[†] Formerly North Ltd controlled 53% of Robe River Iron Associates (Rio Tinto acquired North Ltd during 2000); additional partners are Japanese (Mitsui Iron Ore 33%, Nippon Steel Corporation 10.5% and Sumitomo Metal Corporation 3.5%).
[‡] Savage River mines low grade ore and produces a beneficiated concentrate for iron ore pellets; 2.1 Mt is pellets.
[#] Based on the master data set, 2005 iron ore production was 250.04 Mt compared to the figure above of 244.74 Mt. This is most likely due to inconsistencies in reporting, such as wet versus dry tonneages (eg. BHP Billiton reports on a wet tonnes basis); see 2003 Edition, DITR (var.).

[a] Includes all reserves and resources as reported by the specified company in their most recent announcement and/or RIU (var.).
[b] Hamersley Iron includes Paraburdoo, Mt Tom Price, Marandoo, Yandicoogina and Brockman.
[c] Tallering Peak commenced production in February 2004 (MGIL, var.). Mt Gibson Iron Ltd have not reported mineral resources in recent annual reports; resource figure from May 2006 Investor Presentation.
[d] Unknown deposits / locations.
[e] Includes Cloud Break and Christmas Creek; earlier resource estimates from Fortescue were larger but at about half the grade.
[f] Includes Koolanooka-Blue Hills plus Koolanooka magnetite resources.
[g] Includes the Buzzard, Giffen Well, Hawks Nest, Kestrel, Peculiar Knob, Sequoia and Wilgena Hill deposits. SA Steel & Energy was a research and development project and is now closed. SASE was 90% owned by AuIron Energy Ltd. Resources from Davies *et al.* (2002).
[h] Based on Canavan (1965) and Ferenczi (2001).

6.2 Bauxite-Alumina-Aluminium

6.2.1 Brief History

The proving of extensive bauxite resources had long been a major hope of the Australian Government and mining industry in the early twentieth century. Prior to 1950, small scale aluminium fabrication plants existed, but these were generally insufficient to meet rapidly growing demand or were dedicated for military use only. The difficult days of World War II and the desperate need for aluminium strongly re-inforced this view, and the Commonwealth, aiming to become independent of expensive imported aluminium, decided in 1941 to build an aluminium smelter at Bell Bay in Tasmania, based on imported alumina. Construction at Bell Bay started in 1948 with production commencing in 1955. The Bell Bay smelter was sold to a joint venture led by Comalco Ltd[13] in November 1960.

By the late 1950's the search for bauxite was gaining impetus rapidly across Australia, with remarkable success. Major new bauxite resources were discovered at Weipa on the west coast of Cape York Peninsula in northern Queensland, in the Darling Ranges south of Perth in Western Australia and on Marchinbar Island and Gove on the north-eastern corner of Arnhem Land in the Northern Territory. By the mid-1960's new mines had been developed and begun operation at Weipa and the Darling Ranges with Gove coming online in 1971. In addition, the Bell Bay alumina refinery and aluminium smelter had been expanded with further alumina refineries and aluminium smelters operating or under construction at Point Henry (VIC), Gladstone (QLD), Kurri Kurri (NSW), Tomago (NSW) and Kwinana (WA). Australia had achieved not only its aim of self-sufficiency in integrated aluminium production but could now also play a major role in the bauxite-alumina-aluminium world export market through almost continual expansion to the present. As of mid-2007, most existing projects are expanding further still, with a new alumina refinery recently opened at Gladstone.

Further detail on the history of the bauxite-alumina-aluminium industry is widely available, with the works of Lindsley (1965), Raggatt (1968), Trengrove (1979), Rattigan (1990) and Griffiths (1998) being of particular note. The monographs of Knight (1975a), Woodcock (1980), Hughes (1990), Woodcock & Hamilton (1993) and Berkman & Mackenzie (1998), also contain numerous relevant papers.

In 2007, the following bauxite-alumina-aluminium projects are operating, expanding and/or under construction (Baker, 1993; Rattigan, 1990) (and recent company announcements) :

Bauxite mines (6 operating) -

- Weipa, QLD, fully owned by Comalco (Rio Tinto 100%);
- Gove, NT, operated by Nabalco (Alcan 100%) (*undergoing expansion*);
- Boddington (formerly Mt Saddleback), WA, operated by Worsley Alumina Pty Ltd[14];
- Huntly, WA, operated by Alcoa World Alumina & Chemicals (AWAC)[15];
- Jarrahdale, WA, operated by AWAC;
- Willowdale, WA, operated by AWAC.

Alumina Refineries (7 operating) -

- Gladstone alumina refinery, based on Weipa bauxite, operated by Queensland Alumina Ltd[16];
- Comalco Gladstone alumina refinery (*recently completed*), based on Weipa bauxite, operated by Comalco (Rio Tinto 100%);
- Pinjarra, WA, based on Huntly bauxite, operated by AWAC;
- Wagerup, WA, based on Willowdale bauxite, operated by AWAC;
- Kwinana, WA, based on Jarrahdale bauxite, operated by AWAC;

[13] The Comalco Ltd led joint venture originally included Kaiser Aluminium and Chemical Corporation (USA) (one-third) and the Tasmanian Government (one-third), leaving Comalco a one-third interest. Comalco now owns 100%, who are in turn now owned 100% by Rio Tinto Ltd.
[14] Worsley Alumina is now owned by BHP Billiton Ltd (86%), Kobe Alumina Associates Pty Ltd (10%) and Nissho Iwai Alumina Pty Ltd (4%).
[15] Alcoa World Alumina & Chemicals (AWAC) is a joint venture between Alcoa Ltd (60%) and Alumina Ltd (40%).
[16] Queensland Alumina Ltd is owned by Rio Tinto 38.6%, Alcan 41.4%, Roussal 20%.

- Worsley, WA, based on Boddington bauxite, operated by Worsley Alumina;
- Gove, NT, based on Gove bauxite, operated by Alcan (100%).

Aluminium Smelters (6 operating) -

- Boyne Island, QLD, based on Gladstone alumina, operated by Rio Tinto (59.4%);
- Tomago, NSW, based on Gladstone and Gove alumina, operated by a joint venture between Alcan (51.55%), CSR (25.235%), AMP (10.815%) and Hydro Aluminium (12.4%)[17];
- Kurri Kurri, NSW, based on Gladstone alumina, operated by Hydro Aluminium (100%);
- Point Henry, VIC, based on Kwinana, Wagerup and Pinjarra alumina, operated by AWAC;
- Portland, VIC, based on Kwinana, Wagerup and Pinjarra alumina, operated by AWAC;
- Bell Bay, TAS, based on Gladstone alumina, operated by Rio Tinto (100%).

6.2.2 Major Provinces

The Weipa, Gove and Darling Ranges regions continue to be the pre-dominant bauxite-alumina provinces in Australia. There are, however, other known major resources, including the Aurukun field south of Weipa and extensive deposits throughout the Kimberley region of northern Western Australia. At present most expansion of the bauxite-alumina industry is occurring through growing existing sites and infrastructure, and it appears unlikely that new fields will come into prominence for some time. The location of bauxite deposits, mines, alumina refineries and smelters are shown in Figure 30.

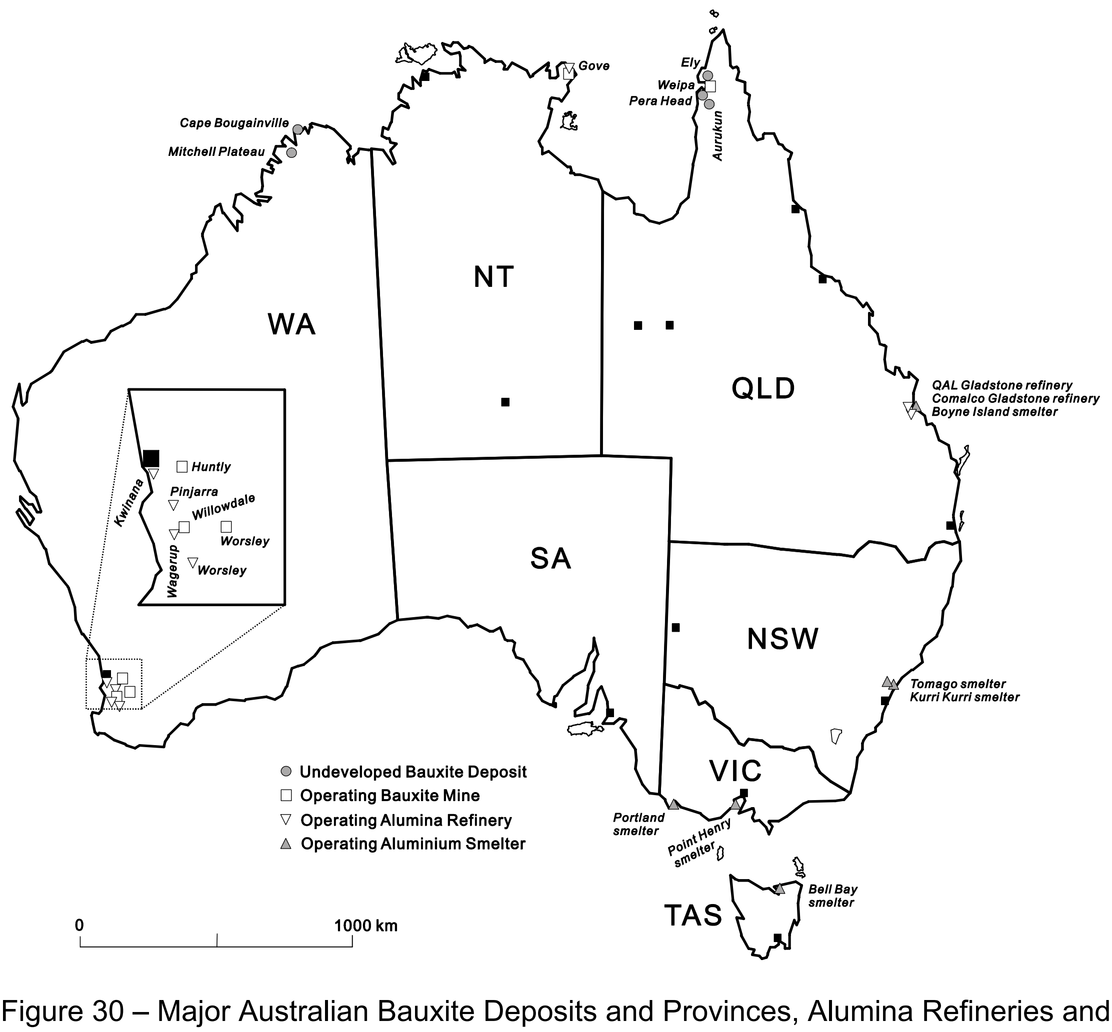


Figure 30 – Major Australian Bauxite Deposits and Provinces, Alumina Refineries and Aluminium Smelters

[17] Based on "Alcan in Australia" (Alcan, 2004). Hydro Aluminium was formerly Norsk Hydro Ltd.

6.2.3 Production

The data for bauxite production is mostly available, though key gaps remain. For instance, annual mine production of bauxite is only reported consistently by Rio Tinto, with WA mines not reporting individual site data. Additionally, no mine reports data on raw bauxite mined versus beneficiated bauxite product. Alumina production is generally not reported on a site basis. There is also no data on overburden/waste rock production, though generalised data can be extracted from geology and mining reports. For example, according to McLeod (1965a), the Gove deposit in about 1965 had about 1.53 m of overburden for the then estimated resources of 138 Mt (pp 27). Although similar data could be found for Weipa and the Darling Ranges, as there is no reporting of overburden data, it can only be assumed that overburden/waste rock quantities are of a similar magnitude as bauxite production.

The principal data sets for bauxite and alumina production statistics are provided in the appendix. The two ABARE publication series, the Australian Mineral Statistics journal (ABARE, var.-a) and annual Australian Commodity Statistics report (ABARE, var.-b), also contain the alumina content of as-mined bauxite, allowing an estimation of the overall bulk alumina grade of Australian bauxite. Some data is also given by the Australian Bureau of Statistics (ABS), though it appears somewhat unreliable when compared to the ABARE data. In general, most companies do not publish the alumina grade of their bauxite production. The compiled data sets are shown in Figures 31 and 32.

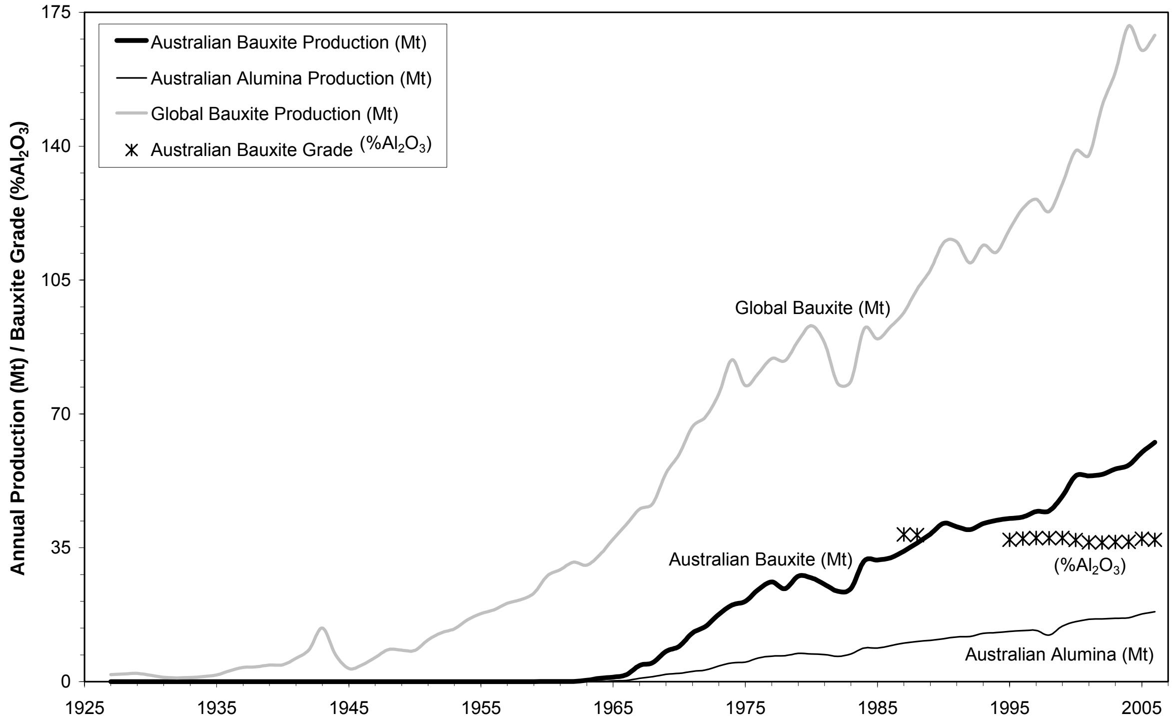


Figure 31 – Australian and Bauxite / Alumina Production, World Bauxite Production, Australian Bauxite Grade

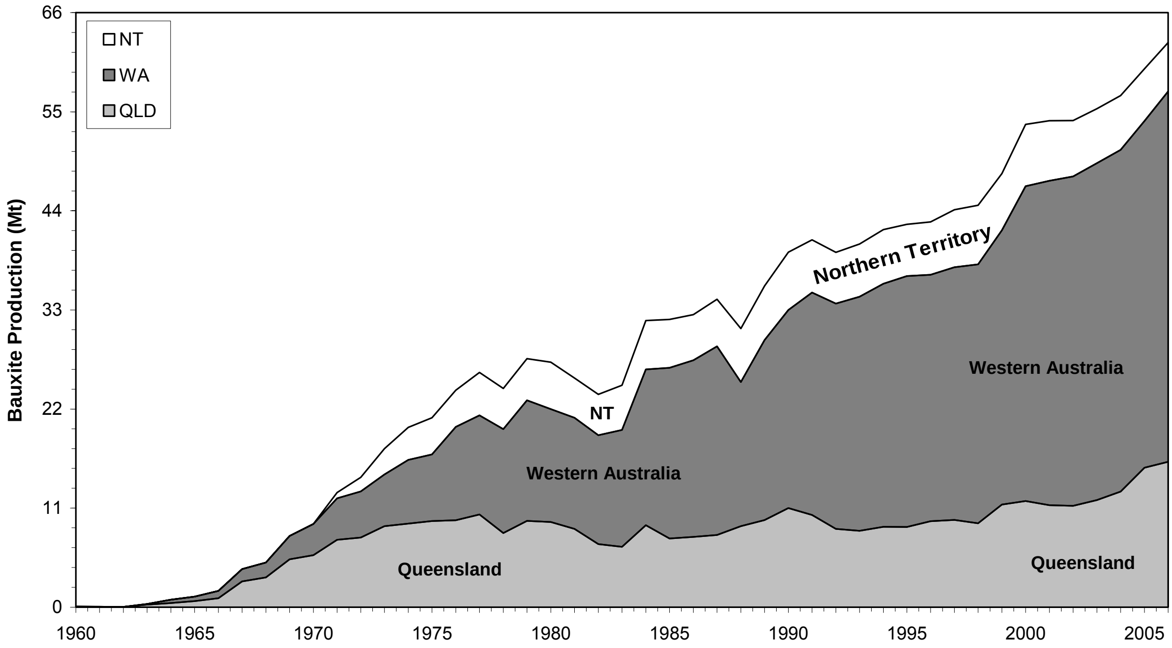


Figure 32 – Australian Bauxite Production by State (small states excluded)

6.2.4 Resources

Australia was long considered to be deficient in major bauxite deposits, especially those capable of supporting an economic, vertically integrated aluminium industry. Up to the 1950's most production was from small deposits with the bauxite principally used for water treatment. The resources at this time were estimated as :

- 1948 – 8.8 Mt (pp 10, 1952 Edition) (BMR, var.);
- 1950 – 8.6 Mt (pp 81) (Raggatt, 1968);
- 1952 – 34.5 Mt (pp 30, 1952 Edition) (BMR, var.);
- 1953 – 21.8 Mt (Raggatt, 1953);
- 1954 – 21 Mt (McLeod, 1998); and
- 1965 - >2,000 Mt (pp 401) (Evans, 1965).

Since the 1960's, the Weipa, Gove and Darling Ranges provinces have been demonstrated to contain large resources of bauxite. The combined data for economic resources over time are shown in Figure 33. The principal data for these resources over time are :

- BMR, Annual Mineral Industry Review (1948 to 1987) (BMR, var.);
- GA, Australia's Identified Mineral Resources (1975 to 2006) (GA, var.);
- Company annual reports, namely CRA / Rio Tinto (CRA, var.; RT, var.), BHP Billiton (BHPB, var.) and Alcan (Alcan, 2004).

Alcoa-operated sites do not publish reserves for their Darling Ranges operations. Hence it is not possible to construct an accurate account of production versus resources for all major mines (as was done previously with iron ore). Based on the available data, a brief review is given below. The resource tonnage is reported according to the JORC code by Rio Tinto and BHP Billiton but not by Alcan.

The total ore reserves and resources at Weipa is 3,307 Mt grading 52.0% Al_2O_3 (pp 47 & 51, 2006 Edition) (RT, var.), while for Worsley Alumina total resources are 682 Mt at 30.8% Al_2O_3 (pp 54-55, 2006 Edition) (BHPB, var.). According to Alcan, between Gove and some leases near Weipa, its reserves are simply stated as 800 Mt (pp 5) (Alcan, 2004) (no specific further information appears to be available).

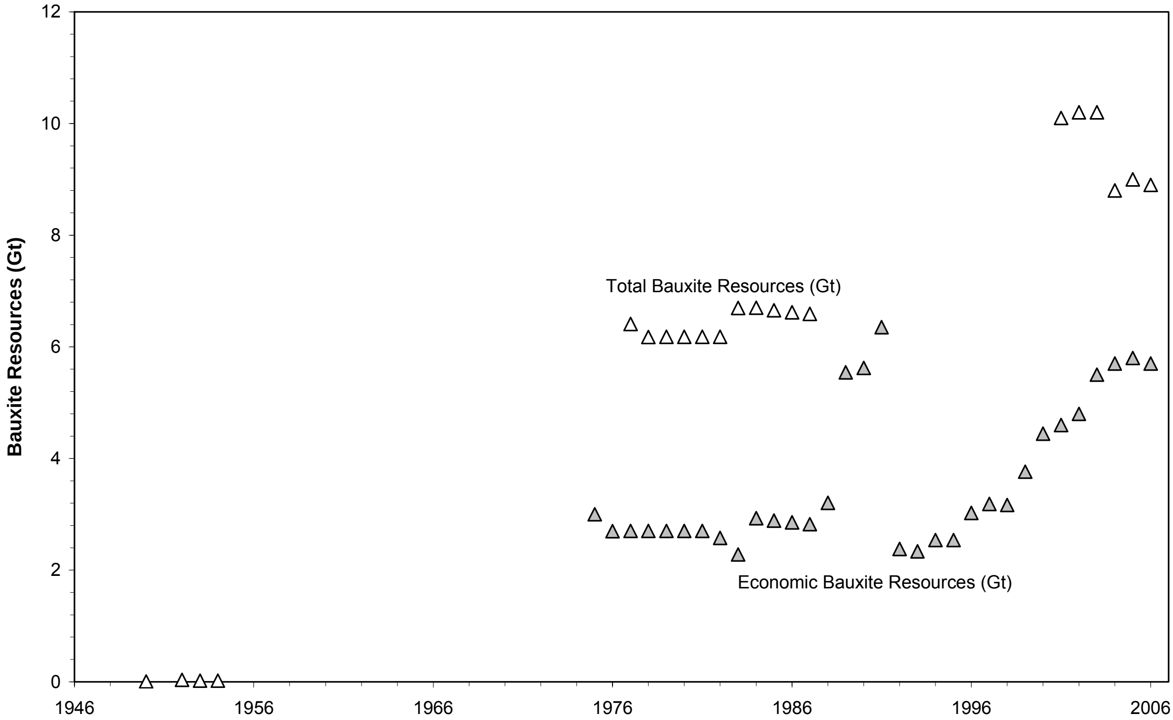


Figure 33 – Australian Economic and Total Bauxite Resources

It is clear that sufficient resources exist for the forseeable future of some decades. For example, total Weipa resources are some 3,307 Mt of bauxite compared to 2006 production of 16.14 Mt bauxite. Assuming a constant mining rate and that all resources are mined, this gives a potential mine life of more than 200 years. The Worsley-operated Boddington mine does not publish bauxite production data, however, an estimate can be obtained. Taking total 2006 WA bauxite production of about 41.11 Mt (ABARE, var.-a) and Alcoa's 2004 bauxite production of 28.63 Mt/yr (Alcoa, 2006), leaves about 12.5 Mt/yr for Boddington. According to BHP Billiton, total reserves and resources for Worsley are 682 Mt (at June 2006) (BHPB, var.), giving a further mine life of more than 50 years.

For currently classed economically demonstrated bauxite resources, as of December 2006 (GA, var.), Australia has about 5,700 Mt of economic bauxite resources, with a further 3,200 Mt of sub-economic and inferred resources. According to earlier GA data and (BMR, var.), total Australian resources of bauxite were almost 10,200 Mt (eg. 2002 GA estimate). Current annual Australian production is growing steadily but is approximately 60 Mt/year. This gives an overall time frame for current economic resources of about 97 years.

The major issue facing the bauxite industry is, similar to the iron ore industry, not simply the alumina grade but also the impurities associated with any deposit (Woodcock, 1980; Woodcock & Hamilton, 1993). A major issue with the processing of bauxite is the reactive silica content of the as-mined ore (Rattigan, 1990).

6.3 Manganese

6.3.1 Brief History

By the 1950's numerous mines had or were producing manganese ore from relatively small deposits in all states and territories, often opportunistically as demand occurred for specific projects (eg. requirements for a nearby mine's metallurgical mill) (see de la Hunty, 1965; Hopkins & Nixon, 1965; Johns, 1965). The reserves of these deposits were small and Australia still required a major manganese deposit to replace imports and facilitate valuable ferro-manganese production (Raggatt, 1968).

There were pockets of iron ore from the Middleback Ranges in South Australia which were highly manganiferous (up to 30% Mn) and these were keenly used by BHP in steel making at Newcastle (Jack, 1922; McLeod, 1965b), however, a high quality manganese deposit was a preferred alternative. There was also growing demand for manganese in metallurgical mills processing various types of metal ores, such as uranium and others from the 1950's (see BMR, var.; Knight, 1975a).

In 1960, a geologist working for the Commonwealth's Bureau of Mineral Resources (BMR), P R Dunn, noted manganese outcrops[18] while visiting remote Groote Eylandt in the Gulf of Carpentaria in the Northern Territory (Turnbull, 1993). The significance of the potential find was quickly realised, with the BMR conducting detailed follow-up investigations. In 1962, the Broken Hill Proprietary Company Ltd (BHP) became involved, and established the Groote Eylandt Mining Company Pty Ltd (or 'GEMCO') in 1964. The first shipment within Australia occurred in March 1966 and the first export shipment occurred to Japan in September 1966. The production grew rapidly and reached about 2.2 Mt/year by the mid-1970's, stabilising around this rate since this time. BHP sold GEMCO in December 1998 to South African mining group Samancor Ltd[19].

The only other significant manganese deposit which has been developed since the 1950's is the Woodie Woodie deposit in northern Western Australia. From 1953 to 1972 it supplied about 300 kt of manganese ore, at which point it was closed. In 1990, Portman Mining re-developed the project, with annual production rates varying from 200 to 400 kt ore. The smaller Mike manganese mine, operated by Valiant Consolidated, was close to Woodie Woodie, with Valiant purchasing Woodie Woodie from Portman in July 1996, giving Valiant control of the manganese region.

In the Tennant Creek mineral field of the Northern Territory, a new manganese project was recently developed at Bootu Creek by Hong Kong-based OM Holdings, with a production rate of about 0.6 Mt/year starting from early 2006.

The future of manganese in Australia will be dominated by Groote Eylandt for many years, given its large remaining high-grade resources, though smaller projects such as Woodie Woodie and Bootu Creek will make important contributions.

6.3.2 Major Mines

The major manganese mines presently operating are Groote Eylandt, NT, and Woodie Woodie, WA. A new project at Bootu Creek, NT, commenced full-scale operations in early 2006. The locations of major Australian manganese projects are shown in Figure 34.

[18] The presence of manganese on Groote Island had been noted by Matthew Flinders in 1803 and H Y L Brown in 1907 (pp 1227) (Turnbull, 1993).

[19] At this time, December 1998, Samancor was de-listed from the South African stock exchange and became a joint venture of Billiton Plc (60%) and Anglo American Corporation of South Africa Ltd (40%). Ironically, soon after Billiton Plc merged with BHP in 2000 to form BHP Billiton Ltd (BHPB), givng majority ownership again of Groote Eylandt/GEMCO (60%).

Figure 34 – Australian Manganese Past and Current Mines and Deposits

6.3.3 Production

The production data for manganese ore over time is readily available, especially since the vast majority of production has occurred since the mid-1960's. The principal data sources are ABARE (var.-a, var.-b), BMR (var.) and Kalix *et al.* (1966), as well as state annual reports (eg. NTDME, var.; WADM, var.) and specific company annual reports (eg. BHPB, var.; CM, var.; Portman, var.). There is some confusion between as-mined manganese ore, beneficiated ore and ore concentrates, however, a master data set has been compiled (see appendix). According to (Woodcock, 1986), about 3.5 Mt of raw ore was required to produce 2.1 of manganese concentrate (pp 27).

In general, the grade of manganese ore is divided into two categories – metallurgical and dioxide, depending upon its use. Metallurgical grade manganese ore, >50% MnO_2, is used in chemical processing applications, generally as an oxidant to ensure efficient extraction of various minerals. Dioxide grade manganese ore, 30-50% MnO_2, is generally used in steel making. Almost all of the manganese ore production is of the dioxide grade, with only about 10% being metallurgical grade. The distinction of ore type is commonly not reported.

The grade of manganese has been reported for some years (1987 and 1988) by BMR (var.) with recent years during the 1990's to the present been reported by ABARE (var.-a). Overall, the data suggests a consistent grade of around 46-48% Mn for manganese ores and concentrates produced, with some minor variation. It is very difficult, however, to distinguish this output from the mining and beneficiation of raw manganese ores. That is, the quantity of as-mined ore needed to produce the manganese dioxide.

All manganese mining has been by open cut. Given the expected long life of Groote Eylandt, plus existing and potential projects, the use of open cut mining is unlikely to change.

The information for waste rock is not generally reported, though some data for Woodie Woodie was reported by Portman Mining (eg. Portman, var.), a practice continued by Consolidated Minerals after they acquired the project from Portman in 1996 (eg. CM, var.). Some additional data for the Woodie Woodie project is available from Pearson & Holly (1993). The deposits mined are a series of pockets or lodes of ore, with the waste:ore ratios in the early 1990's for these lodes being:

- just over 5:1 for the Lox and Radio Hill lodes (pp 1235);
- 8:1 for the Cracker lode (pp 1235).

For the Mike mine near Woodie Woodie, Valiant Consolidated (now Consolidated Minerals) also reported waste rock data on an annual and quarterly basis.

Based on CM (var.), the overall waste:ore ratio for future expanded production from Woodie Woodie is likely to remain about 5:1.

The bulk manganese ore production by state and Australian exports is shown in Figure 35. Due to the lack of waste rock data for Groote Eylandt, this aspect has not been included. For comparison, Australian production and exports of manganese ore compared to world production of contained manganese is shown in Figure 36.

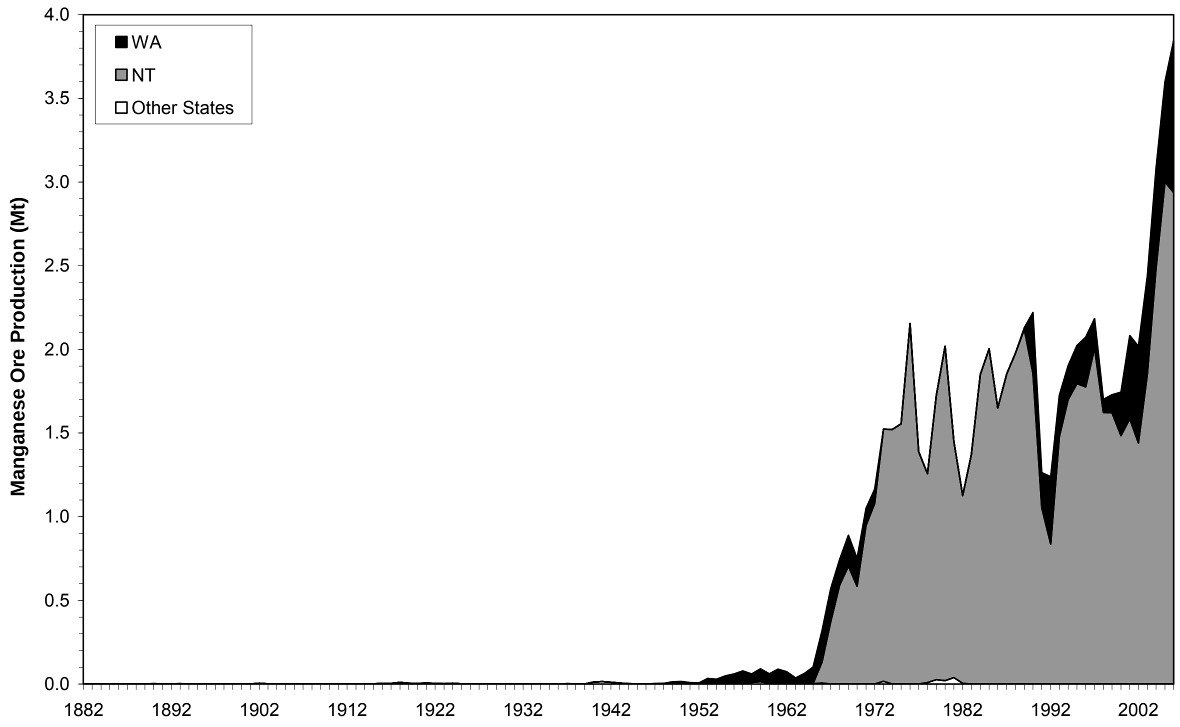


Figure 35 – Australian Manganese Production by State

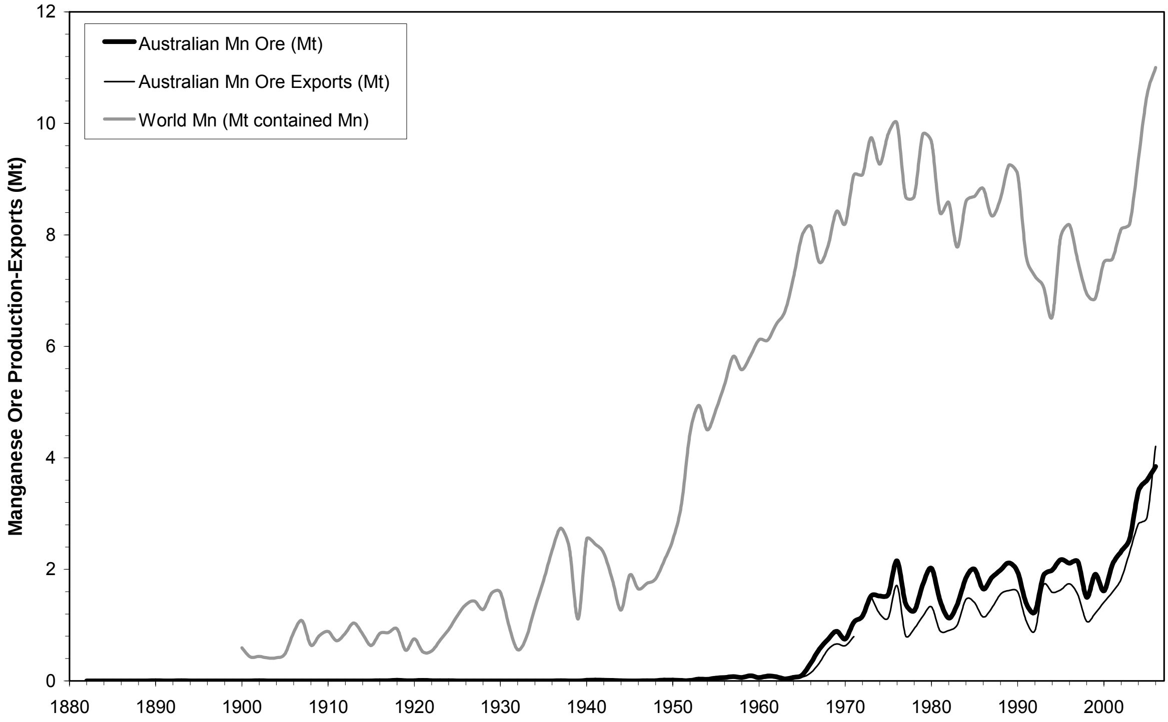


Figure 36 – Australian and Global Manganese Production
Note : Difference in reported production – Mn ore versus contained Mn.

6.3.4 Resources

The economic resources of manganese ore in Australia is generally no well published. Some recent data is provided by GA (var.), though data prior to 2000 is somewhat limited. Specific earlier data includes :

- 1953 – Australia, resources in were estimated at 0.60 Mt grading about 40% Mn (pp 20) (Raggatt, 1953);
- 1959 – Western Australia, resources in 1959 were estimated at 3.9 Mt grading >40% Mn and a further 3.3 Mt grading 30-40% Mn (pp 140) (de la Hunty, 1965);
- 1975 – Australia, resources were estimated at 490 Mt (McLeod, 1998);
- 1985 – Australia, resources were estimated at 326 Mt (McLeod, 1998).

According to GA (var.), the December 2006 economic resources of manganese ore are 139 Mt, with a further 190 Mt sub-economic and 160 Mt inferred resources. The bulk of this is held at Groote Eylandt, though aggressive exploration by Consolidated Minerals at their Woodie Woodie project has continued to increase resources above and beyond annual mining depletion. The most recent estimate for Woodie Woodie's manganese resources is 15.49 Mt grading 41.8% Mn (June 2006) (CM, var.). This compares to the resources known in 1995 of about 3 Mt (1995 Edition) (Portman, var.), just before Portman sold Woodie Woodie to Consolidated Minerals[20] in July 1996. The most recent resource estimate given by BHP Billiton (BHPB, var.) for Groote Eylandt states 169 Mt grading 47.6% Mn (pp 64, 2006 Edition), although this figure has varied widely over recent years. The resources at Bootu Creek are estimated at 15.9 Mt grading 25.2% Mn (December 2006) (OMH, var.).

Economic resources over time are shown in Figure 37. Australian production of manganese ore in 2006 was ~3.84 Mt, which compares to the total GA resource estimate of about 488 Mt – sufficient for more than a century at present rates.

[20] Consolidated Minerals Ltd was previously called Valiant Consolidated Ltd.

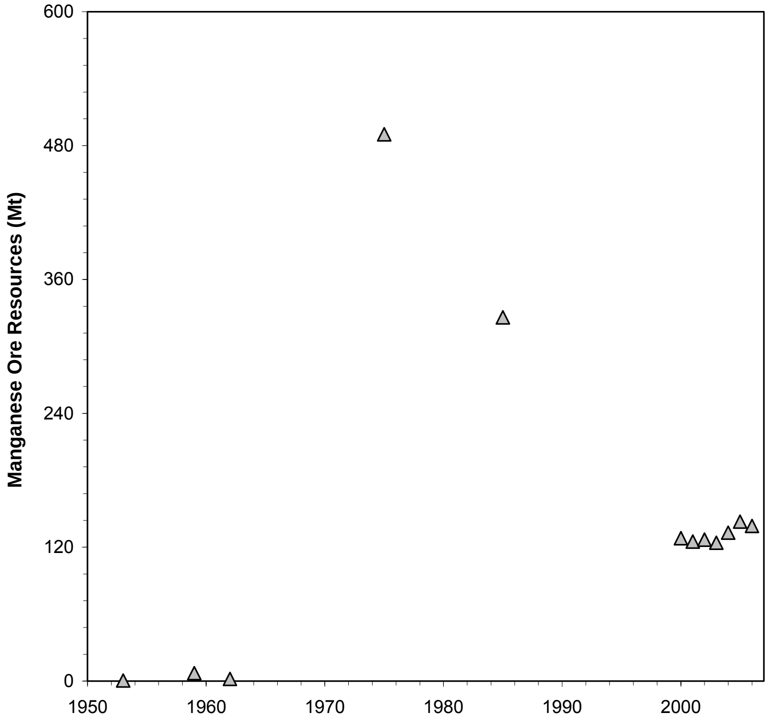


Figure 37 – Australian Manganese Ore Resources Over Time

6.4 Mineral Sands

6.4.1 Brief History

Heavy mineral sands are named due to the dense and heavier nature of the principal minerals sought, rutile-zircon-ilmenite-monazite, compared to the sand matrix within which they are most commonly found in economic deposits.

The Australian heavy mineral sands industry had somewhat humble beginnings in the 1930's and is presently a major world producer of mineral sands products, namely rutile (TiO_2), ilmenite ($FeTiO_2$), zircon (ZrO_2) and monazite (a phosphate mineral rich in rare earths and thorium). The principal elements being sought are titanium (Ti, from rutile and ilmenite), zirconium (Zr) from zircon and rare earths from monazite. The industry grew out of the emergence of large scale dredging technology in the early 1900's, initially developed for alluvial gold and tin mining, and has adapted and expanded to its present position.

Further detail on the history of the mineral sands industry is given by Blaskett & Hudson (1965), Morley (1981), Raggatt (1968) and Rattigan & Stitt (1990).

In the early years, mines were generally developed along the coastal areas of New South Wales and Queensland, with the south-west of Western Australia becoming a significant area of mining in the 1960's. Many of these areas were also popular tourism areas, or were viewed as important areas for conservation and national parks. Thus, by the mid-1970's, some projects had been refused permission to proceed, with major resources such as those on Fraser Island being closed to mining and made a national park (listed as a world heritage property in 1992). The remaining mines, such as those on North Stradbroke Island, still lead to some controversy on occasion. By the 1990's, Western Australia was the dominant mineral sands producer in Australia.

For some components of heavy mineral sands concentrates, the resources or ore grades are not the problem compared to the demand within markets. For example, monazite production halted across Australia during the late 1990's due to cheap global competition from China and briefly re-appeared in 2002. Monazite was still present in the ore mined but was not extracted due to the lack of customers in the world market (Australia does not use monazite).

An important factor that helped Australia developed a leading world position in the mineral sands market was its development of technology in the 1960's for processing the large quantities of ilmenite-dominant mineral sands resources, especially in Western Australia. By removing the iron present in ilmenite, a 'synthetic' rutile product can be produced of marketable quality. Another important issue was the ban on exports of low grade mixed concentrates by the Commonwealth, effective 1 January 1950, which forced the Australian industry to shift to the production of high grade single mineral concentrates, and also facilitated downstream processing such as titanium pigment production.

The inland Murray Basin region stretching across New South Wales, Victoria and South Australia is emerging as a potential major province for future mines. In the mid-1980's, CRA Ltd discovered a major province near Horsham in western Victoria. The area, known as the 'WIM' deposits, are low grade but very extensive. Pilot mining and milling work demonstrated that the WIM-style deposits were too fine-grained for conventional processing. Another Victorian prospect which was developed in 2001 was the Wemen project near Mildura.

Recent exploration in western South Australia in the Eucla Basin is suggesting it to be a highly prospective region for potential mineral sands projects. Based on work reported to date, significant large, new prospects have been identified which are rich in valuable zircon.

6.4.2 Major Provinces

The coastal regions of Australia continue to provide the dominant regions for mineral sands mining. These are the east coast of New South Wales and Queensland and the south-west coast of Western Australia. The east coast deposits are generally rutile-zircon-ilmenite while WA deposits are generally ilmenite (Ward, 1965). The Murray Basin is an emerging and somewhat promising province, with recent exploration in western South Australia also pointing to the Eucla Basin as a highly prospective region for potential mineral sands projects. These regions are shown in Figure 38.

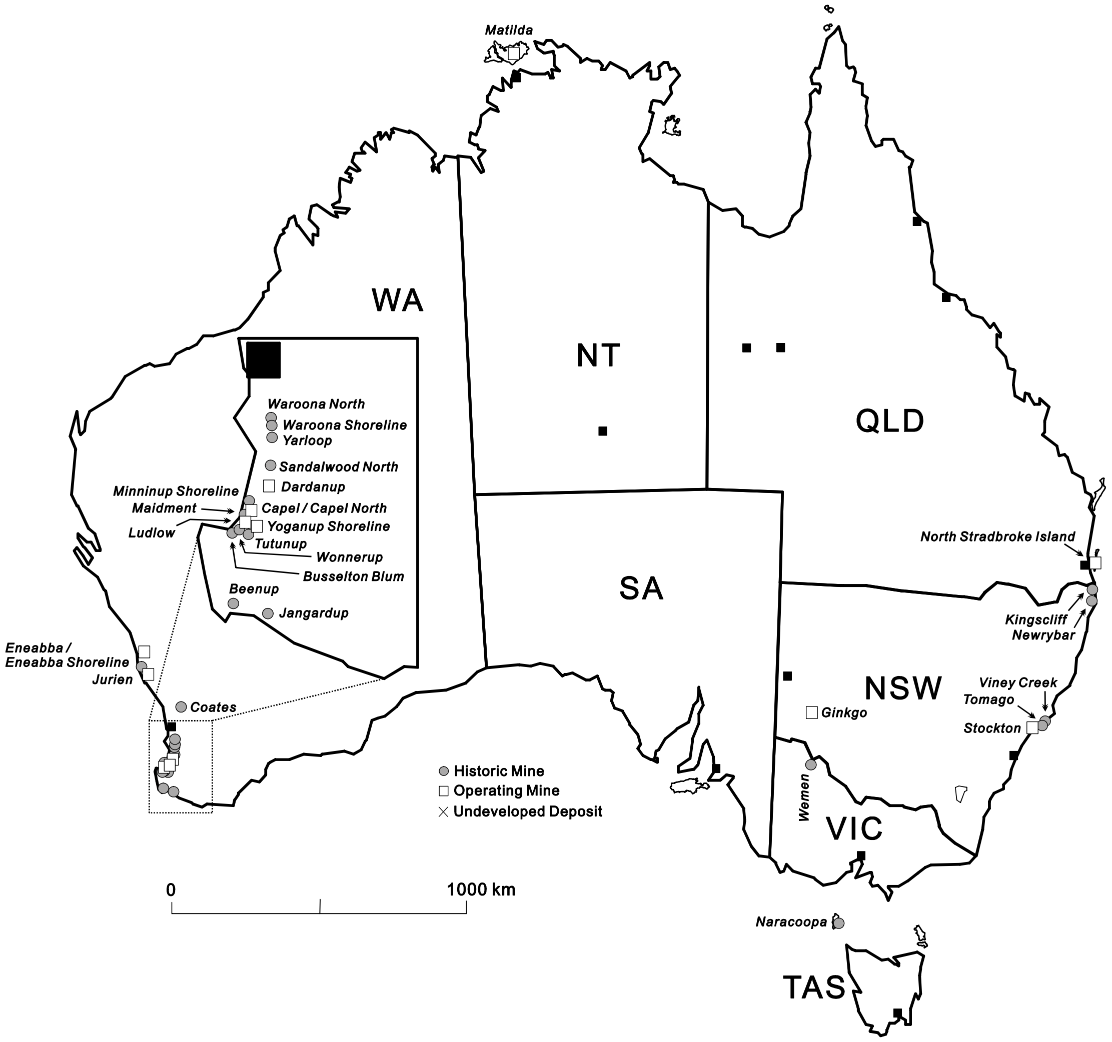


Figure 38 – Australian Provinces for Mineral Sands

6.4.3 Production

There is only quite sparse data available for the mineral sands industry with regards to ore mined and milled and its associated heavy mineral grade and overburden/waste. Good data sets are available for the total state production of rutile, ilmenite, zircon and monazite, principally from ABARE (var.-a, var.-b), BMR (var.) and Kalix *et al.* (1966), as well as state annual reports and publications (eg. NSWDM, var.; NSWDMR, var.-b; QDM, var.; WADM, var.), though gaps for some years remain. There is also apparently confusion between concentrates and mineral content between some reports, however, given the high percentage grade content of mineral sands concentrates (eg. >95%), this is not significant. The master data set is provided in the appendix and shown in Figures 39 and 40.

Historically, Western Australian mineral sands deposits are higher grade but more difficult to mine by dredging than typical east coast deposits in New South Wales and Queensland (pp 1254) (Anderson, 1993).

It was stated by Lee (2001) that ore grades are declining gradually and that the mineralogy is becoming more complex over time, requiring more vigilant attention in mine planning and operations. For East Coast mineral sands mines, were operating at grades of 1.5% each for rutile and zircon at cut-off grades of 0.3% each in the early 1980's but by around the year 2000 grades were 0.15% each for rutile and zircon and cut-off grades of 0.15% each (pp 318).

As with many bulk commodities, impurities are important in their marketable quality (eg. Raggatt, 1968). For East Coast and Murray Basin deposits high chromium levels are a major issue (eg. Lee, 2001; Rattigan & Stitt, 1990; Ward, 1965). As with manganese and iron ores, the reporting of impurities is rare.

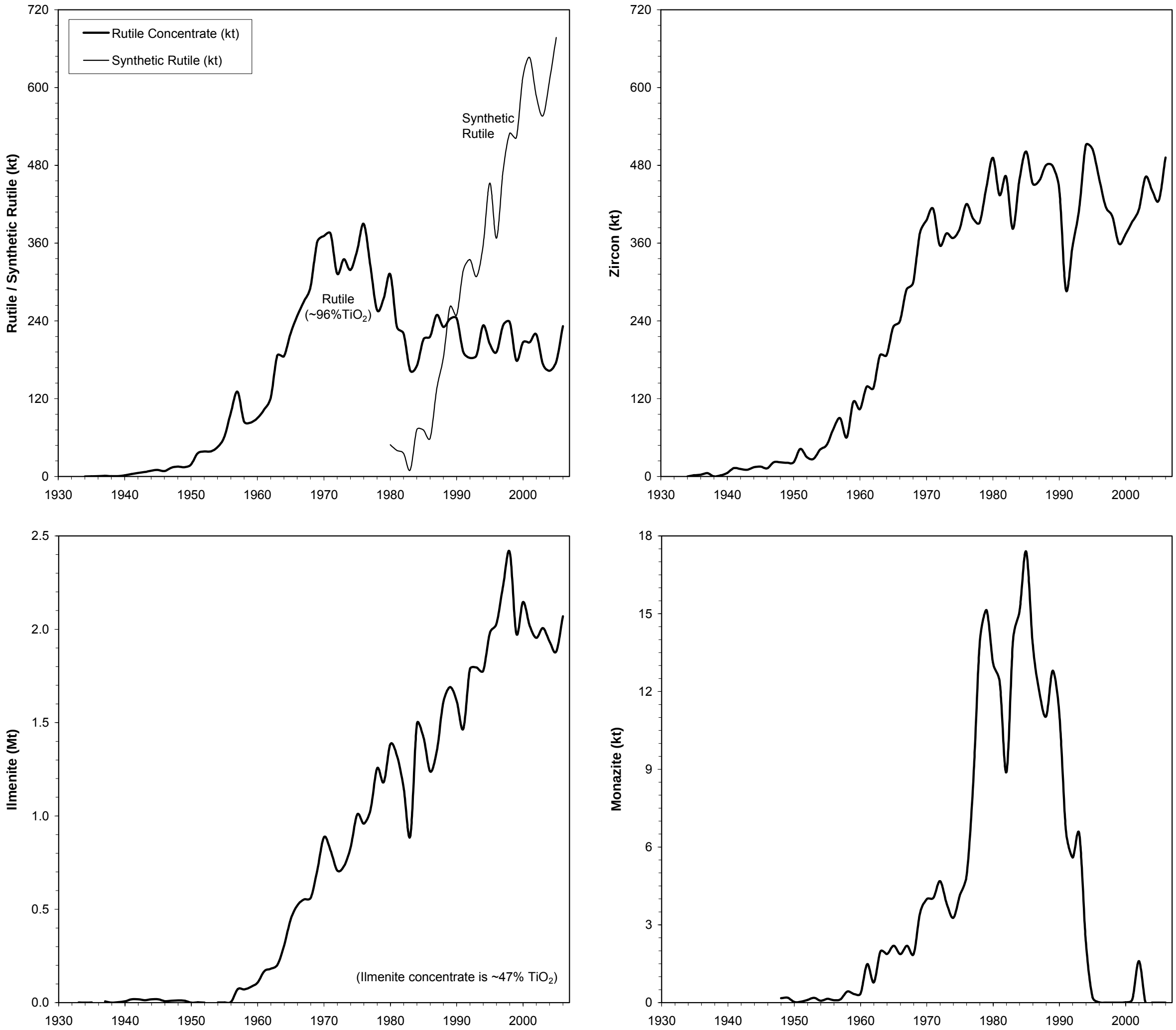


Figure 39 – Australian Mineral Sands Production : Rutile / Synthetic Rutile, Ilmenite, Zircon and Monazite

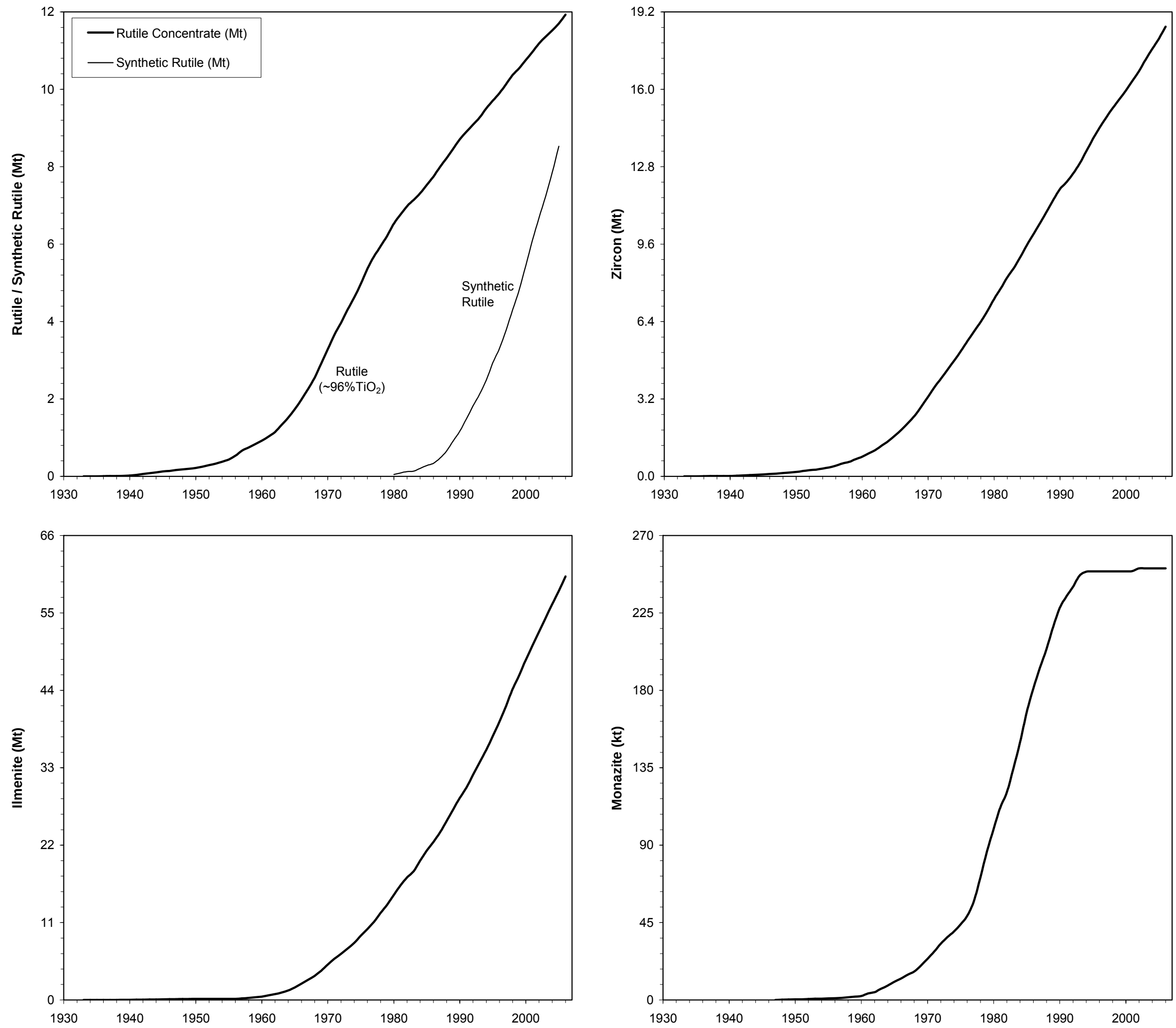


Figure 40 – Cumulative Australian Mineral Sands Production : Rutile, Ilmenite, Synthetic Rutile, Zircon and Monazite

6.4.4 Resources

In the early 1980's there was significant concern within the mineral sands industry that known mineable resources were only sufficient for approximately a further 20 years (Anderson, 1993). Continued and broad-ranging exploration has continued to both replace mined resources and increase overall resources. The data set for mineral sands resources is given by GA (var.) (without monazite) and is shown in Figure 41. The resources data for 1953 is from Raggatt (1953) while 1955 is from McLeod (1998).

As can be seen, Australian economic resources continued to increase significantly over the past decade, mainly related to recent exploration success in the Murray Basin. The economic resources, as of December 2006, of ilmenite, rutile and zircon, were 218.5, 21.7 and 33.9 Mt, respectively (2007 Edition) (GA, var.). Further sub-economic and inferred resources of ilmenite, rutile and zircon, were 174.9, 41.8 and 50.1 Mt, respectively (2007 Edition) (GA, var.). Of the economic ilmenite, rutile and zircon resources, 16.7, 16.3 and 24.2%, respectively, are classified as inaccessible to mining (eg. due to conservation or other land use restrictions). The 2006 production rates of ilmenite, rutile and zircon were 2,069, 232 and 492 kt/year, respectively, ensuring sufficient resources at present rates for at least 25 years.

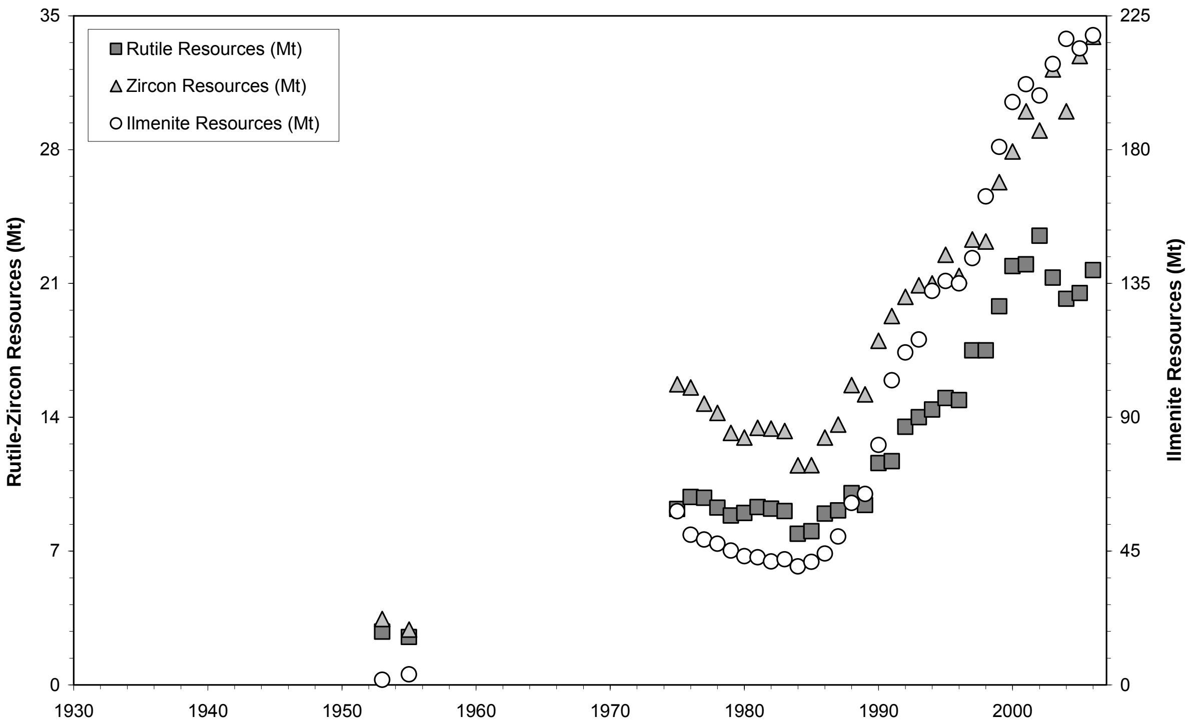


Figure 41 – Australian Economic Resources of Mineral Sands: Rutile, Ilmenite and Zircon

7. Results : Base-Precious Metals and Diamonds

7.1 Copper

7.1.1 Brief History

The copper mines of Australia hold an important place in mining history, as they were the first metal deposits to be discovered and worked on a significant and economic scale from 1842 – almost a decade before the gold rush began in 1851. The production of copper has been continuous ever since with Australia, as of 2007, maintaining an important and growing role in world copper production.

The 1840's saw several Cu discoveries in South Australia (SA) close to Adelaide at Kapunda, Montacute, and Burra followed in 1861 by the Moonta-Wallaroo field on the Yorke Peninsula. The first major copper project developed was Kapunda, which had been discovered in 1842 about 72 km north of Adelaide. The mine officially opened on 8 January 1844 and was critical in the early economic success of the fledgling colony of South Australia (Mumme, 1988). For the first five years the ore was transported by horse drays to port for shipment to Swansea in Wales, UK. The first smelter was erected at Kapunda in 1849 but was severely affected by the draw of labour to the Victorian gold fields in the early 1850's, though production of moderate quantities of high grade ore continued until 1879 (Dickinson, 1944; Drexel, 1982).

In October 1845, two roaming shepherds found high grade copper ore at Burra – a mine which within a few years was producing ore grading some 25% and contributing some 10-20% of world copper production (Bampton & Taylor, 2000; Dickinson, 1990). Burra was originally known as the "Monster Mine" due to its rich copper ore (Mumme, 1988). Smelters were built in 1849, and as the underground mine enlarged groundwater became an increasing problem. The use of open cut mining was first suggested by English mining engineer John Darlington, which, after considerable mine disassembly and re-construction, began in 1870 and operated until 1875 when underground mining was re-commenced (Dickinson, 1942; Drexel, 1982; Higgins, 1956). Increasing costs and low copper price forced the closure of Burra in 1877 – having produced about 240 kt of ore yielding an average 22% Cu for 52,400 t Cu and about 470 kt waste rock (Drexel, 1982; Johnson, 1965).

The dominance of SA in Australian copper mining, mainly from Burra and Kapunda but joined by other smaller projects such as Kanmantoo, Blinman and Bremer, took another major step forward in 1861 with the discovery of the Moonta and Wallaroo lodes on the Yorke Peninsula north-northwest of Adelaide. The mines brought significant economic prosperity to the region and state, providing the basis for a long-term copper mining and smelting industry which far exceeded the life of Burra and other first generation projects. The privately owned Moonta mine became the first mine in Australia to pay £1 million by 1876 – a major feat for its time (Drexel, 1982). In the mid-1800's, SA copper production were supplying about 10-20% of world copper demand (Bampton & Taylor, 2000; Dickinson, 1990). The Moonta-Wallaroo smelters, for a period of time, became the largest facilities of their kind in the world outside the Swansea smelters (Cumming & Drew, 1987).

The low Cu prices prevailing between 1875 to 1900 plus increasingly difficult mining conditions led to the closure of almost all mines except the Moonta-Wallaroo field, which merged their previously independent operations in 1889 to stay economic (O'Neil, 1982). The Moonta-Wallaroo field was hit by hard times during World War 1 and then decreasing resources, high labour costs, coal shortages and a depressed copper price, and was forced to finally close in 1923. The advances in ore treatment enabled the processing of previously considered waste as well as copper-rich tailings piles (Drexel, 1982). The total combined production by this time was estimated to be 9.1 Mt ore grading about 3.7% Cu for 336 kt Cu and minor gold and silver by-products (Flint, 1983).

The rise of Queensland as a copper-rich state began in the early 1860's with the development of the Peak Downs mine in 1862. From 1863 to 1867 some 100,000 t of ore grading 17% Cu were smelted, including some higher grade ore shipped to Swansea (Wales, UK) (QDM, 1953).

At the height of Peak Downs' success came the discovery of the extensive Cloncurry copper-gold field in north-west Queensland in 1867, and although it entered production quickly it soon failed to deliver on its potential. The Cobar field in north-west New South Wales was discovered in 1870 and soon began to grow in importance. Both the Cloncurry and Cobar fields faced the tyranny of distance, want of capital and a thirst for water – key factors in their early rise and eventual fall (eg. Brooke, 1975; Brooks, 1990), though Cobar outlasted the Cloncurry field in its first period of major mining activity.

The late 1800's saw increasing pressure on all copper mines and fields, leading to some major structural changes emerging (Brown, 1908; Carne, 1908). The prolonged depressed Cu price forced the closure of many smaller mines, leaving only large companies and fields surviving. Another major issue was the exhaustion of the rich oxidised ores and the need to process and smelt the more abundant but lower-grade sulphide ores. By the 1890's, both the Moonta-Wallaroo and Cobar fields had declined in ore grade to ~4-5% Cu. This created serious challenges for the industry, which worked even harder to maintain production. A major aspect of their success in this regard was the increasing mechanisation of the mines and smelters.

There was minor copper production from Western Australia and the Northern Territory from the 1880's to the early 1900's, though the remoteness and harsh environment prevented any significant scale emerging.

The Cobar field sustained production to about 1920, when depressed copper prices forced the closure of virtually the entire field. The principal producer was the Great Cobar, which produced 4.15 Mt of ore to yield about 115 kt Cu or ~2.8% Cu (pp 16) (Kenny, 1923). Other producers included Nymagee (24.8 kt Cu), Chesney (6.15 kt Cu), New Cobar (5.15 kt Cu) and numerous smaller mines of 2-3 kt Cu each (Kenny, 1923) (see appendix). A period of gold production occurred between 1935 to 1952 with minor copper production.

The period 1890 to 1910 saw two major developments – the opening of the Mt Lyell copper-silver-gold field in western Tasmania in 1894 and the conversion of the Mt Morgan gold mine in central coastal Queensland to a significant gold-copper producer in 1906. The development of these two large projects spear-headed the new era of increasing mechanisation in copper mining and smelting.

The Mt Lyell field created a number of important milestones in copper smelting as well as the Australian mining industry (see Blainey, 2000). Initially there were two principal mines on the field – the 'Iron Blow' mine of the Mt Lyell company and the North Lyell mine and company. Firstly, the Mt Lyell directors had employed talented American metallurgist Robert Carl Sticht, whose studious direction made the Mt Lyell mine the first in the world to successfully smelt the ore using the native pyrite within it – no coke or smelter charge was necessary. This had been the dream of European and other metallurgists for some centuries. Secondly, the Mt Lyell project was the first mine in Australia to successfully use large-scale open cut mining techniques – although trialled previously at Burra, the scale at Mt Lyell, even for the flux quarries for the smelters, was considerable in all respects. Thirdly, the Mt Lyell project required vast transport, energy and township infrastructure – including the first Abt rack-and-pinion railway system built in Australia to allow navigation across the steep and rugged terrain.

Fourthly, there has perhaps been no other corporate battle over mining rights and shareholder interests as that between the two Irishmen Bowes Kelly and James Crotty. The contest became so bitter that Crotty's North Lyell company even replicated the construction of a railway at a substantive capital cost to transport its own products and requirements. The battle finally ended in 1903 when the two companies merged to create the dominant Mt Lyell Mining and Railway Company Ltd – which within a few years proved to be the financial saviour of both mines as Mt Lyell had better management and infrastructure but dwindling reserves and grades while North Lyell had strong grades and reserves but very poor financial management and infrastructure.

Fifthly, Mt Lyell again led the development of even larger open cut mining with the development in 1935 of the West Lyell open cut (which closed in 1974). Finally, the environmental impacts of the Mt Lyell field have been extensive (see Koehnken, 1997) – trees cut down for timber support and use in the smelters made the surrounding landscape bare, with the smelter in turn producing acid rain from sulphur dioxide emissions which sterilised the soil and allowed erosion. The surrounding environment now resembles a desert scape in the midst of what was once dense forest. The discharge of tailings and waste rock, which leach significant quantities of acid mine drainage into the Queen and King Rivers, has also led to the severe biological impacts reaching the marine ecosystems of the Macquarie Harbour. There are very few mine sites across Australia, if any, which can boast the extent of environmental impacts as Mt Lyell.

Remarkably, the Mt Lyell field has been in virtually continuous production since 1894, and by June 2006 had produced some 137.8 Mt of ore grading about 1.2% Cu, 5 g/t Ag and 0.31 g/t Au to produce ~1.52 Mt Cu, ~650 t Ag and ~40 t Au with more than 45 Mt of waste rock (see appendix). Perhaps just as remarkable is that known ore reserves are still estimated at ~30 Mt grading 1.34% Cu and ~0.3 g/t Au (see appendix). A 1992 assessment of potential ore available argued some 396 Mt at 0.6% Cu could be present, containing about 2.4 Mt Cu – or some 1.5 times the total copper production to date (pp 21, 1992 Edition) (TDM, var.).

The rich Mt Morgan Au-Cu mine utilised a mixture of underground and open cut mining. Mt Morgan faced a strenuous decade in the 1920's as economic problems coupled with a major fire destroyed the mine in 1925. Mt Morgan was re-developed as a dedicated large-scale open cut operation in 1931, remaining in production until 1982 with tailings re-processing until 1990 (Parbo, 1992). The total production from Mt Morgan was 50 Mt of ore grading 5.3 g/t Au and 0.85% Cu to yield 243 t Au, 50 t Ag and 374 kt Cu, with waste rock of about 100 Mt (see appendix). Similarly to Mt Lyell, Mt Morgan has caused significant environmental impacts on the adjacent Dee River due to acid mine drainage (Sullivan *et al.*, 2005).

The twentieth century continued to produce major new copper deposits, especially towards the last two decades. Until Mt Isa started production in 1953, most copper was produced as a co-product with gold and/or silver at Mt Lyell, Mt Morgan and the Cobar field. A major trend throughout the latter half of the twentieth century was the use of open cut mining and the gradual declining of average copper grades of ores milled. Most recent copper projects have also been associated with gold and/or silver production. Some major lead-zinc-silver projects have also produced copper as a by-product (eg. Captain's Flat, Rosebery, Woodlawn).

A chronology of major copper mines in the twentieth century includes :

- 1903 – amalgamation of the companies on the Mt Lyell field to form a single company – Mt Lyell still remained operating in 2007;
- 1906 – the Mt Morgan gold mine starts copper production (almost continuously until 1982);
- 1943 – Mt Isa switches to Cu production for the remaining war years, soon followed by larger operations from 1953 (alongside existing Pb-Zn-Ag operations);

- 1948 – Discovery and development of various copper deposits in the Tennant Creek gold field, central Northern Territory;
- 1964 – CSA Cu-Ag mine in the Cobar field is re-developed into a major producer (including small by-products of lead and zinc);
- 1970's – old mines in South Australia are re-mined, such as Kanmantoo, Burra and Mt Gunson, based on bulk mining from open cuts and lower ore grades, and some additional ore discovered through further exploration (eg. Cattle Grid deposit at Mt Gunson);
- 1988 – Olympic Dam Cu-U-Au-Ag project, northern SA, is bought on-stream;
- 1990's – Re-development of the many small to moderate scale copper mines across the Clonclurry copper field, including major new mines at Osborne (underground/open cut, 1995), Gunpowder-Mammoth (underground/open cut), Eloise (underground, 1996), Ernest Henry (open cut, 1997);
- 1993 – Nifty, east of the Pilbara region in northern WA, starts production;
- 1994 – Northparkes Cu-Au open cut/underground mine commences in central NSW;
- 1998 – Cadia Hill Cu-Au open cut mine commences in central NSW;
- 2000 – Ridgeway Cu-Au underground mine, adjacent to Cadia Hill, commences.

The discovery of the giant Olympic Dam deposit in 1975 by Western Mining Corporation (WMC) heralded a previously unrecognised style of mineral deposit, that of iron oxide copper-gold or 'IOCG' deposits, and has enabled a major advance in mineral resource exploration. The Olympic Dam deposit is also highly unusual in its metal association consisting of Cu, uranium (U), Au, Ag and rare earths. Significant greenfields Cu deposits are still being discovered (eg. Prominent Hill, SA), though most known Cu resources are lower grade than current operations, broadly average around 1% Cu or lower and are, at present, commonly proposed as open cut mines (see next sections).

By 2006, Australia had produced 18.73 Mt Cu, of which 12.11 Mt Cu (64.6%) was produced from 1985 to 2006.

The prospects for the current scale of the Australian copper industry to continue remain promising, with significant new deposits still being discovered (eg. Prominent Hill, SA, west of Olympic Dam, and more recently Carrapateena, SA, south-east of Olympic Dam). Although Australia remains a moderate producer in world terms, some Australian companies have significant interests in major world mines, such as BHP Billiton's (57.5%) and Rio Tinto's (30%) interest in Escondida, Chile, BHP Billiton's Tintaya project, Peru (recently sold to Xstrata Ltd), Rio Tinto's 100% of Bingham Canyon in Utah, USA and minority interest (~30%) in the Grasberg-Freeport project in West Papua, amongst several others.

A map of Australia's past, present and potential copper projects is shown in Figure 42.

7.1.2 Major Provinces

The major copper provinces of Australia continue to be (Figure 42) :

- Mt Isa-Clonclurry belt, western QLD;
- Cobar field, central northern NSW;
- Parkes field, central NSW;
- Gawler Craton-Stuart Shelf region, central northern SA;
- Paterson Province, northern WA;
- Mt Lyell field, north-western TAS.

Figure 42 – Location of Major Australian Copper Projects and Fields

7.1.3 Production

The data for copper mining is generally widely available for the twentieth century, but generally quite variable for the nineteenth century. The principal data sources and references for all copper mines or fields, as well as significant copper by-product projects, are included in their respective table in the appendices.

Overall, the data for ore milled and copper production, as well as by-products or co-products, is readily available. However, there is not consistent reporting of waste rock data and assay grades of ore milled. In general, data until about 1950 is yield only (corrected to assay grade with recovery efficiency if possible), with most mines since this time generally reporting assay data[21]. The data compiled has allowed the proportion between underground and open cut mining to be calculated.

[21] The exception being the Tennant Creek field, where only the copper yield is most often reported. Where possible, based on some limited years of assay grades, corrections have been applied to estimate true grades in the master data sets (see Tennant Creek tables in the Appendix).

Base metal projects with a significant copper production have been included in the overall data set, as they have been an important source of copper supply throughout the twentieth century. Although a degree of judgement was required here, this has been decided on the basis of grades (eg. >0.2% Cu) and/or production (eg. >250 t Cu). For example, although Broken Hill has been a major producer of Cu it has not been included in master totals since the ore grade is low (~0.1% Cu) and the Cu is only extracted as a consequence of the Pb-Zn-Ag already having been mined and concentrated (Hellyer has also been excluded). In this case, the proportion of estimated Cu production to reported Cu production has been adjusted to allow for the minor source of Cu from such mines.

In general, most Cu producers have been largely operated as a single mine type, either open cut or underground, with very few operating a mixed regime. The estimate for open cut mining in the 1870's, during the trial at Burra, is an over-estimate since there is a major lack of mining-milling data for Cu mining around this period. Additionally, the proportion of Cu derived from open cut mining is presented using both the percentage of ore and the percentage of Cu, showing the generally lower grade nature of open cut mines.

For waste rock, an excellent history of reporting of data for Mt Morgan exists from 1903 to 1982 (QDM, var.). Waste rock data for Mt Lyell has also been reported by BMR (var.) and TDM (var.), though virtually no data was reported prior to 1943. An early estimate of waste rock for Mt Lyell in 1902 suggested a ratio of 2.2 waste:ore (MLMRCL, 1902). There are only some copper projects for which waste rock data is available since 1975, namely Cadia, Ernest Henry, Mt Gunson, Poona, Red Dome, Rum Jungle (and the Olympic Dam underground mine), with varying degrees of completeness. Occasional data is available for Burra, Nifty, and several smaller copper projects. Combined these mines represent a significant portion of copper production though not all open cut copper projects, leaving the true extent of waste rock production under-represented in the master data set. The production data is shown in Figures 43 to 47. The estimate of calculated versus reported copper production, Figure 45, shows generally greater than 90% of reported production from about 1890 onwards.

A compilation of the most significant copper projects to date in Australia is shown in Table 7, with significant copper by-product projects shown in Table 8. Detailed tables of individual projects with complete references for major projects and including smaller to moderate scale copper mines are given in the appendix. Overall copper production is dominated by Mt Isa, Olympic Dam and Mt Lyell, the only deposits to date which have produced more than one million tonnes of copper, and together account for 56.4% of Australian copper by 2006.

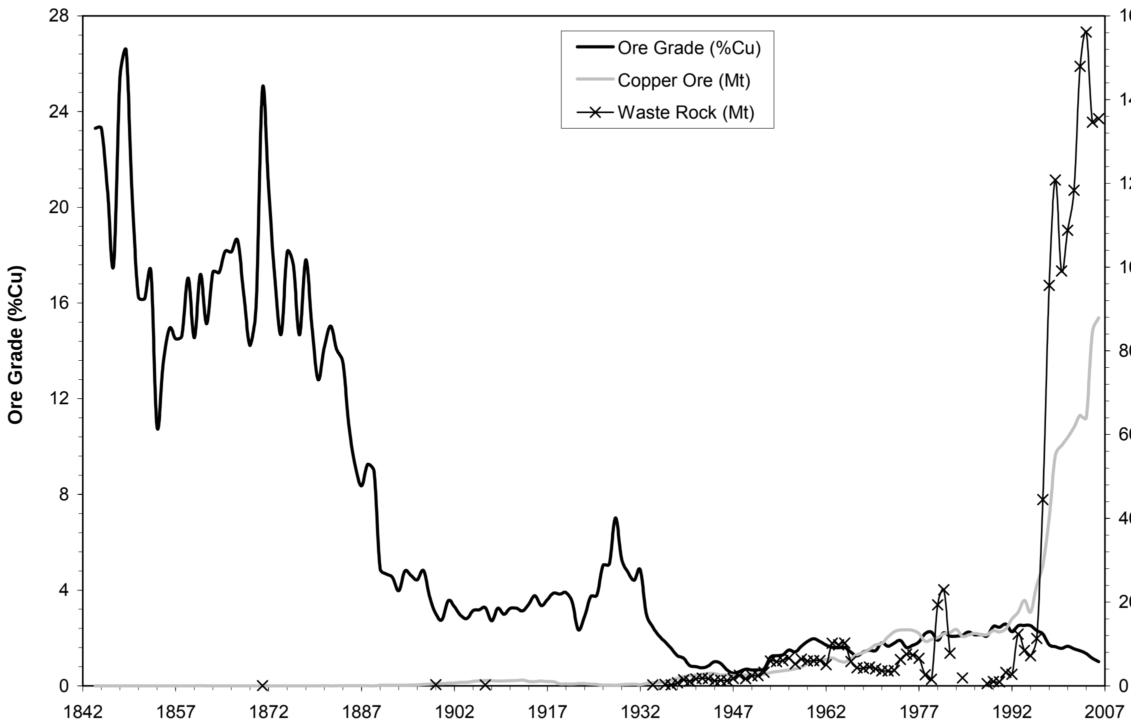


Figure 43 – Copper Ore Grades, Ore Milled and Waste Rock (minimum reported)

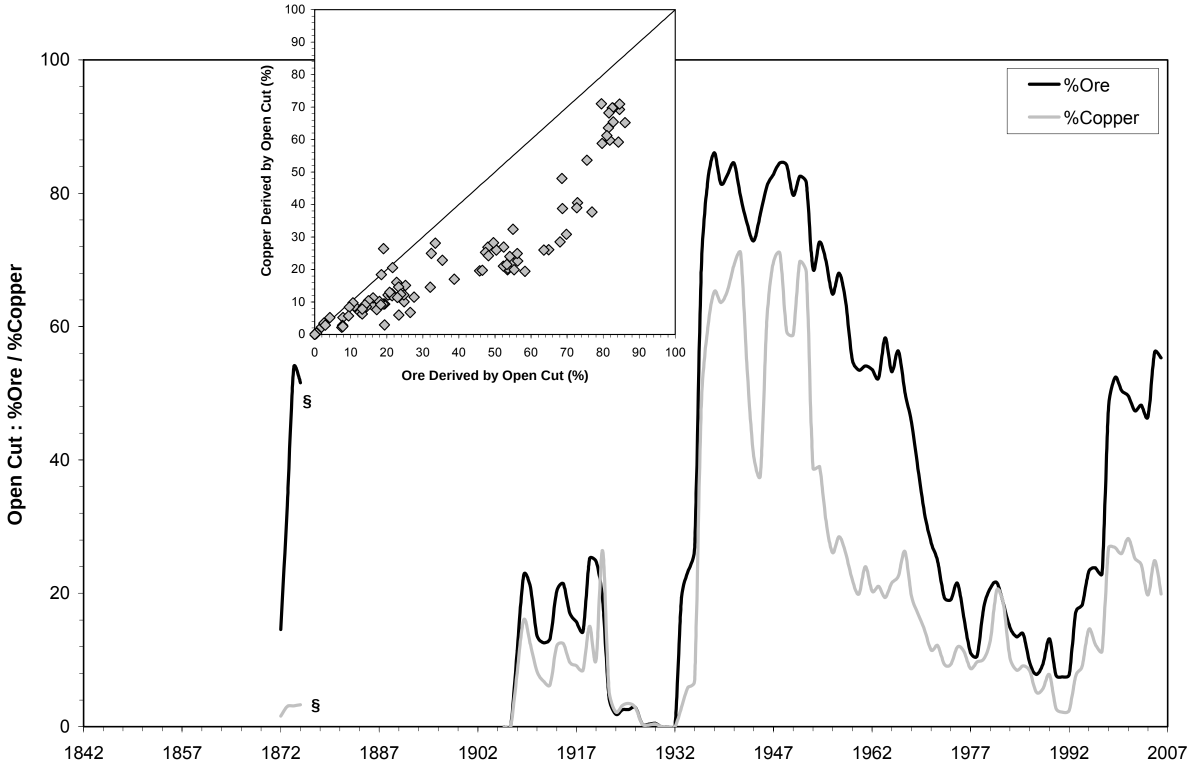


Figure 44 – Open Cut Copper Mining : %Ore and %Copper

§ This is a significant over-estimate since there is only minimal data for mining around this period; assuming typical ore grades around this period (say ~15% Cu), this would give a percentage of open cut ore around this period of about 3-4% in line with percentage of copper produced by open cut).

Table 7 – Significant Australian Copper Projects (>25 kt Cu)

Mine / Field	Principal	Metals	Mine	%Open	Ore	Ore Grades			Production			Waste
(map reference)	Period	Extracted	Type	Cut (ore)	Milled (Mt)	%Cu	g/t Au	g/t Ag	kt Cu	t Au	t Ag	Rock (Mt)
Mt Isa (Cu)	1943-2006[#]	Cu	UG	<4	220.9	3.27	-	~4	6,895	-	»321	»12.2[a]
Olympic Dam[b]	1988-2006[#]	Cu-U-Ag-Au	UG	-	94.48	2.57	~0.55	~5.9	2,140	28.12	279.1	»11
Mt Lyell[c]	1894-2006[#]	Cu-Ag-Au	UG/OC	~46	137.8	~1.2	~0.31	~5	1,519[c]	~39[c]	~646[c]	»45
Ernest Henry	1997-2006[#]	Cu-Au	OC	100	93.94	1.12	0.55	-	936.5	35.93	-	~484
Cobar-CSA[d]	1911-2004[#]	Cu-Ag-Pb-Zn[d]	UG	-	25.38	2.62	-	~23	645.9	-	~383	no data
Northparkes	1994-2006[#]	Cu-Au	UG/OC	no data	56.62	1.17	0.55	~1.7	572.0	22.72	-	no data
Osborne	1995-2006[#]	Cu-Au	UG/OC	~7.2	16.91	2.9	1.0	-	465.1	13.39	-	~22.8
Mt Morgan	1883-1990	Cu-Au	OC	~90	49.74	0.85	5.29	~1	374	242.6	»45	~100
Tennant Creek Field[e]	1948-1999	Cu-Ag-Au	UG	minor	12.32	3.26	4.85	~5.5	361	46.25	~61.2	no data
Gunpowder-Mt Gordon	1970-2006[#]	Cu	UG/OC	~45	~8.83	~4.34	-	-	~351.3	-	-	»17
Moonta-Wallaroo	1860-1923	Cu	UG	-	~9.1	3.7	~0.34	~0.56	336	~1.7	~2.7	no data
Cadia Hill	1998-2006[#]	Cu-Au	OC	100	137.19	0.19	0.72	-	219.0	72.26	-	407
Ridgeway	2000-2006[#]	Cu-Au	UG	-	27.15	0.89	2.55	-	218.5	59.36	-	no data
Nifty	1994-2006[#]	Cu	OC/UG	~95.7	~17.0	~1.85	-	-	~208.7	-	-	»46
Highway-Reward	1998-2005	Cu-Au-Ag	OC/UG	~62	3.72	5.56	~1.0	~11.5	187.6	~1.02	~18.84	~50
Cobar Field[f]	1869-1961	Cu-Au-Ag	UG	-	7.60	2.39	~2.1	»0.1	186.2	15.79	»0.41	no data
Selwyn Field	1989-1998	Cu-Au	UG/OC	~20	~8.5	~2.0	~3.4	-	~156	~26	-	no data
Clonclurry Field[f]	1867-1981	Cu-Au-Ag	UG/OC	minor	~1.43	10.4	-	-	148.0	-	-	no data
Eloise	1996-2004	Cu-Au-Ag	UG	-	3.723	4.05	1.05	~12	143.0	2.38	~41.6	no data
Mt Gunson-Cattlegrid	1898-1994	Cu-Ag-Au	OC	~100	~9.0	~1.7	-	~8.3	~142.4	0.452	63.25	»40
Girilambone	1993-2002	Cu	OC	100	10.1	1.4	-	-	115.1	-	-	~20
Burra	1845-1983[§]	Cu	OC/UG	~90	2.35	~3.8	-	-	92.4	-	-	~5.3
Horseshoe Lights	1988-1994	Cu-Au	UG/OC	no data	2.49	3.35	no data	-	69.7	no data	-	no data
Kanmantoo	1846-1976[§]	Cu	OC	~99	4.15	~1.0	-	~2	~42	-	-	~24

[#] Still operating at year's end. [§] Production not continuous. [a] This is from mining of the Black Rock open cut only (mainly 1957 to 1965); no waste rock from underground mining reported. [b] see U data (Table 5). [c] Production based on annual data; some confusion exists between contained and extracted metals. [d] See Pb-Zn-Ag data (Table 14). [e] Includes Peko, Orlando, Ivanhoe, Juno, Warrego and Gecko mines. [f] Includes Great Australia and nearby small mines. [g] Includes Great Cobar, Queen Bee, Chesney, Nymagee, Mt Hope, Gladstone, Burraga, New Cobar, Budgerygar, and other small mines (Au-Ag grades and production approximate only). Note : By/co-product from Cu-Zn-Ag and Pb-Zn-Ag mines/fields can be seen in Tables 8 (and 14).

Table 8 – Significant Australian Co/By-Product Copper Projects

Mine / Field	Principal Period	Primary Metals	Ore Mt	Grade %Cu	Prod. kt Cu	Other Metals
Broken Hill, NSW	1883-2006[#]	Pb-Zn-Ag	205.2	~0.1	~230.1	Au
Woodlawn, NSW	1979-1998	Pb-Zn-Ag	14.58	~1.7	174.1	Au
Golden Grove, WA	1991-2006[#]	Cu-Zn-Ag	16.84	~2.2	~180.3	Au
Rosebery, TAS	1936-2006[#]	Pb-Zn-Ag	29.02	~0.50	106.3	Au
Thalanga, QLD	1989-1999	Pb-Zn-Ag	4.93	1.91	69.5	-
Kambalda, WA	1967-2005[#]	Ni	~43.1	~0.23	»61.3	Co
Teutonic Bore, WA	1981-1985	Cu-Zn-Ag	1.44	3.68	51.4	-
Benambra, VIC	1992-1997	Cu-Zn-Ag	0.96	5.99	48.9	-
Herberton-Chillagoe, QLD	1883-1943	Pb-Cu-Ag	0.90	4.63	41.6	Au
Peak, NSW	1992-2006[#]	Au	8.19	0.68	38.0	Pb-Zn
Captain's Flat, NSW	1939-1962	Pb-Zn-Ag	4.01	0.64	19.0	Au
Hellyer, TAS	1985-1999[§]	Pb-Zn-Ag	14.92	~0.2	~12.7	Au

[#] Still operating at year's end. [§] Hellyer is likely to be re-developed for tailings reprocessing during 2007.

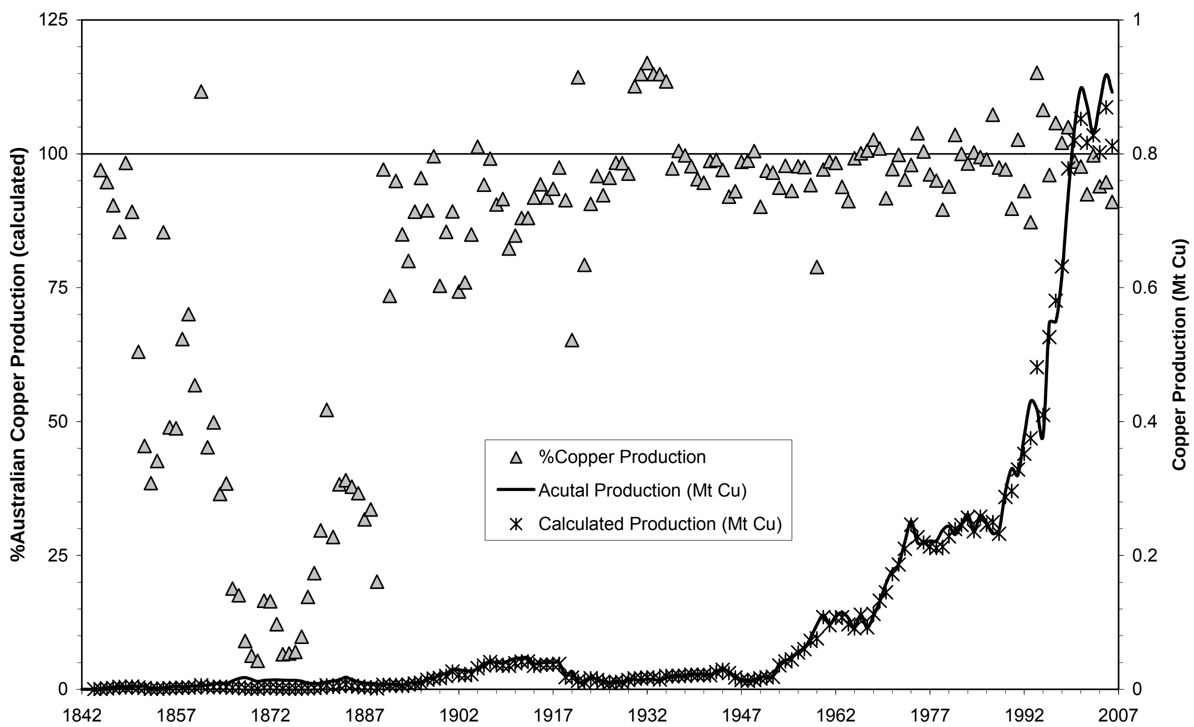


Figure 45 – Calculated versus Actual Australian Copper Production

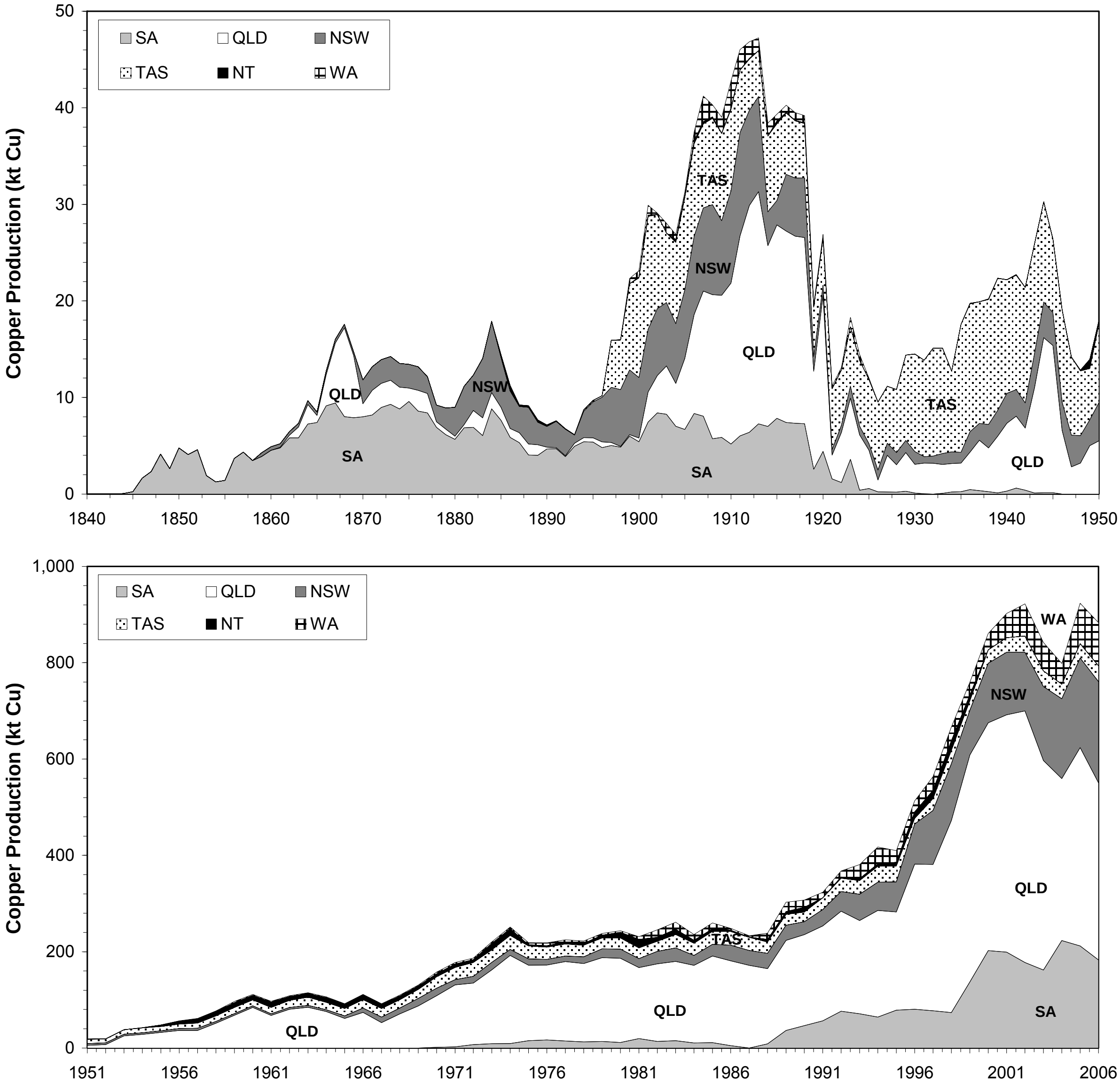


Figure 46 – Australian Copper Production by State (excluding Victoria)

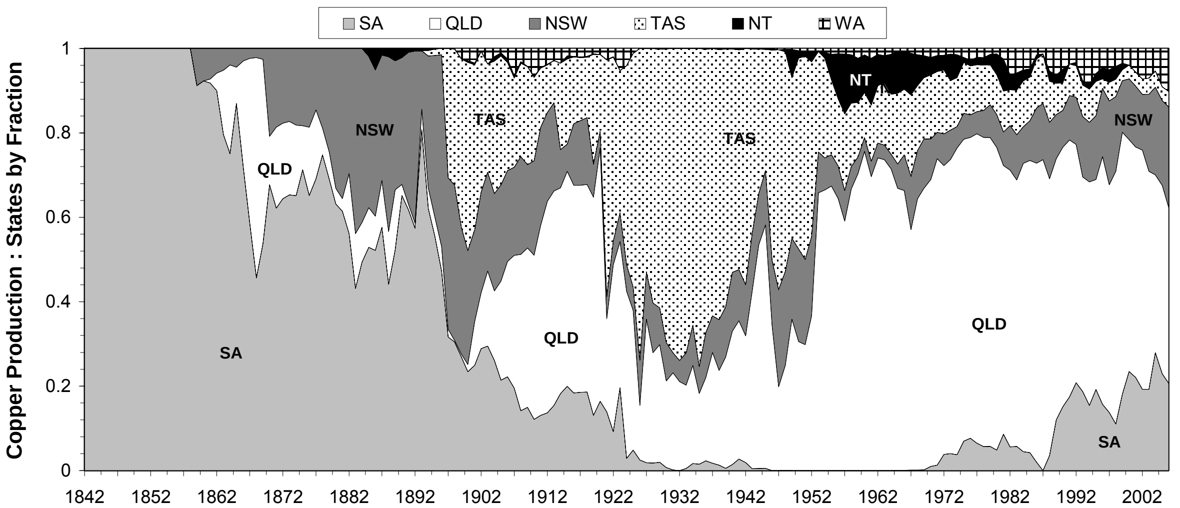


Figure 47 – Australian Copper Production by State Fraction (excluding Victoria)

7.1.4 Resources

The economic copper resources of Australia have been compiled from early mining and geology publications as well as more recent data, specifically :

- 1914 – economic history analysis (Schmitz, 1986);
- 1953 to 1975 – BMR data from Elliott (1977);
- 1948 to 1987 – BMR data (BMR, var.);
- 1948 to ~1985 – State Department of Mines data (annual reports, etc);
- ~1948 to ~2005 – numerous individual mining company annual reports;
- 1975 to 2006 – GA data (GA, var.).

The economic copper resources over time are shown in Figure 48, including Australian and world production. Additionally, the combined ore grade of the resource is presented, when available from the various references. As can be seen, production has increased commensurate with additional resources being discovered and mined. Importantly, as noted previously, significant new copper deposits continue to be discovered in Australia combined with notable additions to resources at existing copper deposits (eg. Olympic Dam). A table of major copper deposits is compiled in Tables 9 and 10 below, based on recent company announcements and reports. Some deposits or prospects are not formally classified as economic based on JORC methods, however, they are being actively evaluated and further drilled by their respective companies with a view to a potential economic project and hence provide a useful addition to existing projects. The estimated total resource of 66.3 Mt Cu is considerably higher than the GA estimate of 42.4 Mt Cu, largely due to the inclusion of all Olympic Dam resources – which is 44.4 Mt Cu alone – and other prospects as noted above.

Overall, given 2006 production of 892 kt, known economic resources of 42.4 Mt and constant production, there is sufficient for another 50 years though it is clear that this will be from copper ore moving towards 1% Cu or lower.

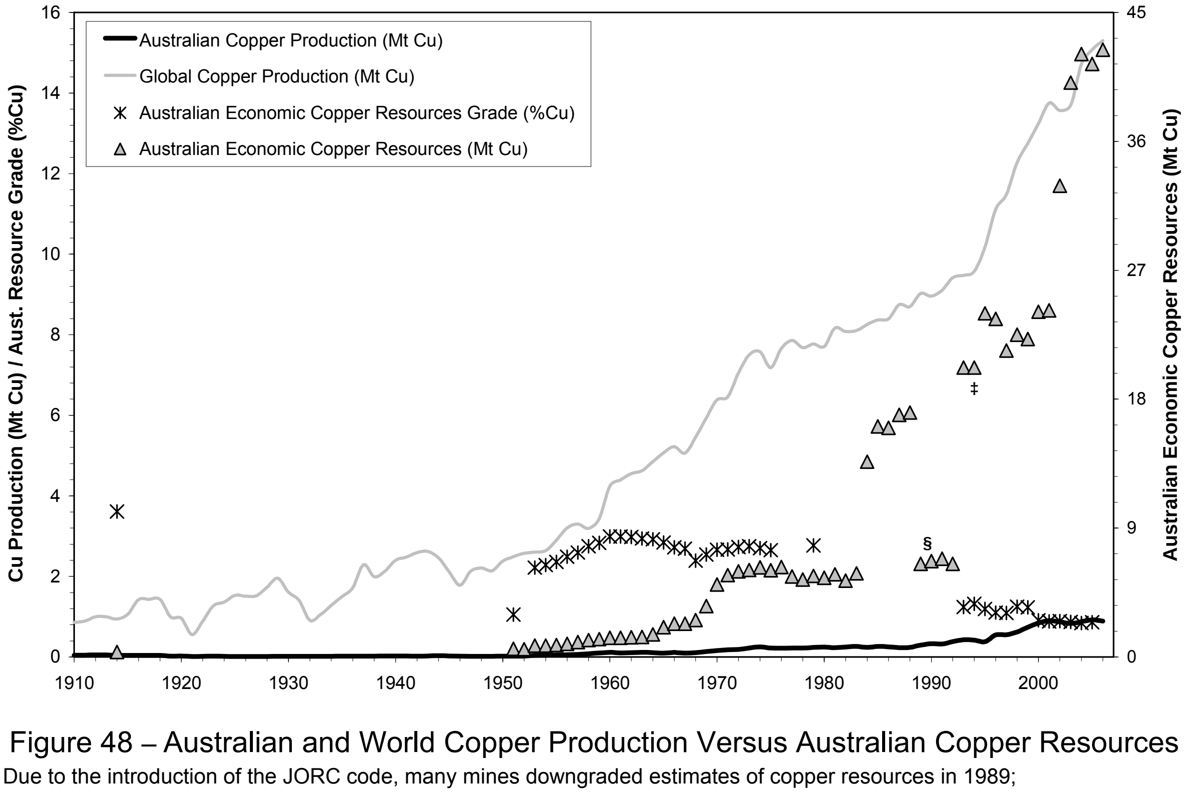


Figure 48 – Australian and World Copper Production Versus Australian Copper Resources

§ Due to the introduction of the JORC code, many mines downgraded estimates of copper resources in 1989;

‡ Following further drilling at Olympic Dam and Northparkes plus the discovery of Ernest Henry, copper resources were subsequently increased in 1993 (see GA, var.).

Table 9 – Australian Copper Resources and 2005 Production by Operating Project

Project/ Deposit	Mine Type	2005 Prod. kt Cu	Resources					
			Ore Mt	%Cu	kt Cu	Other Metals	Date	Reference
Olympic Dam	UG [§]	211.7	3,970	1.1	43,700	U-Ag-Au	June 2005	BHPB (var.)
Mt Isa	UG	177.5	172	2.6	4,550	Ag[a]	June 2005	Xstrata (2006)
Ernest Henry	OC	129.0	71	1.0	710	Au	June 2005	Xstrata (2006)
Northparkes	UG/OC	54.0	66.4	1.05	697	Au	Dec. 2005	RT (var.)
Telfer	OC/UG	43.2	514	0.18	925	Au	June 2005	Newcrest (var.)
Ridgeway	UG	42.3	73	0.62	453	Au	June 2005	Newcrest (var.)
Cobar-CSA	UG	39.7[b]	15.4	4.01	618	Ag	July 2002	RIU (var.)
Osborne	UG/OC	39.5	8.90	2.27	202	Au	Dec. 2005	RIU (var.)
Mt Lyell	UG	27.7	29.42	1.37	403	Ag-Au	March 2005	TDM (var.)
Cadia Hill	OC	24.5	281	0.17	478	Au	June 2005	Newcrest (var.)
Golden Grove	UG	23.1	14.94[c]	1.9[c]	284	Zn-Ag-Au	Dec. 2005	Oxiana (var.)
Tritton	UG	19.3	13.6	2.5	340	-	Dec. 2005	Straits (var.)
Nifty	OC/UG[d]	16.9	41.5	2.7	1,120	-	Dec. 2005	ABML (2006)
Whim Creek	OC	8.7	14.4	0.8	115	-	Dec. 2005	Straits (var.)
Sally Malay	OC/UG	3.9	3.331	0.74	24.6	Ni	June 2005	SMM (var.)
Mt Garnet	OC	3.0	30.89	~0.7	216	Pb-Zn-Ag-Au	June 2005	KZ (var.)
Peak[#]	UG	2.5	3.82	0.75	28.7	Au	Dec. 2005	Goldcorp (var.)
Mineral Hill[#] *(closed)*	UG	2.4	0.378	2.7	10.2	Au	June 2005	Triako (var.)
Rosebery	UG	1.7	6.46	~0.44	28.4	Pb-Zn-Ag-Au	March 2005	Zinifex (var.)
Mt Gordon	UG/OC	-	17.6	2.9	510	-	Dec. 2005	ABML (2006)
Eloise *(closed)*	UG	-	1.45	4.06	58.9	Au	April 2006	RIU (var.)
Selwyn *(closed)*	UG/OC	-	15.6	1.09	170	Au	June 2002	RIU (var.)
	Sub-Total		**5,365**	**~1.03**	**55,642**			

[#] Primarily gold projects with copper as an important by-product (or major product, eg. Mineral Hill).

[§] Despite the depth to ore at Olympic Dam (some 350 m), there is active investigation by BHP Billiton Ltd at present in converting to an open cut to take better advantage of the full scope of these known ore resources.

[a] Silver is recovered from the copper anode slimes at Mt Isa, but is generally not reported due to its relatively low revenue.

[b] 2004 production only.

[c] Golden Grove resources are total for all ore types.

[d] Nifty was converted to an underground mine in 2006.

Table 10 – Australian Copper Resources by Proposed Projects

Project/ Deposit	Proposed Mine Type	Resources					
		Ore Mt	%Cu	kt Cu	Other Metals	Date	Reference
South Australia							
Prominent Hill	OC	100.5	1.47	1,481	Au-(U)	Dec. 2005	Oxiana (var.)
Kalkaroo	OC	70	0.47	329	Au-Mo	June 2005	Havilah (var.)
Kanmantoo	OC	25.37	1.0	254	Au	April 2006	Hillgrove (var.)
Queensland							
Mt Isa[§]	OC	277	1.2	~3,300	-	June 2005	Xstrata (2006)
Ernest Henry[§]	UG	44	1.4	637	Au	June 2005	Xstrata (2006)
Roseby	OC	123.2	0.73	906	-	June 2006	UR (var.)
White Range[†]	OC	24.17[†]	~1.1[†]	~255[†]	-	June 2005	MM (var.)
Lady Annie[‡]	OC	19.25[‡]	~0.9[‡]	~168[‡]	-	Oct. 2006	CopperCo (var.)
Einasleigh	OC	6.5	0.6	39	-	early 2006	RIU (var.)
Mt Oxide	OC	2.81	2.9	81	-	June 2004	RIU (var.)
E1/Mt Margaret	-	7.93	1.11	88	-	June 2005	RIU (var.)
Mt Chalmers	-	3.56	1.2	43	Au	March 2005	RIU (var.)
New South Wales							
Cadia East	UG	530	0.33	1,758	Au	June 2005	Newcrest (var.)
Peak Hill	UG	11.27	0.11	12.4	Au	June 2005	Alkane (var.)
Copper Hill	OC	105	0.33	344	Au	May 2006	GCR (var.)
Girilambone North	UG	1.1	2.0	22	-	Dec. 2005	Straits (var.)
Western Australia							
Boddington[#]	OC	344	0.103	356	Au	Dec. 2005	Newmont (var.)
Maroochydore	OC	51.4	1.0	514	Co	Dec. 2001	Straits (var.)
Coppin Gap	OC	102	0.152	155	Mo	~1990	Jones (1990)
Northern Territory							
Redbank	OC	4.23	1.5	64	-	May 2006	RIU (var.)
	Sub-Total	**1,853**	**~0.58**	**10,806**			
	Total	**7,216**	**~0.92**	**~66,300**			

[§] Resources based on extensions through conversion from existing mine to proposed mine (eg. Mt Isa UG to OC; Ernest Henry OC to UG).
[#] Primarily gold projects with copper as an important by-product (or major product, eg. Mineral Hill).
[†] Includes White Range, Mt Watson and Mt Cuthbert.
[‡] Includes Lady Annie, Mt Clarke, Flying Horse and Swagman.

7.2 Gold

7.2.1 Brief History

There is perhaps no other industrial endeavour that has had such a profound effect on the Australian nation as gold – economically, socially, environmentally and politically. Although there had been numerous observations of the presence of gold in many parts of eastern Australia before 1850, they were not considered of any consequence by their discoverers. The great Californian gold rush, which started in 1849, created a sudden and intense interest in gold in Australia. In February 1851 near Bathurst, west of Sydney, gold was found in payable quantities : Australia's golden age had begun. Prospecting greatly accelerated and gold was found in central Victoria by July 1851. By the end of 1851, the rush was in full swing and gold was flowing freely throughout the Victorian and New South Wales colonies. For many of the following decades, continuing cycles of boom and bust have characterised the gold industry across Australia, involving wars, depressions and difficult markets. Numerous books and monographs tell the story of the 1850's gold rush and its progression throughout Australia into the early 1900's. Only a brief history is given herein for completeness in reference to the production and resources data, thereby enabling key events to be discerned.

The principal sequence of economic gold fields being discovered and confirmed in various states is :

- 1851 – *February* – New South Wales (Ophir-Bathurst) (Woodall, 1990);
- 1851 – *July* – Victoria (Clunes) (Annear, 1999);
- 1852 – *August* – South Australia (Echunga) (Horn & Fradd, 1986);
- 1852 – Tasmania (Mangana) (Nye & Blake, 1938);
- 1867 – Queensland (Gympie) (Parbo, 1992);
- 1870 – Northern Territory (Pine Creek) (Ahmad *et al.*, 1999);
- 1885 – Western Australia (Kimberley) (Maitland, 1900).

The first Australian gold discovery which led to actual mining operations is believed to be the Victoria mine (originally mined for copper), about 18 km north-east of Adelaide (Horn & Fradd, 1986). It was discovered on 4 April 1846 but quickly proved disappointing, only producing 0.75 kg (or 24 oz[22]). Although numerous other occurrences around south-eastern Australia had been reported by the end of 1850, like the Victoria mine, they had been of little significance (or this was missed) and did not attract economic attention.

The scale of the 1850's gold rush across Australia was immense. For example, between 1851 to 1860 about 40% of world gold production came from Australia, principally Victoria and New South Wales (Campbell, 1965). Almost all of this production came from alluvial and near surface prospecting. This led to the influx of immigrants from all over the world to the Australian gold fields, causing a major and sustained rise in the total population. The fields were the centres of emerging prosperity and helped to forge many regional towns and economic centres, many of which survived long after the fields lost their productivity.

Over the decade 1851 to 1860, Australian gold production for 1851 was 9.9 t Au (320,000 oz), soared to 86.4 t Au in 1852 and 96.3 Au t in 1853 and remained stable around 80-90 t Au/year until 1858. Peak production occurred in 1856 of 96.5 t Au.

The peak production from the easily won surface gold (alluvial) occurred in 1858 and fell rapidly after this time, with the gold industry then shifting extraction to hard rock mines, primarily quartz reefs (Bowen & Whiting, 1975; Raggatt, 1968). This led to the creation of mining syndicates and companies to cope with the rapidly increasing scale and challenges of individual mines (Fahey, 2001; Woodland, 2002).

[22] For gold, all units have been converted to the metric system. For example, 1 t = 32,150 ounces or 1 ounce = 31.1 grams.

This change allowed relatively steady gold production for a period, especially from the major fields of central Victoria, though with increased labour and processing requirements (eg. batteries). At the turn of 1890, however, Queensland had caught up to Victoria, which by then had begun a gradual decline.

This early period of gold production, as well as the social benefits, also saw some severe events such as the Eureka Stockade rebellion at the Ballarat gold field in December 1854 and anti-Chinese riots in some places (eg. Clunes, VIC; Lambing Flat and Burrangong, NSW).

Australian gold production gradually declined towards the late 1800's until the discovery of the rich Coolgardie and Kalgoorlie fields in Western Australia in 1892 and 1893, respectively. At this time production rose from around 40 t Au/year over 1889-1892 to reach a new record high of 119.4 t Au by 1903, of which some 53.7% came from Western Australia.

By the turn of the century at 1900 all states had active gold mining and prospecting of various scales. The then gold boom was being driven almost entirely by the Coolgardie-Kalgoorlie fields. In contrast to other states, the Western Australian gold rush was characterised by a very minor amount of alluvial gold with most gold quickly being dominated by hard rock mining and milling (eg. see data in WADM, var.). Over 1894 to 1896 a total of 960 new WA-based mining and prospecting companies were floated on the London stock exchange (Woodall & Travis, 1979a).

The Western Australian rush was prolific in rapidly increasing Australia's gold output to record levels by 1903 but overall Australian production began a steady decline from this time. The period of World War 1 Europe from 1914 to 1918 made further progress for the gold industry difficult. The escalating problems facing many mines included declining ore grades, increased production costs and a static gold price (but declining in real terms). This forced many mines to close by the early 1920's (Travis & Marston, 1990).

Australia reached a near-historic low in production of 13.3 t Au in 1929 (throughout the 1920's production hovered around 20 t Au/year). A minor resurgence in gold mining began in 1932, due to the doubling of the gold price, and reached 51.2 t Au in 1939, but this was not sustained as World War 2 caused major challenges across the sector. In the 1950's the Commonwealth government introduced a gold mining subsidy scheme, without which several mines would have faced premature closure (Travis & Marston, 1990). Production throughout the 1940's to 1970's generally ranged between 15-30 t Au/year, including a near-historic low of 15.6 t Au in 1976.

The discovery of major new gold deposits (or fields) was relatively slow throughout most of the 1900's until the 1970's. In 1971, geologists of BHP and Newmont discovered the large and remote Telfer deposits in northern Western Australia (Royle, 1990). In 1980, following up on earlier geological studies over 1976-78 by the Western Australian Geological Survey and Alwest Pty Ltd, Reynolds Australia Pty Ltd confirmed the surprise discovery of the large Boddington gold deposits south-east of Perth (El-Ansary & Collings, 1990).

From this point forward the gold industry has sustained a remarkable turnaround. The invention of carbon-in-pulp (CIP) cyanide milling technology in the USA facilitated the development of large, low grade deposits through open cut mining (or underground mining, or even both in some cases) (Close, 2002; Huleatt & Jaques, 2005; La Brooy *et al.*, 1994; O'Malley, 1988). This coincided with a sustained increase in the real price of gold, which moved from some US$1/kg (US$30/ounce) to reach as high as US$26 (US$800/ounce), stabilising around US$10-15/kg (US$300-450/ounce) (eg. Kelly *et al.*, 2004; Morgan, 1993).

These two factors combined to facilitate a major resurgence in exploration and production across Australia, led by Western Australia but with Queensland, New South Wales and the Northern Territory also making significant contributions. From the early 1980's the pace of exploration had climbed dramatically and many major new gold resources were outlined, often simply by re-visiting old mines and delineating the low-grade ore around previously mined higher grade lodes. Between 1979 and 1988 there were 16 major gold deposits delineated which contained at least 10 t Au, including the Boddington-Hedges field of south-west WA at 93.5 t Au and the Kambalda-St Ives field at 117.9 t Au (Woodall, 1990).

Australian gold production in 1989 had surged to 204 t Au, stabilised at around 280-310 t Au/year over 1996-2003 though production since has been about 260 t Au/year. A significant degree of gold is now also produced as a co-product or by-product, particularly with copper. Based on known resources and projects, the Australian gold industry is likely to still have some decades of prosperity, though concern often surfaces from within the gold mining sector about the longevity of resources and the relatively rapid mining cycle for gold deposits.

7.2.2 Major Provinces

There are numerous major provinces where gold has been produced historically as well as fields with active mining operations in recent years, often in conjunction with base metal mining (eg. copper). In general, most major gold fields were found during the 1800's, with the only major new discoveries during the 1900's being the Tennant Creek gold-copper field in 1933 and the large Telfer deposits in northern Western Australia in 1972 and the Boddington gold field southeast of Perth in the late 1970's. A location map of past and present gold mines and producers is given in Figure 49.

7.2.3 Production

There is reasonably extensive data for gold production, though there is generally only sparse data for hard rock gold production until the 1870's (Victoria being the exception). The principal sources are the state Mines' Departments annual reports, with most states reporting data compilations for various forms of gold mining (alluvial, prospecting, quartz/hard rock, base metal by/co-product, etc). Due to the decline of the gold industry in some states the annual compilation was no longer reported (eg. NSW last reported systematic data tables in 1916, thereafter requiring a manual compilation). Additional data was derived from the annual reports, which often included a statistical compilation or presentation of major base metal mines which produced gold. Production by state is given in Table 11.

In general, most data up to about 1950 is based on the yield of gold only and not assay grade. A significant degree of data up until about 1975 is also yield but a major proportion is assay grade. From 1975 to 2003, the considerable majority of production data is assay grade with only a small amount of yield data. The continually falling gold grade was noted by (Galt, 2000), which could lead to even further increases in project scale (in turn leading to bigger companies operating gold mines – a process which has occurred since this time).

A major deficiency in most gold mining data is the lack of attention to waste rock. The Mt Morgan Au-Cu and Mt Lyell Cu-Au mines have mostly excellent historical data sets (see appendices) – with both sites, coincidentally, having major acid mine drainage impacts on surrounding water resources. These sites were the principal open cuts which produced gold during the 1900's until the advent of the 1980's new generation of gold mines.

The reporting of waste rock is highly variable across the gold mining sector. Until the early 1980's gold boom, almost all waste rock was associated with open cut Cu-Au mining at Mt Lyell and Mt Morgan. The Telfer project also began to contribute to waste rock production by the early 1980's with a typical waste:ore ratio of 12 (Mason, 1980; Woodcock, 1986).

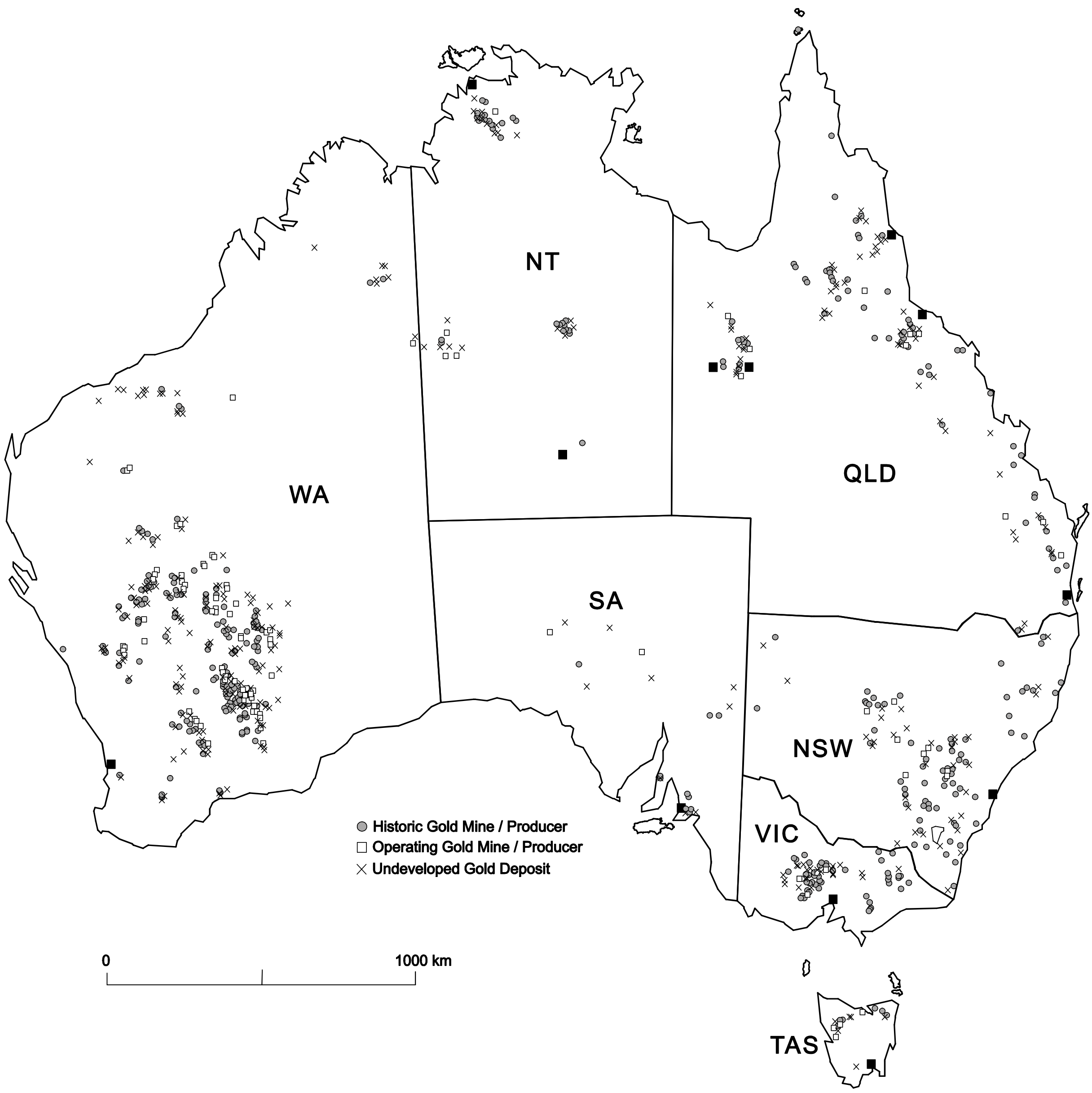


Figure 49 – Australian Gold Provinces : Major Fields and Mines

Table 11 – Australian Gold Production by State (t Au)

QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1,336.6	819.0	2,377.9	196.2	55.8	6,021.4	514.4	11,324.8

At Noble's Nob, in the Tennant Creek gold field of central NT, the waste:ore ratio was 5 in the late 1970's (pp 462) (Reveleigh, 1980). For the small open cuts at Central Norseman operations, south of Kalgoorlie in WA, the waste:ore ratios were 18.9 and 13.1 for the No 1 and 2 open cuts, respectively, in the late 1970's (pp 467) (Robertson, 1980).

The references for the data sets for Australian gold ore mining and milling by state are provided in the appendix and shown in Figures 50 and 51, with state production in Figure 52. The principal source of gold by ore type is shown in Figure 53, based on data from states and associated references (eg. BMR, var.) and individual mines/producers.

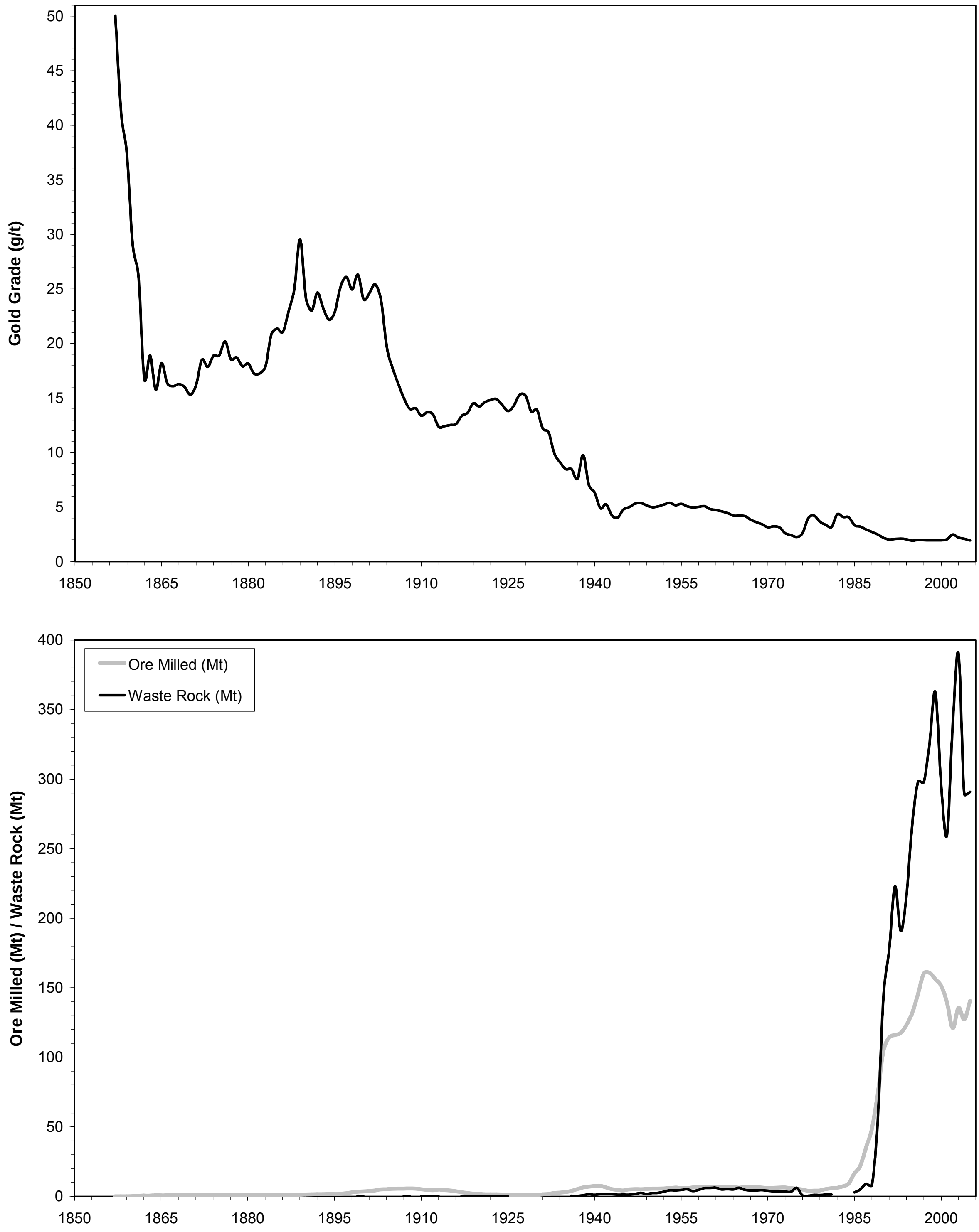


Figure 50 – Australian (Milled) Gold Production : Gold Grade, Ore Milled and Waste Rock

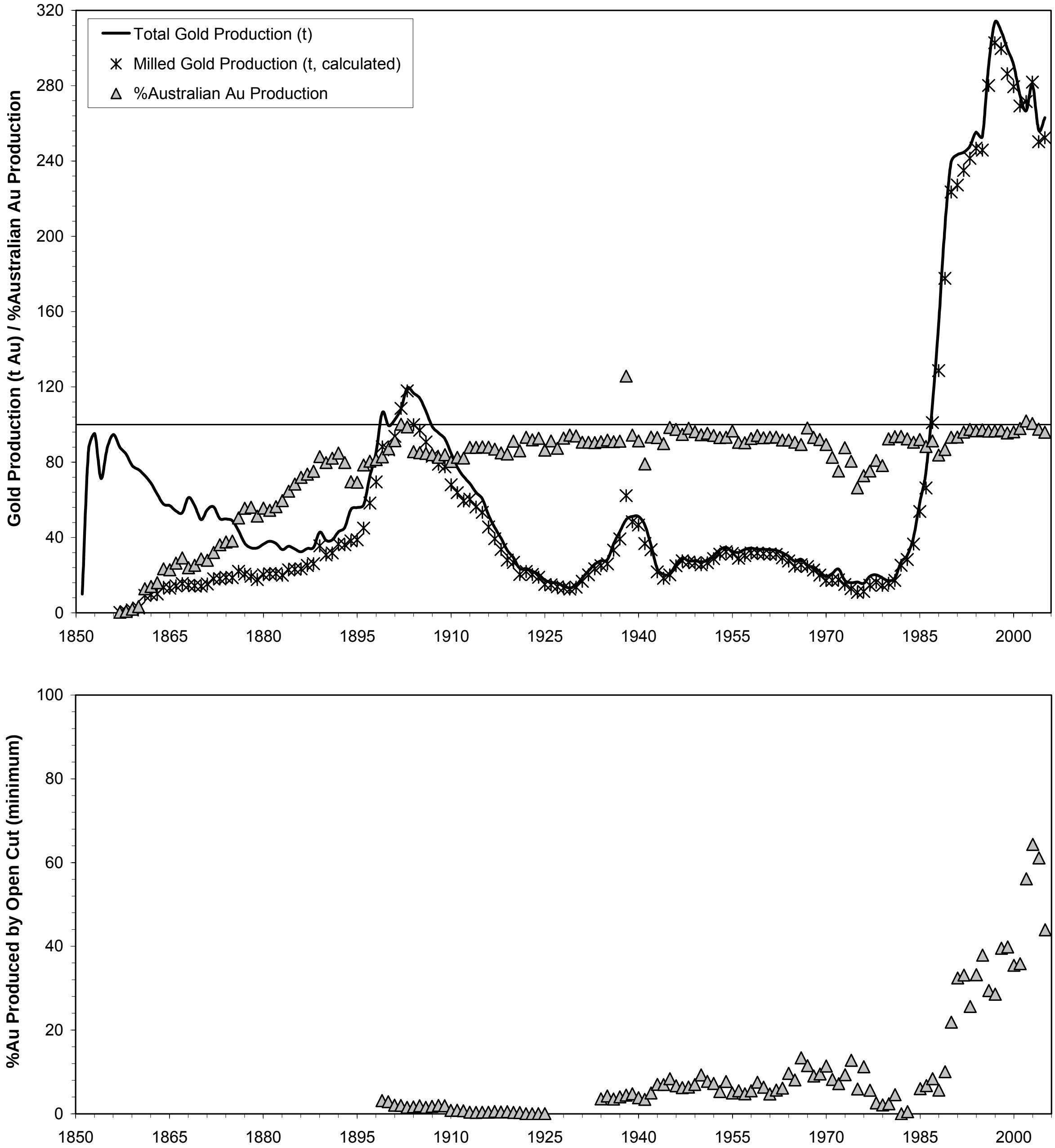


Figure 51 – Calculated versus Actual Australian Gold Production and Minimum Gold Produced by Open Cut Mining

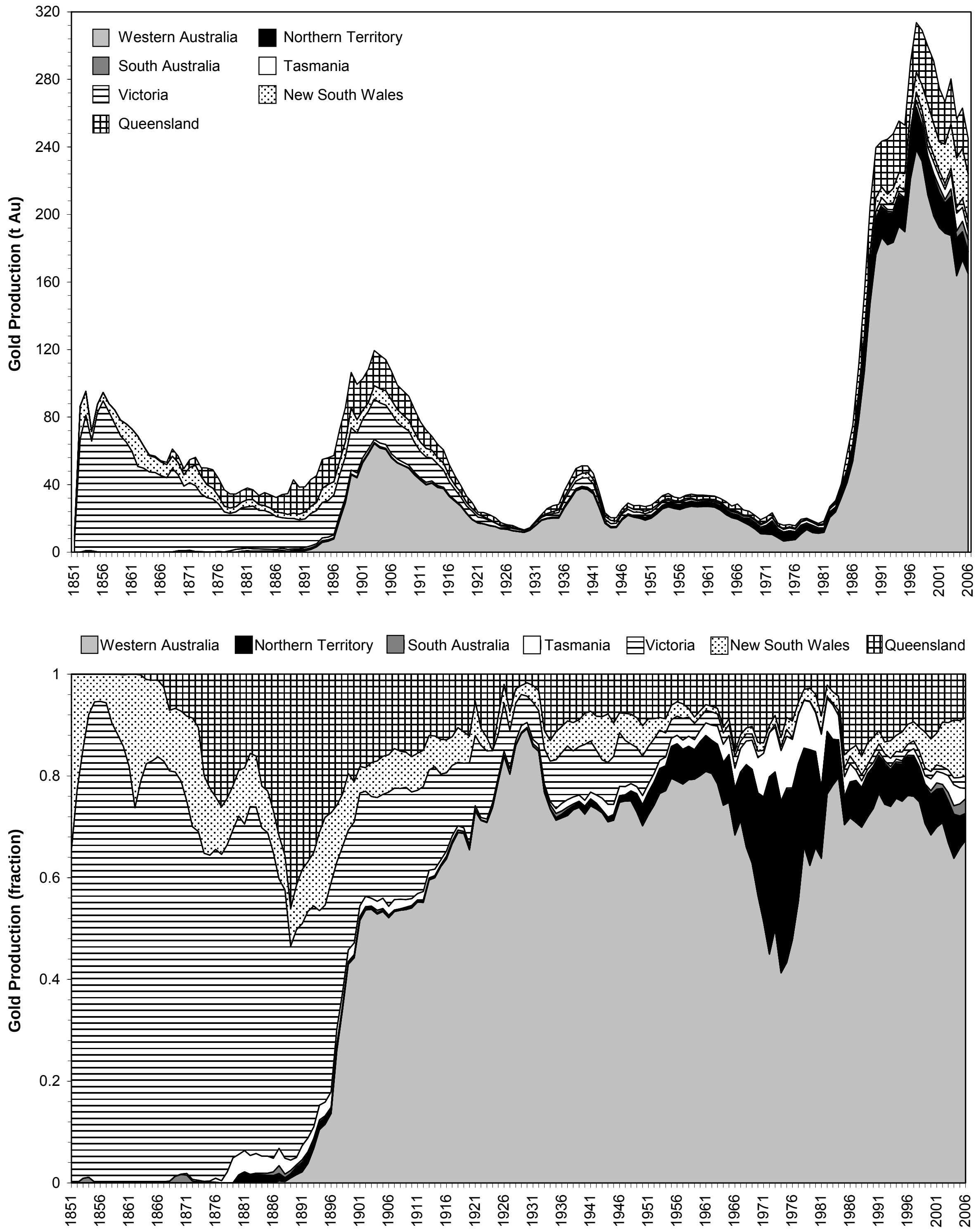


Figure 52 – Australian Gold Production by State : Total and Fraction

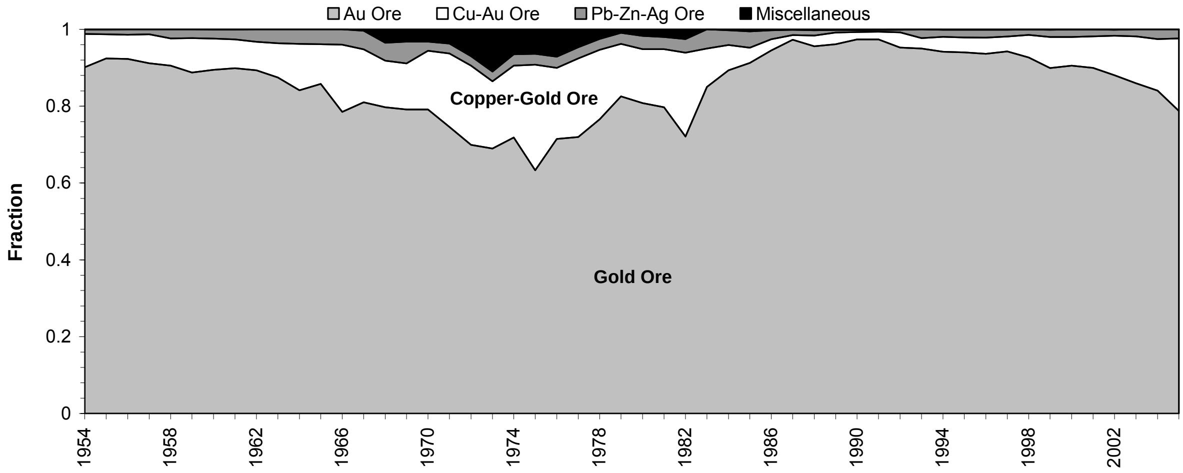


Figure 53 – Gold Source by Ore Type (Fraction) : Au, Cu-Au, Pb-Zn-Ag, Other

7.2.4 Resources

Although Australia has had a productive and vibrant gold industry for over 150 years, the extent of economic gold resources has always been a difficult issue to quantify (mines also tended to only prove reserves a few years in advance). The available estimates include :

- 1955 – British Commonwealth Geological Liaison Office (BCGLO, 1956);
- 1960 – BMR estimate (McLeod, 1998);
- 1975 to 2006 – GA data (GA, var.).

Some limited data is available on gold ore resource grade over time (additional to above) :

- 1950 – Kalgoorlie field (Golden Mile mines only) had ore reserves of 10.54 Mt grading 7.95 g/t Au for 83.8 t Au (Finucane & Jensen, 1953);
- 1955 – Australia had 79.84 Mt of gold and base metal ores grading 2.65 g/t and for 211 t Au; gold only ores were 13.0 Mt grading 9.64 g/t for 125 t Au (BCGLO, 1956);
- 1965 – Kalgoorlie field (Golden Mile mines only) had ore reserves of 12.11 Mt grading 7.52 g/t Au for 91.1 t Au (Finucane, 1965);
- ~1979 – Australia had 61.5 Mt of gold and base metal ores grading 2.92 g/t and for 180 t Au; gold only ores were 14.7 Mt grading 7.05 g/t for 104 t Au (Brodie-Hall, 1980; Woodcock, 1980);
- 1990 – Woodall (1990) estimated Australian reserves and indicated gold resources of 1,644 t Au contained in 532.5 Mt of ore grading 3.09 g/t Au, with a further 389 t Au contained in base metal/polymetallic or by-product ore deposits (566 Mt at 0.69 g/t Au) (pp 66).

The economic gold resources over time are shown in Figure 54, including Australian and world production, with the Australian and world resources-to-production ratio shown in Figure 55. As can be seen, production has increased commensurate with additional resources being discovered and mined. Importantly, as noted previously, significant new gold deposits continue to be discovered in Australia combined with notable additions to resources at existing gold mines/deposits. An extensive compilation of gold resources is given in Tables 12 to 13, including a summary by ore type in Table 14.

It is clear from existing projects and the largest deposits/mines (eg. Boddington, Olympic Dam, Telfer) that future gold production will be sourced from gradually lower grade ore, especially given the increasing significance of Au-Cu/Cu-Au mines (eg. Cadia, Ridgeway). Further to this, several analysts of the gold mining sector have noted that future deposits are likely to be deeper than at present as well more remote (eg. Galt, 2000; Huleatt & Jaques, 2005; Jaques & Huleatt, 2002; Parry, 1998; Schodde, 2004; Travis & Marston, 1990).

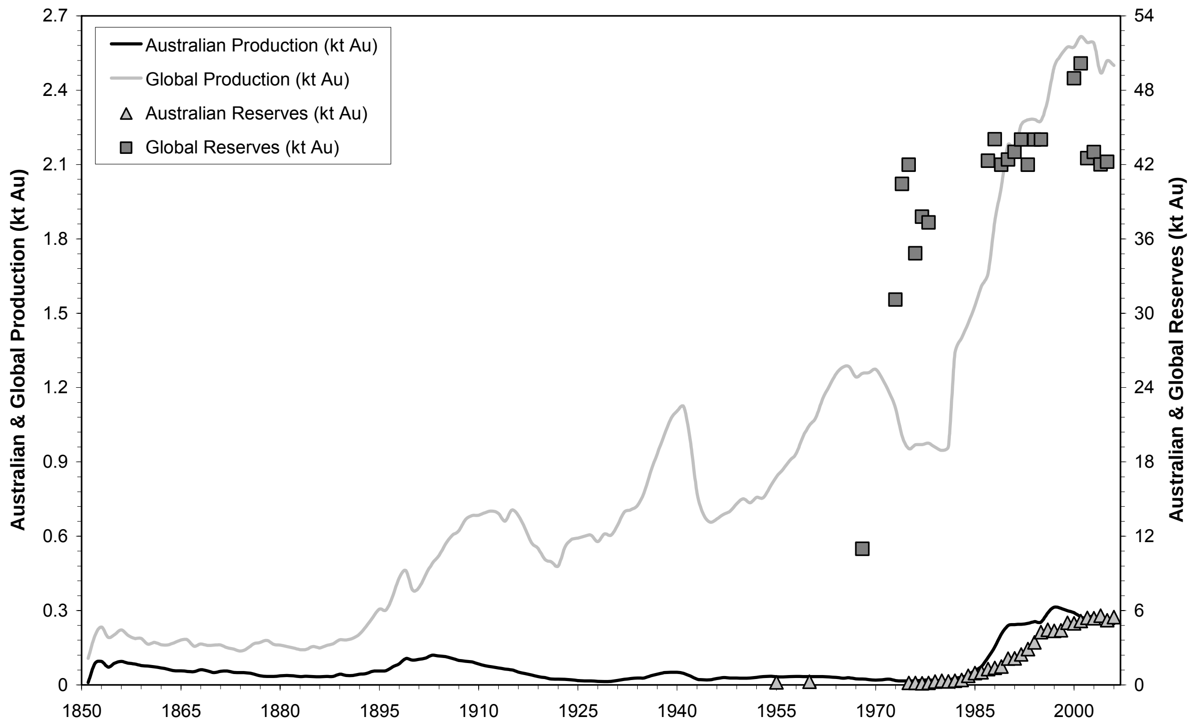


Figure 54 – Australian and World Gold Production and Resources

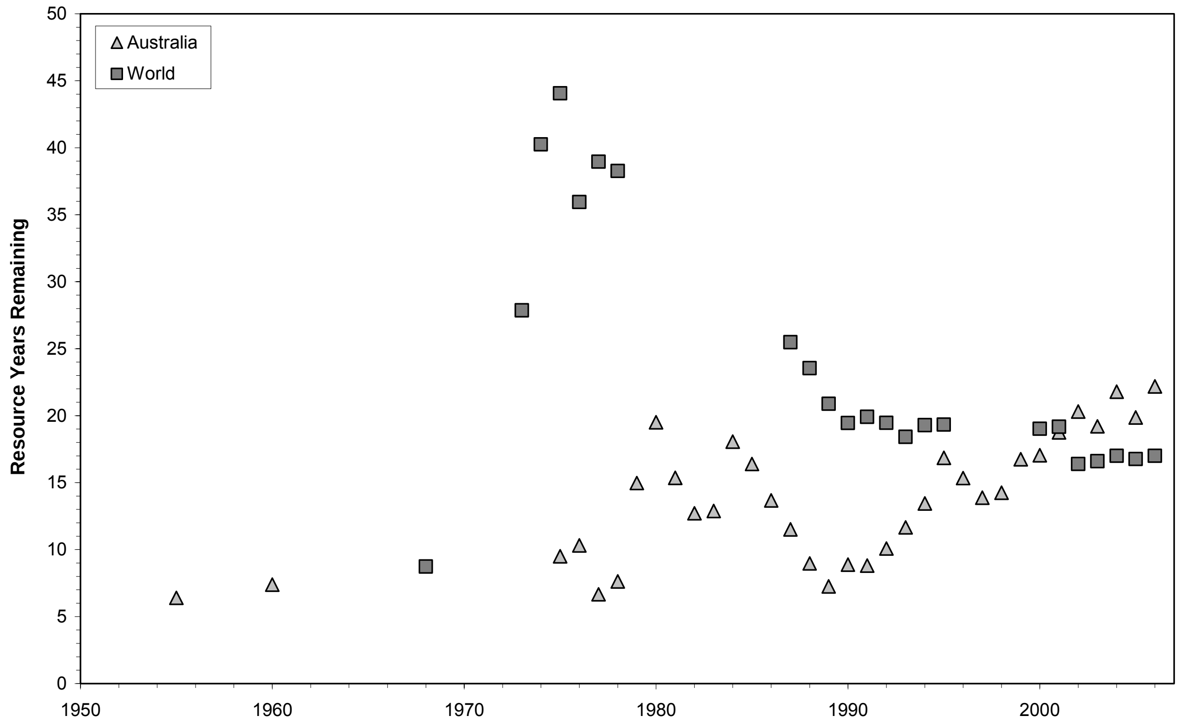


Figure 55 – Australian and World Gold Resource Years Remaining
(Resources-to-Production Ratio)

Overall, given 2006 production of 247 t Au, known economic resources of 5,480 t Au and constant production, there is sufficient for only 22 years though this situation is likely to remain dynamic (ie. similar to the past).

Table 12 – Economic Resources at Australian Gold Mines and Deposits (>20 t Au)

Mine/Resource	Metals	Status	Ore (Mt)	Grade (g/t Au)	Gold (t Au)
Olympic Dam	Cu-U-Au-Ag	Operating	3,970	0.45	1,797
Telfer	Au-Cu	Operating	516.0	1.55	801.1
Cadia East	Au-Cu	Deposit	830	0.69	568.8
Boddington Extended	Au-Cu	Care-Maintenance	561.0	0.80	450.3
Bendigo	Au	Care-Maintenance	23.5	14.50	340.8
SuperPit	Au	Operating	165.4	2.05	339.4
Warrior / Charters Towers	Au	Operating	23	14.00	322.0
Plutonic	Au	Operating	40.2	5.38	216.4
Cadia Hill	Au-Cu	Operating	241	0.68	163.6
Kalgoorlie West Field	Au	Operating	34.8	4.61	160.8
Lake Cowal	Au	Operating	127.5	1.25	159.9
South Kalgoorlie	Au	Operating	93.2	1.70	158.0
Mt Magnet	Au	Operating	50.1	3.15	157.6
St Ives	Au	Operating	54.3	2.90	157.5
Gwalia / Leonora	Au	Operating	78	1.89	147.5
Sunrise Dam	Au	Operating	40.1	3.33	133.7
Ridgeway	Au-Cu	Operating	73.1	1.76	128.2
Granny Smith	Au	Operating	21.0	5.07	106.2
Tanami-Granites	Au	Operating	20.4	5.14	105.0
Agnew	Au	Operating	17.8	5.40	96.1
Prominent Hill	Cu-Au	Under Construction	121.6	0.66	80.5
Burnside JV	Au	Deposit	28.7	2.61	74.9
Fosterville	Au	Operating	20.3	3.65	74.1
Central Norseman	Au	Operating	16.7	4.15	69.1
Carosue Dam	Au	Care-Maintenance	27.54	2.30	63.3
Lindsays JV	Au	Deposit	25.7	2.44	62.7
Jundee	Au	Operating	8.0	7.84	62.6
Bluebird Field	Au	Deposit	37.2	1.60	59.5
Southern Cross	Au	Operating	17.29	3.23	55.9
Big Bell	Au	Care-Maintenance	21.5	2.56	55.0
Lawlers	Au	Operating	9.9	5.26	52.3
Mt Rawdon	Au	Operating	58.0	0.90	52.2
Stawell	Au	Operating	12.3	4.25	52.1
Meekatharra	Au	Deposit	28.44	1.79	50.9
Thunderbox	Au	Operating	24.0	2.10	50.3
Peak NSW	Au	Deposit	7.7	6.51	50.1
Northparkes	Cu-Au	Operating	64.6	0.69	44.9
Laverton	Au	Deposit	29.5	1.50	44.3
Redemption	Au	Deposit	19.0	2.28	43.4
Westonia	Au	Deposit	38.24	1.11	42.5
Darlot	Au	Operating	9.0	4.59	41.2
Rosemont	Au	Deposit	19.1	2.09	39.9
Copper Hill	CuAu	Deposit	105	0.33	34.7
Mt Garnet Field	Pb-Zn-Ag-Cu-Au	Operating	31.9	1.07	34.3
Wiluna	Au	Operating	7.24	4.68	33.9
Randalls-Aldiss	Au	Deposit	13.1	2.55	33.4
Ernest Henry	Cu-Au	Operating	71.0	0.46	33.0
Fortnum / Peak Hill WA	Au	Care-Maintenance	13.1	2.50	32.8
Selwyn	Au-Cu	Deposit	15.6	2.08	32.4
Kalkaroo	Cu-Au	Deposit	70.0	0.46	32.2
White Foil	Au	Care-Maintenance	13.2	2.40	31.7
Maud Creek	Au	Deposit	10.36	3.03	31.4
Duketon	Au	Deposit	17.7	1.77	31.3
Ballarat East	Au	Under Construction	3.1	9.00	27.9
Golden Eagle / Nullagine	Au	Deposit	13.2	2.02	26.7
Frog's Leg	Au	Operating	4.5	5.70	25.4
Davyhurst	Au	Care-Maintenance	11.2	2.21	24.8
South Laverton	Au	Deposit	9.67	2.45	23.7
Tunkillia	Au	Deposit	10.5	2.20	23.1
Yamarna	Au	Deposit	12.6	1.82	22.9
Mt Bundy-Rustlers Roost	Au	Deposit	16.60	1.33	22.1
Ravenswood	Au	Operating	24.5	0.90	22.1
Binduli	Au	Care-Maintenance	12.0	1.77	21.2
Higginsville	Au	Deposit	6.0	3.50	20.9
Cracow	Au	Operating	1.97	10.59	20.9
Hillgrove	Au-Sb	Care-Maintenance	3.9	5.22	20.4

Note : Most resources either June or December 2005 (some are 2004 or early 2006) from the respective company annual report (eg. Newcrest, BHP Billiton, Newmont, Barrick, AngloGold Ashanti, Gold Fields, etc).

Table 13 – Economic Resources at Australian Gold Mines and Deposits (5-20 t Au)

Mine/Resource	Metals	Status	Ore (Mt)	Grade (g/t Au)	Gold (t Au)
Golden Grove	Cu-Zn-Ag-Au	Operating	12.0	1.61	19.3
Kunanulling	Au	Deposit	10.59	1.80	19.1
Tomingley-Wyoming	Au	Deposit	7.1	2.64	18.9
Brightstar	Au	Deposit	5.9	3.16	18.7
Phillips River	Cu-Au	Deposit	7.7	2.33	18.1
Hodgkinson Basin	Au	Deposit	10.52	1.7	17.9
Pajingo	Au	Operating	1.8	9.84	17.9
Rosebery	Pb-Zn-Ag-Cu-Au	Operating	6.5	2.70	17.6
Coyote	Au	Care-Maintenance	3.7	4.70	17.4
Mt Gibson	Au	Care-Maintenance	8.8	1.98	17.3
Tom's Gully-Quest 29	Au	Under Construction	3.1	5.66	17.3
Indee	Au	Deposit	10.46	1.55	16.2
Paulsens	Au	Operating	1.4	11.80	16.2
Bronzewing	Au	Care-Maintenance	5.1	3.17	16.1
Cadia Extended	Au-Cu	Deposit	40.14	0.40	16.0
Gullewa	Au-Cu	Deposit	2.65	6.04	16.0
Gidgee	Au	Care-Maintenance	2.7	5.94	15.9
Laverton JV	Au	Under Construction	7.2	2.20	15.8
Beaconsfield	Au	Operating	0.9	16.46	15.4
Peak Hill NSW	Au	Care-Maintenance	11.3	1.29	14.5
Lake Carey	Au	Deposit	6.6	2.04	13.5
Twin Hills	Au	Operating	0.96	13.84	13.3
Wallbrook	Au	Deposit	6.24	2.11	13.2
Morning Star VIC	Au	Deposit	3.71	3.55	13.2
Lady Ida	Au	Deposit	7.2	1.8	13.0
Bullabulling	Au	Operating	9.0	1.44	13.0
Bannockburn	Au	Deposit	6.72	1.89	12.7
Meekatharra JV	Au	Deposit	7.5	1.68	12.6
Youanmi	Au	Deposit	6.01	2.05	12.3
Challenger	Au	Operating	1.6	7.53	12.3
Major's Creek	Au	Deposit	3.72	3	11.2
Sickle	Au	Deposit	6.05	1.8	10.9
Lord Nelson / Henry	Au	Operating	4.1	2.64	10.8
Gympie	Au	Operating	1.60	6.40	10.3
Mt Lyell	Cu-Au	Operating	29.42	0.34	10.0
Lewis Ponds	Pb-Zn-Ag-Cu-Au	Deposit	6.60	1.5	9.9
Osborne	Cu-Au	Operating	10.14	0.95	9.6
Melrose	Au	Deposit	6.7	1.43	9.5
Kirkalocka	Au	Operating	5.3	1.77	9.4
Klondyke	Au	Deposit	4.34	2.1	9.1
Miranda-Vivien	Au	Deposit	1.36	6.67	9.1
Spring Hill	Au	Deposit	3.6	2.34	8.4
Daisy Milano	Au	Operating	0.32	24.97	8.1
White Dam	Au	Deposit	7.32	1.09	8.0
Bamboo Creek	Au	Operating	4.94	1.60	7.9
Murchison-Dalgaranga	Au	Deposit	4.4	1.78	7.9
Millrose	Au	Deposit	3.7	2.13	7.8
Roseby	Cu-Au	Deposit	127.2	0.06	7.6
Agate Creek-Sherwood	Au	Deposit	5.7	1.33	7.6
Blackburn	Au	Deposit	6.6	1.12	7.4
Dreadnought	Au	Deposit	3.5	2.10	7.4
Henty	Au	Operating	0.75	9.55	7.2
Moyagee-Lena	Au	Deposit	0.89	7.8	6.9
Wingina Well	Au	Deposit	3.44	1.84	6.3
Snake Well	Au	Deposit	2.5	2.30	5.7
Glenburgh	Au	Deposit	1.73	3.21	5.6
Comet-Webb's Patch	Au	Deposit	0.84	6.1	5.1
Kanmantoo	Cu-Au	Deposit	25.37	0.2	5.1
Chalice	Au	Deposit	1.57	3.22	5.1

Note : Most resources either June or December 2005 (some are 2004 or early 2006) from the respective company annual report (eg. Newcrest, BHP Billiton, Newmont, Barrick, AngloGold Ashanti, Gold Fields).

Table 14 – Total Economic Resources at Australian Gold Mines and Deposits by Ore Type

Mine/Resource Category	Ore (Mt)	Grade (g/t Au)	Gold (t Au)
Polymetallic (Pb-Zn-Ag-Cu-Au / Cu-Zn-Ag-Au)	58.2	1.41	81.9
Copper-Gold (including Cu-U-Au)	4,626	0.45	2,080.6
Gold-Copper (including Au-Sb)	2,283	0.96	2,197.2
Gold only – Deposits	714.7	2.56	1,831.1
Gold only – Operating Mines *(including Under Construction)*	1,026.0	3.00	3,078.3
Total	**8,708**	**~1.06**	**9,269**

7.3 Lead-Zinc-Silver

7.3.1 Brief History

Following on from the copper, gold and tin booms of the previous decades, the 1880's was to be the decade for lead-silver (and later therefore zinc). It is this decade to which can be attributed, directly or often indirectly, the establishment of the majority of major mining companies in Australia – the Broken Hill Proprietary Company (BHP), Zinc Corporation, North Broken Hill Ltd (North), and Broken Hill South Ltd (BHS). As can be seen the prominence of the Broken Hill field has been of prime importance in this regard. Through Broken Hill Australia became world famous as a major and sustained producer of silver, lead and zinc for many decades.

In general, this section is focused on mining projects which have at least two out of lead, zinc and silver. The dominant source for these metals has been Pb-Zn-Ag ores but more recently Cu-Zn-Ag and Pb-Zn-Ag-Cu-Au ores have also been important producers. Further detail on the history of lead-zinc-silver and associated projects can be found in Clark (1904), Brown (1908), Curtis (1908), Andrews (1922), Woodward (1965), Raggatt (1968), Legge & Haslam (1990), Parbo (1992) and Griffiths (1998). The monographs of Knight (1975a), Woodcock (1980), Glasson & Rattigan (1990), Hughes (1990), Woodcock & Hamilton (1993) and Berkman & Mackenzie (1998), also contain numerous relevant papers. There are also numerous papers and books on the history of the Broken Hill and Mt Isa fields.

The Glen Osmond Pb-Ag mine was opened in May 1841 just east of the young settlement of Adelaide, arguably Australia's first base metal mine (but was quickly overtaken by the major SA copper discoveries). In Western Australia the Northampton field, about 400 km north of Perth, was producing lead ore with a very low silver content from 1852. The Yerranderie and Captain's Flat fields in eastern New South Wales were discovered in the 1870's, with Yerranderie containing particularly high silver grades, while the Mt Garnet-Chillagoe field in northern Queensland was discovered towards the end of this decade. The Cobar copper-gold field, first discovered in 1869, contributed very minor lead-silver production around this period. In general, the earliest lead-silver mines in Australia were of a relatively small and often uneconomic nature (or at least very limited periods of economic working) (Legge & Haslam, 1990).

The pace of interest in Pb-Zn-Ag was moderately small – copper, gold and tin were the glamour minerals of interest for the ensuing decades until the early 1880's. At this time some major discoveries were made : the Thackaringa-Silverton and Broken Hill fields in far western New South Wales in 1876 and 1883, respectively (though Thackaringa was not proved until 1880), the Zeehan field of western Tasmania in 1882, and the Lawn Hill field of north-western Queensland in 1887.

The confirmation of the Thackaringa-Silverton field in 1880 led to a small mining rush, especially following the discovery of the Umberumberka deposit close by. In the end the field was relatively short-lived and failed to deliver significant benefits but led prospectors to the real prize awaiting nearby. In September 1883 a boundary rider named Charles Rasp discovered what he thought was a prominent outcrop of tinstone (cassiterite). The tinstone turned out to be lead-silver ore and the Broken Hill 'line of lode' was on its way to world fame.

The initial view was not optimistic – the early prospecting was disappointing in that only low grades of lead carbonate ores were examined with the near surface silver-rich kaolin (clayey) ores being missed. The kaolin ores were finally discovered in late 1884 – with an initial 47 t of ore producing 1 t Ag or a grade of some 21,000 g/t or 2.1% Ag (Clark, 1904). Further work from January to June 1885 confirmed the extent of rich silver ores and this finally gave the commercial impetus to explore and develop the field further (Andrews, 1922; Dickinson, 1939; Jaquet, 1894; Koenig, 1983).

The Broken Hill Proprietary Company Ltd – BHP – was registered on 10 August 1885 and the development of large-scale mining, milling and smelting operations began in earnest. Later in 1885, the northern end was taken up by the Broken Hill North Silver Mining Company Ltd (later North Broken Hill or NBH) while the southern end was pegged by the Broken Hill South Silver Mining Company Ltd (BHS). The line of lode was soon pegged by numerous hopeful companies, most backed by British investors or financiers. By the end of the decade, Broken Hill was famous world-wide as a rich silver field with increasingly important lead production. At this stage there was no interest in zinc – the focus was squarely on the rich silver grades being mined from oxidised ore in the weathered zone by BHP and others (Andrews, 1922; Jaquet, 1894).

Over the following two decades, however, the Broken Hill field had to solve two critical challenges – the decline of readily mineable oxidised ore and the zinc problem.

The early mining of the oxide ore lead to easy milling and smelting but the rapidly declining silver grades of this ore forced the field to address the questions of future ore sources (Jaquet, 1894; O'Malley, 1988). By this stage there was known to be very large resources of deeper sulphide ore (mainly within the northern NBH and southern BHS leases) but there was no method at that time for economic milling. The engineers and metallurgists of the field set to work and developed an array of processes for concentrating the lead minerals from fresh ore (eg. the Wilfley Table) (O'Malley, 1988; Parbo, 1992; Raggatt, 1968). The first sulphide ore was treated economically in 1895 (Dickinson, 1939).

In order to continue improving economic efficiency on the Broken Hill field, the zinc problem then had to be solved. By 1900 very little interest had been shown in zinc, as the main focus had always been on silver with lead increasing strongly in importance – zinc was merely allowed to be discharged in tailings dumps. In 1904 it was estimated that these dumps contained about 6.69 Mt grading 6% Pb, 19% Zn and 184 g/t (pp 79) (Woodward, 1965). The problem was that there was no known method for efficient zinc separation and recovery. A considerable amount of metallurgical expertise was mobilised[23], and the new method of flotation was invented with great success, including key variants of the flotation method (Raggatt, 1968). The technology was applied to the zinc-rich tailings by the Zinc Corporation (ZC) in 1905 and later modified to a froth flotation technique for fresh ore. The use of flotation went on to revolutionise the milling of sulphide ores around the world (Bear *et al.*, 2001; Newnham & Worner, 1983; O'Malley, 1988). By 1910, the future of Broken Hill again seemed well assured for coming decades.

The Broken Hill field saw an 18 month-long strike from 1919, which when combined with the economic impacts of World War 1 and the disastrous fire at the Port Pirie smelter in 1921 caused great economic pain for the field and most of its companies (Andrews, 1922).

The strong ethos developed at Broken Hill of continually evolving mining and metallurgical approaches has helped to underpin several companies working on the field (Raggatt, 1968). Many of the companies who started life in the Broken Hill field have gone on to invest in and/or develop many other mines or industries across Australia. For example O'Malley (1988), Parbo (1992) and Raggatt (1968) :

- Large smelting centres at Port Pirie, SA, and Cockle Creek, NSW;
- BHP initiated large-scale iron ore mining in SA in 1903, initially for flux at the Port Pirie lead-smelters but later steel production at Newcastle in 1915 (primarily as a way to provide for its future beyond Broken Hill);

[23] Including Melbourne brewer Charles Vincent Potter (Parbo, 1992).

- Many Broken Hill company directors, engineers and metallurgists went on to important roles in guiding other mining companies to prosperity (eg. Bowes Kelly, William Orr and Hermann Schlapp at Mt Lyell);
- The 1916 creation of the Electrolytic Zinc Company of Australasia Ltd (EZ) to establish a zinc refinery near Hobart, TAS (initially jointly owned by NBH, BHS, ZC and Amalgamated Zinc (De Bavay's) Ltd) – formerly, zinc concentrate had been sold to Germany;
- BHS developed the CSA mine at Cobar in the mid-1960's;
- The Zinc Corporation, after merging with British mining interests, formed the Consolidated Zinc Corporation, which later in 1962 was effectively merged with Rio Tinto Zinc Ltd (RTZ) from the UK to form Conzinc Riotinto Australia Ltd or CRA Ltd (now fully integrated with RTZ to form Rio Tinto Ltd/Plc, a dual-listed Anglo-Australian mining house).

The ties with the Broken Hill field have now been effectively closed by all companies. The exit of the founding BHP occurred in 1939, while the operations of North Broken Hill and the Zinc Corporation/CRA were merged into a single independent company in 1988 called Pasminco Ltd (now Zinifex Ltd), who were forced to sell the operations to emerging miner Perilya Mines Ltd in 2002 (due to the financial collapse of Pasminco in 2001).

In 2006 the Broken Hill field was still in operation having produced some 205.2 Mt of ore grading about 10.45% Pb, 10.14% Zn and 159 g/t Ag, which has yielded approximately 20.15 Mt Pb, 19.12 Mt Zn, 30,211 t Ag, 231 kt Cu, more than 27.6 t Au and minor metals such as antimony and cadmium (see appendix). The known ore resources at Broken Hill as of June 2006 are, remarkably, still some 19.2 Mt grading 8.5% Pb, 10.4%Zn and 102 g/t Ag (Perilya, var.). Although the field has faced imminent closure several times in its past (due to various reasons, such as economics, strikes, technological difficulties), there are still those with great optimism regarding the future for even further ore resources at or very close to Broken Hill (eg. Plimer, 2004) – the future will indeed reveal the truth. The current owner, Perilya Mines Ltd, is actively investing and exploring and hopes to keep the Broken Hill field in production well beyond its current predicted closure date of about 2013 (Perilya, var.).

In remote north-west Queensland in February 1923, to the west of the famous Clonclurry copper field, a new major lead-zinc-silver (and later copper) field was discovered by a roving boundary rider – Mt Isa. Despite a rush the full potential of the new field was slow to be realised, due primarily to the lower average ore grades compared to those at Broken Hill, the more difficult nature of the finer grained ore to mill and smelt and the generally small quantity of more easily treatable oxidised ore (Berkman, 1996).

Unlike Broken Hill, however, the entire field was quickly amalgamated into a single operating company by late 1925 – Mt Isa Mines Ltd (MIM) – which was destined to become another major Australian mining company (Raggatt, 1968) (until a successful hostile takeover by Xstrata Ltd in mid-2003, partly facilitated by a general apathy over MIM's perceived failure to deliver on the eternal optimism surrounding the history of the Mt Isa project).

The complete control by the new MIM soon proved to be a significant advantage – Mt Isa needed an intense amount of capital to finance it into production. As with the Mt Lyell project in Tasmania, developing operations at Mt Isa required completely new infrastructure on a large scale, including roads, a long-distance railway to export products, a new town, as well as major mining and metallurgical infrastructure (Raggatt, 1968). Despite the scale of the Mt Lyell project in the 1890's, the development of the Mt Isa Pb-Zn-Ag project in the late 1920's was arguably Australia's first mega-scale and planned mining and smelting project. The pioneering effort was based on a 1928 ore resource of some 21.2 Mt grading 6.1% Pb, 8.2% Zn and 115 g/t Ag (Legge & Haslam, 1990). For comparison, in 1928 the Broken Hill field milled 1.2 Mt at 14.3% Pb, 11.2% Zn and 205 g/t Ag (see appendices).

When Mt Isa began production in 1931 the world lead market was effectively collapsing. From the 1920's to 1932 the price of lead fell by more than half, forcing MIM to continue to seek further financial assistance in 1930 and again in 1939 (Raggatt, 1968).

Although MIM was able to deliver a small profit for the financial year 1936/37, it was not until after World War 2 and the 1950's development of its copper operations that was MIM finally able to deliver sustained and significant returns to its shareholders.

In 1947 the equally large Hilton Pb-Zn-Ag deposit was discovered 20 km north of Mt Isa (Legge & Haslam, 1990). Following the opening up of the copper lodes at Mt Isa, MIM has undergone almost continual expansion, especially in its economic copper business (see copper section). Mt Isa has faced numerous challenges since 1950, including serious financial challenges, labour strikes, technical problems and the like.

By 2006, Mt Isa's total production was 153.9 Mt ore grading about 6.40% Pb, 6.84% Zn and 158 g/t Ag to yield 7.68 Mt Pb, 7.03 Mt Zn and 19,080 t Ag (see appendix). As of June 2006 the Pb-Zn-Ag ore resources at Mt Isa, Hilton and George Fisher deposits were 167.8 Mt grading about 4.7% Pb, 8.6% Zn and 93 g/t Ag while potential open cut resources were 337 Mt grading about 2.7% Pb, 4.0% Zn and 64 g/t Ag (Xstrata, 2007).

Throughout the latter half of the 1900's numerous and often significant discoveries of lead-zinc-silver or similar ores have been made, including :

Lead-Zinc-Silver

- 1955 – McArthur River (HYC), NT;
- 1964 – Woodcutters, NT;
- 1966 – Beltana-Aroona, SA;
- 1970 – Lady Loretta, QLD;
- 1971 – Sorby Hills, WA;
- 1972 – Elura, NSW;
- 1976 – Abra, WA;
- 1978 – Cadjebut-Blendevale, WA;
- 1989 – Century Zinc, QLD;
- 1990 – Cannington, QLD;
- 1991 – Magellan, WA.

Copper-Zinc-Silver

- 1978 – Benambra, VIC;
- 1979 – Golden Grove, WA.

Lead-Zinc-Silver-Copper-Gold

- 1969 – Woodlawn, NSW
- 1974 – Que River, TAS;
- 1975 – Thalanga, QLD;
- 1983 – Hellyer, TAS.

The McArthur River-HYC[24] deposit was discovered by MIM geologists in 1955. Ore resources were as large as the Broken Hill or Mt Isa fields with strong zinc grades but of a lower overall Pb-Ag grade and containing extremely finely disseminated sulphides – making the ore very difficult to treat (Beattie & Leung, 1993; Miller, 1980). Prior to development in the mid-1990's resources were estimated at 227 Mt grading 4.1% Pb, 9.2% Zn, 41 g/t Ag and 0.2% Cu (Logan *et al.*, 1990). The milling problems took MIM some decades of research to overcome, inventing new 'Isamill' grinding technology in the process (Enderle *et al.*, 1997; Pease *et al.*, 2006) to produce a mixed Pb-Zn concentrate (as opposed to separate concentrates from standard Pb-Zn-Ag operations). Commercial operations started in 1995 and by 2006 McArthur River had produced 13.91 Mt of ore grading 5.5% Pb, 14.0% Zn and ~59 g/t Ag to yield 0.37 Mt Pb, 1.51 Mt Zn and 441 t Ag (see appendix).

Almost all of the above listed deposits have now been developed, some for two decades or more (with some only lasting short periods also; eg. Benambra). The large and higher grade projects, such as Century Zinc (high Zn) and Cannington (high Pb-Ag) have made considerable contributions to increased production and stabilising or even increasing average Australian Pb-Zn-Ag ore grades.

[24] McArthur River was previously known as the HYC deposit, based on the phrase "Here's Your Chance" (Raggatt, 1968).

Although the original emphasis at Broken Hill was on silver and then quickly shifting to lead, the primary economic return and importance is now placed on zinc production, which is more than twice that of lead.

In 1990 BHP returned to the Pb-Zn-Ag sector with the major discovery of the high grade Cannington deposit, south-east of Mt Isa. Intensive exploration and associated studies led to a commercial mine opening by late 1997 – effectively the first new mine for several decades with strong lead grades but especially high silver grades. Prior to construction, ore resources in May 1997 were estimated at 43.8 Mt grading 11.6% Pb, 4.4% Zn and 538 g/t Ag (Bailey, 1998).

Overall, there remains a significant resource base upon which to operate the lead-zinc-silver industry in Australia, at least for a few decades. This will be based on lower lead, zinc and silver ore grades and increasingly from poly-metallic projects.

7.3.2 Major Provinces

The major lead-zinc-silver provinces of Australia continue to be (shown in Figure 56) :

- Broken Hill field, western NSW;
- Cobar field, central northern NSW;
- Mt Isa-Clonclurry belt, western QLD;
- Herberton-Chillagoe field, northern QLD;
- Lachlan fold belt, eastern VIC/south-east NSW;
- Rosebery field, north-western TAS;
- Kimberley field, north-east WA;
- Yilgarn Craton, central WA.

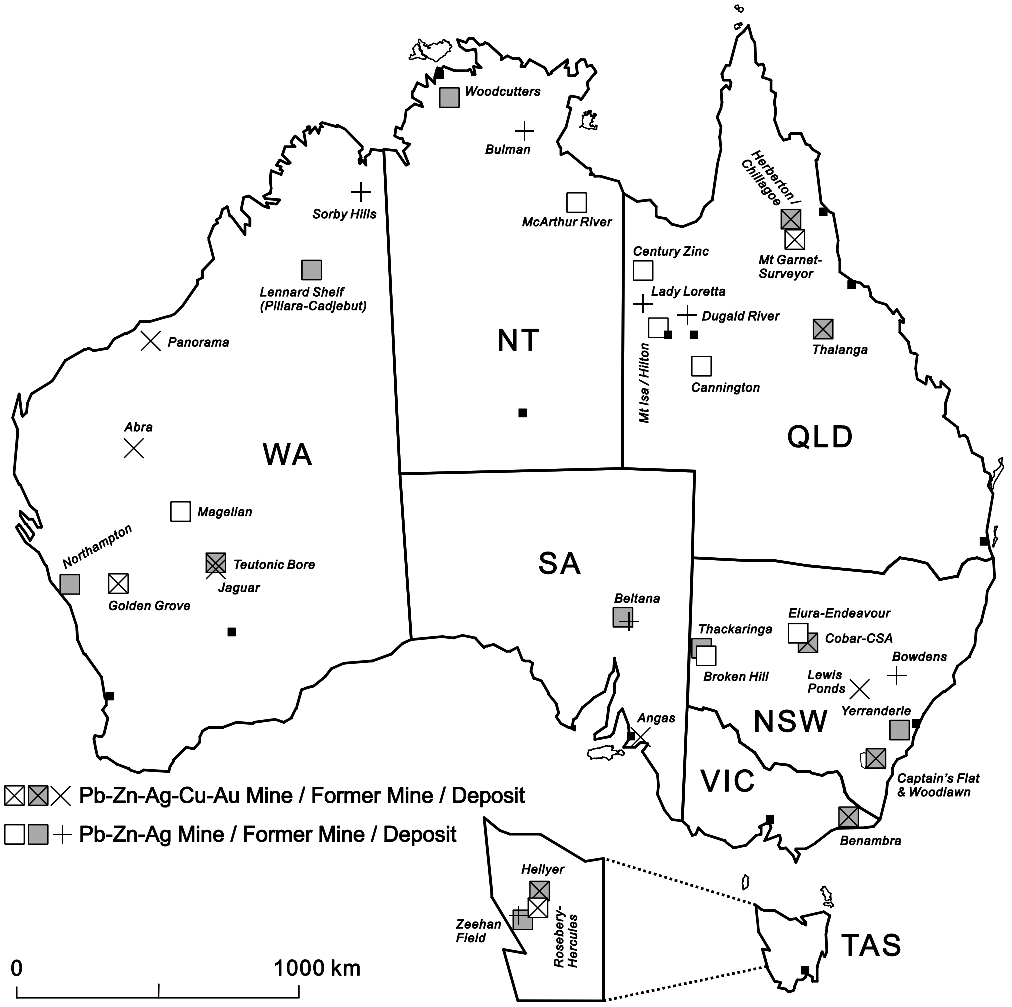


Figure 56 – Australian Lead-Zinc-Silver Provinces : Major Fields and Mines

7.3.3 Production

The availability of production data for lead-zinc-silver is largely governed by the Broken Hill and Mount Isa fields plus earlier data from the Northampton field. There is reasonably extensive historical data for metals produced, though mining data is somewhat variable prior to about 1910. Another critical issue is that from 1913 data was reported for Broken Hill as ore milled with assay grades plus metal production, and subsequently Mt Isa and most other mines adopted this approach. The principal data sources and references for all lead-zinc-silver mines or fields are included in their respective table in the appendices.

The master data sets for lead-zinc-silver production are shown in Figures 57 to 59, with lead-zinc production fraction in Figure 60 and lead-zinc grades at major mines in Figure 61. Total production for various mines/fields is given in Table 15.

The long-term trends of ore milled and ore grades, Figure 57, are dominated by Broken Hill for most of the period presented. The data for the Northampton field (WA) from 1850 to 1883 is included though it must be pointed out that it was a very small Pb producer with no Zn or Ag and only beneficiated concentrate data are available – not as-mined ore grades. This period is therefore shown as a dotted line for Pb grade in Figure 57. Prior to 1913 the annual data for the Broken Hill field was not reported consistently, though data for some years and some companies are available either from NSWDM (var.) or the online report archives of the NSW Department of Mines (the 'DIGS' system[25]). Due to the changing milling and smelting sites of this period, and the fact that a considerable degree of the mined metals were refined in states other than NSW (eg. SA or exported to Europe), there is some confusion over the extent of Broken Hill-derived production (hence the variability in calculated versus reported production until about 1900). The period 1883-1912 is therefore based on approximate data. This early period is also based on effective metal yields from the ore, whereas from 1913 onwards, full reporting by NSWDM (var.) is based on actual assayed ore grades and individual mine production. The drop in ore milled, ore grades and production for 1920 is related to the prolonged strike at Broken Hill.

The high variability in Zn grades until 1910 is related to the problem of Zn extraction. As data prior to 1913 is commonly based on yield and not assay grade, only the payable Zn quantity in concentrates is available (often not for all mines) and the true Zn grade therefore remains unknown. From the 1890's, given the shift to sulphide ores and the published assay grades of ore resources for some of the major Broken Hill companies (eg. BHP, NBH, BHS), it is most likely that true Zn grades were comparable to Pb of around 15-20% Zn (eg. the tailings dump by 1904 contained 19% Zn), as marked on Figure 57. The short-term decline in Zn grades from 1930 to 1935 is due the start up of Mt Isa in 1931, which focused on higher grade Pb-Ag ore (~10.5% Pb, ~170 g/t Ag) in its early years with lower Zn grades (~4%) while Zn production began in 1935 from combined Pb-Zn-Ag ore (~8.3% Pb, ~10.5% Zn, ~200 g/t Ag). Further peaks in Zn grades are related to temporary mining of higher grade ores, deposit variability, and/or the start and expansion of new mines (eg. Rosebery, TAS, in 1936, McArthur River and Century Zinc in the late 1990's).

In general, the proportion of ore mined through open cut or underground techniques is clear, as most projects are either and not mixed (or have reported this data, eg. Woodlawn), with the dominant mining technique for Pb-Zn-Ag projects has been underground.

As with other commodity sectors, there is often very little attention paid to reporting the waste rock associated with Pb-Zn-Ag ores. There is waste rock data available for some projects or for some periods of major projects, though there is clearly a lack of enough data to present an accurate account of this aspect. There are two major issues – early open cuts at Broken Hill and waste rock data.

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[25] The 'DIGS' system stands for *Digital Imaging of Geological System*, and is a major online archive; see **digsopen.minerals.nsw.gov.au**

Firstly, there is only minimal data shown for open cut mining prior to about 1960. To overcome the geotechnical stability problems of underground mining at Broken Hill, some open cut mining of shallow oxidised ore was undertaken to relieve rock stresses in underground mines. Approximately 1.4 Mt of ore was mined by open cut between 1890-1905 (pp 57) (Woodward, 1965), with waste volumes moved by some mines for certain years reported by NSWDM (var.). The data to estimate the fraction of ore derived from this period is approximate only, with open cut ore reaching a maximum of ~10% in the late 1890's. No significant further open cut mining is understood to have occurred.

Secondly, there is no waste rock data included due to the fact that the respective companies have not publicly reported such data. This is despite several open cut mines being developed since 1970, including Woodlawn (NSW), Woodcutters (Northern Territory), Century Zinc (QLD), Blackwoods, Potosi and others at Broken Hill as well as minor open cuts at Rosebery-Hercules (TAS). Other specific data for recent/current projects includes :

- Beltana (1974-76) – produced 132 kt Zn ore, 11 kt Pb ore and 500 kt waste rock (Rangott, 1980);
- Woodlawn – initial mine design and planning expected a waste:ore ratio of 7 from a reserve of 10 Mt total ore (Hickson, 1980);
- Blackwood's open cut, Broken Hill – an operating waste:ore ratio of ~8 (MMM-Staff, 1980);
- Century Zinc – differing estimates are available for the total life-of-mine waste:ore ratio, with the 2000 Edition of QNRME (var.) stating ~5.5 while the 2002 Edition of QNRME (var.) states ~12 – given pre-mine ore resources of 105 Mt (1999 Edition) (Pasminco, var.) this suggests a total waste rock possibly of the order of 600 to 1,260 Mt;
- Mt Isa – Black Star open cut project (started production February 2005) – an overall waste:ore ratio was predicted of 4 (Wallis, 2005);
- McArthur River open cut – an overall waste:ore ratio was predicted of ~4.3 (URS & MRM, 2005).

The McArthur River project has recently been given environmental approvals to proceed with a large open cut (including a 6 km diversion of the McArthur River itself), increasing throughput from 1.2 to 1.8 Mt/year. If the large 'Isa open cut' resource is also developed by Xstrata, this could see the majority of Pb-Zn-Ag ore mined by open cut in the near future. Overall, the current and potential future extent of waste rock production re-inforces the need to publicly report waste rock data.

The metal production by mine/field, Figure 58, shows the clear dominance of the Broken Hill field throughout most of the period, with the addition of Mt Isa from 1931 and its increased significance from about 1962 onwards, the major influence of Cannington from 1997, as well as smaller producers since about 1940 (eg. Captain's Flat, Rosebery, Hellyer, etc).

The extent of calculated versus reported production, Figure 58, shows the data and extraction issues discussed above. Prior to 1913, there was confusion over the extent of contained metals mined at Broken Hill. The uncertainties in this data explain the variability in calculated versus reported Pb production to 1913. After this time, however, the master data shows generally 96-98% of reported Pb production to 1968, and still mostly 95% to 2006. For Zn, there is very little data prior to 1904. From 1904 to 1935 the calculated versus reported Zn production is almost always 100%, and maintains 92-100% until 1986, and is slightly more variable at 90-100% to 2006. Overall, this demonstrates that the ore milled and grade data accurately represents the trends in Pb-Zn-Ag mining in Australia over ~1855-2006.

The long-term trends in the proportion of Pb-Zn production, Figure 60, show a clear, sustained shift towards greater Zn than Pb (as noted by Legge & Haslam, 1990). This is also facilitated by the development the Cu-Zn mine at Golden Grove or Zn-dominant ores such as Century Zinc and McArthur River.

The long-term trends in Pb-Zn grades for major mines is shown in Figure 61, showing clear declines overall and the relative grades of newer projects as they are developed.

Table 15 – Australian Lead-Zinc-Silver Projects

Project		Mine	Metals Mined	Ore Grades						Primary Production			Other Metals		Waste
/ Deposit		Type		Mt	%Pb	%Zn	g/t Ag	%Cu	g/t Au	Mt Pb	Mt Zn	t Ag	kt Cu	t Au	Rock (Mt)
Broken Hill	1883-2006[#]	UG/OC	Pb-Zn-Ag-Cu-Au	205.2	10.54	10.14	159	~0.1	-	20.15	19.12	30,211	~231	»27.6	»10
Mt Isa	1931-2006[#]	UG	Pb-Zn-Ag	153.9	6.40	6.84	158	-	-	7.676	7.030	19,080	-	-	»1[b]
Rosebery[a]	1913-2006[#,§]	UG	Pb-Zn-Ag-Cu-Au	29.02[a]	4.59[a]	13.45[a]	149[a]	0.50[a]	2.47[a]	1.097[a]	3.485[a]	3,542[a]	106[a]	54.3[a]	no data
Century Zinc	2000-2006[#]	OC	Zn-Pb-Ag	34.97	2.08	12.03	58	-	-	0.448	3.278	1,289	-	-	no data
Elura / Endeavour	1983-2006[#]	UG	Pb-Zn-Ag	24.01	5.41	8.44	105	-	-	0.941	1.611	1,300	»3.2	»0.1	-
Cannington	1997-2006[#]	UG	Pb-Zn-Ag	19.80	11.65	4.12	538	-	-	2.008	0.524	9,305	-	-	-
Cadjebut-Pillara[c]	1988-2003	UG	Pb-Zn	18.53	~3.0	~8.2	-	-	-	~0.52	~1.47	-	-	-	-
Hellyer	1985-1999	UG	Pb-Zn-Ag-Cu-Au	14.93	6.2	12.2	148	~0.2	~2	0.526	1.424	862	12.7	»0.5	-
McArthur River	1995-2006[#]	UG/OC	Pb-Zn-Ag	13.91	5.5	14.0	~59	-	-	0.369	1.506	~441	-	-	no data
Woodlawn	1978-1997	OC/UG	Pb-Zn-Ag-Cu-Au	14.58	~3.9	~9.3	~75	~1.7	~0.6	0.330	1.064	624	174	1.11	»20
Golden Grove	1991-2006[#]	UG	Cu-Zn-Ag-Au	16.84	~0.4	11.0	~35	2.2	~0.5	0.024	1.297	~538	180	~6.5	-
Woodcutters	1985-1999	OC/UG	Pb-Zn-Ag	4.721	~6.0	~12.9	~80	-	-	0.161	0.439	~276	-	-	no data
Captain's Flat	1884-1962[§]	UG	Pb-Zn-Ag-Cu-Au	4.147	6.03	10.32	55.5	0.68	1.64	0.218	0.360	194	21.6	2.69	»0.43
Thalanga	1989-1999	UG/OC	Pb-Zn-Cu	4.929	2.45	8.16	~25	1.91	-	0.084	0.334	»16.7	66.0	»0.01	no data
Cobar-CSA	1905-2004[#,§]	UG	Cu-Ag-Zn-Pb	25.38	~0.5	~1.62	~20	2.62	minor	0.072	0.275	~383	645.9	»0.04	-
Teutonic Bore	1981-1985	OC/UG	Cu-Zn-Ag-Au	1.441	-	12.42	156	3.68	-	-	0.164	0.188	51.4	-	5.34
Beltana / Aroona	1974-1998[§]	OC	Zn-Pb	0.402	~2	~38	-	-	-	~0.001	0.146	»0.5	-	-	»2
Mt Garnet-Surveyor	2003-2006[#]	OC/UG	Pb-Zn-Ag-Cu-Au	1.407	4.2	11.9	84	1.13	0.73	0.039	0.147	73.9	8.9	0.496	»2.8
Northampton	1850-1967[§]	UG	Pb	0.498	19.49	-	~2	-	-	0.097	-	~1	-	-	-
Herberton-Chillagoe	1890-1920	UG	Pb-Cu-Ag-Au	0.899	6.03	-	265	~4.6	~4.8	0.054	-	238.5	41.6	~4.28	-
Zeehan Field	1893-1959	UG	Pb-Ag	0.591	6.92	-	290	-	-	0.041	-	170.9	-	-	-
Magellan	2005-2006[#]	OC	Pb	1.804	7.3	-	~2	-	-	0.094	-	-	-	-	~10.86
Yerranderie	1884-1953[§]	UG	Pb-Ag-Au	0.127	22.31	-	2,687	-	4.94	0.028	-	341.4	-	0.627	-

[#] Still operating at year's end. [§] Production not continuous. [a] Includes ore sourced from Hercules and Que River. [b] This is from mining of the Black Star open cut only (mainly 1957 to 1965); no waste rock from underground mining reported. [c] May re-open in near future. Note : Minor by/co-product mines are included in the Appendix.

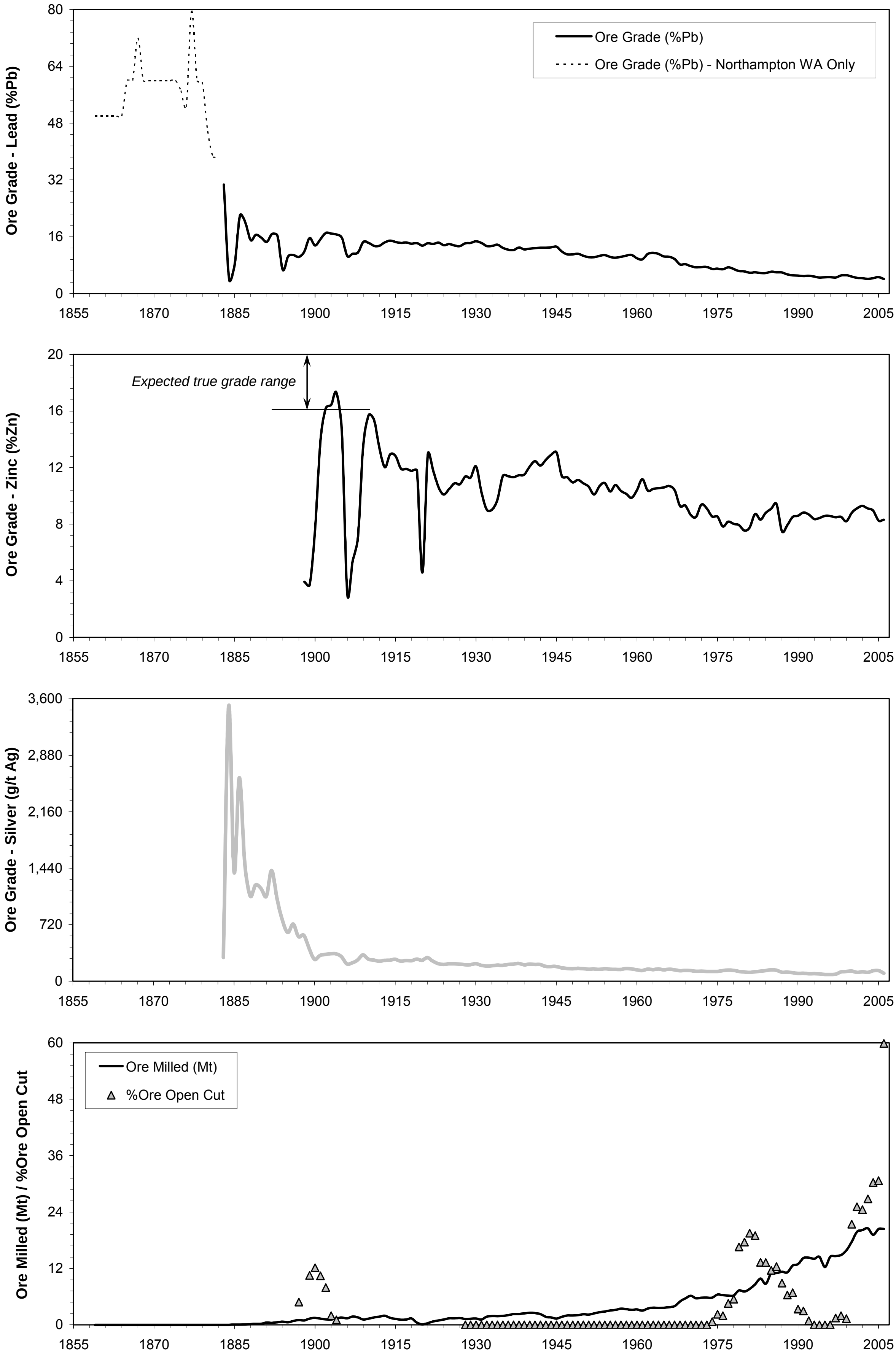


Figure 57 – Lead-Zinc-Silver Milling : Ore Grades, Ore Milled and Open Cut Mining

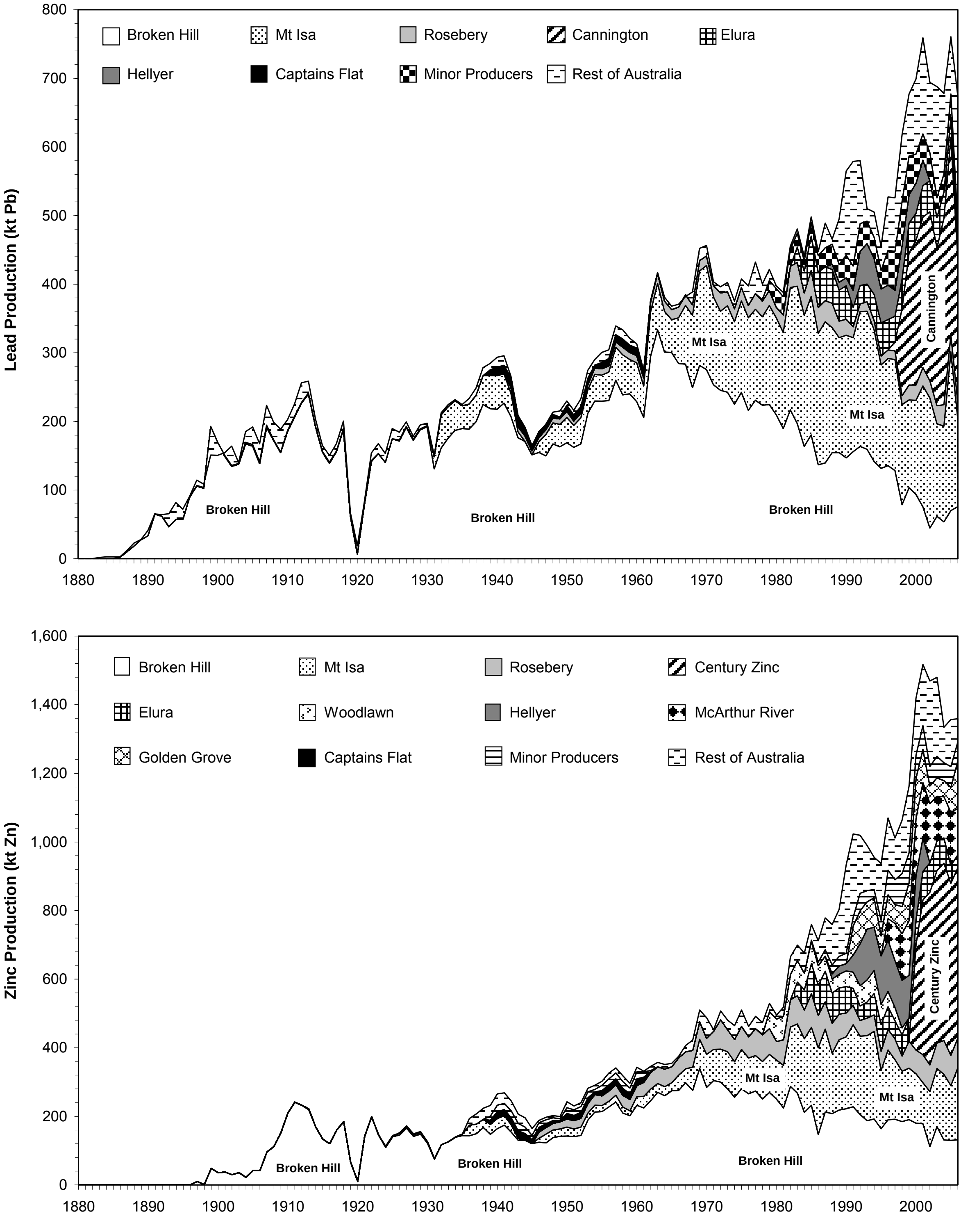
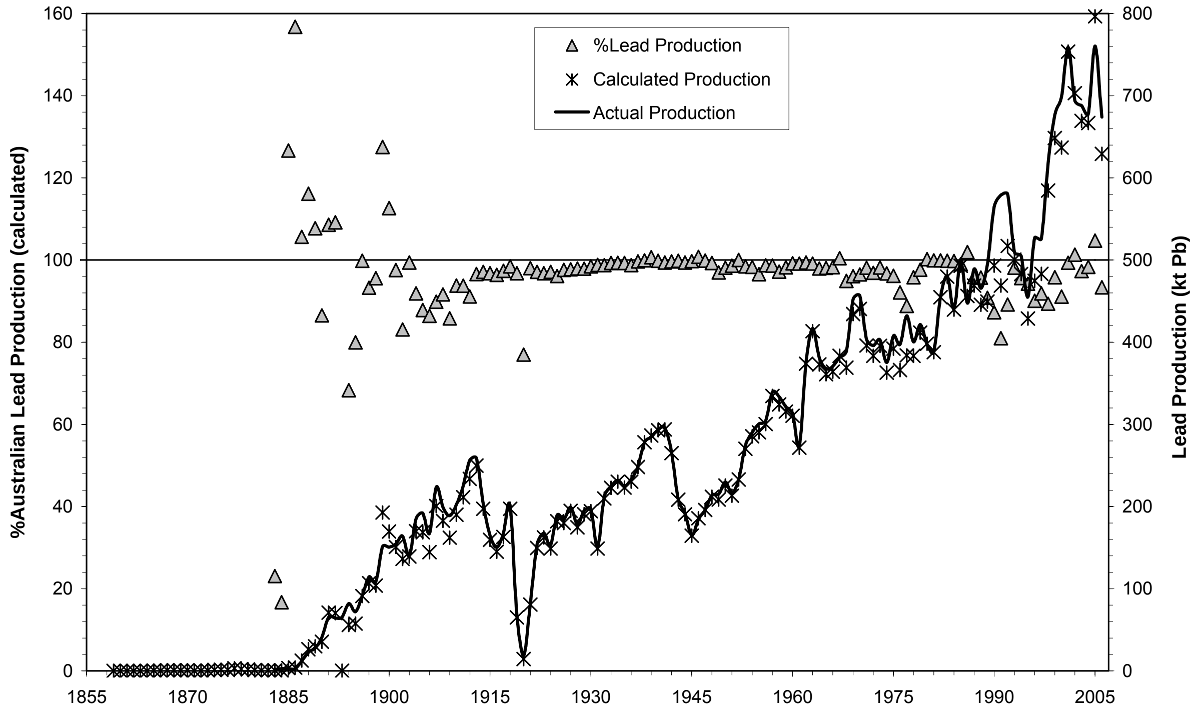


Figure 58 – Australian Lead and Zinc Production by Mine/Field



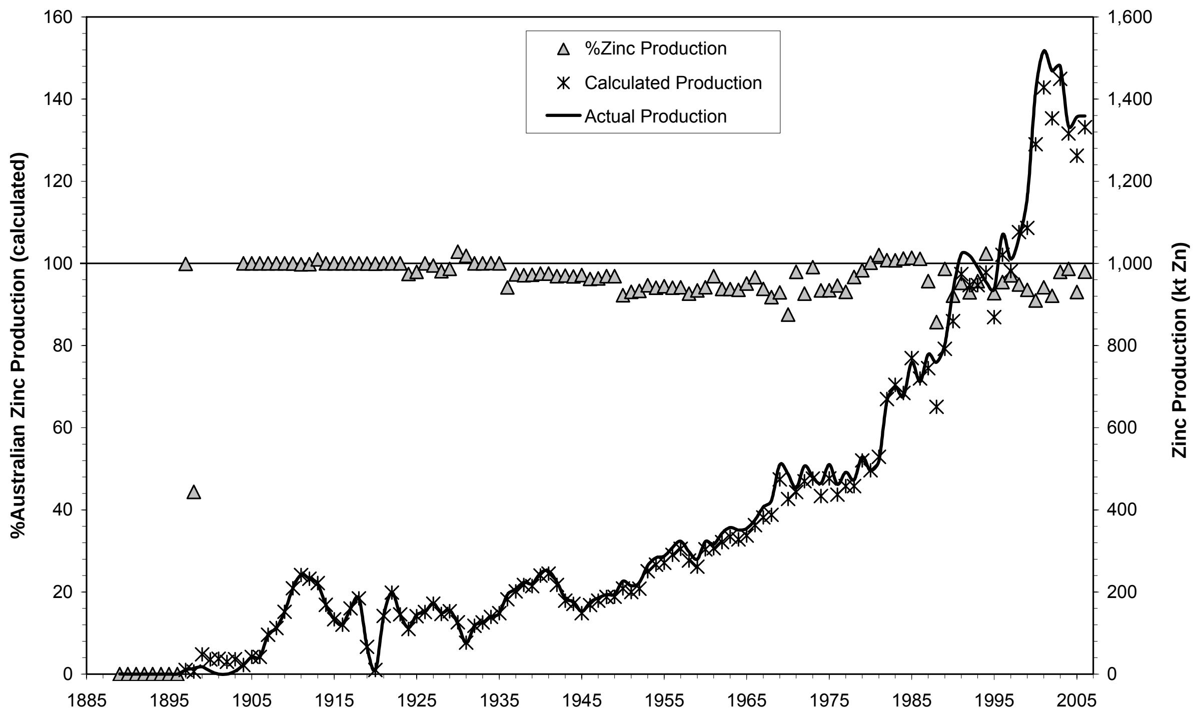


Figure 59 – Calculated versus Actual Australian Lead and Zinc Production

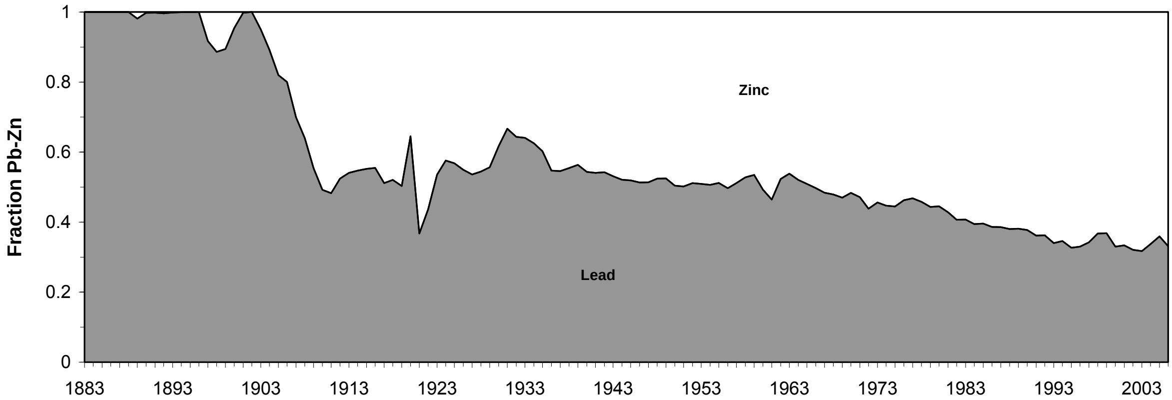
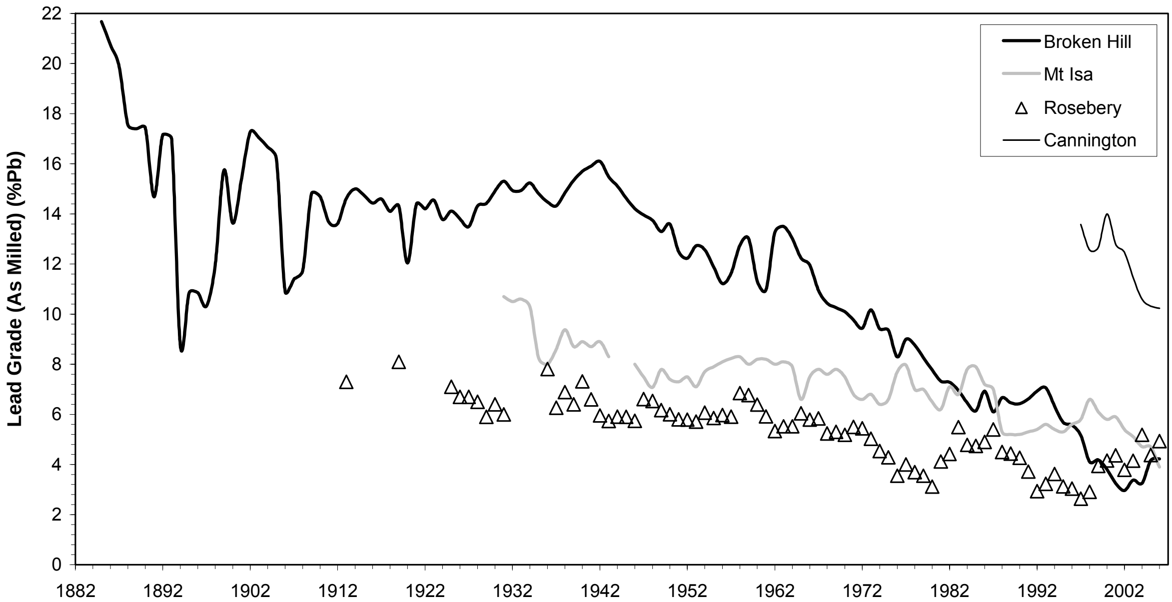


Figure 60 – Australian Lead-Zinc Production Fraction



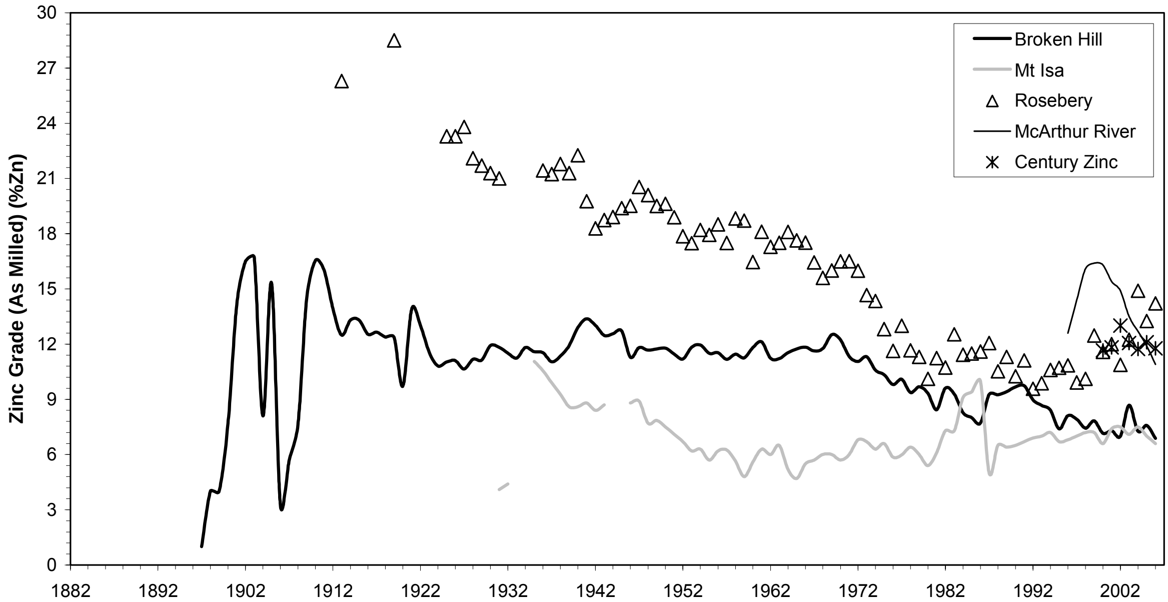


Figure 61 – Lead-Zinc-Silver Ore Production and Grades at Major Mines

7.3.4 Resources

The extent of lead, zinc and consequently silver resources is reasonably well known in Australia over time, due largely to the shear size and dominance of Broken Hill, with data also available for Mt Isa and Rosebery (see appendix). From 1975 to 2006 data is provided by GA (var.), with additional data provided by BMR (var.) and McLeod (1965a, 1998) and state Mines' Departments. Data for a particular year prior to 1975 is only included where it is clear that this is clearly all known deposits for that year (eg. 1931 – Broken Hill field mines plus Mt Isa and Captain's Flat). All compiled data is shown in Figure 62 for Pb and Figure 63 for Zn.

New deposits still being discovered – eg. Reliance Zn oxide deposit near the Beltana-Aroona deposits in South Australia (Groves *et al.*, 2002), though large size deposits have not been discovered since Century Zinc and Cannington in the early 1990's. In general, it appears that most changes over recent years is due to re-assessments of economic resources at known deposits, mines or prospects.

A compilation of economic resources by operating projects is given in Table 16 and by deposits / prospects in Table 16.

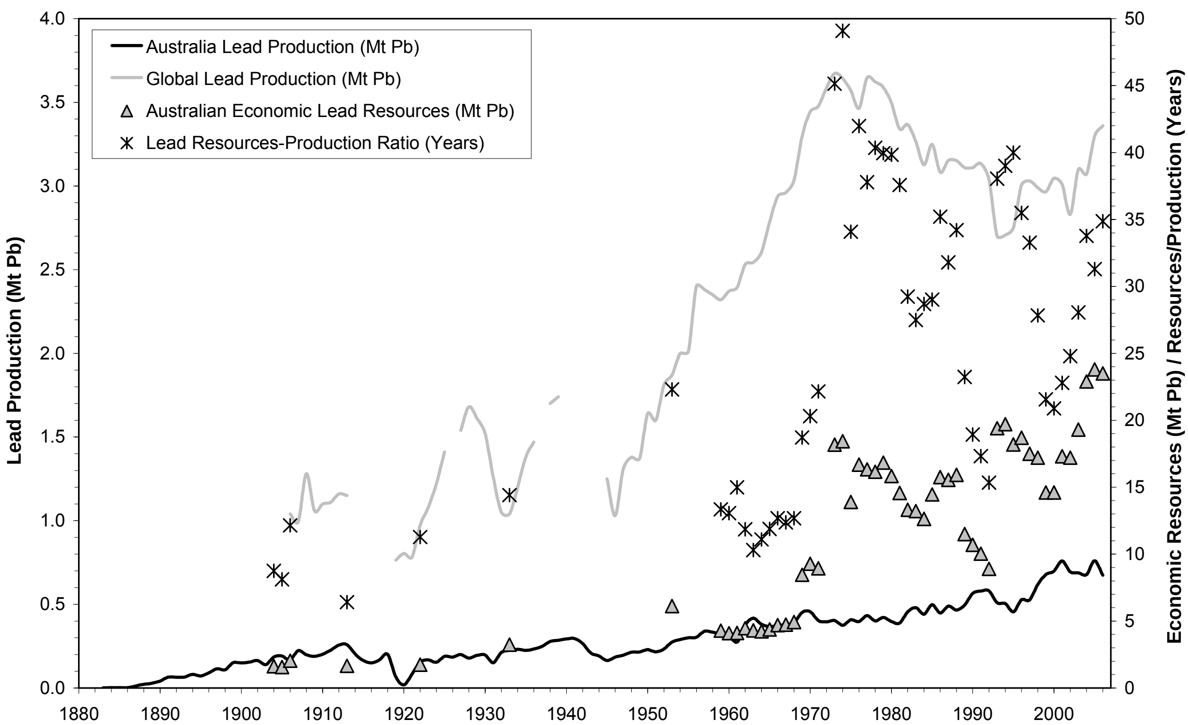


Figure 62 – Australian and World Lead Production Versus Australian Lead Resources

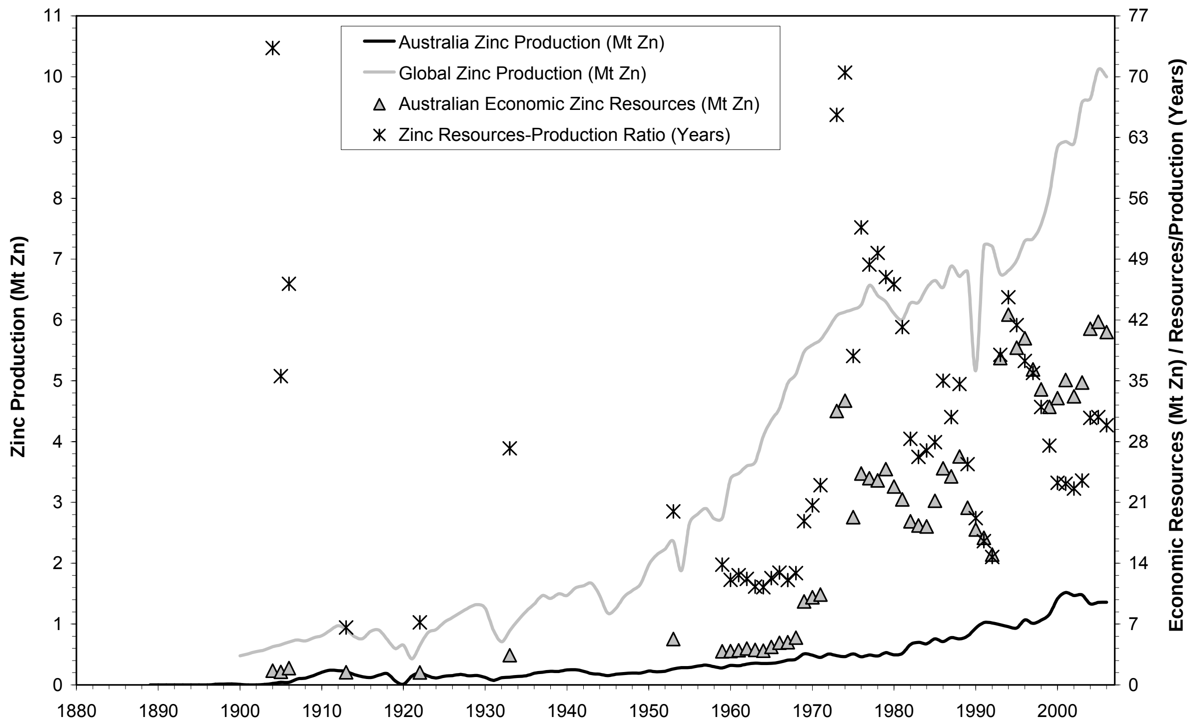


Figure 63 – Australian and World Zinc Production Versus Australian Zinc Resources

Table 16 – Australian Lead-Zinc-Silver Resources by Operating Project

Project / Deposit	Mine Type	Metals Mined	Ore Resources				Other Metals	Contained Metals Mt Pb-Zn-Cu / t Ag	Resource Date	Reference
			Mt	%Pb	%Zn	g/t Ag				
Cannington	UG	Pb-Zn-Ag	33	11.15	4.40	498	None	3.68-1.45-na / 16,434	June 2005	BHPB (var.)
Broken Hill	UG	Pb-Zn-Ag	17.73	5.9	9.9	63	minor Cu-Au	1.05-1.76-na / 1,117	March 2005	Perilya (var.)
Mt Isa[a]	UG/OC	Pb-Zn-Ag	156.5[a]	4.9[a]	8.4[a]	93[a]	none	7.64-13.21-na / 14,569	June 2005	Xstrata (2006)
Mt Isa open cut[b]	OC	Pb-Zn-Ag	312	3.2	4.0	70	none	10.06-12.57-na / 21,980	June 2005	Xstrata (2006)
Century Zinc	OC	Pb-Zn-Ag	67.6	1.5	12.7	38	none	1.01-8.59-na / 2,591	March 2005	Zinifex (var.)
Rosebery[c]	UG	Pb-Zn-Ag-Cu-Au	6.46	4.6	15.2	186	0.44% Cu 2.7 g/t Au	0.30-0.98-0.03 / 1,202	March 2005	TDM (var), Zinifex (var.)
Golden Grove[d]	UG	Cu-Zn-Ag-Au	10.86[d]	1.2[d]	8.4[d]	73[d]	~1.9% Cu[d] ~1.5 g/t Au[d]	0.13-0.91-0.21 / 794	Dec. 2005	Oxiana (var.)
Mt Garnet-Surveyor[e]	OC/UG	Pb-Zn-Ag-Cu-Au	26.38[e]	~0.8[e]	~3.2[e]	~29[e]	~0.8% Cu[e] ~0.9 g/t Au[e]	0.21-0.84-0.22 / 775	June 2005	KZ (var.)
Elura / Endeavour	UG	Pb-Zn-Ag	17.6	4.9	8.7	69	~0.2% Cu	0.86-1.53-na / 1,214	June 2005	CBH (var.), RIU (var.)
McArthur River	UG/OC	Pb-Zn-Ag	156.3	4.9	11.3	47	minor Cu	7.67-17.63-na / 7,381	June 2005	Xstrata (2006)
Cadjebut-Pillara[f]	UG	Pb-Zn	3.1[f]	2.0[f]	8.4[f]	nd	none	0.06-0.26-na / na	Dec. 2005	Teck (var.)
Magellan[g]	OC	Pb-(Ag)	28.6[f]	5.5[f]	nd	nd	none	1.57-na-na / na	Dec. 2005	IWI (var.)
Beltana-Aroona	OC	(Pb)-Zn	0.941	nd	30.6	nd	none	na-0.288-na / na	March 2005	Perilya (var.)

[a] Includes the Black Star open cut (commissioned early 2005) and Hilton and George Fisher underground mines. [b] Proposed open cut only. [c] Includes South Hercules. [d] Cu-Zn-Ag-Au ore resources only (excludes Cu only and Au only ore). [e] Includes nearby deposits of Mungana, Mt Garnet, Surveyor / Surveyor 1 East, Dry River South, Balcooma and King Vol (but excluding Red Dome copper resources). [f] Currently on care and maintenance and includes Pillara, Kapok, Kapok East, Kapok West, Kutarta, Cadjebut, Fossil Downs and Napier Range (an older 2002 resource by WM (var.) gave figures of 21.54 Mt ore at 3.6% Pb and 7.7% Zn). [g] Includes Magellan, Cano, Pinzon and Drake deposits (a 1995 resource of 210 Mt ore grading 1.8% Pb was given by McQuitty & Pascoe, 1998).

Table 17 – Australian Lead-Zinc-Silver Resources by Deposit / Prospect

Project / Deposit	Metals Present	Ore Resources				Other Metals	Contained Metals Mt Pb-Zn-Cu / t Ag	Resource Date	Reference
		Mt	%Pb	%Zn	g/t Ag				
Broken Hill Western Mineralisation	Pb-Zn-Ag	16.7	2.2	3.2	26	none	0.37-0.53-na / 434	June 2005	CBH (var.)
Dugald River	Pb-Zn-Ag	47.9	2.1	12.1	44	none	1.01-5.80-na / 2,108	March 2005	Zinifex (var.)
Abra	Pb-Ag-Cu-Ba	200	1.8	-	6	0.18% Cu, 6% Ba	3.6-na-0.36 / 1,200	~1990	Boddington (1990)
Zeehan-Comstock	Pb-Zn-Ag	6.7	5.2	4.8	52	none	0.35-0.32-na / 348	June 2005	TDM (var.)
Panorama[a]	Cu-Zn-Ag-Au	16.05	~0.1	~4.5	~22	~1.3% Cu	0.02-0.72-0.20 / 361	March 2006	Morant (1998), RIU (var.)
Bowdens	Pb-Zn-Ag	61.0	0.28	0.39	49.5	none	0.17-0.24-na / 3,019	April 2006	RIU (var.)
Sorby	Pb-Zn-Ag	16.24	5.25	0.6	56	none	0.85-0.10-na / 909	~1990	Jorgensen *et al.* (1990)
Lewis Ponds	Pb-Zn-Ag-Cu-Au	6.62	1.4	2.4	69	0.2% Cu, 1.50 g/t Au	0.09-0.16-0.01 / 455	June 2005	TOM (var.)
Woodlawn[b]	Pb-Zn-Ag-Cu-Au	10.1	4.0	10.2	85	1.8% Cu, 0.55 g/t Au	0.40-1.03-0.18 / 859	Oct. 2006	TOM (var.)
Bulman	Pb-Zn	0.375	2	15	-	none	0.01-0.06-na / na	~1950's	Admiralty (var.)
Lady Loretta	Pb-Zn-Ag	11.6	5.7	16.5	-	none	0.66-1.91-na / na	Sept. 2005	RIU (var.)
Angas	Pb-Zn-Ag-Cu-Au	3.04	3.1	8.0	34	0.3% Cu, 0.5 g/t Au	0.09-0.24-0.01 / 103	Nov. 2005	Terramin (var.)
Jaguar	Cu-Zn-Ag-Au	1.65	0.69	11.23	114	2.86% Cu	0.01-0.19-0.05 / 188	Jan. 2005	RIU (var.)

[a] Includes the Sulphur Springs, Kangaroo Caves and Bernts deposits.
[b] Mainly residual resources after original mining project, now being evaluated for re-opening.

7.4 Nickel

7.4.1 Brief History

The large-scale production of nickel is one of Australia's most recent additions to its mining industry. The history of nickel mining in Australia is covered by Raggatt (1968), Woodall & Travis (1979b), Trengrove (1979), Marston (1984), Gresham (1990), Sykes (1995), Pratt (1996) and Griffiths (1998). The monographs of Knight (1975a), Woodcock (1980), Glasson & Rattigan (1990), Hughes (1990), Woodcock & Hamilton (1993) and Berkman & Mackenzie (1998), also contain numerous relevant papers.

The earliest production of nickel in Australia was from 1913 to 1938 in the Zeehan mineral field of western Tasmania, when about 585 t of nickel was produced intermittently from copper-nickel sulphide ore from the Five Mile group of mines (pp 47) (McLeod, 1965b). According to Hughes (1965), these group of small mines produced of the order of 10,000 t of ore grading between 8-17% Ni as well as 5-14% Cu (pp 524), though McLeod (1965a) suggests that only some 5,500 t of ore was sold to overseas smelters for processing (pp 453). According to McIntosh Reid (1925), ore sold totalled 1,208 t grading 11.6% Ni and 5.5% Cu from the Dundas-Cuni mine and 2,820 t grading 11.1% Ni and 5.1% Cu from the Melbourne Cu-Ni mine. Despite broad interest in nickel, the difficulty in mining these small deposits and the general collapse of mining in the Zeehan field around this time led to no further activity.

Between 1953 and 1965 a number of important nickel prospects were discovered, namely :

- 1953 – the Claude Hills prospect in the remote Tomkinson Ranges of far north-western South Australia; reserves in 1975 were estimated at 4.7 Mt grading 1.5% Ni with 4.4 Mt waste rock (pp 1009) (Hiern, 1975). By 1970, the broader Wingellina region, including across the border into the Blackstone Ranges of Western Australia, had been shown to host some 56 Mt of potentially mineable nickel laterite ore grading 1.243% Ni and 0.087% Co (Sprigg & Rochow, 1975), though this area was particularly remote;
- 1955 – Beaconsfield lateritic nickel prospect (Noldart, 1975);
- 1957 – Greenvale lateritic nickel prospect (Fletcher & Couper, 1975);
- 1965 – Marlborough lateritic nickel prospects (including Brolga, Canoona, South Stopeaway and Coorumburra (Pratt, 1996).

These prospects, however, were either extremely isolated (Wingellina) or very difficult to mill (nickel laterites).

In late January 1966 Western Mining Corporation (WMC) discovered a 2.7 m intersection of high-grade nickel at 8.3% Ni from 145.7 m depth – indicating a possibly large high-grade nickel prospect at Kambalda, south of Kalgoorlie in Western Australia (Parbo, 1980; Raggatt, 1968; Woodall & Travis, 1979b). Exploration quickly proved up Kambalda and WMC announced their discovery and intention to proceed with the nickel project on 4 April 1966.

The Kambalda region, in old Archaean geology, had not been considered prospective for nickel sulphide deposits (Woodall & Travis, 1979b) and the global significance of the find was quickly realised – Australia's nickel boom began and a new industry was soon to thrive.

It is curious perhaps that the numerous indications of nickel mineralisation in the broader region had been missed for some decades in a major mining centre such as Kalgoorlie (Raggatt, 1968). The presence of nickel sulphide and laterite minerals was known in the WA gold centres as early as 1910, and was regularly documented up until the 1950's – yet no interest was shown in exploration for nickel and their significance was missed.

Prior to 1966, George Cowcill, a tenacious prospector, had roamed the Kambalda region since 1931. In 1954, at the height of the uranium exploration boom he returned to Kambalda and collected samples he hoped were radioactive for analysis at the WA School of Mines. Although no uranium was found, the samples were assayed for and showed significant nickel and copper. After Cowcill heard that WMC was diversifying from gold into other minerals, he contacted a long-time associate, John Morgan, telling him of his nickel find. Morgan, who worked for Gold Mines of Kalgoorlie (a WMC gold company), quickly followed through and with strong support from senior WMC management a major exploration effort resulted in the formal announcement of the Kambalda nickel province in April 1966.

By the end of 1966 WMC announced an ore reserve of 1.93 Mt grading 4.15% Ni – a considerably higher grade than nickel mines in Canada though smaller in deposit size (Marston, 1984) (at this time, Canada was the world's major Ni producer, averaging 236 kt Ni/year from ore grading ~1.2% Ni; see NRC, var.). The Kambalda ore also contains minor copper, often around 0.2-0.35% Cu, plus minor cobalt at approximately 0.05% Co. The management at WMC, led by Arvi Parbo, moved quickly to capture the strong market for nickel and began construction of a new mining-milling project at Kambalda while exploration was still continuing (Marston, 1984).

The new Kambalda mill came on-stream in mid-1967 and by the end of the year had produced nickel concentrates containing 2,093 t Ni from ore averaging 4.57% Ni (see appendix). The mill was in a state of perpetual expansion for many years. Perhaps the most important aspect of the unprecedented rapid development of Kambalda, especially with hindsight, was that the major Canadian nickel mines underwent protracted labour strikes from 1966 to1969 – thereby facilitating WMC's access to supply the world market and strong economic returns in the critical early years of production (Marston, 1984; Sykes, 1995). The high financial risk of WMC's development strategy should not be under-estimated (Griffiths, 1998).

The ongoing exploration efforts proved the Kambalda region to be very rich in nickel deposits, with WMC's Kambalda reserves by 1975 estimated at 24.55 Mt at 3.23% Ni (Marston, 1984) plus the 7.69 Mt at about 3.4% Ni already mined and milled (see appendix).

The Kambalda discovery ignited a major nickel exploration boom across Australia, but particularly Western Australia. By 1970, numerous nickel deposits had been discovered of varying economic potential, with some already being mined or in the process of development. This includes (eg. Knight, 1975a; Marston, 1984; Parbo, 1992; Pratt, 1996; Woodall & Travis, 1979b) :

- 1968 – Kambalda field – Scotia, Nepean (March), Redross, Wannaway, and others in the Widgiemooltha-Spargoville belt south of Kambalda;
- 1969 – further Kambalda discoveries, Mt Windarra near Laverton (September), Mt Keith near Wiluna (November), Carr-Boyd Rocks (December);
- 1970 – Yakabindie (late) and further low-grade deposits near Wiluna; Black Swan high-grade Ni sulphide deposit north-east of Kalgoorlie;
- 1971 – Perserverance deposit near Agnew (April); the Forrestania nickel field some 260 km south-west of Kalgoorlie (on the edge of the south-west WA wheat belt);
- 1972 – Sherlock Bay nickel deposit in the western Pilbara.

The rapid pace of discovery and delineation of nickel resources, especially in Western Australia, is perhaps unparalleled. Based on the intensity of exploration work, by June 1976 WA nickel sulphide resources had been estimated at some 85.6 Mt of higher grade ore at 2.4% Ni and a further 755 Mt of lower grade ore at 0.6% Ni, containing 2.1 and 4.8 Mt nickel, respectively (Woodall & Travis, 1979b).

By the mid-1970's a major integrated nickel industry had been developed in Australia – achieved in less than a decade. This included several nickel sulphide mines in Western Australia (see Marston, 1984), the Greenvale nickel laterite mine and associated Yabulu refinery in Queensland (1974), the Kwinana nickel refinery south of Perth (commissioned 1970) and the Kalgoorlie nickel smelter (commissioned December 1972). The nickel sulphide projects were mostly very economic for their owners, especially WMC, although the large Greenvale project took some years before reaching a sound commercial footing. Production and development stabilised from this time, with the difficult market conditions for nickel in the 1980's dampening industry expansion (Marston, 1984; Pratt, 1996).

By 2005 the Kambalda field had produced 43.13 Mt of ore grading 3.13% Ni, about 0.25% Cu and 0.06% Co (cobalt) to yield 1,195 kt Ni and more than 61 / 10 kt Cu / Co, respectively (Cu and Co production data is not consistently reported for Kambalda, as well as many other Ni mines). Due to WMC selling all of their Kambalda mines to junior companies (operating the Kambalda mill on a toll basis), an exact resource position remaining on the field is now somewhat difficult. Prior to this strategy, WMC stated total ore resources of 17.3 Mt of ore grading 3.26% Ni, containing 564 kt Ni (1999 Edition) (WMC, var.-b). Based on exploration results since this time and an analysis of numerous junior miners' annual reports, Ni ore resources are still likely to be of the same magnitude and grade (see appendix).

From the early 1990's the nickel industry has undergone some major changes, bought about by a strong market, the development of new 'high pressure acid milling' (HPAL) technology for difficult nickel laterite deposits and several new small and large mines coming on stream :

- 1994 – WMC's large-scale Mt Keith project, WA, operating on 0.6% Ni sulphide ore;
- 1997 – high-grade Black Swan Ni sulphide project, WA;
- 1999 – Cawse Ni laterite project, WA, using new HPAL technology;
- 1999 – Bulong Ni laterite project, WA, using new HPAL technology;
- 2000 – Murrin Murrin Ni laterite project, WA, using new HPAL technology;

The advent of the 'high pressure acid leach' technology for processing Ni laterite ores has been controversial, partly as they were the first HPAL mills built globally to process Ni laterite ores in four decades (the only prior HPAL mill was at Moa Bay, Cuba, built in 1959). The HPAL mill was promoted as a robust, workable technology offering low capital and unit production costs (as discussed by Bacon *et al.*, 2000; King, 2005; Moskalyk & Alfantazi, 2002; Reid & Barnett, 2002). The initial performance of the three WA Ni laterite mines, however, has been much less than hoped – all three projects have (or had) capital and operating costs higher than feasibility study estimates and failed financially (O'Shea, 2003; Reid & Barnett, 2002). Bulong and Cawse were operated for about two and a half years before closure, both struggling to maintain production targets. Cawse was sold to OM Group in December 2001, who closed the refinery section and altered the mill to produce a mixed carbonate concentrate (no data is available since this time). Murrin Murrin, after considerable technical and financial problems, appears to have overcome some of the difficulties but has never expanded to reach the intended rate of 115 kt Ni/year by 2000 (eg. pp 12, 2000 Edition, MR, var.). Annual production over 2001 to 2005 ranged from 25 to 30 kt Ni/year (around 67% of design or nameplate capacity of 45 kt Ni/year; O'Shea, 2003).

The Yabulu Ni laterite refinery, based on the Caron process and originally built in the early 1970's to treat Greenvale and later Brolga ore, began importing laterite ore from the Pacific rim in the late 1980's, mainly Indonesia and New Caledonia. After various ownership changes, Yabulu is now owned by BHP Billiton. In 2004 BHP Billiton committed to developing the Ravensthorpe Ni laterite mine in WA with an intermediate Ni hydroxide product to be treated at Yabulu. The Ni laterite resources at Ravensthorpe are 389 Mt at 0.62% Ni and 0.03% Co (2005 Edition) (BHPB, var.).

Following several years of exploration efforts, Allegiance Mining NL began construction during 2004 of a medium-size nickel project west of Zeehan, based on the recent drilling success and proven Avebury nickel deposits – finally fulfilling the west coast district's century old promise of nickel mining.

Overall, Australia's nickel industry is in a relatively strong position and will continue to evolve as economics and technology develop in the future.

7.4.2 Major Provinces

The principal provinces for nickel in Australia continue to the Yilgarn Craton of central Western Australia, especially the Kambalda field and stretching north to Honeymoon Well near Wiluna. Other important deposits include those in the Pilbara, Kimberley and the Zeehan field of western Tasmania. Nickel laterite deposits are also important. A map of Australian nickel mines and deposits is given in Figure 64.

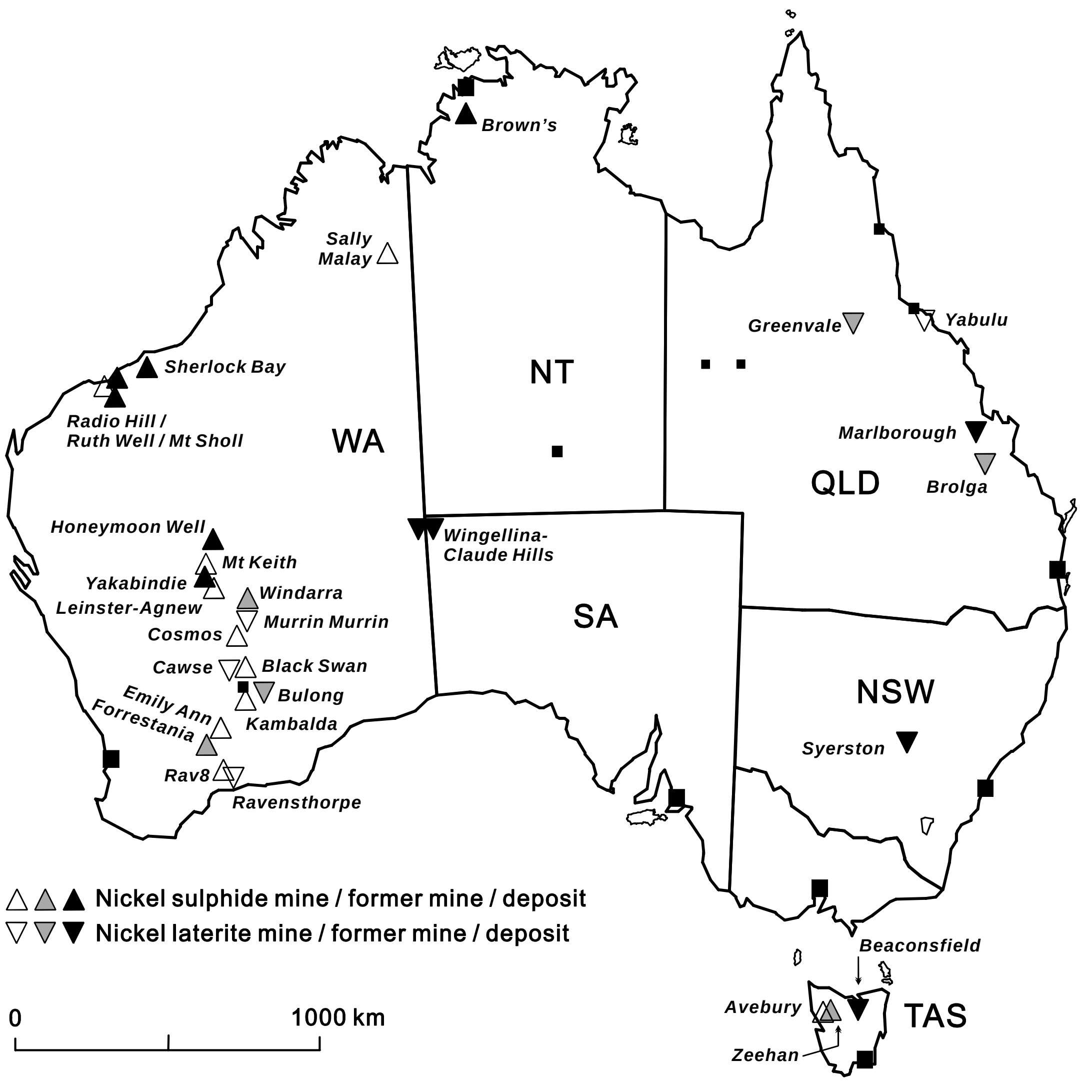


Figure 64 – Australian Nickel Provinces : Major Fields and Mines

7.4.3 Production

In general, due to the relative youth of the nickel sector in the Australian mining industry, data is mostly available although some gaps persist. The compiled statistics for Ni mining are shown in Figures 65 to 67, with total production from major Ni mines/fields given in Table 18. A somewhat unusual feature of Australian Ni production is the dominance of one company – Western Mining Corporation (WMC) – their mines or majority-controlled joint ventures have produced about 67% of Australian Ni (see appendix).

The earliest production of Ni from the Zeehan field in Tasmania was high grade, as shown in Figure 65, though uneconomic. The emergence of the Kambalda region as a world-class Ni province lead to a rapid rise in Ni production. The initial ore grades in the late 1960's were high, ~4% Ni, but began a gradual decline. Within a decade the overall average Ni ore grade in Australia was 2% Ni, largely influenced by the start of the Greenvale Ni-Co laterite mine in QLD. With the new Ni mines developed over the period 1995 to 2005 commonly being low grade laterite or disseminated sulphide deposits, the average ore grade has now declined to about 1.2% Ni.

The complete shift from underground to open cut mining is also evident in Figure 65, due to mines such as Greenvale-Brolga, Mt Keith and recent Ni laterite mines. It should be noted, however, that the 1989 re-development of the Agnew-Leinster mine by WMC has included both open cut and underground mining though no data is reported on the proportion derived from each mine type. There is no waste rock data included in Figure 65 due to the almost complete absence of reported data, as the respective companies have not publicly reported such data. For the Greenvale-Brolga mines, based on data compiled, the ore mined was 31.26 Mt while about 24 Mm^3 waste rock were extracted (about 35 Mt) (see appendix). The limited data available includes :

- Agnew (now Leinster) – in the mid-1980's the Agnew underground mine had ore production of 0.65 Mt/yr with waste rock of 0.18 Mt/year, a waste:ore ratio of 0.28 (pp 5) (Woodcock, 1986);
- South Windarra – the open cut produced about 8Mm^3 of overburden/waste rock (ie. about 15 Mt) (Tastula, 1980) (South Windarra provided about 59% of the 3.49 Mt of ore during the first phase of the Windarra Ni project between 1973 to 1978).

The degree of completeness for the ore mined and milled, in terms of calculated versus reported production or the fraction of Australian Ni production, Figure 66, is generally excellent and close to 100% though with some variability. This is commonly due to the reporting of concentrates and yield from nickel mining, or no reported contained metal production (with values calculated assuming normal extraction efficiencies).

The contribution of Ni production from laterite ores, Figure 67, based on Greenvale-Brolga and the recent WA mines, has been important and is likely to grow in the future if the technological challenges can be overcome profitably.

The ore milled and grade with cumulative production plus resources over time for the Kambalda field is shown in Figure 68, including cumulative production plus remaining economic nickel resources.

Table 18 – Significant Australian Nickel Mines

Mine / Field	Principal Period	Ore Mt	Grade			Production		
			%Ni	%Cu	%Co	kt Ni	kt Cu	kt Co
Kambalda Field	1967-2005[#]	43.13	3.13	~0.23	~0.06	~1,195	~60	~15
Agnew-Leinster[§]	1978-2005[#,§]	~35.75[§]	2.11[§]	-	-	~610[§]	-	-
Mt Keith[§]	1994-2005[#,§]	~115.6[§]	~0.61[§]	-	-	~465[§]	-	-
Greenvale[a]	1974-1992	30.89	1.43	-	0.124	311.3	-	13.85
Murrin Murrin[b]	1999-2005[#]	~14.25[b]	~1.35[b]	-	~0.09[b]	153.1	-	10.0
Black Swan	1997-2004	2.747	4.66	-	-	113.0	-	-
Windarra	1974-1991	~7.5	~1.34	~0.15	-	~85	>3.0	-
Cosmos	2000-2005[#]	0.853	7.69	-	-	62.8	-	-
Forrestania	1992-1999	3.806	2.01	-	-	55.2	-	-
Nepean	1970-1987	1.060	3.15	-	-	33.6	-	-
Emily Ann	2001-2005[#]	1.327	2.97	-	-	31.6	-	-
Radio Hill	1998-2004	1.199	~2.58	~1.85	~0.14	23.7	16.6	1.23
Scotia	1970-1977	0.823	2.14	0.15	~0.04	18.6	1.2	~1
Sally Malay	2004-2006[#]	1.718	1.23	0.54	0.06	17.7	8.8	0.97
Bulong	1999-2002	1.233	1.79	-	0.139	17.2	-	1.0
Brolga[a]	1993-1995	0.567	1.65	-	0.139	13.3	-	0.58
Redross	1973-1978	0.403	3.37	~0.25	-	13.0	~1	-
Rav8	2000-2005	0.417	3.45	-	-	12.8	-	-
Spargoville	1975-1980	0.601	2.37	~0.25	-	12.6	~0.7	-
Cawse[c]	1997-2000[c]	1.128[c]	1.32[c]	-	0.165[c]	10.4[c]	-	1.8[c]
Carr Boyd	1973-1975	0.210	1.43	0.46	-	3.0	1.0	-

[#] Still operating at the end of year.
[§] Due to the takeover of WMC Ltd by BHP Billiton Ltd in August 2005, data for Agnew-Leinster, Mt Keith and the Kambalda field mill are not available since the March 2005 quarterly report of WMC. Most data for 2005 for Kambalda has been compiled from junior miners supplying ore to the Kambalda mill, but still retains some gaps.
[a] The Greenvale and Brolga nickel laterite deposits were both milled at Yabulu near Townsville.
[b] Full production data was only recently started to be reported for Murrin Murrin, with earlier data estimated based on resource grades, limited data and reportedefficiencies.
[c] Cawse closed in early January 2001 but was bought by OM Group Incorporated in December 2001 and after major process modifications was back in production again in 2002 but no production data is available since this time.

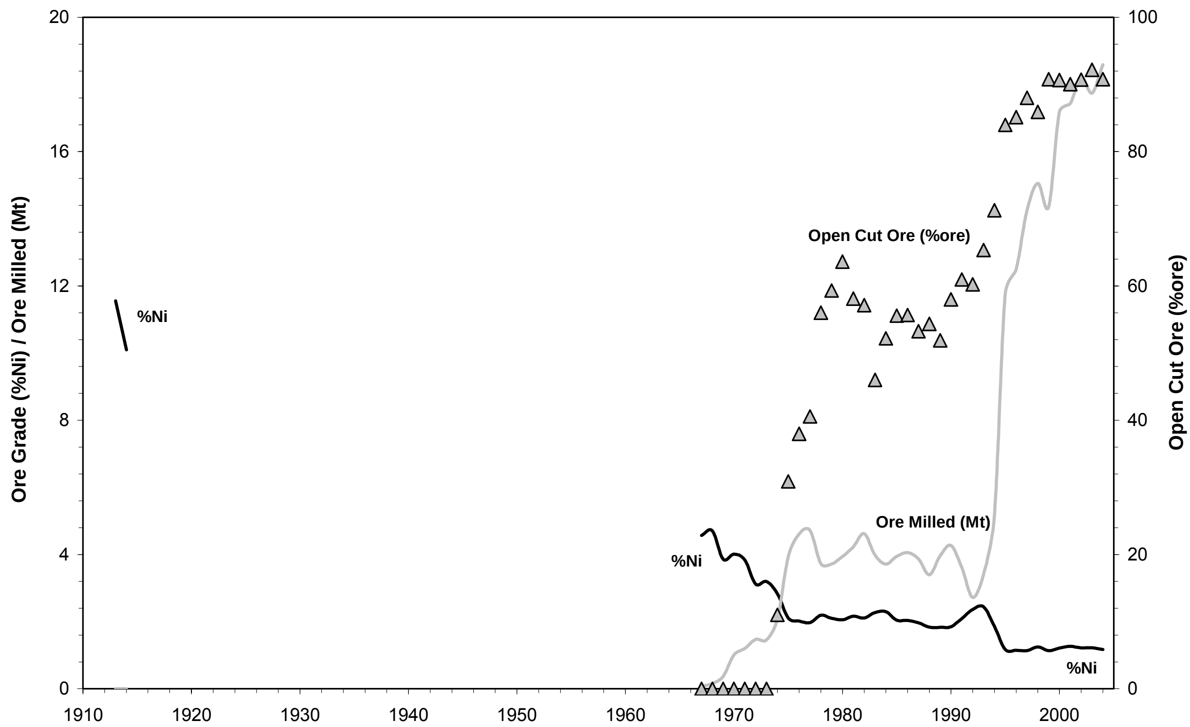


Figure 65 – Australian Nickel Production : Ore Grade, Ore Milled and Open Cut Mining

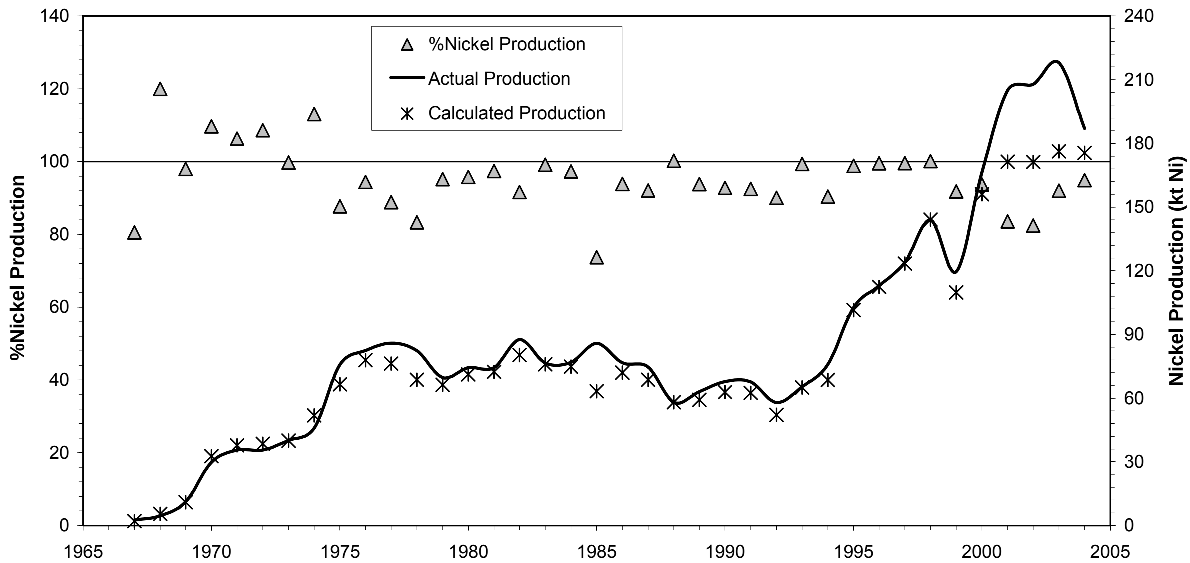


Figure 66 – Calculated versus Actual Australian Nickel Production

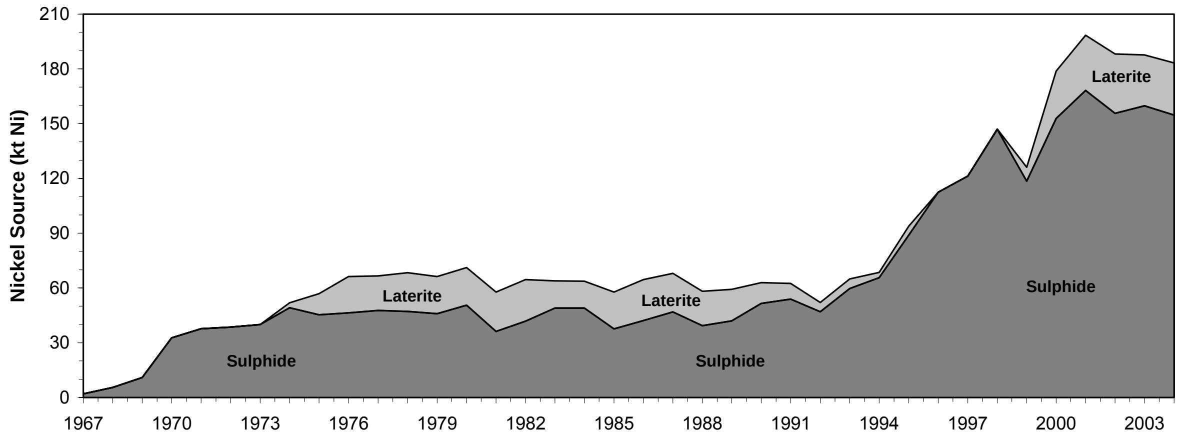


Figure 67 – Australian Nickel Production by Ore Type : Laterite and Sulphide

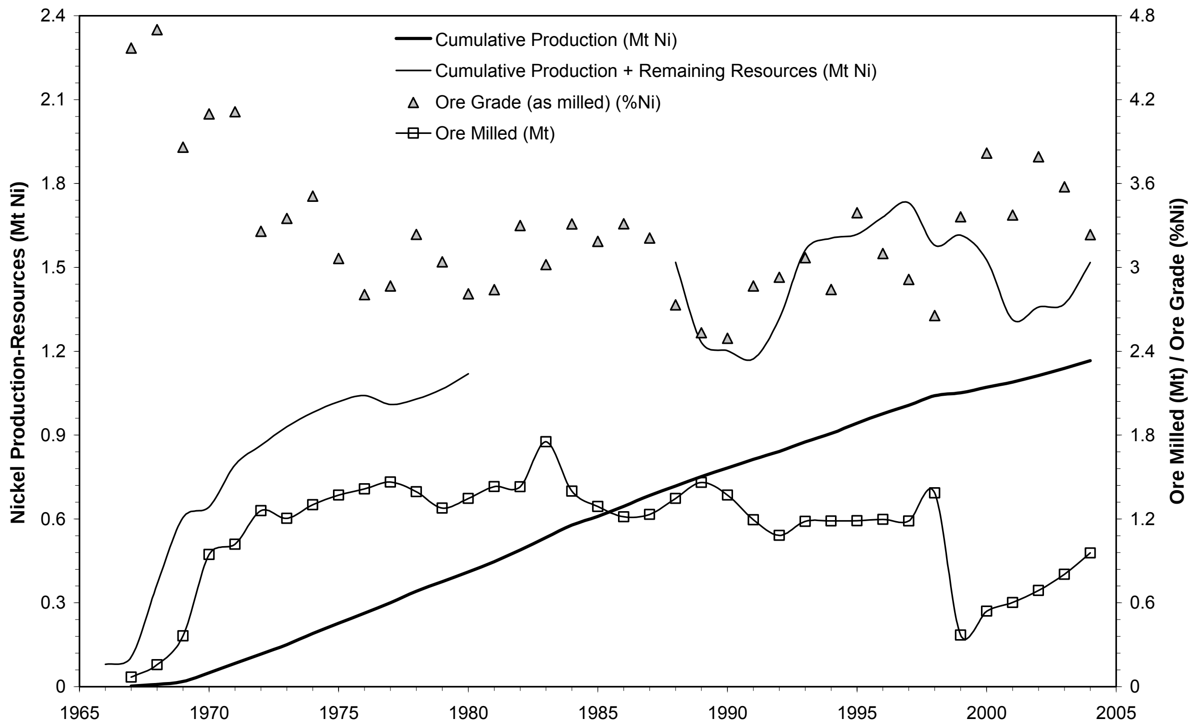


Figure 68 – Kambalda Ni-Cu-Co Field Production Over Time

7.4.4 Resources

The assessment of Australia's identified and economic nickel resources, perhaps due its relatively recent addition to the Australian mining industry, is reasonably well documented. The key reports include Marston (1984), Pratt (1996) and GA (var.).

According to McLeod (1965a), as of about 1964, Australia possessed no nickel resources of consequence or economic potential (pp 453-457). Following Kambalda and the nickel boom, however, Australia is now proven to contain significant resources of economic nickel, especially in nickel laterite ores.

Australian Ni production versus economic resources, Figure 69, indicates sustained growth in both production and resources. A key feature of Australian Ni resources, is that although economic resources appeared somewhat stagnant between 1972 to 1989, the total identified resources were significant and continued to grow substantially (eg. Marston, 1984; Pratt, 1996). The large increase in economic Ni resources since 1990 has been due to the conversion of some of the identified (or uneconomic) resources to economic status (eg. Mt Keith, Murrin Murrin).

As of December 2004, it is estimated that Australia has 22.6 Mt Ni in economically demonstrated resources, with an additional 4.1 and 19.5 Mt Ni of sub-economic and inferred resources, respectively (2005 Edition) (GA, var.). The economic Ni resources are held in 9.7 and 12.9 Mt Ni of sulphide and laterite resources, respectively (2005 Edition) (GA, var.). The estimated global economic Ni resources are 61.8 Mt Ni (2005 Edition) (GA, var.).

Some possible future Ni projects include the proposed Yakabindie open cut Ni sulphide mine, Anomaly 1 open cut Ni sulphide mine, Honeymoon Well and the Kalgoorlie open cut Ni laterite mine (resources in Table 19).

Based on presently known economic resources and 2004 production of 185 kt Ni, there are sufficient resources to maintain existing Ni production for more than 100 years. Similarly to Cu and Pb-Zn-Ag, future production will have to come from increasingly lower grade sulphide ores as well as more difficult laterite ores – providing a significant challenge for environmental requirements such as solid wastes, energy, water and pollutant emissions per unit metal produced.

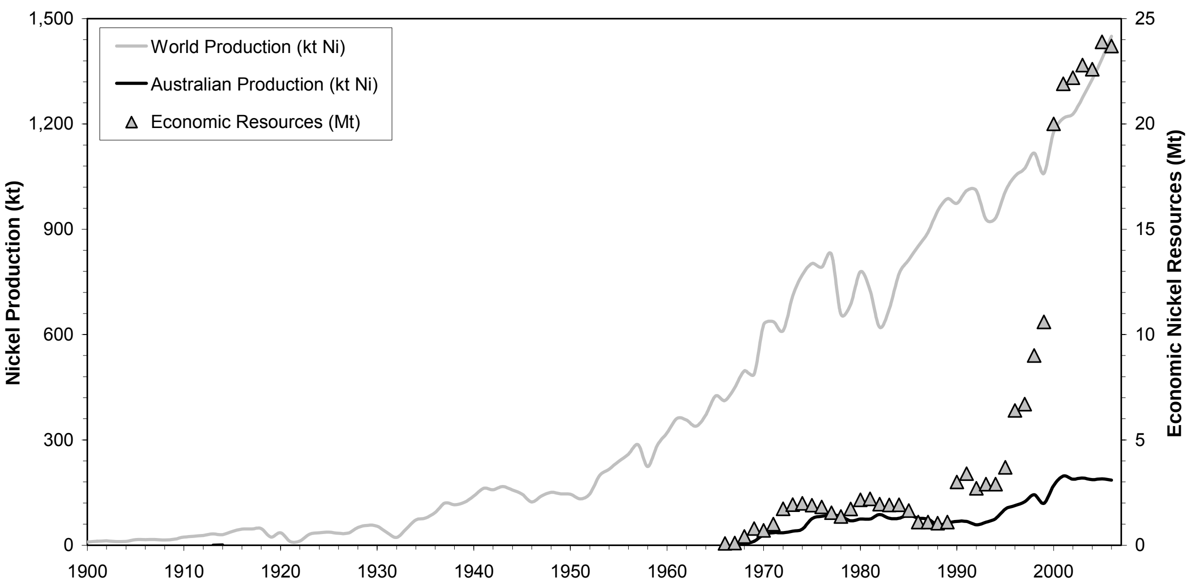


Figure 69 – Australian and World Ni Production and Australian Economic Nickel Resources

Table 19 – Significant Australian Nickel Resources

Mine /	2004 Prod.	Ore	Grade		Contained Metal			Reference
Field	(kt Ni)	Mt	%Ni	%Co	kt Ni	kt Co	Date	
Kambalda	28.12	15.819	2.22	-	351	-	~2004 [§]	Various [§]
Agnew-Leinster	44.58	196.9	0.88	-	1,726	-	Dec. 2004	WMC (var.-b)
Mt Keith	43.08	437.2	0.53	-	2,321	-	Dec. 2004	WMC (var.-b)
Cosmos	12.30	0.48	7.88	-	37.8	-	June 2004	JM (var.)
Emily Ann	7.71	1.101	3.97	-	43.7	-	Dec. 2004	LionOre (var.)
Sally Malay	2.60	3.736	1.74	0.09	65	3.36	Jan. 2002	SMM (var.)
Black Swan	~11	9.291	1.19	-	110.4	-	Dec. 2003	MPI (var.)
Murrin Murrin	28.52	320	0.99	0.063	3,168	202	June 2004	MR (var.)
Radio Hill	0.9	1.428	0.61	0.03	8.7	0.4	June 2004	Fox (var.)
Cawse [‡]	-	212.2	0.67	0.035	1,422	74.3	June 2000 [‡]	CME (var.)
Rav8	-	0.0336	3.86	-	1.3	-	June 2003	TR (var.)
Prospects								
Yakabindie	-	290	0.58	-	1,677	-	Dec. 2004	WMC (var.-b)
Cliffs	-	2.5	4.08	-	102	-	Dec. 2004	WMC (var.-b)
Jericho	-	34.5	0.6	-	207	-	Dec. 2004	LionOre (var.)
Ravensthorpe	-	389	0.62	0.03	2,410	117	June 2004	BHPB (var.)
Avebury-Zeehan	-	4	1.5	-	60	-	June 2004	Allegiance (var.)
Anomaly 1	-	36.3	0.74	-	267	-	June 2004	JM (var.)
Maggie Hays	-	11.666	1.46	-	170.5	-	Dec. 2004	LionOre (var.)
Honeymoon Well	-	135.2	0.80	-	1,082	-	Dec. 2004	LionOre (var.)
Kalgoorlie [†]	-	891	0.74	0.05	6,593	446	June 2004	Heron (var.)
Mt Sholl	-	5.553	0.54	0.04	30.0	2.22	June 2004	Fox (var.)
Marlborough	-	210	1.02	0.06	2,142	126	Sept. 2002	PR (var.)
Syerston	-	76.8	0.73	0.13	561	100	July 2000	BRM (var.)
Total	**178.8**	**1,198**	**~0.77**	**-**	**~9,250**	**-**		

[§] Due to WMC selling out of mining and only maintaining milling at Kambalda, remaining ore resources are compiled from numerous junior miners who sell ore to WMC for toll milling. Companies included are (IG, var.; Mincor, var.; Reliance, var.; TR, var.; View, var.). For further data and the history of ore resources at Kambalda, see the master data set in the Appendix.
[†] The Kalgoorlie Ni laterite project now combines the resources of the Goongarrie, Siberia, Bulong and Hampton deposits.
[‡] The Cawse nickel laterite project, originally developed by Centaur Mining & Exploration (CME), was sold to OM Group Corporation in 2002. Since this time, although the project is still operating, no production statistics are available.

7.5 Diamonds

7.5.1 Brief History

The Copeton-Bingara region of north-east New South Wales produced just over 200,000 carats[26] of diamonds between 1872 to 1882 (Hickling, 1984; Karpin, 1993). Numerous diamonds have also been found across Australia, though generally in isolated occurrences.

The discovery of a major diamond deposit was a highly desired prize by the mining industry for many decades. Despite continuing exploration and geologic theory (eg. Hickling, 1984), there was little success until the 1970's. Continuing work in the Kimberley region of north-east Western Australia led to the discovery of some 70 diamondiferous pipes[27], importantly including the Ellendale pipes in the western Kimberley (Smith *et al.*, 1990). The exploration techniques which led to these discoveries proved most valuable, and formed the basis for continuing and by then accelerating work. The Ellendale pipes were tested in detail from 1977 to 1980, processing about 230,000 t of ore for a return of about 13,000 carats of diamonds (a yield of 0.057 carats/t), but the Ellendale pipes ultimately were considered too low grade and sub-economic (Smith *et al.*, 1990).

Between August to October 1979, continuing exploration work in the eastern Kimberley by the Ashton Mining-CRA Joint Venture led to the discovery of diamonds in the alluvial sediments of Smoke Creek. On 2 October, Ashton-CRA geologists located the source and the giant Argyle deposit – the high grade AK1 pipe – had been revealed.

The Argyle/AK1 pipe was one of the most significant mineral deposits in Australia discovered in the last 25 years of the twentieth century. Indeed, Argyle was the highest grade primary (hard rock) diamond deposit ever discovered by that time in the western world[28] (Karpin, 1993). The ore reserves were initially estimated conservatively at 61 Mt grading 6.8 carats/t (or 415 million carats) (pp 1437) (Karpin, 1993). The quality of Argyle diamonds, however, are mostly low value industrial (53%) and near-gem quality (41%) diamonds with high value gem quality diamonds only comprising 6% (Karpin, 1993).

In 1982, during exploration nearby to Argyle, the Freeport of Australia-Gem Exploration Joint Venture located another alluvial diamond deposit 30 km downstream from Argyle at Bow River. The deposit was mined from early 1988 to 1995.

Following detailed exploration, metallurgical testing and mine planning, the Argyle project began in 1983. Initially, parts of the alluvial deposits were mined and processed from January 1983 to December 1985, when the large open cut mine of the AK1 pipe and mill was bought on-stream. In its first full year of operation in 1986, Argyle produced 29.2 million carats of diamonds – amounting to some 40% by volume of world natural diamond production and 8% by value (Karpin, 1993; Smith *et al.*, 1990). The Argyle project was originally owned by CRA Ltd (56.8%), Ashton Mining Ltd (38.2%) and the Western Australian Government (5%), and is currently owned 100% by Rio Tinto Ltd (the successor of CRA, who eventually took over Ashton Mining in 2001).

In the Northern Territory, both Ashton and CRA continued an aggressive exploration program. The technical challenges were more difficult than the Kimberley, but the long-term effort led to the discovery of the Emu pipes in September 1984 by CRA in the remote Gulf country of the north-east NT. After a considerable amount of exploration and evaluation, CRA dropped the Emu leases, and they were picked up by Ashton.

[26] A carat is a weight measure used uniquely for diamonds. 1 carat = 0.2 grams (ie. 1 kg = 5,000 carats).

[27] Due to the geological process of forming diamonds in deep volcanic systems reaching to the surface, diamond deposits are often referred to as "pipes" to reflect their geology.

[28] Two major primary diamond deposits were recently discovered in northern Canada, the Diavik and Ekati projects, considered to be of similar size and significance as Argyle.

It took many years of endeavours by Ashton, being rewarded with the discovery of the Merlin pipes just south of those at Emu. The Merlin pipes were sometimes covered with 40 to 60 m of sandstone (Fisher, 2002). Ashton developed a mining project at Merlin in 1999, though after Ashton was taken over by Rio Tinto in late 2000, the project was closed prematurely in early 2003 (see later resources section). The Kimberley Diamond Company has recently taken over the Ellendale project, and began a commercial mining operation in 2002, which is presently expanding. A map of the locations of diamond mines and prospects is shown in Figure 70.

Figure 70 – Location of Australian Diamond Mines and Prospects

7.5.2 Major Mines

Excluding Copeton production before 1975, there have been four diamond mines developed in Australia – Argyle, Bow River and Ellendale in Western Australia and the Merlin project in the Northern Territory. Only the Argyle project has considerable resources remaining, though a shift from open cut to underground mining will occur in the near future. The smaller Ellendale project, combining a series of diamond deposits, is currently expanding. Merlin is presently closed but still contains a moderate low grade resource.

7.5.3 Production

The data for diamond production is mostly readily available, due principally to the dominance of Argyle. In general, the data has been sourced directly from respective company reports and associated technical papers (detailed in the appendix). The data for ore milled is complete, however, this is rarely accompanied by true assay grade[29]. There remain some minor gaps for Bow River, though given the scale of Argyle at some 99% of total Australian diamond production, these gaps do not affect the compiled master data set in any meaningful way.

The data for waste rock at Argyle is also mostly complete, principally from Ashton (var.) (but curiously not CRA/Rio), though recent years for Argyle are not available from Rio since their takeover of Ashton (the last waste rock data reported was up to September 2000). The waste rock with alluvial mining has generally not been publicly reported. The master data includes 20 Mt of waste rock pre-stripping at the AK1 open cut from November 1983 to August 1985 prior to the commencement of full-scale mining and milling in December 1985 (pp 441) (Smith *et al.*, 1990) (see also WADM, var.).

The initial Argyle mine plan called for mining of 3 Mt/yr ore and 10.5 Mt/yr waste for the first 7 years, then increasing to 13 Mt/yr waste (pp 1447) (Yates *et al.*, 1993). The total mine plan called for 123 Mt ore and 315 Mt waste to be mined. The Argyle project has been expanded since this time, and in late 2005 Rio Tinto approved the development of underground mining of the AK1 pipe to extend Argyle's life to 2018 (including an expansion of the open cut to continue ore production during the transition).

At Bow River, the overall waste:ore ratio for the life of the project was estimated at 1.38:1 (pp 1449) (McCracken & Major, 1993). According to Smith *et al.* (1990), for ore reserves of 16.21 Mt grading 0.389 carats/t, the quantity of waste rock was 21.72 Mt (a waste:ore ratio of 1.34:1) (pp 444). Based on the 1996 Annual Report of Normandy (var.), Bow River produced 24.9 Mt of ore to yield 7.2 Mcarats (including 0.32 Mcarats from tailings reprocessed between 1991 to 1994), representing a yield of 0.289 carats/t.

The Merlin project, smaller and lower grade than Bow River but containing significant gem quality diamonds, operated from mid-1999 to early 2003. Merlin was re-opened by Striker Resources Ltd (now renamed North Australian Diamonds Ltd) in 2006 and has re-processed tailings and started conventional mining and processing again.

A summary of these projects to date is given in Table 20. The production over time is shown in Figure 71.

Table 20 – Australian Diamond Projects by 2006

Project	**Principal**	**Ore**	**Grade**	**Yield**	**Resources (2006)**			**Principal**
	Period	Mt	carats/t	Mcarats	Mt	carats/t	Mcarats	**References**
Ellendale	1977-80, 2001-2006§	~7.94	**0.071**	~0.566	- 78.1	- 0.064	- 4.98	Hughes & Smith (1990), KDC (var.)
Bow River	1988-1995	24.9	**0.289**	7.2	(exhausted)			Normandy (var.)
Merlin	1999-2003, 2006†	~2.53	**0.205**	~0.52	19.5	0.18	3.52	Ashton (var.), NAD (var.), RT (var.)
Argyle	1983-2006§	230.2	**3.17**	730.0	106	2.1	220.6	ADM (var.), Ashton (var.), RT (var.)
		Waste rock ~838.1 Mt			103	2.1	215.6	

§ Still operating at end of 2006; ore reserves are top and ore resources are bottom.
† Exploration and pilot milling only during 2006; data does not include additional diamonds from tailings reprocessing.

[29] In diamond mining, data is generally presented in terms of yield only. There is insufficient Argyle data to correct yield to assay (true ore) grades.

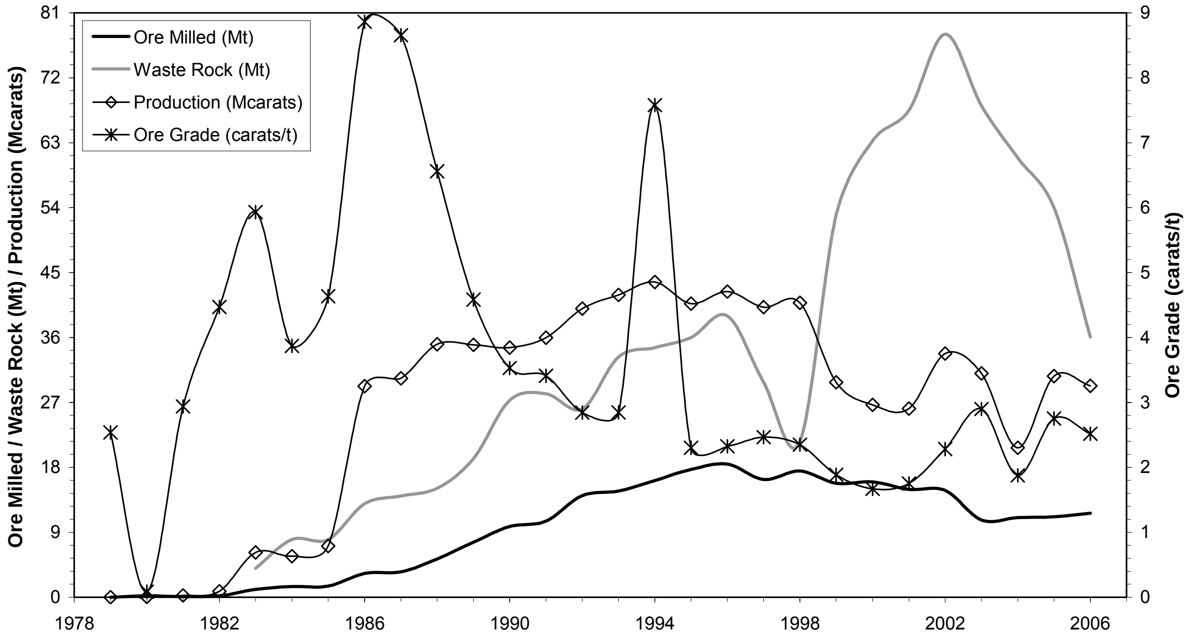


Figure 71 – Australian Diamond Milling : Ore Grade, Ore Milled and Waste Rock
Note : Waste rock for years 1983-85 and 1987 are best estimates based on papers and reports.

7.5.4 Resources

As noted previously, diamond deposits were unknown in Australia prior to the 1970's. Since the Ellendale and Argyle discoveries in the Kimberley, major economic diamond resources have been proven, almost entirely related to the sheer size of the Argyle/AK1 deposit.

The resources compiled below are based on reported annual resources by Rio Tinto (and its predecessors) for Argyle (CRA, var.; RT, var.), Kimberley Diamond Company for Ellendale (KDC, var.), and available data for the Merlin deposits (Ashton, var.; RT, var.). There is little reporting of the type of diamonds over time by deposit, such as industrial or gem quality. Although not in Australia, both Rio Tinto and BHP Billiton have recently developed two large diamond mines in the arctic of northern Canada at Diavik and Ekati, respectively.

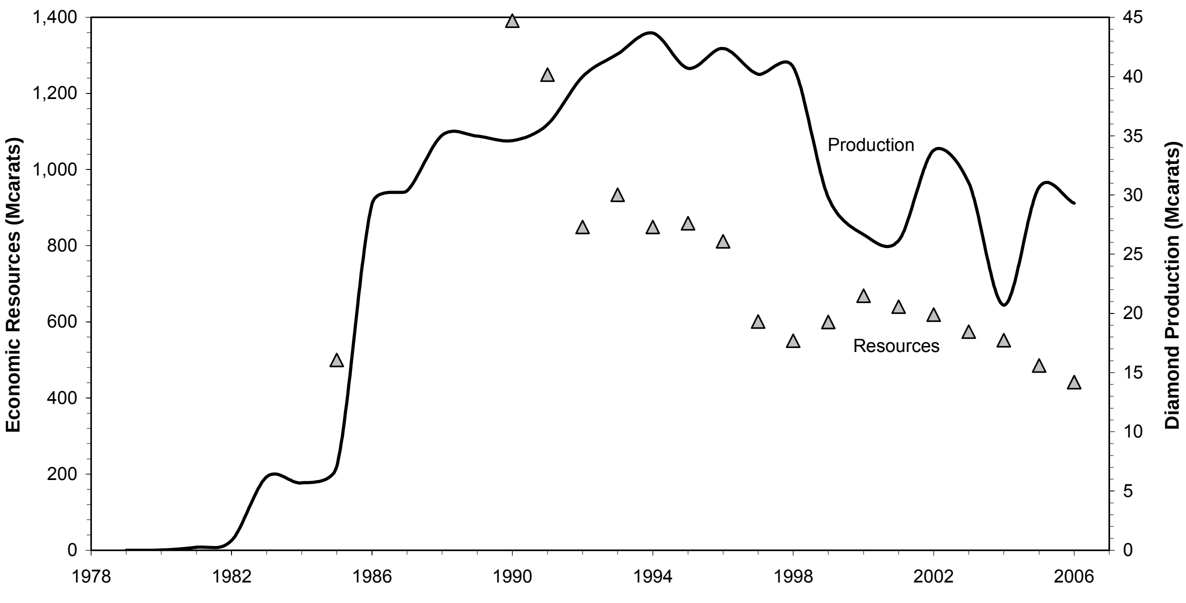


Figure 72 – Australian Economic Diamond Resources (Mcarats)

8. Analysis : Key Trends Affecting Sustainability

8.1 Ore Grades

A key hypothesis for this report was to investigate whether ore grades are in long-term decline, and if so quantify the rates for this decline. As discussed for each particular mineral, there can be various factors behind the evolution of Australian average ore grade, such as changing economics, new technologies, exhaustion or discovery of major deposits, social issues (eg. strikes), and the like. A combined plot of ore grades for all base and precious metals and diamonds is shown in Figure 73. A generalised trend is also indicated.

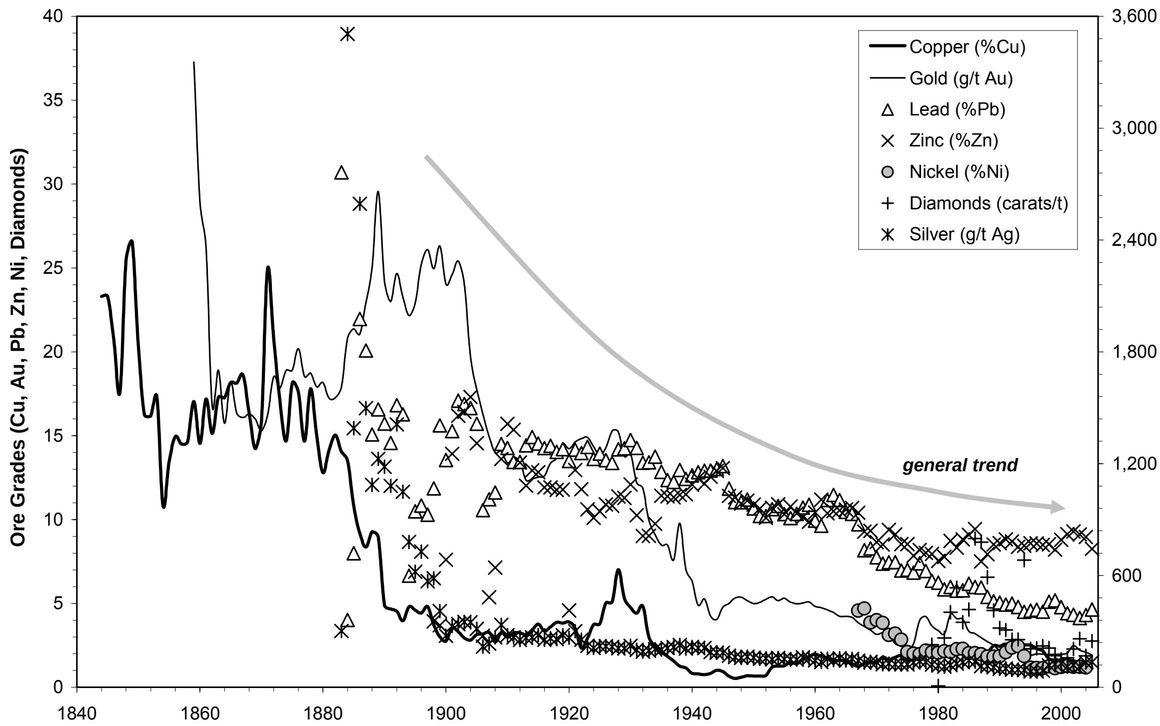


Figure 73 – Combined Average Ore Grades Over Time for Base and Precious Metals

Based on currently known economic ore resources, ore grades for all minerals will invariably continue to gradually decline though at a slower rate than the past. Although exploration success is still finding new deposits for most minerals, high grade deposits are becoming increasingly uncommon. Actual ore grades for a specific mine are, of course, a function of factors such as technology, economics and social/environmental constraints – however, the long-term data shown in Figure 73 clearly show that gradual declines can be expected to continue with no real prospect of ever returning to the higher grades of the past.

8.2 Waste Rock / Overburden

The extent of waste rock / overburden produced by mining is clearly not recognised as a major issue by many segments of the mining industry. For many large mining projects the extent of waste rock / overburden mined annual is commonly not reported. There are multiple reasons for needing to know the extent of waste rock / overburden :

- ***Economics*** – the excavation, transport, and management of waste rock presents a significant cost. The ratio of waste rock to ore, especially for open cut mines, can often be a critical element of economic mine planning. Further to this, waste rock dumps cover a significant area and therefore require major costs in rehabilitation. If future environmental requirements specify the backfill of mined out open cuts, it is critical to know the mass or volume of waste rock for good engineering design of rehabilitation measures.
- ***Mine Infrastructure*** – mine infrastructure often requires the use of waste rock / overburden during mine construction or operation, especially as tailings dams. Failure to adequately predict the extent of waste rock and its necessary characteristics (strength, density and the like), may prove costly in the re-design of tailings dams, or even lead to a delay in mine development.
- ***Environmental*** – the scale and nature of waste rock often presents significant environmental risks if not identified and managed accordingly. Historically this has not been achieved, with numerous former / abandoned mine sites leaving major pollution legacies following closure. This is principally due to the formation of acid mine drainage (AMD) – the sulphide minerals in the waste rock reacts with the water and oxygen in the surface environment, leading to the creation of sulphuric acid which in turns dissolves salts and heavy metals. AMD-polluted water is invariably quite toxic to aquatic ecosystems. There are numerous mine sites around Australia (and internationally) which have left major legacies of acid mine drainage impacting on surrounding and downstream ecosystems, of which some infamous case studies include :
  - *Mt Lyell* – the 100 Mt of tailings discharged to the Queen and King Rivers until 1994 as well as the 50 Mt of waste rock has created perhaps Australia's most notorious environmental legacy of acid mine drainage impacts – which reach as far downstream as the marine ecosystems of Macquarie Harbour;
  - *Mt Morgan* – poor tailings as well as waste rock management has created a major legacy of AMD impacts in the adjacent Dee River, with the Queensland Government now liable for a rehabilitation cost of the order of $100 million or higher;
  - *Rum Jungle* – a complete lack of tailings and waste rock management during operations created a major legacy of AMD impacts in the adjacent Finniss River. The Commonwealth Government, as owner of the former project, contributed about $20 million for rehabilitation in the 1980's but this work is not meeting expectations – with recent evidence that the covers are allowing more water to infiltrate into the underlying waste rock – thereby continuing the AMD cycle. Significant pollution loads still emanate from the Rum Jungle waste rock dumps;
  - *A range of former mines across Australia could also be discussed (across all climatic zones).*

As noted for coal, copper, gold and uranium, the extent of waste rock produced by these sectors has increased dramatically since the mid-twentieth century, but especially since 1980. The two components of this include both the waste rock:ore ratio as well as the total quantity of waste rock. If the ratio continues to increase over time as is apparent for many minerals, this will lead to ever increasing volumes of waste rock to be managed. At present there is not sufficient data on the public record to examine this quantity of waste rock with respect to the potential for acid mine drainage or other environmental problems, leaving major uncertainty with respect to the long-term sustainability of waste rock production and management.

It is clear that waste rock / overburden is a fundamentally strategic and critical issue facing the mining sector in Australia, as well as worldwide, yet it remains under-recognised for the range of issues it presents and is not consistently reported along-side standard metrics for mining projects such as milling and financial performance.

8.3 Economic Resources

The extent of economic resources for the minerals studied in this report generally show, over the long-term, that they have been maintained at reasonable resources-to-production ratios throughout the twentieth century. For some minerals, periods of major exploration, discovery and development have facilitated extensive projects to be initiated (eg. Pilbara iron ore, Darling Ranges bauxite-alumina), while for other minerals it is broad-ranging success in greenfields and brownfields exploration which has led to gradual increases in known economic resources (especially gold and copper). A compilation of known economic resources and 2005 production is given in Table 21, including the resources-to-production ratio as a measure of the years remaining (assuming constant annual production).

Table 21 – 2005 Economic Resources, Production and Resources-Production Ratio

Mineral	Production	Economic Res.	Years Left	Sub-Economic Res.§
Bauxite	59.96 Mt	5,800 Mt	97 years	3,200 Mt
Black Coal	~398 Mt	39,200 Mt	99 years	67,900 Mt
Brown Coal	67.15 Mt	37,400 Mt	557 years	156,100 Mt
Copper	918 kt	41.4 Mt	45 years	36.4 Mt
Diamonds	30.65 Mcarats	493 Mcarats	16 years	-
Gold	262.98 t	5,225 t	16.8 years	5,836 t
Ilmenite	~1.88 Mt	214 Mt	114 years	170.4 Mt
Iron Ore	~261.7 Mt	16,400 Mt	63 years	20,800 Mt
Manganese Ore	~3.60 Mt	143 Mt	~40 years	345 Mt
Lead	767 kt	23.8 Mt	31 years	33.8 Mt
Nickel	187 kt	22.6 Mt	121 years	23.7 Mt
Rutile	177 kt	20.5 Mt	116 years	42.1 Mt
Uranium	11.25 kt	1.35 Mt	120 years	-
Zinc	1,367 kt	41.8 Mt	31 years	47.3 Mt
Zircon	426 kt	32.9 Mt	77 years	50.3 Mt

§ includes para-marginal, sub-marginal and inferred resources from GA (2006); diamond resources from company reports while uranium is from OECD-NEA & IAEA (2006).

As can be seen, in general most minerals have about a century of economic resources remaining, though this assumes 2005 production remains constant – clearly unrealistic given the long-term trends of climbing production for almost all minerals studied in this report. For some metals, such as copper and gold, ongoing exploration is continuing to lead to increases in economic resources over time.

According to GA (var.), it "is notable that resources levels for major commodities like black coal, iron ore and base metals have plateaued" (pp 10, 2006 Edition). A key question with regards to this observation is not whether geologic resources are 'finite' but the future conditions under which mineral resources are likely to be considered 'economic' and the associated social and environmental costs of mineral production. As noted and discussed throughout the report, key issues which are broadly recognised include the need for deeper exploration and mining, land access issues, sustainability performance, environmental management and mine rehabilitation performance. Many of these aspects are particularly sensitive to ore grade and mining technique, suggesting that the environmental cost in terms of energy, water and reagent consumption and pollution emissions are likely to rise per unit metal/mineral produced.

The fact that mineral resources are not perceived to be approaching exhaustion yet is of concern given that production continues to climb. To maintain this climbing rate of production will continue require major new mineral discoveries of similar magnitude as regions such as the Pilbara, Darling Ranges, Mt Isa, etc. This is, of course, an increasingly recalcitrant task.

The fundamental question with regards to economic resources is therefore the environmental and social costs of extraction – not simply the quantity currently classified as economic.

8.4 Minesite Rehabilitation

A recognised major issue with respect to modern mining is rehabilitation – or closure and stewardship following either the exhaustion of economic ore or a mining project becoming uneconomic. Historically there were very little statutory requirements for mine rehabilitation, with the minimal obligations often centred around public safety and visual amenity – rarely environmental aspects. A range of issues need to be considered with respect to rehabilitation, and this section will only briefly analyse some of these.

Firstly, there is still a major legacy of mining-impacted land which has not been rehabilitated. This largely results from old and abandoned mines before community expectations and modern legislation have required rehabilitation upon mine closure. The extent of this problem varies between states, though only limited data is publicly available. By 2003 in Western Australia, it has been estimated that a total of 165,040 ha has been disturbed by mining while only 36,952 ha has had preliminary rehabilitation, with the full data shown in Table 22 and Figure 74. In Queensland 73,586 ha has been disturbed with only 20,313 ha having been rehabilitated (to June 1997), shown in Figure 75 (Anderson, 2002). This gap is likely to be similar across Australia (although the cumulative totals would vary).

For Western Australia, the combined area of open cuts, waste rock dumps and tailings dams is almost two-thirds of the cumulative area disturbed by mining. For areas with 'preliminary rehabilitation', only some 8% of tailings dams have been rehabilitated while 25% and 49% of open cuts and waste rock dumps have been rehabilitated, respectively. Thus it is clear that former open cut voids, waste rock dumps and tailings dams are placing significant pressure on the rehabilitation requirements and efforts for modern mining projects.

The legacy of abandoned mines is acknowledged as a key issue by the mining industry, especially with regards to a continuing "social licence to operate" (IIED & WBCSD, 2002).

Secondly, a major issue which is not widely acknowledged is that of the long-term effectiveness of rehabilitation measures. That is, the long-term performance of various engineering approaches to mined land rehabilitation to reduce surface water and groundwater pollution, erosion issues, minimise gaseous emissions (eg. radon, methane), restore a productive land use following mining and the like. Although the engineering and regulatory standards are considerably better at present than in the past, there remains concern over long-term effectiveness (eg. Rum Jungle; see Mudd, 2002).

Finally, and perhaps most critically, there are not yet uniform standards or criteria for determining 'acceptable' rehabilitation. This is a vexed issue for many local communities (especially indigenous communities), mining companies, regulators as well as governments. Further discussion of this aspect is beyond the scope of this report, however, successful rehabilitation of mined land is recognised as a key component of sustainability in mining (Bell, 2006; Mulligan, 2006).

Table 22 – Extent of Rehabilitation of Mine Sites in Western Australia (ha)

Activity	2003			Cumulative Total to 31 Dec 2003		
	Disturbed by Mining	Preliminary Rehabilitation	Revege-tation	Disturbed by Mining	Preliminary Rehabilitation	Revege-tation
Borefields & pipelines	9	4	6	1,930	415	85
Camp site	8	3	2	1,366	394	304
Exploration	57	15	6	4,980	1,513	836
Mine Infrastructure	395	182	166	51,171	5,263	4,037
Open Cuts	655	285	109	35,678	8,815	6,105
Tailings Dams/ Evaporation Dams	271	319	278	33,693	2,753	2,117
Waste Rock Dumps/ Heap Leach Piles	632	695	828	36,222	17,799	11,639
Total	**2,027**	**1,503**	**1,395**	**165,040**	**36,952**	**25,123**

Reference : Data Courtesy of WA Department of Industry & Resources (WADoIR) (Email – J Gregory, 9 March 2004).

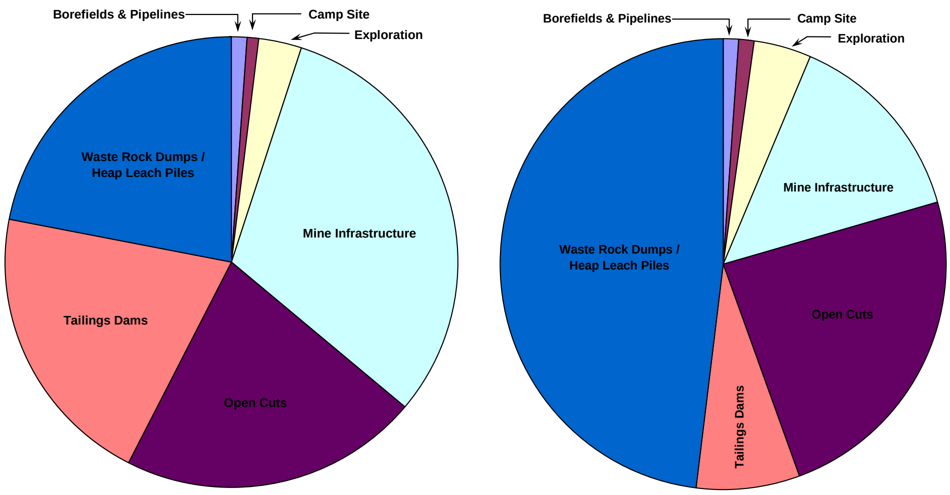


Figure 74 – WA Cumulative Mined Area by Disturbance and Preliminary Rehabilitation Type
(data from Table 22)

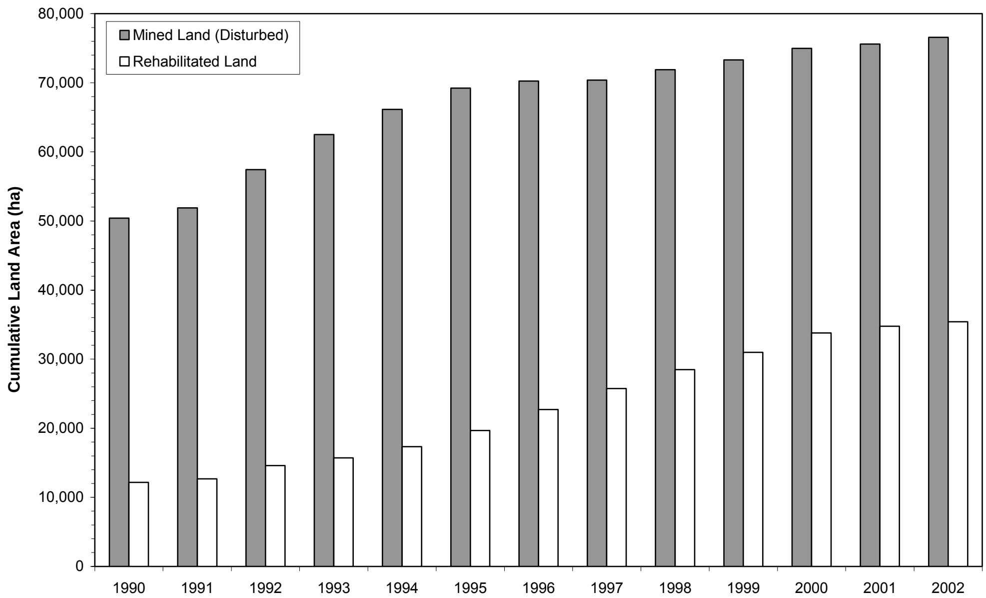


Figure 75 – Queensland Cumulative Mined and Rehabilitated Land to 2002 (Anderson, 2002)

8.5 Environmental and Sustainability Reporting

The data compiled and presented within this report raises a number of issues with respect to sustainability reporting for the mineral industries. In recent years a number of relevant environmental and sustainability reporting protocols have been developed, including the statutory Australian 'National Pollutant Inventory' (NPI) (NPI, 2001), the more corporate-style 'Global Reporting Initiative' (GRI) (GRI, 2006), including the GRI Mining Sector Supplement (GRI, 2005), as well as the 'International Cyanide Management Code' (ICMC) (ICMI, 2002) specifically relevant to gold mining. This reporting goes beyond standard production and financial data to include data on water, energy, emissions and wastes associated with mining. Although most of these aspects are not covered in this report, a review is presented to provide a context for the basis for this style of reporting.

Firstly, most protocols are voluntary (except the NPI), thereby allowing selective uptake by mining companies (though this is less likely in the future as uptake of the GRI increases).

Secondly, the protocols do not require consistent and compulsory reporting of key aspects such as waste rock, cyanide, water quality and quantity and the like – while reporting omissions are often left unjustified by companies. For example, GRI leaves the proportion of recycled water (EN10) as an 'additional' indicator and not 'core' for reporting purposes. While the reporting of wastes by type and destination (EN22) is core, and is supposed to include hazardous and non-hazardous wastes, some mining companies who use the GRI still do not report waste rock under EN22. The additional GRI Mining Sector Supplement proposes wastes under EN22 as "site waste, eg. waste oils, spent cell lining, office, canteen and camp waste, scrap steel, tyres and construction waste" (pp 27), and further discusses the need to report "large volume wastes" – waste rock/overburden and tailings – as a function of a site risk assessment (pp 29).

Thirdly, many mines or companies reporting energy, greenhouse, water and cyanide data over time and fail to explain sudden abrupt increases or reductions in any of these aspects. This is sometimes related to corporate takeovers or merger activity leading to new policies or methodologies for estimating and assessing sustainability data, but this is rarely explained in subsequent. Some mine sites report substantive changes but provide no explanation at all. Alternately, some company reports do not report certain aspects. For example, some companies report cyanide consumption but not greenhouse emissions, while the reverse applies for other companies – sometimes despite both companies basing their reporting framework on the GRI framework.

Fourthly, many industrialised countries either have or are developing systems such as the NPI to facilitate more accurate assessment of pollutant/contaminant loads being released to the environment, especially with respect to 'State of the Environment' style reporting. The NPI only considers those emissions of pollutants which are effectively released to the environment and defines waste rock and tailings facilities as 'land transfers' only – leaving waste rock data outside the scope of reportable NPI emissions (though any escape from waste rock or tailings facilities would be reportable to the NPI). As a bare minimum the quantity of waste rock should be a core reporting indicator by GRI, NPI and others (for combined financial, environmental and social reasons), with further details noting the nature of the waste rock – especially with respect to leaching and/or acid mine drainage issues. The recent cyanide code (ICMC) does not require public reporting of cyanide consumption even though a gold mine could be certified for its cyanide management regime. The NPI collates and reports on total cyanide emissions but it specifically does not report nor allow data to be analysed on an individual site basis (emissions are not the same as reagent consumption in gold ore processing). The common lack of waste rock and cyanide reporting does not facilitate accurate sustainability assessment nor allow claims to be tested.

As noted throughout this report, there is generally systematic declining trends for ore grades of most metals and minerals mined in Australia. This is critical as it is well known for many metals that as ore grades decline the energy cost per unit metal begins to increase exponentially (eg. copper, Norgate & Rankin, 2002b); nickel laterites, (Kemp & Wiseman, 2004). This is well recognised for grinding, since the milling of lower grade ores is leading to finer grinding which requires more energy (Mwale *et al.*, 2005). When this issue is combined with increasing waste rock it is clear that the solid waste burden and energy, water, reagents/chemicals and emissions required for metal production will face substantial challenges with respect to sustainability analysis in the future.

Finally, the various codes and protocols, especially the GRI, are still very new and have not been in use long enough as yet to allow industry to adopt them widely and report more consistently across various companies and mines. Given the deficiencies identified above, there remains room for major improvement with respect to mining across all its sectors. With more comprehensive reporting it may be possible to improve the correlations between aspects such as energy, water and cyanide consumption, greenhouse emissions and production variables such as mine type, ore grade, throughput and mill technology.

9. Conclusions and Recommendations : Sustainability and the Australian Mining Industry

This unique report has compiled and presented perhaps one of the most comprehensive statistical and qualitative study of a national mining industry published to date. The need for this is simple : are mineral resources truly "finite" and therefore mining can never truly be ascribed as a sustainable enterprise – or is there substantive evidence to allow a more sophisticated model for sustainability in mining ?

At the start of this study, five central hypotheses were put forward to assess :

- ***ore grades are in gradual but permanent decline,***

There is strong evidence that for most mineral commodities that average ore grades have declined over time. A common pattern is the mining of rich ores upon discovery and early development, followed by a rapid decline as dominant ore types evolved (eg. oxidised to sulphide copper ores), and then a more gradual waning as economics and technology combine to make lower grade projects viable. For some bulk commodities, such as iron ore and bauxite, there is limited evidence for declining ore grades but this is masked by beneficiation and reporting of iron content of shipped product only. Based on current mineral deposits, for all commodities there appears no real prospect of average ore grades increasing in the medium to long-term.

- ***scale of individual mines is generally increasing,***

For every commodity studied, the economic scale of mines over time has increased over time. For example, annual copper production in the 1870's averaged between 9,000 to 14,200 t Cu but from numerous mines across South Australia, New South Wales and Queensland. From the 1990's individual copper projects produce between 10,000 to 200,000 t Cu. This pattern of increasing scale is across all commodities studied in this report.

- ***solid waste burden (waste rock/overburden and tailings) per unit mineral is increasing,***

For most commodities there are clear trends of increasing solid waste burden, even allowing for the common lack of reporting of waste rock. For many commodities the extent of waste rock/overburden mined far exceeds the ore mined – especially the case for copper, gold and black coal. Given the extent of sulphides likely to be present in much of the tailings and waste rock, this could lead to significant risks such as acid mine drainage in the future – especially given the recalcitrant environmental problems caused by smaller scales at numerous abandoned and/or rehabilitated mining projects around Australia (eg. Mt Lyell).

- ***continually expanding production continues to put pressure on economic resources,***

Mineral resources are often perceived and argued to be 'finite' yet for all commodities analysed in this report economically mineable resources have increased over time (except for manganese and diamonds). Additionally, major exploration and mining booms have been driven by the discovery of new provinces and fields (eg. Pilbara, Weipa), new technology (eg. 'CIP') or economics – with the most recent mining boom of the past few years being caused by sustained rises in demand and prices. However, despite political controversy over economic resources in the past, (eg. iron ore), for many commodities economic resources have stagnated since about the 1980's and increasing production is leading to a sharpening decline in the years of resources remaining. For some commodities, such as mineral sands and gold, economic resources continue to increase – though there are fewer and fewer regions which have not seen modern exploration, leading many to argue for deeper exploration. The end product of this becomes the increasing effort required to maintain existing levels of economic resources let alone continue increases.

- ***more complex ores are now being developed, often with significant impurities.***

Over time the mining industry has needed to develop technologies to continue economic operations or expand production capacity, with the zinc problem, sulphide ore and nickel laterite problems being prime examples among others. At present there is no systematic reporting of the nature of various ores being mined and processed. Given the relatively recent introduction of sustainability reporting, there is only a limited opportunity to examine if this leads to a gradual increase in reagent, energy and water requirements as well as pollutant release problems (especially greenhouse emissions) with respect to more metallurgically complex ores. It is well recognised in the mining industry that ores are becoming more complex, especially as ore grades decline in tandem, but the exact significance in terms of energy, water, and the like remains relatively unstudied.

Overall, the mining industry has certainly sustained itself economically, and for some commodities there is evidence that this could be maintained for some decades. For a few commodities, such as gold, lead and zinc, present economic resources will last for approximately three decades or less. The commodity histories and data compiled in this report clearly show the fundamental influence of economics, social issues, technology as well as ongoing exploration on economic mineral resource estimates over time. However, the critical underlying issue which remains poorly recognised and understood in the mining industry is the environmental costs associated with the continually increasing scale of the mining industry. Considering the perpetual decline in ore grades and increasing waste rock produced, this points to potentially increasing environmental costs in the future in terms of energy, water, greenhouse emissions and the like – especially if these aspects are analysed with respect to unit mineral production and not ore throughput.

The long-term trends in Australian mining compiled and analysed in this report give hope to some but cause for concern for others.

Ultimately, the sustainability of the mining industry continues to hang in the balance.

APPENDIX A :

TOTAL MINERAL PRODUCTION

10. Black Coal

- *Black Coal Production by State 1829-2006*

  Data Sources/References : (ABARE, var.-b; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; QDM, var.; SADM, var.-b; TDM, var.; VDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)
- *Black Coal Production by Mining Method – Queensland*

  Data Sources/References : (BMR, var.; QDM, var.; QNRM, var.-a, var.-b)

  Note : For 1992-2006, data is financial year (QNRME, var.) while Totals are calendar years (Barlow-Jonker, QNRM or ABARE).
- *Black Coal Production by Mining Method – New South Wales*

  Data Sources/References : (BMR, var.; Gourlay, 1955; NSWDM, var.; NSWDMR, var.-a, var.-b)
- *Black Coal Production by Open Cut – Tasmania*

  Data Sources/References : (TDM, var.)
- *Black Coal Production by Open Cut – South Australia*

  Data Sources/References : (SADM, var.-a, var.-b)
- *Black Coal Production by Open Cut – Western Australia*

  Data Sources/References : (WADM, var.; WADoIR, var.)
- *Black Coal Production by Mining Method – Australia*

  Data Sources/References : compiled from previous tables.
- *Black Coal Exports – Australia*

  Data Sources/References : (BMR, var.; Kalix *et al.*, 1966; NSWDM, var.)
- *Black Coal Production Versus Resources – Australia and World*

  Data Sources/References : Australia (ABARE, var.-a, var.-b; BMR, var.; GA, var.); World production 1864-1901 (Anonymous, var.), 1980-2003 (EIA, var.); World resources (GA, var.)

Black Coal Production Statistics by State (Raw) (t)

Year	Queens-land	New South Wales	Victoria	Tasmania	South Australia	Western Australia	Australia (Mt)	
							Total	Cumulative
1829		792	[§] *Prior*	[#] *Prior*			0.001	0.05
1830		4,064	*to 1829 :*	*to 1860 :*			0.004	0.06
1831		5,080	~50,800	63,783			0.005	0.06
1832		7,257					0.007	0.07
1833		6,921					0.007	0.07
1834		8,626					0.009	0.08
1835		12,590					0.013	0.10
1836		12,848					0.013	0.11
1837		16,340					0.016	0.13
1838		17,496					0.017	0.14
1839		21,624					0.022	0.16
1840		30,740					0.031	0.20
1841		35,398					0.035	0.23
1842		40,538					0.041	0.27
1843		26,276					0.026	0.30
1844		23,488					0.023	0.32
1845		22,681					0.023	0.34
1846		39,588					0.040	0.38
1847		41,384					0.041	0.42
1848		46,174					0.046	0.47
1849		49,292					0.049	0.52
1850		72,355					0.072	0.59
1851		68,692					0.069	0.66
1852		68,482					0.068	0.73
1853		98,358		***7,783*** [#]			0.098	0.83
1854		118,508		***8,000*** [#]			0.119	0.95
1855		139,269		***8,000*** [#]			0.139	1.09
1856		192,999		***8,000*** [#]			0.193	1.28
1857		213,801		***8,000*** [#]			0.214	1.49
1858		219,859		***8,000*** [#]			0.220	1.71
1859		313,144		***8,000*** [#]			0.313	2.03
1860	12,524	374,764		***8,000*** [#]			0.375	2.40
1861	14,439	347,540					0.277	2.68
1862	24,452	484,146					0.471	3.15
1863	24,384	440,831					0.499	3.65
1864	25,400	557,796					0.553	4.20
1865	33,528	594,893	2,345				0.633	4.83
1866	39,945	786,626		14,538			0.806	5.64
1867	18,276	782,332		8,474			0.804	6.44
1868	19,925	969,499	102	9,199			0.961	7.40
1869	11,298	934,490		10,420			0.949	8.35
1870	23,001	882,461		9,943			0.957	9.31
1871	17,272	913,165		9,679			0.986	10.29
1872	28,171	1,028,625	10	8,271			1.124	11.42
1873	34,151	1,211,948	512	10,309			1.281	12.70
1874	44,138	1,325,486	2,956	9,424			1.377	14.08
1875	32,621	1,351,005		7,843			1.412	15.49
1876	51,437	1,341,037	1,113	6,198			1.445	16.94
1877	61,893	1,467,379	2,459	9,622			1.576	18.51
1878	53,421	1,600,705		12,508			1.688	20.20
1879	55,892	1,608,715		9,666			1.686	21.88
1880	58,981	1,489,639		12,415			1.590	23.48
1881	66,662	1,797,911	3	11,342			1.807	25.28
1882	75,627	2,143,031	10	8,944			2.145	27.43
1883	106,426	2,561,800	435	9,014			2.637	30.06
1884	122,659	2,793,095	3,332	7,309			2.892	32.96
1885	213,053	2,924,925	813	6,760			3.112	36.07
1886	232,314	2,875,458	1,105	10,557			3.151	39.22
1887	242,634	2,969,257	3,411	28,075			3.219	42.44
1888	316,395	3,254,699	8,710	42,242			3.568	46.01
1889	269,755	3,714,122	14,830	37,287			3.929	49.94
1890	343,758	3,109,850	14,835	51,327			3.681	53.62

Black Coal Production Statistics by State (Raw) (t)

Year	Queens-land	New South Wales	Victoria	Tasmania	South Australia	Western Australia	Australia (Mt)	
							Total	Cumulative
1891	275,949	4,102,536	23,199	43,948			4.186	57.80
1892	269,327	3,841,463	23,737	36,584			4.171	61.97
1893	268,633	3,330,781	93,194	35,248			3.804	65.78
1894	275,036	3,730,829	174,407	30,987			4.144	69.92
1895	328,237	3,798,406	197,335	33,221			4.345	74.27
1896	377,332	3,972,069	230,187	42,574			4.651	78.92
1897	364,142	4,453,728	240,057	42,871			5.110	84.03
1898	414,461	4,781,551	246,746	48,441		3,564	5.512	89.54
1899	501,913	4,670,580	266,578	43,291		55,205	5.600	95.14
1900	505,086	5,595,617	214,982	51,443		120,305	6.407	101.55
1901	548,104	6,063,921	212,678	46,165		119,721	6.838	108.38
1902	509,555	6,037,083	228,767	49,645		143,138	6.983	115.37
1903	515,926	6,456,524	65,227	49,854		135,562	7.189	122.56
1904	520,207	6,116,126	123,689	62,087		140,767	6.980	129.54
1905	537,795	6,738,252	157,617	52,825		129,402	7.537	137.07
1906	616,480	7,748,384	163,201	53,742		152,151	8.700	145.77
1907	694,204	8,796,451	140,801	59,833	12,654	144,651	9.720	155.49
1908	707,473	9,293,377	115,277	62,045		178,052	10.252	165.75
1909	768,682	7,132,197	130,224	67,221		217,731	8.605	174.35
1910	885,105	8,304,284	374,964	83,764		266,361	9.867	184.22
1911	905,833	8,830,670	664,326	57,980		253,897	10.879	195.10
1912	916,601	10,043,988	598,569	54,417		299,800	11.951	207.05
1913	1,054,551	10,580,792	603,415	55,924		318,839	12.622	219.67
1914	1,070,854	10,556,872	627,417	61,767		324,317	12.692	232.36
1915	1,040,661	9,600,192	597,514	65,569		291,253	11.718	244.08
1916	922,251	8,257,196	423,858	56,464		306,350	10.186	254.27
1917	1,065,249	8,425,553	473,680	64,427	724	331,775	10.363	264.63
1918	998,924	9,208,187	446,608	61,126		342,432	11.059	275.69
1919	946,537	8,769,659	430,728	67,313		408,140	11.028	286.72
1920	1,127,672	10,887,455	449,317	76,636		469,413	13.077	299.79
1921	970,039	10,966,081	523,097	67,540		476,318	13.003	312.80
1922	973,855	10,346,063	568,233	70,346		445,458	12.612	325.41
1923	1,077,633	10,646,169	484,452	82,009		427,445	12.802	338.21
1924	1,141,087	11,804,107	526,608	77,204		428,614	13.908	352.12
1925	1,196,008	11,578,538	542,794	83,005		444,460	13.881	366.00
1926	1,240,596	11,059,938	600,457	103,996		482,416	13.608	379.61
1927	1,116,625	11,304,132	695,193	113,849		509,529	13.592	393.20
1928	1,093,561	9,599,368	668,856	130,556		536,875	12.130	405.33
1929	1,390,645	7,739,620	715,089	132,376		553,435	10.678	416.01
1930	1,112,191	7,206,544	714,743	140,935		509,448	9.810	425.82
1931	854,769	6,535,300	580,483	125,809		439,318	8.699	434.52
1932	855,178	6,892,770	439,271	113,643		422,371	8.846	443.36
1933	889,576	7,232,332	531,368	118,438		465,733	9.398	452.76
1934	971,863	7,999,151	362,669	115,451		508,348	10.049	462.81
1935	1,068,810	8,837,756	484,119	125,693		545,783	10.926	473.74
1936	1,063,629	9,346,657	433,553	134,380		574,116	11.630	485.37
1937	1,138,102	10,212,343	262,072	92,579		562,366	12.362	497.73
1938	1,131,241	9,724,065	312,174	85,093		614,469	12.170	509.90
1939	1,338,568	11,374,965	370,733	100,982		566,456	13.597	523.49
1940	1,305,893	9,702,900	271,977	84,466		548,058	12.335	535.83
1941	1,477,288	11,953,949	331,664	111,469		565,479	14.507	550.34
1942	1,663,342	12,401,230	317,860	136,593	1,676	590,475	14.950	565.29
1943	1,726,713	11,657,075	291,694	148,216		540,051	14.572	579.86
1944	1,686,230	11,219,626	261,815	145,939	35,174	567,255	14.134	593.99
1945	1,660,902	10,339,074	251,254	151,462	42,115	552,057	13.277	607.27
1946	1,592,600	11,365,365	194,351	161,291	137,627	652,564	14.108	621.38
1947	1,913,549	11,870,053	176,462	169,814	196,445	742,194	15.059	636.44
1948	1,770,274	11,908,989	170,221	182,263	243,295	744,665	15.019	651.45
1949	2,001,914	10,907,876	124,467	184,524	350,152	762,604	14.333	665.79
1950	2,357,932	13,002,993	128,454	225,909	265,518	827,382	16.721	682.51
1951	2,513,355	13,729,456	150,107	240,678	394,516	862,051	17.890	700.40
1952	2,786,112	15,262,454	146,121	251,865	424,211	843,748	19.714	720.11
1953	2,557,081	14,400,612	154,338	237,367	455,660	900,361	18.705	738.82
1954	2,804,983	15,324,592	143,579	268,429	503,028	1,034,636	20.079	758.90
1955	2,791,120	14,972,179	135,014	304,009	462,572	918,253	19.583	778.48

Black Coal Production Statistics by State (Raw) (t)

Year	Queens-land	New South Wales	Victoria	Tasmania	South Australia	Western Australia	Australia (Mt)	
							Total	Cumulative
1956	2,778,414	15,047,128	120,728	303,492	489,166	843,287	19.582	798.06
1957	2,744,802	15,636,480	113,354	272,430	618,656	852,080	20.238	818.30
1958	2,621,659	16,104,563	110,093	280,688	767,102	884,816	20.769	839.07
1959	2,635,897	15,963,839	91,885	304,158	701,420	926,018	20.623	859.69
1960	2,692,514	18,020,786	78,204	302,433	898,976	937,151	22.930	882.62
1961	2,826,681	19,325,138	67,425	259,921	1,132,998	777,992	24.390	907.01
1962	2,843,622	19,334,905	57,629	276,699	1,414,358	933,818	24.861	931.87
1963	3,296,066	19,243,249	51,289	210,599	1,535,907	916,935	25.255	957.13
1964	3,231,288	21,030,241	47,811	153,580	1,763,891	1,003,219	27.841	984.97
1965	4,220,904	14,356,080	42,923	104,096	2,047,916	1,009,641	31.942	1,016.91
1966	4,771,629	25,877,238	36,087	83,987	2,053,019	1,078,073	33.867	1,050.78
1967	4,850,623	27,241,996	32,579	77,766	2,077,254	1,079,145	35.263	1,086.04
1968	6,766,765	30,834,331	26,735	92,385	2,111,517	1,104,777	40.826	1,126.87
1969	8,672,000	33,975,000	456	117,788	2,245,839	1,107,978	46.082	1,172.95
1970	10,464,000	35,900,000	128	114,000	1,856,000	1,217,000	49.211	1,222.16
1971	11,455,000	34,567,000		124,000	1,492,000	1,190,000	49.002	1,271.16
1972	17,684,000	39,176,000		132,000	1,602,000	1,168,000	59.689	1,330.85
1973	19,977,000	37,882,000		115,000	1,510,000	1,171,000	67.867	1,398.72
1974	28,501,000	38,703,000		127,000	1,671,000	1,146,000	70.449	1,469.17
1975	30,476,000	40,174,000		162,000	1,759,000	2,114,000	74.684	1,543.85
1976	35,115,000	44,717,000		189,000	1,872,000	2,269,000	84.161	1,628.01
1977	35,005,000	47,947,000		199,000	1,960,000	2,358,000	87.469	1,715.48
1978	34,461,000	50,679,000		224,000	1,585,000	2,404,000	89.352	1,804.83
1979	37,508,000	50,888,000		237,000	1,674,000	2,735,000	93.043	1,897.88
1980	37,579,000	50,720,000		234,000	1,719,000	3,154,000	93.406	1.9879
1981	34,682,000	52,374,000		346,000	1,577,000	3,247,000	110.945	2.0988
1982	36,784,000	55,956,000		515,000	1,464,000	3,719,000	119.068	2.2179
1983	37,128,000	55,962,000		473,000	1,380,000	3,935,000	120.482	2.3384
1984	50,777,000	57,430,000		458,000	1,325,000	3,686,000	139.094	2.4775
1985	60,976,000	62,259,000		526,000	2,041,000	3,769,000	158.256	2.6357
1986	66,134,000	66,412,000		555,000	2,368,000	3,831,000	170.031	2.8058
1987	68,492,000	69,879,000		621,000	2,521,000	3,721,000	178.567	2.9843
1988	87,638,764	79,787,000		648,000	2,534,000	3,789,743	176.604	3.1609
1989	94,874,781	90,774,106		632,375	2,930,781	3,830,472	192.278	3.3532
1990	98,982,000	94,429,000		569,173	2,560,940	4,831,172	201.368	3.5546
1991	101,238,000	97,386,000		560,589	2,694,941	5,114,267	206.978	3.7616
1992	111,103,000	102,477,000		486,797	2,800,290	5,655,459	222.486	3.9840
1993	111,136,000	104,496,000		494,873	2,625,020	5,470,875	224.352	4.2084
1994	115,624,000	103,900,000		564,282	2,690,480	5,034,977	228.093	4.4365
1995	119,090,000	110,509,000		607,911	2,454,760	6,062,404	238.833	4.6753
1996	124,344,000	116,662,000		559,270	2,601,320	5,814,923	249.932	4.9253
1997	134,277,000	129,826,000		545 820	2,754,914	5,692,147	273.182	5.1984
1998	134,044,000	132,365,000		566 720	2,857,095	5,609,555	275.586	5.4740
1999	156,298,000	134,283,000		563 117	2,670,226	6,231,484	300.004	5.7740
2000	159,314,000	134,691,000		565 988	3,342,358	6,204,588	303.945	6.0780
2001	180,500,000	142,948,000		473,097	3,197,532	6,204,695	333.192	6.4112
2002	196,101,000	143,580,000		547,693	2,982,545	6,262,538	349.648	6.7608
2003	197,777,439	144,550,000		545,978	3,033,747	6,026,581	357.790	7.1186
2004	212,850,000	151,610,000		640,000	3,520,125	6,312,011	375.200	7.4938
2005	229,340,000	158,710,000		570,678	3,637,983	6,406,041	397.730	7.8915
2006[P]	225,250,000[P]	163,740,000[P]		708,825[P]	3,820,000[P]	7,245,139[P]	399.750[P]	8.2913[P]
Total	**3,576.9**	**4,162.2**	**22.74**	**25.87**	**110.4**	**194.2**	**(All Mt)**	

[P] Preliminary data only.

Black Coal Production by Mining Method – Queensland

Year	Underground (t)		Open Cut (t)			Total (t)	
	Raw	Saleable	Raw	Saleable	Overburden (m^3)	Raw	Saleable
1946			104,496		184,057	1,594,104	
1947			244,413			1,918,208	
1948			220,076		66,516	1,769,872	
1949	1,571,804		431,733			2,003,557	
1950	1,895,217		467,679		362,170	2,362,896	
1951	1,895,898		624,448			2,520,345	
1952	2,038,422		747,690		228,097	2,786,112	
1953	1,972,697		584,384		322,307	2,557,081	
1954	2,099,857		705,126		409,613	2,804,983	
1955	2,141,794		649,326			2,791,120	
1956	2,131,551		630,852			2,762,402	
1957	2,203,693		501,707			2,705,400	
1958	2,135,879		483,183			2,619,062	
1959	2,174,256		458,760			2,633,016	
1960	2,324,448		381,024			2,705,473	
1961	2,229,669		624,068			2,853,737	
1962	2,230,683		627,035			2,857,717	
1963	2,472,153		825,200			3,297,353	
1964	2,779,876		1,094,676			3,874,552	
1965	3,035,072		1,223,274			4,258,347	
1966	3,230,443		1,541,186			4,771,629	
1967	3,110,162		1,740,461			4,850,623	
1968	3,069,620		3,706,289			6,775,909	
1969	3,152,015		5,520,000			8,672,015	
1970	3,137,000		7,327,000			10,464,000	
1971	3,554,000		7,901,000			11,455,000	
1972	3,958,000		13,726,000			17,684,000	
1973	3,836,000		16,141,000			19,977,000	
1974	3,403,000	2,392,000	17,682,000	11,277,000		21,085,000	13,669,000
1975	2,986,000	2,034,000	19,824,000	13,110,000		22,810,000	15,144,000
1976	3,253,000	2,170,000	22,553,000	14,328,000		25,806,000	16,498,000
1977	4,538,000	3,332,000	30,467,000	22,571,000		35,005,000	25,903,000
1978	4,169,000	2,925,000	30,291,000	22,010,000		34,460,000	24,935,000
1979	4,606,000	3,249,000	32,901,000	24,375,000		37,507,000	27,624,000
1980	4,470,000	3,056,000	33,109,000	25,482,000		37,579,000	28,538,000
1981	4,978,000	3,410,000	40,047,000	31,272,000		45,025,000	34,682,000
1982	5,595,000	3,827,000	42,898,000	32,957,000		48,493,000	36,784,000
1983	5,163,000	3,475,000	43,402,000	33,653,000		48,565,000	37,128,000
1984	5,354,000	3,758,000	59,948,000	47,019,000		65,302,000	50,777,000
1985	5,700,000	4,024,000	71,181,000	56,952,000		76,881,000	60,976,000
1986	5,962,000	4,179,000	77,005,000	61,955,000		82,967,000	66,134,000
1987	5,241,000	3,747,000	82,858,000	64,745,000		88,099,000	68,492,000
1988						87,638,764	68,563,000
1989						94,874,781	74,224,000
1990						98,982,000	77,068,000
1991						101,238,000	79,012,000
1992	9,826,925	7,652,000	98,495,765	76,433,000	592,917,662	108,322,690	84,085,000
1993	10,696,504	8,484,000	100,238,153	76,817,000	645,530,693	110,934,657	85,301,000
1994	13,119,095	9,880,000	98,005,877	75,859,000	605,214,251	111,124,972	85,739,000
1995	16,506,960	12,620,000	103,463,813	81,876,000	597,528,031	119,970,773	94,496,000
1996	13,197,200	10,433,000	107,062,316	83,330,000	615,886,773	120,259,516	93,763,000
1997	18,161,926	13,075,000	109,819,054	86,362,000	631,426,105	127,980,980	99,437,000
1998	23,765,413	14,306,000	111,790,629	91,446,000	711,416,321	135,556,042	105,752,000
1999	27,689,013	15,366,000	116,080,491	97,268,000	633,236,546	143,769,504	112,634,000
2000	38,175,259	26,682,000	117,541,034	97,666,000	663,404,226	155,716,293	124,348,000
2001	38,320,608	30,428,000	134,562,086	107,924,000	796,240,767	172,882,694	138,352,000
2002	38,776,870	31,134,000	151,289,383	117,229,000	1,017,745,687	190,066,253	148,363,000
2003	34,772,285	27,250,000	160,393,269	126,352,000	1,016,288,832	195,165,554	153,602,000
2004	32,381,527	23,864,000	172,018,875	136,197,000	1,110,321,059	204,400,402	160,061,000
2005	34,684,715	26,684,000	191,930,545	145,982,000	1,316,078,788	226,615,260	172,666,000
2006[P]	34,288,934[P]	24,681,000[P]	192,405,887[P]	147,202,000[P]	1,404,382,807[P]	226,694,821[P]	171,883,000[P]

Black Coal Production by Mining Method (t) – New South Wales

Year	UG Raw	UG Saleable	OC Raw	OC Saleable	Overburden	Total Raw	Total Saleable
1944	11,095,613		184,159	*Note : Open cut mining was attempted in the 1930's in NSW but did not become large scale until 1944.*		11,279,772	
1945	9,807,633		532,541			10,340,174	
1946	10,597,903		768,478			11,366,381	
1947	10,896,061		973,992			11,870,053	
1948	10,634,254		1,274,736			11,908,989	
1949	9,538,790		1,369,085			10,907,876	
1950	11,375,721		1,627,262			13,002,983	
1951	11,403,799		2,325,657			13,729,456	
1952	12,691,774		2,570,679			15,262,454	
1953	12,650,969		1,749,643			14,400,612	
1954	13,922,542		1,402,051			15,324,592	
1955	14,056,360		915,416			14,972,179	
1956	14,224,000		822,960			15,047,128	
1957	14,896,592		739,648			15,636,480	
1958	15,373,096		731,520			16,104,563	
1959	15,522,448		440,944			15,963,839	
1960	17,253,712		767,080			18,020,786	
1961	18,480,024		845,312			19,325,138	
1962	18,487,136		847,344			19,612,273	
1963	18,631,408		611,632			19,243,249	
1964	20,302,728		727,456			21,030,241	
1965	23,606,760		909,320			24,516,080	
1966	24,687,784		1,189,736			25,877,238	
1967	26,100,024		1,141,984			27,241,996	
1968	28,853,384		1,981,200			30,834,331	
1969	31,750,000		2,225,040			33,975,000	
1970	33,044,000		2,856,000			35,900,000	31,757,000
1971	31,420,000		3,147,000			34,567,000	29,836,000
1972	33,552,000		5,624,000			39,176,000	34,065,000
1973	32,271,000		5,611,000			37,882,000	32,862,000
1974	30,336,000	26,472,000	8,358,000	7,253,000		38,694,000	33,648,000
1975	31,412,000	26,678,000	8,798,000	7,445,000		40,210,000	34,080,000
1976	35,793,000	30,626,000	8,951,000	7,437,000		44,744,000	38,064,000
1977	37,338,000	30,626,000	10,571,000	9,381,000		47,909,000	40,518,000
1978	38,501,000	32,396,000	12,178,000	10,343,000		50,679,000	42,743,000
1979	37,979,000	32,086,000	12,909,000	10,699,000		50,888,000	42,785,000
1980	36,752,000	31,151,000	13,968,000	11,565,000		50,720,000	42,738,000
1981	46,112,000	40,151,000	14,657,000	12,223,000		60,769,000	52,381,000
1982	45,846,000	40,437,000	19,030,000	15,519,000		64,876,000	55,956,000
1983	43,430,000	38,109,000	22,699,000	17,853,000		66,129,000	55,963,000
1984	42,196,000	36,973,000	26,127,000	20,457,000		68,323,000	57,430,000
1985	44,301,000	38,995,000	30,738,000	23,264,000		75,039,000	62,259,000
1986	46,775,000	40,955,000	33,535,000	25,457,000		80,310,000	66,412,000
1987	49,594,000	43,511,000	34,011,000	26,368,000		83,605,000	69,879,000
1988	43,839,000	39,088,000	34,518,000	26,666,000		78,357,000	65,754,000
1989	48,389,000	43,008,000	39,286,000	30,133,000		87,675,000	73,141,000
1990	51,310,000	45,558,000	43,119,000	32,640,000		94,429,000	78,198,000
1991	50,667,000	45,528,000	46,719,000	35,177,000		97,386,000	80,705,000
1992	49,390,000	44,072,000	53,087,000	40,935,000	**(m^3)**	102,477,000	85,007,000
1993	48,962,000	43,213,000	55,534,000	42,123,000		104,496,000	85,336,000
1994	47,303,000	42,006,000	56,597,000	43,840,000	244,000,000	103,900,000	85,846,000
1995	51,723,000	44,977,000	58,786,000	44,989,000	260,975,200	110,509,000	89,966,000
1996	54,622,000	46,997,000	62,040,000	47,303,000		116,662,000	94,300,000
1997	55,960,000	48,493,000	73,866,000	56,144,000	352,606,800	129,826,000	104,637,000
1998	54,648,000	46,519,000	77,717,000	58,705,000	342,665,100	132,365,000	105,224,000
1999	52,797,000	45,142,000	81,486,000	60,912,000		134,283,000	106,054,000
2000	52,546,000	44,820,000	82,144,000	61,874,000		134,690,000	106,694,000
2001	54,589,000	46,744,000	88,359,000	66,372,000		142,948,000	113,116,000
2002	49,915,000	42,471,000	93,665,000	69,380,000		143,580,000	111,851,000
2003	47,522,000	39,927,000	97,029,000	73,356,000		144,551,000	113,283,000
2004	48,862,000	40,159,000	103,439,000	77,059,000	448,542,251	152,301,000	117,218,000

Black Coal Production by Mining Method – Tasmania

Year	Open Cut (t)	Overburden (m^3)	%Open Cut	Total (t)	
				Raw	Saleable
1985/86	20,000		4.00	500,163	339,000
1986/87	33,000		5.30	622,635	
1987/88	57,600		9.46	608,700	404,800
1988/89	90,371		15.32	589,943	356,282
1989/90	40,011		6.71	596,576	359,940
1990/91	19,394		3.77	514,715	312,156
1991/92	61,900	400,000	11.41	542,356	352,701
1992/93	70,773	330,000	11.83	598,355	250,736
1993/94	109,299	609,000	19.85	550,666	316,047
1994/95	210,893	966,000	31.20	675,926	275,157
1995/96	268,332	1,866,872	47.41	565,995	206,619
1996/97	177,898	1,100,000	33.00	539,022	297 274
1997/98	133,624	953,000	22.65	589,960	380 300
1998/99	113,011		17.04	663,182	385 437
1999/00	37,121	23,000	6.59	563,337	398 181
2000/01	48,372		10.09	479,347	349 389
2001/02	32,080		5.94	539,820	387,158
2002/03	22,264		4.13	538,704	359,620
2003/04	67,938		14.28	475,857	335,538
2004/05	101,081		17.71	570,678	399,345
2005/06	708,825		15.15	708,825	432,116

Black Coal Production Statistics – South Australia (all open cut)

Year	Raw (t)	Overburden (m^3)
1943	0	166,667
1944	65,654	286,323
1945	68,191	240,255
1946	159,973	135,964
1947	277,923	268,552
1948	326,246	690,795
1949	462,529	816,210
1950	358,583	490,110
1951	438,225	948,749
1952	423,225	870,856
1953	339,057	786,116
1954	399,442	1,061,182
1955	351,807	418,375
1956	540,091	1,037,220
1957	618,656	1,033,740
1958	767,102	1,936,116
1959	701,420	2,017,156
1960	898,365	2,654,139
1961	1,130,236	2,664,839
1962	1,413,408	2,903,693
1963	**721,612**	**1,241,644**

Year	Raw (t)	Overburden (m^3)
1964	1,767,958	2,979,307
1965	**2,037,615**	**2,080,143**
1966	2,053,401	3,417,786
1967	2,077,963	3,807,075
1968	2,109,734	3,617,914
1969	2,247,038	3,956,714
1970	1,855,233	3,363,595
1971	1,487,246	2,175,924
1972	1,533,892	2,987,116
1973	1,586,228	3,597,996
1994/95	2,454,760	11,446,000
1996/97	2,754,914	15,906,000
1997/98	2,857,095	15,700,000
1998/99	2,670,226	12,326,000
1999/00	3,342,358	14,761,000
2000/01	3,197,532	16,310,000
2001/02	2,982,545	17,050,000
2002/03	3,033,747	16,183,000
2003/04	**3,279,796**	17,779,000

Note : Data for years 1943-1973 is from (SADM, var.-a), while data for years 1994/95-2003/04 is courtesy of NRG Flinders (Email, G Betteridge, NRG Flinders, 31 May 2005).

Black Coal Production Statistics – Western Australia

Year	**Open Cut** (t)	**Overburden** (m^3)	**%OC**	**Underground** (t)	**Total Coal** (t)
1943	**0**		**0**	540,051	540,051
1944	**68,000**		**12**	499,255	567,255
1945	114,585		20.76	437,471	552,056
1946	156,862		24.04	495,701	652,564
1947	150,719		20.29	591,977	742,696
1948	148,283		19.91	596,445	744,728
1949	209,956		27.53	552,653	762,610
1950	262,443		31.72	564,987	827,430
1951	374,223		43.41	487,853	862,076
1952	415,380		49.23	428,368	843,748
1953	399,436		44.36	500,925	900,361
1954	417,250		40.33	617,387	1,034,636
1955	308,996		33.65	609,257	918,253
1956	211,878		25.13	631,408	843,286
1957	151,159		17.74	700,920	852,080
1958	92,951		10.51	791,865	884,816
1959	112,347		12.13	813,671	926,018
1960	114,300		**12.20**	822,851	937,151
1961	263,584		33.88	514,408	777,992
1962	325,741		34.88	608,077	933,818
1963	306,386	830,270	33.40	611,006	917,392
1964	348,806	958,018	34.77	654,413	1,003,219
1965	493,249	1,628,792	48.85	516,392	1,009,641
1966	576,924	1,791,728	53.51	501,148	1,078,073
1967	576,956	2,117,169	53.46	502,189	1,079,145
1968	614,843	1,988,735	55.65	489,935	1,104,777
1969	637,903	2,433,686 §	57.57	470,076	1,107,978
1970	742,064	2,264,834 §	60.98	474,936	1,217,000
1971	775,408	2,283,293 §	65.14	414,592	1,190,000
1972	**745,184**		**63.80**	422,816	1,168,000
1973	**748,503**		**63.92**	422,497	1,171,000
1974	**756,933**		**66.05**	389,067	1,146,000
1975	**1,562,655**		**73.92**	551,327	2,113,982
1976	**1,716,522**		**75.66**	552,209	2,268,731
1977	**1,819,908**	2,012,867	**77.18**	538,097	2,358,005
1978	1,849,654		76.96	553,849	2,403,503
1979	2,143,280		78.36	591,923	2,735,203
1980	**2,489,661**		**79**	**661,809**	3,151,470
1981	2,577,548		79.38	676,855	3,254,403
1982	2,961,574		79.63	740,623	3,702,197
1983	3,153,945		80.15	798,823	3,952,768
1984	2,900,000		**78.68**	792,665	3,692,665

Note : Data sourced from (WADM, var.). Underground coal mining ceased in 1994, with all coal since this time being through open cut mining.

§ Overburden for Muja open cut only. Muja produced most of the open cut coal around this time but not all (eg. >90%).

Black Coal Production Statistics – Australia (raw)

Year	Underground (Mt)	Open Cut (Mt)	Overburden [§] (Mm^3)	Year	Underground (Mt)	Open Cut (Mt)	Overburden [§] (Mm^3)
1940	11.913	0.045		1973	37.393	24.011	3.60
1941	14.440	0.068		1974	35.225	28.468	
1942	15.111	0.058		1975	35.848	31.944	
1943	14.364	0.062	0.167	1976	36.337	35.093	
1944	13.664	0.252	0.286	1977	44.433	44.818	2.01
1945	12.348	0.648	0.240	1978	45.298	45.904	
1946	11.145	1.169	0.320	1979	45.557	49.627	
1947	11.897	1.551	0.269	1980	44.610	48.796	
1948	11.865	1.886	0.757	1981	54.683	58.859	
1949	11.323	2.361	0.816	1982	55.675	66.354	
1950	13.210	2.522	0.852	1983	53.001	70.635	
1951	14.133	3.721	0.949	1984	51.694	90.300	
1952	15.574	4.159	1.099	1985	54.296	103.960	
1953	15.525	3.184	1.108	1986	57.123	112.908	
1954	17.067	2.959	1.471	1987	59.177	119.390	
1955	17.233	2.336	0.418	1988	51.859	123.412	
1956	17.409	2.155	1.037	1989	56.888	135.180	163.50
1957	19.003	2.011	1.034	1990	60.558	140.810	
1958	18.692	2.075	1.936	1991	61.015	145.963	
1959	18.891	1.713	2.017	1992	61.896	160.590	593.32
1960	20.742	2.161	2.654	1993	62.517	161.835	645.86
1961	21.500	2.866	2.665	1994	62.246	165.847	849.82
1962	21.639	3.214	2.904	1995	66.745	172.088	870.92
1963	22.013	3.279	2.072	1996	70.474	179.458	617.75
1964	23.904	3.935	3.937	1997	77.277	195.905	1,001.04
1965	27.267	4.674	3.709	1998	79.128	196.458	1,070.73
1966	28.533	5.361	5.210	1999	87.349	212.655	645.56
1967	29.736	5.537	5.924	2000	91.858	212.087	678.19
1968	33.147	8.414	5.607	2001	93.876	239.316	812.55
1969	36.126	10.629	6.390	2002	88.113	261.535	1,034.80
1970	37.509	12.781	5.628	2003	81.890	275.900	1,032.47
1971	36.287	13.315	4.459	2004	82.320	292.890	1,576.64
1972	38.810	21.697	2.987	2005	89.120	308.610	1,316.08

[§] Overburden data as compiled from available state data. ***No single year of data represents all or 100% of overburden from open cut coal mining for that year.***

Black Coal Exports (t) – Australia

1858	12,232	1883	667,249	1908	2,601,815	1933	287,505	1958	837,108	1983	54,650,000
1859	45,059	1884	707,823	1909	1,608,082	1934	297,095	1959	806,897	1984	64,330,000
1860	95,147	1885	776,663	1910	1,730,375	1935	310,021	1960	1,839,727	1985	86,100,000
1861	51,310	1886	719,419	1911	1,714,863	1936	312,461	1961	2,895,912	1986	90,300,000
1862	115,169	1887	724,583	1912	2,186,823	1937	345,834	1962	2,955,716	1987	97,700,000
1863	85,475	1888	898,254	1913	2,132,081	1938	399,159	1963	3,225,569	1988	102,100,000
1864	90,350	1889	1,094,714	1914	2,150,872	1939	388,198	1964	4,882,848	1989	97,660,000
1865	91,749	1890	683,087	1915	1,393,693	1940	268,701	1965	5,940,000	1990	104,580,000
1866	199,858	1891	861,033	1916	944,878	1941	335,385	1966	8,870,000	1991	113,370,000
1867	163,836	1892	887,676	1917	656,897	1942	244,860	1967	8,040,000	1992	123,300,000
1868	222,488	1893	685,650	1918	362,431	1943	258,108	1968	10,480,000	1993	129,180,000
1869	259,168	1894	965,254	1919	536,542	1944	160,265	1969	14,410,000	1994	129,060,000
1870	246,710	1895	985,242	1920	1,029,591	1945	192,225	1970	17,970,000	1995	136,240,000
1871	189,523	1896	1,120,761	1921	2,195,926	1946	90,016	1971	18,960,000	1996	138,550,000
1872	279,459	1897	1,216,793	1922	1,045,227	1947	49,138	1972	21,850,000	1997	145,750,000
1873	352,696	1898	1,181,328	1923	1,131,941	1948	50,702	1973	25,830,000	1998	162,610,000
1874	411,929	1899	1,193,176	1924	1,357,873	1949	49,019	1974	28,390,000	1999	169,410,000
1875	414,684	1900	1,413,004	1925	993,732	1950	68,469	1975	32,420,000	2000	175,780,000
1876	331,079	1901	1,373,070	1926	807,049	1951	112,820	1976	30,430,000	2001	193,500,000
1877	357,602	1902	1,342,445	1927	820,062	1952	179,657	1977	35,370,000	2002	197,870,000
1878	389,227	1903	2,053,017	1928	564,507	1953	382,807	1978	37,910,000	2003	207,740,000
1879	382,993	1904	1,637,113	1929	352,205	1954	373,658	1979	38,280,000	2004	224,750,000
1880	205,927	1905	2,058,190	1930	299,215	1955	205,295	1980	43,160,000	2005	233,750,000
1881	378,672	1906	2,094,793	1931	394,548	1956	243,209	1981	47,250,000	2006[P]	236,960,000[P]
1882	509,340	1907	2,689,918	1932	349,519	1957	771,241	1982	46,120,000		

Black Coal Production versus Resources Statistics (Mt)

Year	Australia		World	
	Raw (Production)	**Economic Resources**	**Raw** (Production)	**Economic Resources**
1975	74.68	19,500		
1976	84.16	20,200		
1977	87.47	23,110		
1978	89.35	23,710		
1979	93.04	27,890		
1980	93.41	28,570		
1981	110.95	29,470		
1982	119.07	30,400		
1983	120.48	31,000		
1984	139.09	35,000		
1985	158.26	34,000		
1986	170.03	34,000		
1987	178.57	49,500		
1988	174.40	49,700		
1989	193.04	50,800		
1990	201.37	51,100		
1991	206.99	51,400		
1992	222.52	52,000		
1993	224.22	52,000		
1994	227.81	49,000	3,539.7	
1995	238.72	49,000	3,665.4	
1996	249.98	49,000	3,744.1	
1997	272.55	51,400	3,773.1	
1998	274.88	51,100	3,700.9	
1999	299.48	44,400	3,642.8	
2000	303.55	42,600	3,634.6	770,000
2001	333.32	40,800	3,795.6	788,000
2002	349.47	39,700	3,910.3	784,000
2003	357.79	38,300	4,042.4	776,000
2004	375.20	40,400	~4,100	743,000
2005	397.73	39,200	~4,500	739,000
2006[P]	397.81[P]	37,300[P]	~5,100[P]	734,000[P]

11. Brown Coal

- *Brown Coal & Overburden Production – Victoria 1889-2006*

  Data Sources/References : (Andrew, 1965; BMR, var.; Holmes, 1980; Kalix *et al.*, 1966; McKay, 1950; SECV, var.; VDM, var.; VDPI, var.)
- *Brown Coal Production by Mine – Victoria 1889-2006*

  Data Sources/References : (Andrew, 1965; BMR, var.; Drucker, 1984; IPH, var.; Kalix *et al.*, 1966; LYP, var.; McKay, 1950; SECV, var.; VDM, var.; VDPI, var.; Vines, 1997; YE, var.).
- *Brown Coal Production – Yallourn/Yallourn North 1921-2006*

  Data Sources/References : 1920/21 to 1946/47 (McKay, 1950), 1950/51 to 1962/63 (Andrew, 1965), 1958/59 to 1994/95 (SECV, var.), and total production data (Mether, 2005) supplied by Yallourn Energy[30], overburden and mine production supplemented by (VDPI, var.; YE, var.), with overburden for 1995/96 to 2005/06 calculated based on cumulative total and the average overburden:coal ratio only (to provide indicative overburden totals for the Latrobe Valley).
- *Brown Coal Production – Hazelwood/Morwell 1921-2006*

  Data Sources/References : 1950-2005 supplied by Hazelwood Power[31], also supplemented 1997/98 to 2004/05 by (IPH, var.; VDPI, var.).
- *Brown Coal Production – Loy Yang 1981-2006*

  Data Sources/References : 1980/81 to 1995/96 (Vines, 1997) and recent Environment Reports published by Loy Yang Power Ltd (LYP, var.).
- *Brown Coal Production – Maddingley (Bacchus Marsh) 1944-2006*

  Data Sources/References : (BMR, var.; Knight, 1975b; VDM, var.; VDPI, var.).

Brown Coal Production Statistics : Victoria (t)

Year	Raw	Year	Raw	Year	Raw	Year	Raw
1889	565	1919	177,800	1948	6,799,368	1977	29,250,000
1890	10,015	1920	244,242	1949	7,493,568	1978	32,860,000
1891	6,423	1921	168,642	1950	7,444,353	1979	32,598,000
1892	6,706	1922	150,510	1951	7,961,433	1980	32,895,000
1893	4,572	1923	177,536	1952	8,233,424	1981	32,990,000
1894	3,570	1924	175,825	1953	8,389,416	1982	37,830,000
1895	1,987	1925	917,128	1954	9,480,555	1983	34,120,000
1896	5,908	1926	1,071,413	1955	10,274,001	1984	34,756,000
1897	4,792	1927	1,539,047	1956	10,728,758	1985	37,320,000
1898	2,915	1928	1,597,538	1957	10,912,845	1986	37,637,000
		1929	1,755,932	1958	11,829,927	1987	43,517,000
1901	152	1930	1,902,003	1959	13,243,159	1988	44,288,000
1902		1931	2,228,687	1960	15,206,677	1989	48,653,000
1903	5,752	1932	2,637,485	1961	16,540,042	1990	45,960,000
1904		1933	2,623,464	1962	17,411,637	1991	49,388,000
1905	51	1934	2,695,641	1963	18,751,948	1992	50,717,000
1906		1935	2,312,162	1964	19,337,965	1993	47,898,000
1907	51	1936	3,198,510	1965	20,989,398	1994	49,683,000
1908	508	1937	3,503,310	1966	22,131,505	1995	49,922,000
1909	508	1938	3,734,217	1967	23,757,745	1996	54,281,000
1910	660	1939	3,755,766	1968	23,338,183	1997	60,795,000
1911	6,232	1940	4,397,187	1969	23,274,000	1998	65,274,000
1912	4,076	1941	4,678,721	1970	24,175,000	1999	66,648,000
1913	3,032	1942	5,058,786	1971	23,383,000	2000	67,363,000
1914	2,758	1943	5,254,112	1972	23,697,000	2001	64,958,000
1915	2,910	1944	5,301,661	1973	24,676,000	2002	66,661,000
1916	2,962	1945	5,670,774	1974	27,303,000	2003	66,809,000
1917	39,770	1946	5,798,352	1975	28,178,000	2004	66,343,000
1918	67,259	1947	6,238,382	1976	30,940,000	2005	67,152,000
						2006[P]	67,737,000[P]

[30] C Davis, Yallourn Energy Ltd (subsidiary of TRUEnergy Ltd), Email 27 January 2006.
[31] Now International Power Hazelwood; D Maxwell, IPH, Email 28 October 2003.

Brown Coal Production Statistics : Yallourn

Year	Brown Coal (t)	Overburden (m^3)
1920/21		5,730
1921/22		26,695
1922/23		305,975
1923/24		378,738
1924/25	449,641	183,883
1925/26	701,709	308,957
1926/27	874,868	278,795
1927/28	1,176,983	603,005
1928/29	1,687,200	1,095,187
1929/30	1,797,016	741,465
1930/31	1,879,575	724,569
1931/32	2,605,928	448,106
1932/33	2,608,615	678,734
1933/34	2,735,618	562,368
1934/35	1,765,409	418,212
1935/36	3,037,167	759,356
1936/37	3,149,430	1,043,388
1937/38	3,654,852	908,979
1938/39	3,701,252	892,159
1939/40	4,006,426	825,872
1940/41	4,557,708	1,227,799
1941/42	4,778,853	1,155,396
1942/43	5,056,810	1,646,584
1943/44	4,906,847	1,396,269
1944/45	5,333,485	1,272,028
1945/46	5,535,883	1,142,130
1946/47	5,708,320	1,661,454
1947/48	6,090,622	
1948/49	6,335,381	
1949/50		**1,600,000**
1950/51		**1,299,744**
1951/52		**1,682,021**
1952/53		**2,064,299**
1953/54		**2,140,754**
1954/55		**2,828,854**
1955/56		**2,523,032**
1956/57		**2,140,754**
1957/58		**4,064,281**
1958/59	5,696,154	2,963,193
1959/60	3,776,482	2,246,858
1960/61	3,942,616	2,952,885
1961/62	4,545,848	3,280,892
1962/63	4,668,009	3,512,746

Year	Brown Coal (t)	Overburden (m^3)
1963/64	6,768,408	4,517,354
1964/65	6,567,688	4,421,178
1965/66	6,114,825	4,556,424
1966/67	7,142,184	4,784,509
1967/68	6,529,832	4,887,800
1968/69	6,630,416	4,604,150
1969/70	6,952,488	5,231,850
1970/71	9,547,000	5,344,239
1971/72	8,787,000	3,968,040
1972/73	8,285,000	4,800,000
1973/74	10,105,000	3,400,000
1974/75	11,942,000	3,700,000
1975/76	12,486,000	4,400,000
1976/77	13,499,000	3,200,000
1977/78	13,903,000	**5,382,000**
1978/79	14,975,000	6,500,000
1979/80	15,410,000	5,900,000
1980/81	15,713,000	6,800,000
1981/82	22,275,000	7,200,000
1982/83	21,360,000	5,600,000
1983/84	19,710,000	4,300,000
1984/85	19,033,000	4,100,000
1985/86	15,281,000	5,300,000
1986/87	17,357,000	4,900,000
1987/88	16,210,000	5,600,000
1988/89	15,900,000	4,300,000
1989/90	15,004,000	4,200,000
1990/91	16,500,000	5,000,000
1991/92	17,110,000	500,000
1992/93	16,709,000	4,500,000
1993/94	**~15,815,000**	3,800,000
1994/95	**~16,641,000**	1,100,000
1995/96	17,460,000	**~5,063,000**
1996/97	17,083,000	**~4,954,000**
1997/98	17,924,000	**~5,198,000**
1998/99	17,350,000	**~5,032,000**
1999/00	16,098,000	**~4,668,000**
2000/01	16,234,000	**~4,708,000**
2001/02	15,650,000	**~4,539,000**
2002/03	17,515,000	**~5,079,000**
2003/04	16,585,000	**~4,810,000**
2004/05	17,663,000	**~5,122,000**
2005/06	16,933,000	**~4,911,000**
Total	**~795 Mt**	**~257 Mm^3**

Brown Coal Production Statistics : Yallourn North (t)

Year	Coal	Year	Coal	Year	Coal	Year	Coal	Year	Coal
1889	565	1907	51	1921	75,649	1943	43,384	1954	1,332,747
1890	10,015	1908	508	1922	91,325	1944	89,390	1955	1,528,966
1891	6,423	1909	508	1923	116,886	1945	48,996	1956	1,573,105
1892	6,706			1924	128,044	1946	91,769	1957	1,653,700
1893	4,572	1912	71	1925	170,892	1947	155,893	1958	1,621,696
1894	3,570			1926	223,038	1948	338,238	1959	1,386,359
1895	1,987	1916	132	1927	361,909	1949	417,277	1960	1,078,173
1896	4,750	1917	35,355	1928	168,200	1950	633,039	1961	727,545
1897	4,792	1918	63,517	1929	42,807	1951	941,713	1962	398,276
1898	2,915	1919	111,946			1952	1,105,025	1963	643,984
1905	51	1920	165,285	1942	40,727	1953	1,262,297	1964	507,188

Year	Brown Coal (t)	Overburden (m^3)
1923/24	35,440	31,604
1924/25	173,701	150,267
1925/26	177,809	256,179
1926/27	312,523	410,955
1927/28	324,770	210,232
1928/29	41,729	
1929/30	53,701	
1934/35	256,971	257,120
1940/41	320	46,686
1941/42	33,916	273,481
1942/43	40,247	
1943/44	88,113	
1944/45	47,816	
1945/46	50,025	
1946/47	135,329	
1947/48	200,791	
1948/49	479,423	

Year	Brown Coal (t)	Overburden (m^3)
1955/56		**305,822**
1956/57		**458,733**
1957/58		**611,644**
1958/59		1,323,247
1959/60		595,000
1960/61		13,992
1961/62		139,926
1963/64		575,973
1964/65		521,104
1965/66		45,073
1966/67		590,090
1967/68		25,995
1968/69		385,336
1970/71		7,646
1971/72		955,694
Total	**>19.4 Mt**	**>8.2 Mm^3**

Brown Coal Production Statistics : Maddingley (Bacchus Marsh)

Year	Coal (t)
1944	1,927
1945	7,138
1946	32,581
1947	155,281
1948	215,100
1949	287,219
1950	348,702
1951	401,757
1952	278,190
1953	330,855
1954	512,782
1955	419,011

Year	Coal (t)	Overburden (m^3)
1956	449,835	349,402
1957	467,655	351,695
1958	462,771	305,822
1959	507,135	330,729
1960	439,051	259,949
1961	376,780	156,734
1962	413,053	
1963	422,177	106,579
1964	424,941	96,863
1965	452,322	91,016
1966	452,706	123,252
1967	433,843	122,210
1968	407,779	
1969	323,000	
1970	286,000	
1971	248,000	
1972	234,000	

Year	Coal (t)
1973	199,000
1974	168,000
1975	146,000
1976	148,000
1977	116,000
1978	106,000
1979	103,000
1980	115,000
1981	97,000
1982	110,000
1983	100,000
1984	77,000
1985	70,000
1986	80,000
1987	43,000
1987/88	45,000
1988/89	47,000

Year	Coal (t)
1989/90	22,000
1990/91	40,000
1991/92	40,000
1992/93	36,000
1993/94	31,000
1994/95	43,000
1995/96	40,000
1996/97	39,000
1997/98	28,000
1998/99	22,000
1999/00	4,000
2000/01	11,000
2001/02	10,000
2002/03	15,000
2003/04	18,000
2004/05	19,000
2005/06	22,000

Brown Coal Production Statistics : Loy Yang

Year	Brown Coal (t)	Overburden (m^3)
1981/82		2,570,000
1982/83	0	5,318,303
1983/84	401,742	5,745,192
1984/85	5,007,429	3,653,319
1985/86	7,547,030	3,431,635
1986/87	10,762,429	3,983,635
1987/88	14,692,004	2,280,842
1988/89	16,859,016	4,155,091
1989/90	18,028,144	4,306,555
1990/91	18,028,768	4,886,469
1991/92	17,520,159	6,171,717
1992/93	15,949,128	6,903,541
1993/94	23,598,847	7,974,093
1994/95	24,285,012	4,780,363
1995/96	25,863,472	3,715,175
1997	29,246,176	3,382,799
1998	30,655,404	4,505,882
1999	30,746,910	4,440,134
2000	29,612,546	3,340,091
2001	29,061,804	2,703,537
2002	28,117,599	3,551,017
2003	28,750,081	3,304,158
2004	30,332,932	5,203,890
2005	30,059,964	4,646,446
2006	30,299,544	3,632,277
Total	**~495 Mt**	**~109 Mm^3**

Brown Coal Production Statistics : Hazelwood (Morwell)

Year	Brown Coal (t)	Overburden (m^3)
1910	51	
1911	224	
1950		345,599
1951		828,062
1952		1,166,780
1956	15,240	587,977
1957	56,000	1,141,000
1958	608,000	1,585,780
1959	334,000	1,809,000
1960	1,014,000	1,570,000
1961	2,516,000	727,000
1962	3,298,000	1,035,000
1963	3,874,000	623,000
1964	4,080,000	2,312,000
1965	4,597,000	2,462,000
1966	6,872,000	2,679,000
1967	8,480,000	3,552,000
1968	10,123,000	1,166,000
1969	10,117,000	1,612,000
1970	12,287,000	210,000
1971	11,800,000	1,996,000
1972	13,278,000	2,188,000
1973	14,169,000	2,515,000
1974	14,735,000	1,856,000
1975	14,105,000	2,150,000
1976	15,354,000	2,057,000
1977	16,024,000	2,206,000
1978	15,268,000	2,418,000
1979	15,701,000	3,516,000
1980	15,944,000	4,597,000
1981	14,904,000	3,422,000
1982	13,773,000	3,701,000
1983	11,825,000	2,838,000
1984	11,715,000	2,988,000
1985	12,852,000	2,565,000
1986	11,845,000	2,612,000
1987	12,069,000	2,060,000
1988	12,071,000	1,405,000
1989	14,153,000	2,095,000
1990	11,839,000	4,003,000
1991	13,639,000	1,866,000
1992	14,873,000	3,905,000
1993	14,120,000	4,594,000
1994	7,784,000	2,300,000
1995	7,644,000	784,000
1996	17,704,000	2,757,000
1997	16,279,750	4,775,500
1998	17,262,250	5,443,250
1999	18,859,500	5,336,250
2000	18,737,500	4,416,000
2001	19,747,000	5,387,000
2002	18,886,000	6,261,000
2003	18,800,000	9,300,000
2004	19,300,000	4,900,000
Total	**~603 Mt**	**~151 Mm^3**

Brown Coal Production Statistics : Miscellaneous (t)

Year	Coal
1896	1,260
1901	152
1903	5,752
1910	610
1911	6,009
1912	4,005
1913	3,032
1914	2,758
1915	2,910
1916	2,962
1917	140
1918	3,904
1919	1,465
1921	4,842
1922	523
1923	1,872
1924	1,485
1925	6,610
1926	4,475
1927	1,857
1929	234
1931	7,893
1932	144
1934	508
1935	1,016
1936	2,032
1937	2,540
1938	1,016
1939	864

- *Brown Coal Production – Anglesea 1966-2006*

  Data Sources/References : Alcoa Ltd does not publish annual production data. The initial development of the Anglesea mine from 1966 to 1969 required the excavation of about 2 Mm^3 overburden (Hay, 1980). For the life of the mine, the average overburden-to-coal ratio was estimated to be 1.6 (Hay, 1980). According to (Alcoa, 2004), current annual production is approximately 1.1 Mt brown coal and 1.8 Mm^3 overburden; supplemented by 1982-2006 (VDPI, var.); supplemented by (BMR, var.; Knight, 1975b; VDM, var.)

Brown Coal Production Statistics : Anglesea (t)

Year	Coal	Year	Coal	Year	Coal	Year	Coal
1959	172,120	1982/83	1,210,000	1990/91	1,179,000	1998/99	1,091,000
1960	95,135	1983/84	1,066,000	1991/92	1,175,000	1999/00	926,000
1961	58,671	1984/85	1,205,000	1992/93	1,084,000	2000/01	963,000
1962	48,979	1985/86	1,119,000	1993/94	1,093,000	2001/02	1,069,000
1963	49,217	1986/87	1,272,000	1994/95	1,162,000	2002/03	1,051,000
1964	46,720	1987/88	1,173,000	1995/96	836,000	2003/04	1,107,000
1965	26,859	1988/89	1,253,000	1996/97	1,005,000	2004/05	943,000
1981/82	1,210,000	1989/90	1,067,000	1997/98	1,030,000	2005/06	1,101,000

Brown Coal Production Statistics : Victoria – By Mine (t)

Year	Yallourn North	Yallourn	Hazelwood	Loy Yang	Anglesea	Maddingley	Misce-llaneous
1896	4,750						1,260
1901							152
1903							5,752
1910			51				610
1911			224				6,009
1912	71						4,005
1913							3,032
1914							2,758
1915							2,910
1916	132						2,962
1917	35,355						140
1918	63,517						3,904
1919	111,946						1,465
1920	165,285						
1921	75,649						4,842
1922	91,325						523
1923	116,886						1,872
1924	128,044						1,485
1925	170,892	712,989					6,610
1926	223,038	745,748					4,475
1927	361,909	1,115,003					1,857
1928	168,200	1,449,128					
1929	42,807	1,725,994					234
1930		1,860,811					
1931		2,221,671					7,893
1932		2,654,168					144
1933		2,621,341					
1934		2,658,907					508
1935		2,256,043					1,016
1936		3,091,583					2,032
1937		3,445,682					2,540
1938		3,733,241					1,016
1939		3,708,567					864
1940		4,346,931					
1941		4,638,180					508
1942	40,727	4,967,693					4,382
1943	43,384	5,118,938					10,874
1944	89,390	4,991,818				1,927	13,565

Brown Coal Production Statistics : Victoria – By Mine (t)

Year	Yallourn North	Yallourn	Hazelwood	Loy Yang	Anglesea	Maddingley	Misce-llaneous
1945	48,996	5,452,105				7,138	23,991
1946	91,769	5,635,984				32,581	38,018
1947	155,893	5,883,305				155,281	43,902
1948	338,238	6,188,472				215,100	57,557
1949	417,277	6,659,648				287,219	129,423
1950	633,039	6,310,298				348,702	152,314
1951	941,713	6,414,665				401,757	203,298
1952	1,105,025	6,550,855				278,190	299,354
1953	1,262,297	6,578,498				396,446	152,174
1954	1,332,747	7,194,808				597,358	355,642
1955	1,528,966	7,844,989	10,835			499,600	389,612
1956	1,573,105	8,235,142	15,240			517,515	395,421
1957	1,653,700	7,862,342	56,000			525,951	397,463
1958	1,621,696	9,126,539	608,000			550,575	295,909
1959	1,386,359	10,129,673	334,000		172,120	564,202	148,932
1960	1,078,173	13,539,909	1,014,000		95,135	490,936	2,524
1961	727,545	15,332,661	2,516,000		58,671	419,904	853
1962	398,276	16,497,609	3,298,000		48,979	466,427	345
1963	643,984	17,579,443	3,874,000		49,217	479,160	144
1964	507,188	18,298,409	4,080,000		46,720	485,567	81
1965	45,073	6,567,688	4,597,000		26,859	452,322	
1966	590,090	6,114,825	6,872,000			452,706	
1967	25,995	7,142,184	8,480,000			433,843	
1968	385,336	6,529,832	10,123,000			407,779	
1969		6,630,416	10,117,000			323,000	
1970		6,952,488	12,287,000			286,000	
1971		9,547,000	11,800,000			248,000	
1972		8,787,000	13,278,000			234,000	
1973		8,285,000	14,169,000			199,000	
1974		10,105,000	14,735,000			168,000	
1975		11,942,000	14,105,000			146,000	
1976		12,486,000	15,354,000			148,000	
1977		13,499,000	16,024,000			116,000	
1978		13,903,000	15,268,000			106,000	
1979		14,975,000	15,701,000			103,000	
1980		15,410,000	15,944,000			115,000	
1981		15,713,000	14,904,000			97,000	
1982		22,275,000	13,773,000		1,210,000	110,000	
1983		21,360,000	11,825,000		1,210,000	100,000	
1984		19,710,000	11,715,000	401,742	1,066,000	77,000	
1985		19,033,000	12,852,000	5,007,429	1,205,000	70,000	
1986		15,281,000	11,845,000	7,547,030	1,119,000	80,000	
1987		17,357,000	12,069,000	10,762,429	1,272,000	43,000	
1988		16,210,000	12,071,000	14,692,004	1,173,000	45,000	
1989		15,900,000	14,153,000	16,859,016	1,253,000	47,000	
1990		15,004,000	11,839,000	18,028,144	1,067,000	22,000	
1991		16,500,000	13,639,000	18,028,768	1,179,000	40,000	
1992		17,110,000	14,873,000	17,520,159	1,175,000	40,000	
1993		16,709,000	14,120,000	15,949,128	1,084,000	36,000	
1994		**~15,815,000**	7,784,000	23,598,847	1,093,000	31,000	
1995		**~16,641,000**	7,644,000	24,285,012	1,162,000	43,000	
1996		17,460,000	17,704,000	25,863,472	836,000	40,000	
1997		17,083,000	16,279,750	29,246,176	1,005,000	39,000	
1998		17,924,000	17,262,250	30,655,404	1,030,000	28,000	
1999		17,350,000	18,859,500	30,746,910	1,091,000	22,000	
2000		16,098,000	18,737,500	29,612,546	926,000	4,000	
2001		16,234,000	19,747,000	29,061,804	963,000	11,000	
2002		15,650,000	18,886,000	28,117,599	1,069,000	10,000	
2003		17,515,000	18,800,000	28,750,081	1,051,000	15,000	
2004		16,585,000	19,300,000	30,332,932	1,107,000	18,000	
2005		17,663,000	18,701,000	30,059,964	943,000	19,000	
2006		16,933,000	18,743,000	30,299,544	1,101,000	22,000	
Total	**~810 Mt**		**~603 Mt**	**~495 Mt**	**~30 Mt**	**~12 Mt**	

12. Uranium

- *Uranium Production by Mine – 1954-2006*
  Data Sources/References : (Mudd, 2007)

Uranium Production Statistics by Mine (t U_3O_8)

Year	Australia[1, 2]	Northern Territory					QLD	South Australia		
		Ranger	Nabarlek	Rum Jungle	Moline	Rock-hole	Mary Kathleen	Olympic Dam	Bev-erley	Radium Hill
1954	13.9			13.9						
1955	362.3			88.4	152.23					121.8
1956	349.0			195.4	31.9					121.8
1957	341.7			220.0						121.8
1958	550.7			174.0			254.92			121.8
1959	1,018.2			147.9	69.6	20.33	658.68			121.8
1960	1,113.2			160.3	122.0	39.7	669.42			121.8
1961	1,338.3			210.5	93.3	39.3	873.48			121.8
1962	1,276.3			248.2	90.6	30.1	907.30			
1963	1,088.5			254.0	96.4	10.2	727.96			
1964	318.6			258.6	60.0					
1965	267.1			267.1						
1966	262.3			262.3						
1967	253.5			253.5						
1968	251.7			251.7						
1969	248.3			248.3						
1970	230.0			230						
1971	46.3			46.3						
1976	423.0						423.0			
1977	420.0						420.0			
1978	607.4						607.4			
1979	832.0						832.0			
1980	1,851.5		1,006.0				834.5			
1981	3,372.9	1,122.2	1,426.0				824.7			
1982	5,252.0	3,134.6	1,258.0				859.4			
1983	3,794.6	2,580.6	1,214.0							
1984	5,185.6	3,775.6	1,401.0					9.0		
1985	3,834.9	2,519.1	1,315.3							
1986	4,898.9	3,496.6	1,402.3							
1987	3,615.8	2,261.5	1,354.3							
1988	4,742.5	3,712.4	578.1					452.0		
1989	4,310.2	3,289.7						1,020.5		
1990	4,163.7	2,894.7						1,269.0		
1991	4,454.0	3,121.0						1,333.0		
1992	2,742.4	1,350.3						1,392.1		
1993	2,639.2	1,335.1						1,304.1		
1994	2,595.0	1,461.8						1,133.2		
1995	4,363.3	3,006.9						1,356.4		
1996	5,857.8	4,138.2						1,719.6		
1997	6,472.8	4,791.8						1,681.0		
1998	5,832.7	4,049.6						1,740.0	33.27	
1999	7,065.0	3,857.2						3,198.0		
2000	8,946.5	4,436.7						4,500.0	0	
2001	9,104.0	4,203						4,355.0	546	
2002	8,097.3	4,470						2,881.3	746	
2003	8,985.0	5,065						3,203	717	
2004	10,591	5,137						4,370	1,084	
2005	11,249	5,910						4,362	977	
2006	8,950	4,748						3,377	825	
Totals	**164,579**	**89,121**	**10,955**	**3,530**	**716**	**140**	**8,893**	**44,656**	**4,928**	**852**

[1] Does not include pilot milling at Yeelirrie and Manyingee in Western Australia in the early to mid-1980's of some 11 t U_3O_8 and 0.5 t U_3O_8, respectively (see (Mudd, 2007).
[2] Does not include small exploration-scale mines.

- *Uranium Milling, Waste Rock and Production – Australia 1911-2006*
  Data Sources/References : (Mudd, 2007)

Uranium Milling, Waste Rock and Production : Australia

Year	**Ore** (t)	**Grade** (% U_3O_8)	**Waste Rock** (t)	**Low Grade Ore** (t)	**WR+LGO** (t)	**Open Cut** (%ore)	**Production** (t U_3O_8)
1911	50	2					
1912	135	1.5					
1913	294	1.9					
1914	629	2.5					
1915	215	1.4					
1925	10	3					0.23
1926	30	1					
1927							0.187
1932							0.152
1954	22,489	0.230	1,890,000		1,890,000	100.0	13.9
1955	51,774	0.672	1,890,000		1,890,000	99.8	362.3
1956	129,744	0.307	1,923,403	1,651	1,925,054	56.1	349.0
1957	199,659	0.201	2,999,571	130,481	3,130,052	37.3	341.7
1958	420,505	0.156	3,230,115	19,752	3,249,867	66.5	550.7
1959	681,566	0.162	794,610	95,890	890,500	76.5	1,018.2
1960	728,823	0.165	923,971	66,672	990,643	72.6	1,113.2
1961	745,737	0.202	2,320,520	85,301	2,405,821	86.3	1,338.3
1962	665,375	0.221	2,178,255	96,876	2,275,130	97.4	1,276.3
1963	570,340	0.206	1,995,946	69,751	2,065,697	98.7	1,088.5
1964	85,804	0.432				93.1	318.6
1965	79,000	0.409				100.0	267.1
1966	79,000	0.372				100.0	262.3
1967	91,000	0.332				100.0	253.5
1968	109,000	0.266	20,000		20,000	100.0	251.7
1969	150,000	0.157				100.0	248.3
1970	150,000	0.118				100.0	230.0
1971	50,000	0.118				100.0	46.3
1976	384,545	0.110	2,750,000		2,750,000	100.0	423.0
1977	381,818	0.110	2,750,000		2,750,000	100.0	420.0
1978	552,182	0.110	2,750,000		2,750,000	100.0	607.4
1979	779,000	0.107	4,930,000		4,930,000	100.0	832.0
1980	752,573	0.338	7,440,000	280,000	7,720,000	100.0	1,851.5
1981	1,687,451	0.296	3,077,426	619,174	3,696,600	100.0	3,372.9
1982	1,901,521	0.285	3,900,000	600,000	4,500,000	100.0	5,252.0
1983	1,078,567	0.437	974,500	711,000	1,685,500	100.0	3,794.6
1984	1,121,244	0.409	3,707,625	1,269,000	4,976,625	98.2	5,185.6
1985	1,047,512	0.454	1,590,000	873,844	2,463,844	100.0	3,834.9
1986	943,769	0.497	2,120,000	945,558	3,065,558	100.0	4,898.9
1987	842,190	0.531	1,160,000	2,881,678	4,041,678	100.0	3,615.8
1988	1,513,678	0.313	1,442,094	1,820,290	3,262,384	64.4	4,742.5
1989	2,450,617	0.199	1,065,929	862,000	1,927,929	44.4	4,310.2
1990	2,701,655	0.183	1,130,932	569,000	1,699,932	40.3	4,163.7
1991	2,736,548	0.185	140,044	792,000	932,044	36.0	4,454.0
1992	2,664,435	0.137	1,281,075	1,942,000	3,223,075	16.0	2,742.4
1993	2,792,298	0.128	1,168,424	1,771,000	2,939,424	15.7	2,639.2
1994	2,958,725	0.126	594,458	1,324,000	1,918,458	19.5	2,595.0
1995	3,929,567	0.157	463,285	14,000	477,285	30.6	4,363.3
1996	4,668,350	0.160	2,096,804	2,772,000	4,868,804	33.6	5,857.8
1997	4,978,787	0.146	1,980,863	4,141,000	6,121,863	37.0	6,472.8
1998	5,231,116	0.145	1,457,369	4,158,000	5,615,369	34.9	5,832.7
1999	8,211,621	0.126	3,715,000	2,867,000	6,582,000	17.9	7,065.0
2000	10,740,946	0.110	3,155,076	3,392,000	6,547,076	17.1	8,946.5
2001	10,000,736	0.087	1,747,859	1,483,000	3,230,859	6.6	9,104.0
2002	10,658,597	0.104	3,333,968	195,000	3,528,968	16.7	8,097.3
2003	10,454,629	0.106	4,500,930	419,000	4,919,930	19.8	8,985.0
2004	10,973,088	0.105	***no data***	***no data***	**~9,250,000**	19.0	10,591
2005	11,850,820	0.106	***no data***	***no data***	**~15,680,000**	19.2	11,249
2006	11,157,136	0.096	***no data***	***no data***	**~10,626,800**	18.6	11,249
Total	**137.2 Mt**	**0.135**	**»95.8 Mt**	**»37.3 Mt**	**»160 Mt**	**30.6**	**164,579**

- *Uranium Production, Exports and Resources - Australia and World*
  Data Sources/References : (ABARE, var.-a, var.-b; BMR, var.; Dickinson, 1945; Mudd, 2007; OECD-NEA & IAEA, var.; Stewart, 1965)

Uranium Production, Exports and Resources : Australia and World (t U_3O_8)

Year	Australia			World	
	Production	Resources	Exports	Production	Resources
1945		1.6 [§]			
1952		2,700 [†]			
1954	13.9				
1955	362.3				
1956	349.0			20,320	
1957	341.7			22,352	
1958	550.7			30,480	
1959	1,018.2			39,461	
1960	1,113.2			36,952	
1961	1,338.3			32,880	
1962	1,276.3			31,367	
1963	1,088.5	12,428 [‡]		27,391	
1964	318.6			23,774	
1965	267.1			18,593	
1966	262.3			17,409	
1967	253.5			16,917	
1968	251.7			19,971	
1969	248.3			21,473	
1970	230.0			21,292	
1971	46.3			22,301	
1972	0			23,439	
1973	0			23,312	
1974	0			21,778	
1975	0			22,495	
1976	423.0	406,755	36	26,283	4,290,000
1977	420.0		1,545	33,423	
1978	607.4	415,008	1,114	39,957	5,040,000
1979	832.0		1,317	44,940	
1980	1,851.5	709,758	1,131	51,895	5,013,000
1981	3,372.9		1,625	52,073	
1982	5,252.0	860,670	5,459	48,841	3,265,000
1983	3,794.6		3,273	43,617	
1984	5,185.6	1,064,637	3,307	45,807	3,647,000
1985	3,834.9		3,447	41,079	
1986	4,898.9	1,063,458	4,166	44,001	3,643,000
1987	3,615.8		3,755	43,232	
1988	4,742.5	1,097,649	4,327	71,682	3,642,000
1989	4,310.2		4,434	68,157	
1990	4,163.7	1,083,501	7,441	58,444	3,384,000
1991	4,454.0		5,008	51,861	
1992	2,742.4	1,074,069	2,961	42,485	3,297,000
1993	2,639.2		3,655	39,186	
1994	2,595.0	1,065,816	3,767	37,269	3,989,600
1995	4,363.3		3,726	39,089	
1996	5,857.8	1,055,205	5,425	42,620	5,068,521
1997	6,472.8		6,916	43,298	
1998	5,832.7	1,072,890	5,553	41,131	5,206,971
1999	7,065.0		7,579	37,939	
2000	8,946.5	1,096,470	8,756	42,576	5,178,498
2001	9,104.0		9,240	42,876	
2002	8,097.3	1,247,382	7,636	42,518	5,410,063
2003	8,985.0		9,614	42,224	
2004	10,591	1,347,597	9,681	47,470	5,591,824

[§] (Dickinson, 1945); [†] Based on contracts for Rum Jungle and Radium Hill of ~1,500 and ~1,200 t U_3O_8, respectively (eg. (Cawte, 1992); [‡] (Stewart, 1965).

13. Iron Ore

- *Iron Ore Production by State :1850-2006*
  Data Sources/References : (ABARE, var.-a, var.-b; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; QDM, var.; SADM, var.-a, var.-b; TDM, var.; VDM, var.; VDPI, var.; WADM, var.; WADMPR, var.; WADoIR, var.)
- *Iron Ore Production : Estimated Iron Grades*
  Data Sources/References : (ABARE, var.-a; BMR, var.; NSWDM, var.)

Iron Ore Production by State (t)

Year	SA
1850	119
1860	5

Year	SA
1862	9
1865	20

Year	SA
1874	6

Year	SA
1879	298
1880	2

Year	NSW
1885	457

Year	QLD	NSW	VIC	TAS	SA	NT	WA	Australia
1889		497			4,467			4,964
1890		463			4,030			4,493
1891		232			6,908			7,140
1892		460			4,251			4,711
1893		1,280			3,099			4,379
1894		440			1,589			2,029
1895		155			1,637			1,792
1896		381			111			492
1897		234			410			644
1898		398					102	500
1899		11,092					13,058	24,150
1900		13,675					12,447	26,122
1901	437	4,333		622			20,898	26,290
1902		13,963		2,424			4,877	21,264
1903	9,965	23,687		6,076	86,291		224	126,242
1904	4,502	9,221		6,949	47,434		1,464	69,571
1905	4,411	7,460		6,401	85,835		3,264	107,372
1906	31,903	1,543		2,642	76,430		1,300	113,818
1907	36,430	47,502		3,048	85,954		1,112	174,045
1908	52,420	62,098		3,658	89,408			207,583
1909	49,414	56,875			16,378			122,667
1910	37,732	77,037			46,939		10	161,719
1911	20,969	61,984			42,977			125,930
1912	15,774	60,980			42,875			119,630
1913	41,491	75,977			61,629			179,097
1914	48,859	140,675			43,304			232,839
1915	46,417	139,170			241,173			426,760
1916	44,868	95,621			191,342			331,831
1917	25,466	99,405			333,640			458,512
1918	43,467	120,542			261,141			425,150
1919	25,071	149,127			272,826			447,025
1920	20,024	133,067			419,647			572,737
1921	4,126	181,830			515,105			701,061
1922		115,146			52,246			167,392
1923	203	181,300			390,585			572,088
1924		147,785			589,593			737,378
1925	351	162,173			596,038			758,562
1926	4,483	163,075			593,085			760,643
1927	514	188,081			733,984			922,579
1928		90,286			628,209			718,495
1929	1,256	11,409			861,378			874,042
1930	2,456	3,861			943,246			949,563
1931	4,629	3,724			293,806			302,158
1932	8,364	3,114			546,535			558,013
1933	8,690	5,454			732,724			746,868
1934	3,282	4,280			1,264,143			1,271,705
1935	1,137	12,262			1,898,619			1,912,018
1936	2,338	3,495			1,917,495			1,923,328
1937	4,551	678		62	1,896,277			1,901,567
1938	5,207	110			2,281,292			2,286,609
1939	4,003	60			2,795,787			2,799,850

Iron Ore Production by State (t)

Year	QLD	NSW	VIC	TAS	SA	NT	WA	Australia
1940	2,886	221		1,186	2,350,369			2,354,662
1941	2,349	206,048	5	2,215	2,276,233			2,486,850
1942	3,815	383,770	22		2,156,005		152	2,543,764
1943	3,095	467,263			2,217,756		85	2,688,200
1944	2,374	305,167			2,061,709			2,369,250
1945	1,742	95,755			1,543,908			1,641,405
1946	1,680	12,888		251	1,847,307			1,862,127
1947	1,363	9,386		399	2,179,857			2,191,006
1948	1,592	9,580		323	2,067,383		7,338	2,086,216
1949	1,493	10,478		1,531	1,470,895		12,724	1,497,121
1950	1,990	11,927		1,545	2,387,421		15,133	2,418,017
1951	1,629	11,891		3,287	2,438,986		36,222	2,492,015
1952	1,273	12,512		4,750	2,726,909		227,369	2,972,813
1953	1,063	5,665		4,904	2,632,796		718,701	3,363,130
1954	165	5,305		6,482	2,912,933		662,172	3,587,056
1955	939	3,462	2,032	6,687	3,092,683		537,088	3,642,890
1956	4,158	3,583	2,337	5,776	3,644,489		342,280	4,002,623
1957	4,341	2,797	2,337	5,867	3,443,465		422,896	3,881,703
1958	1,012	2,984	770	4,334	3,406,238		582,095	3,997,433
1959	1,344	5,328	2,277	5,143	3,477,980		738,717	4,230,790
1960	1,787	12,927	1,171	3,553	3,491,587		943,318	4,454,343
1961	1,774	20,063	701	2,346	4,055,204		1,381,301	5,461,389
1962	2,374	19,821	82	4,147	3,566,429		1,453,644	5,046,498
1963	3,118	15,057	103	4,289	4,310,219		1,354,468	5,687,254
1964	3,518	16,910	108	6,917	4,436,954		1,379,438	5,843,846
1965		25,346	203		4,462,612		2,350,449	6,838,611
1966		32,151	429		4,875,508		6,203,803	11,111,890
1967		24,170	488		4,645,100	318,859	12,355,273	17,343,890
1968		17,423	177		5,565,749	840,416	19,128,834	25,552,599
1969		5,628	151	1,994,255	7,041,731	922,146	28,617,000	38,580,911
1970		32,982	387	1,948,663	7,705,356	1,208,000	40,326,000	51,221,388
1971		26,817	275	2,193,179	6,866,229	1,106,000	51,897,000	62,089,500
1972		28,154	371	2,352,000	6,327,469	940,000	54,782,000	64,429,994
1973		35,691	433	2,415,000	6,579,628	839,000	74,994,000	84,863,752
1974		30,993	364	2,182,000	5,468,306	710,000	88,589,000	96,980,663
1975		25,328	5,061	2,060,000	5,301,012		90,290,000	97,681,401
1976		18,405	3,567	2,228,000	4,090,316		86,937,000	93,277,288
1977		11,659	284	2,046,000	2,692,861		91,185,000	95,935,804
1978		6,319	8,572	2,093,000	2,376,380		78,665,000	83,149,271
1979		2,738	1,969	2,212,000	2,627,898		86,882,000	91,726,605
1980		4,397	0	2,132,000	2,498,386		90,904,000	95,538,783
1981		7,378	0	2,234,000	2,455,944		79,971,000	84,668,322
1982		12,523	0	2,094,000	1,765,379		83,834,000	87,705,902
1983		22,422	1,102	2,229,000	1,505,931		67,302,000	71,060,455
1984		14,384	0	2,022,000	1,752,957		85,271,000	89,060,341
1985		6,863	0	2,484,000	1,726,304		93,237,000	97,454,167
1986		7,279	0	2,190,000	1,976,949		89,848,000	94,022,228
1987		9,996	0	1,861,000	1,995,043		97,892,000	101,758,039
1988		18,317	0	2,534,625	2,062,504		91,285,816	95,886,845
1989		33,559	0	2,495,675	2,520,399		106,469,970	111,494,531
1990			0	2,439,123	2,474,032		103,852,085	108,765,240
1991		57,939	0	1,663,293	2,204,490		114,167,724	118,047,183
1992		69,376	0	1,091,525	2,331,086		108,147,133	111,582,438
1993			0	1,609,003	2,630,000		116,338,708	120,577,711
1994			0	1,677,873	2,774,585		124,263,306	128,715,764
1995			0	1,597,528	2,752,136		135,965,605	140,315,269
1996			0	1,795,844	2,524,333		133,651,298	137,971,475
1997		14,053	0	848,482	2,735,239		151,718,593	155,316,367
1998		11,791	0	875,879	2,843,558		143,751,629	147,482,857
1999		55,794	0	1,878,221	2,741,446		143,005,298	147,639,038
2000		41,671	0	2,121,642	3,006,133		158,865,617	163,998,862
2001		50,256	0	2,074,651	2,605,279		166,014,519	170,703,778
2002		3,934	0	2,208,917	2,823,169		171,764,455	176,800,475
2003			0	2,204,526	3,001,085		194,682,470	199,940,365
2004			0	2,265,446	3,046,576		215,849,192	221,590,638
2005			0	2,076,600	3,395,497		244,473,437	250,042,037
2006[P]				2,197,605[P]	3,974,000[P]		249,918,879[P]	275,042,000[P]
Total	**0.668 Mt**	**5.168 Mt**	**0.043 Mt**	**74.55 Mt**	**233.0 Mt**	**6.884 Mt**	**4,136.7 Mt**	**4,457 Mt**

Iron Ore Production : Estimated Iron Grades (%Fe)

NSW Only		NSW Only		NSW Only		Australia		Australia		Australia		Australia	
Year	%Fe	Year	%Fe	Year	%Fe	Year	%Fe	Year	%Fe	Year	%Fe	Year	%Fe
1907	54.0	1917	49.0	1927	66.0	1970	**64.0** [§]	1980	63.3	1990	62.3	2000	61.73
1908	59.4	1918	61.8	1928	67.4	1971	**63.7** [#]	1981	63.0	1991	62	2001	62.02
1909	57.3	1919	57.0	1929	60.4	1972	64.3	1982	63.4	1992	**61.7** [†]	2002	62.15
1910	55.6	1920	68.1	1935	60.6	1973	63.3	1983	63.8	1993		2003	62.10
1911	62.5	1921	53.5	1941	31.2	1974	63.2	1984	63.9	1994	62.04	2004	62.09
1912	59.2	1922	49.4	1942	48.5	1975	63.0	1985	63.7	1995	62.02	2005	62.10
1913	65.1	1923	53.7	1943	45.2	1976	62.8	1986	63.9	1996	62.10	2006[P]	
1914	55.5	1924	52.7	1944	51.8	1977	63.0	1987	63.7	1997	62.05		
1915	56.7	1925	61.5	1945	49.5	1978	63.5	1988	63.6	1998	61.85		
1916	58.3	1926	66.9			1979	63.1	1989	63.6	1999	61.72		

[§] Based on WA mining data only, representing some 40.66 Mt or about 79.4% of Australian production (see (BMR, var.).
[#] Based on WA mining data only, representing some 51.54 Mt or about 83.0% of Australian production (see (BMR, var.).
[†] Based on only 2 quarters of Australian data only from (ABARE, var.-a).

Special Note : All iron grade data from 1970 onwards is based on saleable production, and does not account for beneficiation at the mine/mill site; hence it is only a coarse indicator of iron ore mining.

- *Iron Ore Resources – Australia*
  Data Sources/References : (Brown, 1908; Canavan, 1965; GA, var.; Harper, 1928; Jack, 1922; Miles, 1953; Raggatt, 1953; WADMPR, var.)
- *Iron Ore Production – World*
  Data Sources/References : (ABARE, var.-b; Kelly *et al.*, 2004)
- *Iron Ore Exports – Australia and World*
  Data Sources/References : (ABARE, var.-b)

Economic Iron Ore Resources : Australia (Gt)

Year	Res.	Year	Res.	Year	Res.	Year	Res.	Year	Res.	Year	Res.
1908	0.021	1959	0.368	1976	17.8	1984	14.98	1992	17.9	2000	13.6
				1977	13.85	1985	16.22	1993	17.9	2001	12.4
1922	0.210	1962	0.576	1978	13.85	1986	15.85	1994	18	2002	13.0
				1979	13.85	1987	14.93	1995	17.8	2003	12.4
1940	0.259	1965	4.69	1980	14.87	1988	15.97	1996	17.8	2004	14.6
				1981	15.47	1989	14.3	1997	16.6	2005	16.4
1953	0.362	1975	17.8	1982	15.58	1990	14.7	1998	15.3	2006[P]	18.6[P]
				1983	15.4	1991	17.866	1999	15.5		

World Iron Ore Production (Mt)

Year	Prod.	Year	Prod.	Year	Prod.	Year	Prod.	Year	Prod.	Year	Prod.
1904	95.5	1921	73.0	1938	162.0	1955	369.0	1972	781.7	1989	991.0
1905	116.0	1922	104.0	1939	204.0	1956	395.0	1973	845.6	1990	980.6
1906	100.0	1923	136.0	1940	204.0	1957	434.0	1974	896.3	1991	952.1
1907	135.0	1924	130.0	1941	220.0	1958	405.0	1975	888.8	1992	907.8
1908	109.0	1925	151.0	1942	235.0	1959	439.0	1976	922.9	1993	944.3
1909	126.0	1926	155.0	1943	231.0	1960	522.0	1977	880.8	1994	967.8
1910	142.0	1927	171.0	1944	203.0	1961	503.8	1978	891.3	1995	1,029.5
1911	133.0	1928	174.0	1945	162.0	1962	523.4	1979	947.6	1996	1,026.2
1912	151.0	1929	201.0	1946	154.0	1963	516.2	1980	917.9	1997	1,074.4
1913	177.0	1930	179.0	1947	187.0	1964	568.9	1981	894.6	1998	1,036.8
1914	118.0	1931	119.0	1948	219.0	1965	624.3	1982	818.2	1999	1,009.9
1915	116.0	1932	76.2	1949	223.0	1966	625.9	1983	782.1	2000	1,078.0
1916	139.0	1933	91.2	1950	251.0	1967	629.2	1984	882.2	2001	1,047.1
1917	142.0	1934	120.0	1951	294.0	1968	687.7	1985	909.6	2002	1,108.5
1918	127.0	1935	138.0	1952	297.0	1969	720.3	1986	920.7	2003	1,213.0
1919	110.0	1936	170.0	1953	338.0	1970	773.9	1987	945.5	2004	1,349.3
1920	124.0	1937	212.0	1954	405.0	1971	780.5	1988	964.4	2005	1,540
										2006[P]	1,690[P]

14. Bauxite-Alumina-Aluminium

- *Bauxite-Alumina Production by State, Australia and World 1927-2006*
  Data Sources/References : (ABARE, var.-a, var.-b; BMR, var.; Kalix *et al.*, 1966; Kelly *et al.*, 2004; NSWDM, var.; NSWDMR, var.-b; NTDME, var.; QDM, var.; QNRME, var.; VDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)
- *Bauxite Resources – Australia*
  Data Sources/References : (BMR, var.; Evans, 1965; GA, var.; Raggatt, 1953; Raggatt, 1968)
- *Bauxite Production – Estimated Alumina Content*
  Data Sources/References : (ABARE, var.-a; BMR, var.)

Bauxite-Alumina Production Statistics by State and Australia (t)

Year	Bauxite					Australia		World
	QLD	NSW	VIC	WA	NT	Bauxite	Alumina	Bauxite
1927			936			936		1,880,000
1928			196			196		2,030,000
1929			555			555		2,150,000
1930			802			802		1,630,000
1931		199	1,406			1,605		1,150,000
1932			1,147			1,147		1,000,000
1933			681			681		1,100,000
1934		161	970			1,131		1,330,000
1935		111	1,064			1,174		1,770,000
1936			752			752		2,830,000
1937		6,793	1,097			7,890		3,750,000
1938		451	1,341			1,792		3,870,000
1939		1,767	820			2,587		4,340,000
1940		2,081	1,446			3,527		4,390,000
1941	373	2,671	2,793			15,624		6,110,000
1942	373	1,832	1,655			3,487		8,360,000
1943	373	734	1,855			2,589		14,000,000
1944	373	2,025	1,842			14,027		6,960,000
1945	373	1,700	1,792			3,492		3,430,000
1946	373	1,438	2,351	0		13,949		4,360,000
1947	373	2,401	2,555	0		4,956		6,320,000
1948	373	2,917	2,818	0		5,735		8,360,000
1949	373	1,284	4,092	0		5,377		8,230,000
1950	373	1,173	2,349	0		3,522		8,180,000
1951	373	2,077	3,089	0		15,325		10,900,000
1952	373	4,091	3,259	0		7,351		12,800,000
1953	373	1,882	2,235	0		4,117		13,800,000
1954	828	2,468	2,279	0		5,575		16,200,000
1955	1,753	2,893	3,039	0		7,684	4,383	17,800,000
1956	889	4,856	4,749	0		10,494	17,133	18,800,000
1957	1,004	3,300	3,527	0		7,830	20,438	20,500,000
1958	1,210	1,691	4,119	0		7,020	22,850	21,400,000
1959	0	4,312	3,519	7,393		15,225	27,330	23,100,000
1960	32,606	3,705	4,299	29,966		70,546	30,278	27,620,000
1961	40,640	2,476	3,596	0		46,712	29,939	29,279,000
1962	20,228	5,309	4,484	0		30,020		31,220,000
1963	292,091	7,470	2,190	58,121		359,872	55,358	30,456,000
1964	454,741	11,082	1,794	386,947		854,564	72,580	33,185,000
1965	665,686	11,016	2,596	507,055		1,186,354	202,000	37,233,000
1966	988,822	18,192	0	820,019		1,827,033	307,000	41,070,000
1967	2,854,866	10,736	2,052	1,375,644		4,243,298	854,000	45,087,000
1968	3,309,107	12,028	0	1,633,716		4,954,851	1,310,000	46,571,000
1969	5,297,210	12,749	4,277	2,607,089		7,921,129	1,931,000	54,475,000
1970	5,771,164	9,896	849	3,474,440		9,256,350	2,152,000	59,490,000
1971	7,481,176	8,697	7,902	4,603,654	631,296	12,732,726	2,713,000	66,663,000
1972	7,734,409	12,640	4,222	5,119,008	1,566,700	14,436,979	3,068,000	69,215,000
1973	8,980,832	7,839	0	5,740,532	2,866,797	17,595,920	4,089,000	75,208,000
1974	9,267,906	9,063	6,800	7,078,188	3,632,043	19,994,300	4,900,000	84,176,000
1975	9,548,149	10,442	0	7,395,026	4,079,383	21,003,464	5,129,000	77,380,000
1976	9,648,350	8,164	2,366	10,354,006	4,071,114	24,083,522	6,206,000	80,662,000
1977	10,288,790	4,504	5,579	10,999,915	4,787,633	26,086,421	6,659,000	84,480,000

Bauxite Production Statistics (t)

Year	Bauxite					Australia		World
	QLD	NSW	VIC	WA	NT	Bauxite	Alumina	Bauxite
1978	8,226,368	3,857	2,136	11,539,150	4,521,000	24,292,511	6,776,000	83,927,000
1979	9,576,944	3,289	3,108	13,378,637	4,621,451	27,583,429	7,415,000	89,131,000
1980	9,444,205	1,618	0	12,555,062	5,178,089	27,178,974	7,246,000	93,061,000
1981	8,694,000	1,727	7,104	12,322,355	4,415,797	25,441,392	7,079,000	88,552,000
1982	7,000,000	1,371	9,204	12,083,758	4,530,684	23,625,042	6,631,000	77,896,000
1983	6,702,000	0	8,585	12,977,470	4,955,817	24,372,291	7,231,000	78,585,000
1984	9,097,000	0	13,291	17,301,880	5,413,139	31,536,913	8,781,000	92,299,000
1985	7,621,000	0	4,081	18,942,621	5,390,342	31,838,898	8,792,000	89,609,000
1986	7,785,000	0	6,207	19,627,130	5,058,964	32,383,773	9,423,000	92,842,000
1987	8,015,000	0	6,535	20,925,911	5,244,698	34,101,721	10,109,000	96,499,000
1988	8,977,000	0	7,345	**21,000,000**[§]	5,936,772	36,192,000	10,518,000	102,588,000
1989	9,661,000	0	6,211	**20,000,000**[§]	5,995,210	38,579,000	10,800,000	107,584,000
1990	11,000,000	0	2,466	**22,000,000**[§]	6,404,358	41,389,000	11,231,000	114,750,000
1991	10,230,000	0	7,925	24,712,000	5,836,060	40,504,000	11,713,000	114,977,000
1992	8,702,000	0	5,021	**25,000,000**[§]	5,679,358	39,741,000	11,783,000	109,468,000
1993	8,469,000	0	0	**26,000,000**[§]	5,846,687	41,320,000	12,598,000	114,124,000
1994	8,907,000	0	1,500	**27,000,000**[§]	6,013,547	42,159,000	12,819,000	112,230,000
1995	8,895,522	0	2,302	27,865,000	5,749,537	42,655,000	13,161,000	118,231,000
1996	9,524,000	0	1,090	27,370,000	5,878,399	43,063,000	13,348,000	123,717,000
1997	9,679,000	0	2,600	28,052,000	6,382,723	44,464,000	13,384,000	126,136,000
1998	9,308,000	0	0	28,756,000	6,566,193	44,653,000	12,173,000	122,867,000
1999	11,386,000	0	0	30,467,000	6,292,200	48,493,000	14,532,000	130,128,000
2000	11,767,000	0	0	34,963,000	6,872,263	53,802,000	15,680,000	138,810,000
2001	11,326,000	0	0	36,002,000	6,664,798	53,799,000	16,313,000	137,647,000
2002	11,241,000	0	0	36,571,000	6,221,516	54,135,000	16,382,000	150,463,000
2003	11,898,000	0	0	37,391,000	6,060,164	55,602,000	16,529,000	159,332,000
2004	12,828,000	0	0	37,946,000	6,018,289	56,593,000	16,701,000	171,443,000
2005	15,474,000	0	0	38,496,000	5,807,869	59,959,000	16,701,000	171,443,000
2006[P]	16,139,000[P]	0	0	41,114,000[P]	5,432,143[P]	62,595,000[P]	16,701,000	
Total	**353.9 Mt**	**235 kt**	**217 kt**	**~750 Mt**	**~181 Mt**	**~1,286 Mt**	**349 Mt**	

[§] Estimate only based on other states and available data.

Australian Economic Bauxite Resources (Mt)

Year	Economic Resources	Inferred Resources
1950	8.6	
1952	34.5	
1953	21.8	
1954	21	
1975	3,000	
1976	2,698	
1977	2,703	6,410
1978	2,703	6,176
1979	2,703	6,179
1980	2,703	6,179
1981	2,703	6,179
1982	2,578	6,179
1983	2,280	6,696
1984	2,930	6,700
1985	2,889	6,655
1986	2,854	6,620
1987	2,825	6,591
1988	3,205	
1989	5,543	
1990	5,622	
1991	6,354	
1992	2,379	
1993	2,337	
1994	2,538	
1995	2,540	
1996	3,024	
1997	3,187	
1998	3,169	
1999	3,764	
2000	4,446	
2001	4,600	10,100
2002	4,800	10,200
2003	5,500	10,200
2004	5,700	8,800
2005	5,800	3,200
2006[P]	5,700[P]	3,200[P]

Australian Bauxite Production – Estimated Alumina Content of Bauxite

	$\%Al_2O_3$
1987	38.5
1988	38.3
1995	37.1
1996	37.4
1997	37.5
1998	37.5
1999	37.6
2000	37.0
2001	36.4
2002	36.4
2003	36.5
2004	36.6
2005	37.4
2006	37.1

15. Manganese

- *Manganese Ore Production by State 1882-2006*
  Data Sources/References : (ABARE, var.-a, var.-b; BMR, var.; Kalix *et al.*, 1966; NTDME, var.; WADM, var.; WADoIR, var.)
- *Manganese Ore Resources – Australia and World*
  Data Sources/References : (BMR, var.; de la Hunty, 1965; GA, var.; McLeod, 1998; Raggatt, 1953)

Manganese Ore Production by State (t)

Year	QLD	NSW	SA	Australia
1882			137	137
1883			338	338
1884		203	60	263
1885			132	132
1886			1,575	1,575
1887			1,475	1,475
1888			1,037	1,037
1889			1,622	1,622
1890		102	2,808	2,910
1891		140	862	1,002
1892		16	715	732
1893			2,467	2,467
1894	142	14	177	333
1895	361	4	49	414
1896	305			305
1897	403			403
1898	68	1		69
1899	747		102	848
1900	76	18		94
1901	221	12	134	368
1902	4,674		18	4,692
1903	1,341			1,341
1904	843			843
1905	1,541			1,541
1906	1,131	61		1,192
1907	1,134	508		1,642
1908	1,403			1,403
1909	613			613

	WA	NT
1948	1,671	
1949	9,571	
1950	12,153	
1951	5,341	
1952	5,126	
1953	30,944	
1954	26,871	
1955	44,901	1,485
1956	57,134	1,347
1957	74,451	1,045
1958	48,345	3,224
1959	76,945	2,026
1960	54,874	1,448

	QLD	NSW	VIC	SA	Australia
1910	805		23		828
1911	1,167		2		1,169
1912	313		20		333
1913	27				27
1914	6		20		26
1915	203	724	99	254	1,280
1916	653	1,955	86	553	3,247
1917	21	3,781		268	4,070
1918	1,327	6,616		1,097	9,040
1919	20	4,725		303	5,049
1920	15	2,571		522	3,109
1921	846	3,571	10	1,622	6,049
1922	68	2,436	152	649	3,324
1923	75	2,597		171	2,843
1924		4,457		321	4,838
1925		1,183			1,183
1926	20	1,311			1,331
1927	246	1,221	15		1,482
1928		170			170
1929		237			237
1930		127			127
1931		0		13	13
1932		108			108
1933		131		20	151
1934		105		2	107
1935		150			150
1936		73			73
1937	1,939	110			2,048
1938	719	221			941
1939		148		7	155
1940	387	1,024		10,826	12,238
1941	201	1,485		12,137	13,824
1942	152	792		9,476	10,421
1943	57	614		5,679	6,350
1944		782		1,240	2,002
1945		1,000			1,000
1946		1,407			1,407
1947		1,612		192	1,804
1948		1,577		254	3,502
1949	237	1,603		1,886	13,296
1950	580	2,133		241	15,107
1951		2,727		27	8,095
1952		2,056			7,182
1953	44	2,482			33,470
1954	140	1,642			28,653
1955	79	1,648			48,114
1956	316	1,537			60,334
1957	1,259	1,486			78,242
1958	7,181	1,888			60,638
1959	9,821	2,619			91,411
1960	3,769	1,604		70	61,766

Manganese Ore Production by State (t)

Year	QLD	NSW	VIC	TAS	SA	NT	WA	Australia	
1961	2,504	897			300	110	85,621	89,432	
1962	2,926	592				317	68,957	72,792	
1963	152	634				487	35,365	36,638	
1964	202	341	15		11	372	61,145	62,087	
1965	1,778	299			0	431	99,467	101,975	
1966	5,588	30			0	125,782	186,140	317,541	
1967		29			0	370,711	198,186	568,926	
1968					24	591,022	152,743	743,790	
1969					91	704,817	184,289	889,197	
1970					360	583,209	167,545	751,113	
1971					274	946,898	103,365	1,050,537	
1972	13				96	1,078,314	86,408	1,164,831	
1973						1,506,319		1,522,424	
1974						1,521,989		1,521,989	
1975						1,554,909		1,554,909	
1976						2,154,000		2,154,167	
1977						1,386,737	2,267	1,389,004	
1978	8,332					1,248,000	922	1,257,254	
1979	26,427					1,696,276	1,395	1,724,098	
1980	20,268					1,997,550	1,693	2,019,511	
1981	38,414					1,409,367	1,196	1,448,977	
1982	4,066					1,122,945	74	1,127,085	
1983						1,370,233		1,370,233	
1984						1,848,889		1,848,889	
1985				208		2,002,960		2,002,960	
1986				177		1,648,921		1,648,921	***%Mn***
1987				116		1,853,279		1,853,279	47.6
1988				120		1,976,087		1,986,000	47.6
1989				135		2,118,554	11,375	2,119,000	
1990						1,856,318	364,577	1,950,000	
1991						1,053,356	209,640	1,390,000	
1992						836,156	402,844	1,239,000	
1993						1,478,503	247,858	1,887,000	
1994						1,699,825	202,523	1,985,000	
1995						1,794,723	227,900	2,177,000	
1996						1,776,109	296,807	2,109,000	
1997						2,006,996	176,990	2,136,000	
1998						1,622,235	79,430	1,501,000	
1999						1,620,564	108,155	1,912,000	48.7
2000						1,484,272	259,536	1,613,000	48.2
2001						1,584,069	498,603	2,084,000	45.8
2002						1,439,801	578,388	2,324,000	45.0
2003						1,852,330	587,836	2,555,000	47.6
2004						2,481,784	597,777	3,401,000	39.3
2005						2,999,439	599,994	3,599,433	48.8
Total	**158 kt**	**76 kt**	**0.4 kt**	**0.8 kt**	**63 kt**	**60.4 Mt**	**7.34 Mt**	**68.9 Mt**	

Economic Manganese Ore Resources (Mt) – Australia and World

	Australia
	Economic
1953	0.588
1959	7.1
1962	<2
1975	490
1985	326

	Australia		World
	Economic	Inferred	Economic
2000	128	197.8	1,871
2001	125	197.5	1,878
2002	126.8	197.5	1,678
2003	124	197.3	967
2004	133	135	1,125
2005	143	155	~1,200
2006	139	160	~1,200

- *Manganese Ore Exports – Australia*
  Data Sources/References : (ABARE, var.-b)
- *Manganese Production – World (contained Mn)*
  Data Sources/References : (Kelly *et al.*, 2004)

Manganese Ore Exports (Mt) – Australia

1960	0.046	1972		1984	1.460	1996	1.740
1961	0.053	1973	1.513	1985	1.403	1997	1.541
1962	0.064	1974	1.203	1986	1.145	1998	1.067
1963	0.017	1975	1.132	1987	1.306	1999	1.213
1964	0.054	1976	1.711	1988	1.553	2000	1.411
1965	0.067	1977	0.811	1989	1.620	2001	1.591
1966	0.144	1978	0.936	1990	1.600	2002	1.830
1967	0.320	1979	1.157	1991	1.075	2003	2.308
1968	0.565	1980	1.328	1992	0.902	2004	1.518
1969	0.664	1981	0.900	1993	1.720	2005	2.929
1970	0.631	1982	0.906	1994	1.590	2006[P]	4.206[P]
1971	0.794	1983	1.004	1995	1.630		

Manganese Production (Mt *contained Mn*) – World

1900	0.592	1921	0.523	1942	2.290	1963	6.630	1984	8.600
1901	0.429	1922	0.535	1943	1.800	1964	7.240	1985	8.690
1902	0.441	1923	0.731	1944	1.270	1965	7.980	1986	8.830
1903	0.411	1924	0.919	1945	1.900	1966	8.150	1987	8.340
1904	0.416	1925	1.170	1946	1.650	1967	7.510	1988	8.650
1905	0.481	1926	1.370	1947	1.750	1968	7.800	1989	9.250
1906	0.868	1927	1.430	1948	1.830	1969	8.420	1990	9.080
1907	1.080	1928	1.280	1949	2.160	1970	8.200	1991	7.600
1908	0.641	1929	1.580	1950	2.530	1971	9.070	1992	7.260
1909	0.811	1930	1.590	1951	3.180	1972	9.080	1993	7.070
1910	0.888	1931	0.982	1952	4.440	1973	9.740	1994	6.530
1911	0.719	1932	0.559	1953	4.940	1974	9.270	1995	7.970
1912	0.856	1933	0.779	1954	4.500	1975	9.810	1996	8.180
1913	1.040	1934	1.310	1955	4.870	1976	10.000	1997	7.520
1914	0.840	1935	1.800	1956	5.310	1977	8.690	1998	6.950
1915	0.636	1936	2.340	1957	5.820	1978	8.690	1999	6.860
1916	0.850	1937	2.740	1958	5.580	1979	9.800	2000	7.510
1917	0.864	1938	2.380	1959	5.830	1980	9.670	2001	7.570
1918	0.934	1939	1.110	1960	6.120	1981	8.400		
1919	0.550	1940	2.540	1961	6.110	1982	8.580		
1920	0.754	1941	2.450	1962	6.400	1983	7.780		

Note : The USGS data, (Kelly *et al.*, 2004), is ***contained manganese***, while the previous ABARE data for Australia, (ABARE, var.-b), is ***manganese ore*** (that is, a beneficiated ore or concentrate).

16. Heavy Mineral Sands (Rutile, Ilmenite, Zircon, Monazite, Synthetic Rutile)

- *Heavy Mineral Sands Production by State : 1906-2006*

Data Sources/References : (ABARE, var.-a, var.-b; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; NSWDMR, var.-b; QDM, var.; QNRME, var.; SADM, var.-a, var.-b; TDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)

Note : For rutile and ilmenite, data up to 1949 includes mixed and low grade concentrates. Rutile concentrates are typically 95-97% TiO_2; while ilmenite is typically 45-47% TiO_2. Synthetic rutile is metallurgically processed ilmenite to produce rutile, also known as 'upgraded ilmenite'. The inconsistency in data sets may reflect the different reporting of rutile/ilmenite versus synthetic rutile. ***Inconsistencies between reported state and national data sets have not been able to be resolved.***

Rutile Concentrate (TiO_2) Production by State (t)

	NSW	Australia
1906		***SA*** - 9
1934	52	12
1935	676	141
1936	2,811	601
1937	6,885	1,117
1938	98	465
1939	3,083	718
1940	7,576	1,643

	QLD	NSW	Australia
1941	1,016	18,372	3,816
1942	3,692	15,766	5,503
1943	6,891	12,942	6,730
1944	14,557	9,660	8,842
1945	12,743	10,259	9,900
1946	5,263	8,306	8,252
1947	6,163	14,612	13,332
1948	6,407	12,889	15,234
1949	5,149	11,568	14,206

	QLD	NSW	Australia
1950	7,853	10,752	18,605
1951	12,323	23,429	35,752
1952	13,781	24,841	38,622
1953	16,382	22,266	38,648
1954	22,276	23,098	45,374
1955	25,613	34,953	60,567
1956	32,412	65,953	98,365
1957	43,432	87,533	130,965

	QLD	NSW	WA	Australia
1958	37,125	47,235	300	84,661
1959	36,090	47,024	102	83,215
1960	34,666	54,866	523	90,055
1961	34,451	67,673	931	103,054
1962	39,117	81,454	531	121,102
1963	48,106	137,311	768	186,622
1964	50,955	133,654	680	185,289
1965	56,161	164,417	229	220,807
1966	71,883	175,291	585	247,760
1967	82,016	187,340	406	269,762
1968	95,346	196,015	859	292,219

	QLD	NSW	TAS	SA	WA	Australia
1969	124,674	230,024	5,323		2,037	362,058
1970	133,823	226,229	7,528		3,288	370,867
1971	135,446	230,647	6,930	11	1,670	374,705
1972	136,937	172,441	431	428	2,902	313,139
1973	135,602	193,523	2,278	754	3,074	335,231
1974	136,932	166,107	4,322	324	11,017	318,702
1975	125,968	172,702	5,504	89	44,087	348,350
1976	138,137	163,140	6,685	36	81,752	389,750
1977	84,634	129,445	770	1	110,431	325,281
1978	52,645	104,583			99,847	257,075
1979	90,298	82,444			101,161	274,533

	QLD	NSW	WA	Australia
1980	119,751	91,872	91,667	311,744
1981	85,195	66,954	61,595	230,817
1982	89,112	47,669	80,199	220,697
1983	80,651	34,840	86,203	163,374
1984	73,767	36,006	60,651	170,424
1985	95,219	36,727	79,669	211,615
1986	103,308	42,579	69,887	215,774
1987	101,639	58,994	85,630	249,207
1988	98,171	56,655	91,192	230,637
1989		61,047	88,972	243,000
1990		67,786	76,065	244,000
1991		62,559	59,134	192,000
1992		55,469	68,964	183,000

	QLD	NSW	VIC	WA	Australia
1993	**56,345**	53,658		56,596	187,000
1994	58,306	42,473		87,161	233,000
1995	75,729	39,532		124,870	204,000
1996	61,333	32,607		110,651	192,000
1997	50,827	33,399		111,779	233,000
1998	84,153	41,869		96,928	238,000
1999	79,865	29,426		113,401	179,000
2000	68,800	10,542		122,147	207,000
2001	64,856	7,652	5,921	112,927	207,000
2002	60,765	5,095	21,328	125,411	219,000
2003	44,808	3,000	28,329	123,633	173,000
2004	38,524	0	11,239	101,893	163,000
2005	72,000	0	0	100,450	176,000
2006[P]	72,000[P]	0	0	96,067[P]	232,000[P]

	QLD	NSW	VIC	TAS	SA	WA	Australia
Total	**~4,195 kt**	**4,643 kt**	**66.8 kt**	**39.8 kt**	**1.7 kt**	**2,951 kt**	**~11,822 kt**

Ilmenite Concentrate ($FeTiO_2$) Production by State (t)

	NSW	Australia
1933		**TAS** - 559
1934	52	12
1935	676	141
1936		601
1937	6,885	1,117
1938	98	465
1939	3,083	718
1940	7,576	1,643

	QLD	NSW	Australia
1941	1,016	17,715	18,731
1942	3,692	14,524	18,216
1943	6,740	6,781	13,521
1944	13,478	4,556	18,034
1945	10,398	8,001	18,399
1946	2,905	5,361	8,266
1947	3,445	6,971	10,416
1948	4,193	7,489	11,682

	QLD	NSW	Australia
1949	4,063	5,958	10,094
1950		51	136
1951		1,253	1,253
1952	15	31	47
1953			
1954	3	473	477
1955	66	478	544
		*1950 - **WA** - 85*	

	QLD	NSW	WA	Australia
1956		997	3,346	4,342
1957	152	992	71,149	72,293
1958		133	70,934	71,067
1959		234	84,681	84,914
1960	22	1,211	106,968	108,201
1961	4	2,044	166,471	168,519
1962		4,357	177,372	181,729
1963		6,071	198,128	204,199
1964	110	6,297	302,079	308,486
1965				448,477
1966				521,987
1967	2,946	11,356	530,610	553,631

	QLD	NSW	SA	WA	Australia
1968	4,605	11,925		545,428	561,958
1969	26,336	11,643		674,447	712,426
1970	120,787	19,171		746,494	886,452
1971	60,804	17,970		735,026	813,800
1972	4,996	8,092	120	694,205	707,413
1973	13,807	10,454	390	694,950	730,698
1974	43,702	10,798	303	761,943	831,528
1975	35,531	10,771	82	945,049	1,008,304
1976	57,896	20,005	144	887,995	959,203
1977		17,935			1,033,358
1978		56,258			1,254,994
1979		44,158			1,181,010

	QLD	NSW	WA	Australia
1980		28,186	1,207,728	1,384,563
1981	6,411	34,704	922,821	1,321,137
1982	26,744	33,643	1,040,106	1,149,212
1983	14,037	24,178	871,302	892,570
1984	68,823	16,780	1,336,332	1,493,171
1985	168,089	15,115	1,163,987	1,418,867
1986	212,239	17,929	946,315	1,237,694
1987	288,715	19,275	996,074	1,349,500
1988	239,327	15,627	939,139	1,610,175
1989		41,557	964,031	1,690,000
1990			988,251	1,616,000
1991		14,967	936,778	1,466,000
1992		13,842	1,044,856	1,787,000

	QLD	NSW	VIC	WA	Australia
1993				1,008,377	1,795,000
1994	140,212			1,079,227	1,777,000
1995	164,597			998,152	1,980,000
1996	186,136			1,077,028	2,030,000
1997	70,335	**20,956**		1,233,849	2,233,000
1998	152,914	**16,459**		1,287,196	2,413,000
1999	94,947	**222,973**		1,237,485	1,976,000
2000	63,900	**9,903**		1,296,485	2,146,000
2001	82,479	**7,293**		834,385	2,019,000
2002	93,882	**4,056**	30,627	837,525	1,954,000
2003	120,392		50,984	862,391	2,006,000
2004	122,110		19,978	761,071	1,934,000
2005	**153,000**	0	0	614,200	**1,881,000**
2006[P]	176,000[P]	130,000[P]	0	713,012[P]	2,069,000[P]

	QLD	NSW	VIC	TAS	SA	WA	Australia
Total	**~4.12 Mt**	**~1.10 Mt**	**102 kt**	**0.6 kt**	**1 kt**	**~39.6 Mt**	**~60.2 Mt**

Synthetic Rutile Production – WA (t)

1980	48,992
1981	40,307
1982	35,704
1983	10,044
1984	72,133
1985	71,618
1986	58,874

1987	134,866
1988	183,499
1989	261,603
1990	249,265
1991	317,958
1992	334,480
1993	308,601

1994	357,528
1995	452,736
1996	367,525
1997	471,866
1998	529,484
1999	522,933
2000	617,534

2001	646,459
2002	586,993
2003	556,253
2004	611,445
2005	677,219

Zircon (Zr) Production by State (t)

	NSW	Australia
1934	28	28
1935	1,825	1,825
1936	2,736	2,736
1937	5,032	5,032
1938	195	195
1939	1,687	1,687
1940	5,536	5,536

	QLD	NSW	Australia
1941	428	12,565	12,995
1942	1,523	9,870	11,397
1943	2,976	6,986	10,499
1944	6,443	7,265	14,224
1945	5,523	9,753	15,276
1946	3,906	8,633	12,598
1947	6,157	16,187	21,921
1948	6,232	16,007	21,873
1949	6,213	14,793	21,306

	QLD	NSW	Australia
1950	6,835	15,046	21,880
1951	10,214	32,428	42,642
1952	10,614	19,296	29,839
1953	11,700	15,587	27,288
1954	14,105	27,470	41,575
1955	15,997	32,994	48,991
1956	22,147	51,410	73,617
1957	29,655	60,323	89,978

	QLD	NSW	WA	Australia
1958	27,047	33,063	108	60,217
1959	35,349	72,925	6,896	115,170
1960	30,496	67,389	3,846	104,000
1961	29,480	101,686	7,498	138,645
1962	39,436	92,759	3,791	135,986
1963	52,626	121,499	12,720	186,845
1964	44,985	120,187	21,855	187,027
1965	47,437	159,271	23,785	230,493
1966	57,602	156,256	25,562	239,419
1967	76,415	179,125	32,681	288,221
1968	81,084	189,273	28,546	298,902

	QLD	NSW	TAS	SA	WA	Australia
1969	92,251	224,818	6,194		51,960	375,223
1970	99,709	229,856	6,173		59,615	395,352
1971	95,296	261,624	3,831		52,197	412,947
1972	113,142	190,479			53,073	356,694
1973	108,287	207,054	741		59,026	375,108
1974	123,417	164,842	5,531	143	73,839	367,772
1975	101,626	175,772	8,799	59	95,958	382,217
1976	123,911	183,585	6,313	121	134,109	420,185
1977	74,809	171,900	923	45	187,239	398,229
1978	62,994	131,337			218,689	391,606
1979	78,377	141,275			270,807	444,975

	QLD	NSW	WA	Australia
1980	102,430	106,477	327,692	491,547
1981		113,009	226,463	434,246
1982		88,010	397,105	462,476
1983		55,588	272,391	382,005
1984	64,018	59,181	336,950	457,599
1985	80,017	47,113	371,754	501,440
1986	84,393	53,607	319,192	451,824
1987	83,658	50,234	320,163	456,590
1988	77,102	49,885	368,164	480,049
1989		55,214	343,821	479,000
1990		45,737	224,461	443,000
1991		46,644	204,332	288,000
1992		54,193	265,166	355,000

	QLD	NSW	VIC	WA	Australia
1993		44,008		299,761	413,000
1994	33,709	34,409		444,264	511,000
1995	44,318	30,976		458,444	505,000
1996	37,430	24,748		372,704	460,000
1997	24,600	32,381		292,791	416,000
1998	41,100	28,342		300,467	401,000
1999	38,148	19,022		322,940	359,000
2000		4,100		347,933	374,000
2001	28,648	4,230	1,307	353,169	393,000
2002	28,266	5,422	4,043	366,452	412,000
2003	27,753	2,000	10,841	420,545	462,000
2004	22,736	0	4,645	414,070	441,000
2005	**54,000**	0	0	416,922	~441,000
2006^{P}	53,000^{P}	15,000^{P}	0	345,329^{P}	492,000^{P}

	QLD	NSW	VIC	TAS	SA	WA	Australia
Total	**~3.32 Mt**	**4.82 Mt**	**20.8 kt**	**38.5 kt**	**0.4 kt**	**10.56 Mt**	**~18.6 Mt**

Monazite Production by State (t)

	QLD	NSW	WA	Aust.
1948	33			33
1949	55	22		77
1950	4	25		29
1951		30		30
1952	132	126		258
1953	77	180		257
1954	28	151		180
1955	45	151		196
1956	88	154		243
1957	86	364		450
1958	111	213	106	430
1959	78	176	82	336
1960	77	39	236	352
1961	129	146	1,211	1,486
1962	67	138	579	784
1963	227	479	1,268	1,973
1964	183	609	1,086	1,878
1965	248	555	1,397	2,200
1966	165	401	1,299	1,865
1967	241	441	1,516	2,198
1968	247	484	1,148	1,879
1969	178	337	2,960	3,475
1970	53	365	3,574	3,992

	QLD	NSW	WA	Aust.
1971	48	1,140	2,854	4,042
1972	38	2,091	2,557	4,686
1973	60	1,348	2,403	3,811
1974	23	904	2,364	3,291
1975	13	890	3,251	4,154
1976	776	412	3,729	4,918
1977	580	820	7,278	8,678
1978	0	210	13,689	13,898
1979	0	1,620	13,487	15,108
1980	466	261	10,015	10,742
1981	0	576	9,938	10,514
1982	0	178	15,058	15,237
1983	137	329	11,943	12,409
1984	0	602	14,461	15,063
1985	0	883	16,467	17,350
1986	0	68	13,677	13,745
1987	179	774	10,913	11,866
1988	578	590	8,879	10,047
1989			10,914	10,914
1990			9,751	9,751
1991			6,653	6,653
1992			4,648	4,648
1993			6,171	6,171
1994			2,869	2,869

	Aust.
1995	0
1996	0
1997	0
1998	0
1999	0
2000	0
2001	0
2002	1,600 §
2003	0
2004	0
2005	0
2006	0

§ Unknown state.

- *Heavy Mineral Sands Resources - Australia*
  Data Sources/References : 1953 (Raggatt, 1953), 1955 (McLeod, 1998), 1975-2006 (GA, var.)

Economic Rutile-Ilmenite-Zircon Resources (Mt)

	Rutile	Ilmenite	Zircon
1953	2.79	1.72	3.44
1955	2.50	3.50	2.90
1975	9.2	58.4	15.73
1976	9.83	50.5	15.56
1977	9.79	48.89	14.71
1978	9.27	47.48	14.23
1979	8.86	45.13	13.18
1980	8.99	43.3	12.94
1981	9.3	42.89	13.45
1982	9.22	41.5	13.41
1983	9.09	42.22	13.28
1984	7.9	39.81	11.48
1985	8.04	41.39	11.49
1986	8.96	44.13	12.94
1987	9.12	49.89	13.62
1988	10.03	61.18	15.68
1989	9.4	64.2	15.2

	Rutile	Ilmenite	Zircon
1990	11.6	80.7	18
1991	11.7	102.4	19.3
1992	13.5	111.8	20.3
1993	14	116.1	20.9
1994	14.4	132.5	21
1995	15	135.8	22.5
1996	14.9	135	21.4
1997	17.5	143.5	23.3
1998	17.5	164.3	23.2
1999	19.8	180.9	26.3
2000	21.9	196	27.9
2001	22	202	30
2002	23.5	198.2	29
2003	21.3	208.8	32.2
2004	20.2	217.2	30
2005	20.5	214.9	32.9
2006	21.7	218.5	33.9

17. Copper

- *Copper Production by State : 1842-2006*
  Data Sources/References : (ABARE, var.-a, var.-b; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; NSWDMR, var.-b; NTDME, var.; QDM, var.; QNRME, var.; SADM, var.-a, var.-b; TDM, var.; VDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)
- *Copper Resources – Australia*
  Data Sources/References : (Alexander, 1953; BCGLO, 1956; BMR, var.; GA, var.; Johns, 1965; LGMPL, 1953; McLeod, 1965a, 1998; Moyses, 1965; QDM, var.; Raggatt, 1968; Staines, 1953; TDM, var.; Wallis, 2005; Woodcock, 1980)
- *Copper Production – World*
  Data Sources/References : (ABARE, var.-b; Kelly *et al.*, 2004)

Copper Production by State (t Cu)

Year	QLD	NSW	VIC	TAS	SA	NT	WA	Australia
1842					2			2
1843					1			1
1844					56			56
1845					249			249
1846					1,641			1,641
1847					2,327			2,327
1848					4,145			4,145
1849					2,621			2,621
1850					4,775			4,775
1851					4,084			4,084
1852					4,582			4,582
1853					1,910			1,910
1854					1,250			1,250
1855					1,402			1,402
1856					3,688			3,688
1857					4,328			4,328
1858					3,475			3,475
1859		376			3,901			4,278
1860	1	376			4,521			4,898
1861	50	376			4,785			5,211
1862	272	376			5,822			6,470
1863	1,118	376			5,822			7,315
1864	2,032	376			7,244			9,652
1865	733	376			7,396			8,505
1866	3,219	376			9,144			12,739
1867	6,238	376			9,418			16,033
1868	9,178	376			8,026			17,580
1869	6,411	376			7,904			14,692
1870	1,356	2,459			7,996			11,811
1871	2,530	2,459			8,199			13,188
1872	2,488	2,459			8,961			13,908
1873	2,480	2,459			9,296			14,236
1874	2,264	2,459			8,809			13,532
1875	1,396	2,459			9,571			13,426
1876	2,139	2,459			8,595			13,193
1877	1,990	1,769			8,412			12,172
1878	583	1,740			6,899			9,222
1879	576	2,187			6,157			8,920
1880	331	2,977			5,669			8,977
1881	336	3,966			6,858			11,161
1882	1,752	3,648			6,909			12,309
1883	1,829	6,157			6,055			14,041
1884	1,679	7,376			8,829			17,885
1885	1,361	5,171			7,630		267	14,430
1886	914	3,894			5,862		569	11,240
1887	1,026	2,741			5,314		143	9,224
1888	1,144	3,796			4,044		181	9,164
1889	1,096	2,341			4,003		223	7,663
1890	188	2,152			4,663		153	7,157
1891	100	2,736			4,694		68	7,598

Copper Production by State (t Cu)

Year	QLD	NSW	VIC	TAS	SA	NT	WA	Australia
1892	82	2,755			3,881		43	6,761
1893	302	846			4,958		35	6,141
1894	422	2,737		114	5,425		41	8,739
1895	441	3,718		148	5,385		13	9,705
1896	589	4,626		148	4,806			10,169
1897	293	5,715		4,879	5,039			15,926
1898	63	5,878		5,142	4,867		25	15,975
1899	164	6,693		8,926	5,994	551		22,328
1900	390	6,251		10,314	5,415	650	111	23,132
1901	3,110	6,500		11,697	7,457	1,026	122	29,913
1902	3,845	6,940		9,730	8,412	150	36	29,113
1903	4,995	6,565	9	7,193	8,270	1,021	1	28,055
1904	4,440	6,193		8,427	7,010	513	301	26,883
1905	7,337	7,122		9,553	6,695	328	224	31,259
1906	10,238	8,092		9,597	8,339	919	329	37,516
1907	12,960	8,612	39	8,706	8,058	2,651	230	41,255
1908	14,933	9,314	35	8,939	5,718	1,242	161	40,340
1909	14,726	7,714	1	9,036	5,851	1,649	44	39,022
1910	16,649	9,568	8	8,450	5,184	2,810	120	42,789
1911	20,710	10,703	37	6,461	6,017	2,090	42	46,058
1912	23,490	9,849		5,286	6,396	1,730	96	46,847
1913	24,033	9,857	37	4,747	7,276	1,332	8	47,290
1914	18,731	3,497		7,855	6,991	1,333		38,407
1915	20,019	2,524		7,944	7,849	675	305	39,315
1916	19,832	5,868		6,352	7,395	746	71	40,265
1917	19,367	6,033		5,921	7,328	800	45	39,494
1918	19,283	6,186		5,612	7,284	726	85	39,177
1919	10,157	1,527		5,107	2,557	251	26	19,626
1920	16,151	1,070		4,869	4,408	378	17	26,894
1921	2,467	582		6,280	1,557	296	8	11,189
1922	5,186	737		5,706	1,204	254	15	13,101
1923	6,342	1,250		6,162	3,579	956	1	18,290
1924	5,720	910		6,805	411	581	8	14,436
1925	3,972	666		6,644	579	140		12,001
1926	1,236	1,016		7,026	235		2	9,515
1927	3,801	1,254		5,904	204			11,163
1928	2,831	1,270		6,524	195	6		10,825
1929	4,011	1,262	1	8,829	281	18		14,403
1930	2,977	1,325		10,100	101		15	14,518
1931	3,185	660		9,990	22			13,858
1932	3,186	749		11,174			4	15,113
1933	2,988	1,145		10,911	73			15,117
1934	2,952	1,220		8,339	210			12,721
1935	2,946	1,120		13,245	260			17,571
1936	3,889	2,105		13,249	457		50	19,750
1937	5,231	1,723		12,619	345		2	19,921
1938	4,530	2,424		12,933	258	6	48	20,199
1939	5,891	2,663		13,668	112		24	22,358
1940	7,019	3,092		11,757	313	7	16	22,204
1941	7,451	2,750		11,831	615	2	76	22,726
1942	6,432	2,587		11,974	398	7	3	21,401
1943	10,930	3,555		11,326	104		24	25,939
1944	16,057	3,678		10,376	137	16	19	30,284
1945	15,247	3,418		7,593	136	37	23	26,454
1946	6,585	2,943		9,530		7	64	19,129
1947	2,822	3,268		8,081		43		14,215
1948	3,199	2,855		6,679	4	29	74	12,841
1949	5,004	2,675		5,313	3	30	937	13,962
1950	5,511	3,955		8,154		89	318	18,028
1951	5,519	3,738		8,920		143	196	18,517
1952	7,077	3,619		7,984	2	186	435	19,303
1953	25,049	3,684		9,044	1	187	89	38,055
1954	28,303	3,233		10,038		402	601	42,578
1955	32,368	3,548		8,528		648	2,915	48,007
1956	36,279	4,358		8,948	1	720	5,992	56,299
1957	36,359	4,452		11,160	2	806	8,728	61,507
1958	51,319	4,087		11,596	1	1,125	8,799	76,926
1959	67,867	3,788	14	12,440	16	2,232	10,112	96,469

Copper Production by State (t Cu)

Year	QLD	NSW	VIC	TAS	SA	NT	WA	Australia
1960	84,077	3,629		11,867	5	1,688	9,920	111,186
1961	67,657	3,566	8	12,892	2	2,241	10,822	97,190
1962	80,510	3,807	10	14,747	2	1,512	8,095	108,684
1963	84,553	3,926	6	17,074	5	1,950	7,261	114,774
1964	75,942	3,687	10	15,117	11	10,090	1,459	106,316
1965	61,372	5,294	3	15,411	23	9,094	636	91,834
1966	73,805	9,390	5	17,277	28	9,957	827	111,290
1967	52,372	11,575	5	17,747	86	9,069	1,043	91,807
1968	70,558	12,475	5	16,867	81	8,029	1,616	109,632
1969	87,253	15,282	66	18,985	162	6,886	2,183	131,056
1970	107,279	15,184	46	23,934	1,529	6,465	3,353	157,790
1971	128,704	11,080	16	25,524	2,257	6,783	2,897	177,261
1972	127,903	13,976		28,293	7,104	6,519	3,017	186,812
1973	153,568	15,351		25,821	8,797	13,853	2,945	220,335
1974	182,621	12,800		29,106	9,454	13,720	3,639	251,340
1975	156,633	13,416		26,460	15,248	2,594	4,610	218,961
1976	155,620	11,697		25,342	16,755	3,040	6,026	218,480
1977	164,663	11,713		25,002	14,593	3,908	4,700	221,579
1978	162,701	14,258		23,908	12,631	3,831	4,782	222,111
1979	173,706	18,540		22,591	13,651	5,739	3,383	237,610
1980	174,606	19,080		23,018	11,755	11,974	3,112	243,540
1981	147,225	18,474		22,402	19,886	17,568	5,784	231,339
1982	160,896	25,886		20,906	13,701	8,720	15,213	245,322
1983	164,992	28,220		27,516	14,922	10,780	15,046	261,476
1984	161,018	20,456		25,569	10,508	6,179	11,941	235,671
1985	179,872	24,301		27,037	11,032	5,012	12,511	259,765
1986	175,959	32,548		28,761	4,893	2,615	3,592	248,368
1987	171,710	31,014		27,061	0	412	2,910	232,695
1988	156,335	31,786		23,258	8,449	5,763	12,726	238,317
1989	187,074	31,715		22,286	36,409	6,000	19,038	296,000
1990	188,811	26,865		20,045	46,494	10,000	14,959	330,000
1991	196,852	34,182		24,283	56,555	0	11,793	320,000
1992	207,541	41,119		27,292	76,394	3,000	12,094	378,000
1993	193,641	54,528		28,395	71,290	4,040	28,980	430,000
1994	221,206	58,796	8,000	32,822	64,320	5,067	35,109	418,000
1995	204,060	62,044	6,000	33,281	78,615	7,600	24,312	379,000
1996	301,337	83,238	1,000	11,481	80,503	13,842	23,072	548,000
1997	303,935	112,000		24,759	77,391	17,000	28,318	549,000
1998	398,736	118,000		27,698	73,607	20,135	28,240	618,000
1999	471,317	93,000		19,833	137,218	11,800	26,228	738,000
2000	472,968	124,000		27,806	202,165		34,039	839,000
2001	492,689	130,000		30,127	199,106		50,277	898,000
2002	522,518	122,000		33,494	177,457		66,761	872,000
2003	434,722	154,000		32,447	161,988		58,777	830,000
2004	336,203	166,000		30,340	223,091		42,887	875,000
2005	410,000	184,000		29,867	211,962		83,953	927,000
2006[P]	368,000[P]	210,000[P]		32,768[P]	182,900[P]		89,472[P]	892,000[P]
Total	**10.45 Mt**	**2.59 Mt**	**15 kt**	**1.68 Mt**	**2.82 Mt**	**367 kt**	**848 kt**	**18.73 Mt**

Economic Copper Resources (Mt Cu) – Australia and World

	Australia
1951	0.545
1952	0.534
1953	0.693
1954	0.697
1955	0.716
1956	0.781
1957	1.048
1958	1.114
1959	1.174
1960	1.325
1961	1.316
1962	2.136
1963	1.794
1964	1.951

	Australia
1965	1.926
1966	2.146
1967	2.168
1968	2.715
1969	4.055
1970	5.546
1971	5.967
1972	6.558
1973	6.770
1974	7.130
1975	7.637
1976	6.28
1977	5.613
1978	5.407

	Australia
1979	5.66
1980	5.53
1981	5.77
1982	5.32
1983	5.83
1984	13.63
1985	16.1
1986	16
1987	16.9
1988	17.06
1989	6.5
1990	6.7
1991	6.854
1992	6.5

	Australia	World
1993	20.2	
1994	20.2	
1995	24	
1996	23.6	
1997	21.4	
1998	22.5	
1999	22.2	
2000	24.1	340
2001	24.2	355
2002	32.9	480
2003	40.1	490
2004	42.1	490
2005	41.4	490
2006[P]	42.4[P]	498[P]

World Copper Production (t Cu)

1900	495,000	1927	1,520,000	1953	2,600,000	1980	7,704,000
1901	526,000	1928	1,730,000	1954	2,640,000	1981	8,164,000
1902	555,000	1929	1,950,000	1955	2,900,000	1982	8,078,000
1903	596,000	1930	1,610,000	1956	3,200,000	1983	8,101,000
1904	660,000	1931	1,400,000	1957	3,300,000	1984	8,258,000
1905	713,000	1932	909,000	1958	3,190,000	1985	8,365,000
1906	724,000	1933	1,050,000	1959	3,430,000	1986	8,393,000
1907	721,000	1934	1,280,000	1960	4,242,000	1987	8,747,000
1908	744,000	1935	1,500,000	1961	4,394,000	1988	8,698,000
1909	828,000	1936	1,720,000	1962	4,555,000	1989	9,025,000
1910	858,000	1937	2,290,000	1963	4,624,000	1990	8,957,000
1911	890,000	1938	1,990,000	1964	4,848,000	1991	9,099,000
1912	1,000,000	1939	2,130,000	1965	5,070,000	1992	9,418,000
1913	996,000	1940	2,400,000	1966	5,220,000	1993	9,475,000
1914	938,000	1941	2,480,000	1967	5,062,000	1994	9,575,000
1915	1,060,000	1942	2,590,000	1968	5,459,000	1995	10,180,000
1916	1,420,000	1943	2,620,000	1969	5,935,000	1996	11,111,000
1917	1,430,000	1944	2,460,000	1970	6,382,000	1997	11,480,000
1918	1,430,000	1945	2,110,000	1971	6,458,000	1998	12,273,000
1919	994,000	1946	1,780,000	1972	7,044,000	1999	12,749,000
1920	959,000	1947	2,130,000	1973	7,498,000	2000	13,244,000
1921	558,000	1948	2,210,000	1974	7,576,000	2001	13,755,000
1922	884,000	1949	2,140,000	1975	7,185,000	2002	13,564,000
1923	1,270,000	1950	2,380,000	1976	7,661,000	2003	13,701,000
1924	1,360,000	1951	2,490,000	1977	7,856,000	2004	14,716,000
1925	1,530,000	1952	2,570,000	1978	7,678,000	2005	15,076,000
1926	1,510,000			1979	7,767,000	2006[P]	15,300,000[P]

18. Gold

- *Gold Production by State : 1851-2006*

  Data Sources/References : (ABARE, var.-b; BMR, var.; Govett & Harrowell, 1982; Kalix *et al.*, 1966; NSWDM, var.; NSWDMR, var.-b; NTDME, var.; PIRSA, var.; QDM, var.; QNRME, var.; SADM, var.-a, var.-b; TDM, var.; VDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)

- *Gold Milling : Queensland*

  Data Sources/References : 1877-1982 (QDM, var.)

  Data Sources/References : 2003-2005 quarterly gold mining statistics (subscription from Minmet Pty Ltd, now Intierra Pty Ltd)

  Data Sources/References : 1985-2005 (AR, var.; Ashton, var.; Aurora, var.; EquiGold, var.; Gympie, var.; LP & Minmet, var.; LR, var.; MIM, var.; Niugini, var.; Normandy, var.; PD, var.; PM, var.; Poseidon, var.; PP, var.; QDM, var.; QNRME, var.; RIU, var.)

- *Gold Milling : South Australia*

  Data Sources/References : 1892-1955 (SADM, var.-a, var.-b)

  Data Sources/References : 1988-2005 (Dominion, var.; WMC, var.-a, var.-b)

- *Gold Milling : New South Wales*

  Data Sources/References : 1892-1962, 1980 (NSWDM, var.)

  Data Sources/References : 2003-2005 quarterly gold mining statistics (subscription from Minmet Pty Ltd, now Intierra Pty Ltd)

  Data Sources/References : 1984-2005 (Alkane, var.; Hillgrove, var.; LP & Minmet, var.; Newcrest, var.; North, var.; NSWDM, var.; NSWDMR, var.-b; RGC, var.; Riddell, var.; RIU, var.; RT, var.; Triako, var.; Woodcock, 1986)

- *Gold Milling : Victoria*

  Data Sources/References : 1857-1976 (Smyth, 1869; VDM, var.; Woodland, 2002)

  Data Sources/References : 1983-2005 (LP & Minmet, var.; MPI, var.; PC, var.; Riddell, var.; RIU, var.; SH, var.; VDPI, var.; WMC, var.-b)

- *Gold Milling : Tasmania*

  Data Sources/References : 1892-2005 (TDM, var.) (also several TAS Geological Survey reports); plus data from Mt Lyell and Rosebery (see specific mine tables in appendix); also (AG, 2002; Barrick, var.; BG, var.; Goldfields, var.; PD, var.; RGC, var.)

  Data Sources/References : 2003-2005 quarterly gold mining statistics (subscription from Minmet Pty Ltd, now Intierra Pty Ltd)

- *Gold Milling : Western Australia*

  Data Sources/References : 1886-1894 (approximated to an annual basis) (Maitland, 1900)

  Data Sources/References : 1895-1968 (BMR, var.; Maitland, 1900; WADM, var.)

  Data Sources/References : 1969-2005 (BMR, var.; WADM, var.; WADoIR, var.), plus data courtesy of Jill Gregory, Department of Industry & Resources (WADoIR)

  Data Sources/References : 2003-2005 quarterly gold mining statistics (subscription from Minmet Pty Ltd, now Intierra Pty Ltd)

  Data Sources/References – *Waste Rock* : 1983-2005 (Acacia, var.; Ashton, var.; Aurora, var.; Barrick, var.; Delta, var.; EquiGold, var.; GCM, var.; Harmony, var.; Homestake, var.; MPI, var.; Newcrest, var.; Newmont, var.; Normandy, var.; North, var.; PD, var.; PM, var.; Poseidon, var.; PP, var.; Resolute, var.; SoG, var.; WMC, var.-b)

- *Gold Milling : Northern Territory*

  Data Sources/References : 1875-1876, 1884-1918 and 1933-1982 (Balfour, 1989, 1990, 1991; BMR, var.; NTDME, var.; SADM, var.-a)

  Data Sources/References : 2003-2005 quarterly gold mining statistics (subscription from Minmet Pty Ltd, now Intierra Pty Ltd)

  Data Sources/References : 1988-2005 (Acacia, var.; AngloGold, var.; Dominion, var.; GRM, var.; LP & Minmet, var.; NFM, var.; Normandy, var.; NTDME, var.; Poseidon, var.; RGC, var.; RIU, var.; WMC, var.-b)

- *World Gold Production : 1851-2006*
  Data Sources/References : (ABARE, var.-b; Govett & Harrowell, 1982; Kelly *et al.*, 2004)
- *Gold Resources : Australia and World*
  Data Sources/References : Australia – 1955 (BCGLO, 1956), 1960 (McLeod, 1998), 1975-2006 (GA, var.); World – 1968-1995 (Craig & Rimstidt, 1998), 2000-2006 (GA, var.)

Gold Production by State (kg Au)

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1851		3,429	6,515					9,944
1852		19,482	66,964		20			86,466
1853		13,974	80,364		850			95,188
1854		5,661	64,971		800			71,432
1855		4,793	82,566		180			87,539
1856		5,046	89,433	13	150			94,642
1857		4,938	82,886	10	140			87,975
1858		8,084	76,034	7	130			84,255
1859	21	9,219	68,785	4	130			78,159
1860	85	10,729	65,135	0.3	120			76,069
1861	29	13,224	59,603	0.2	120			72,976
1862	5	18,068	50,671		100			68,844
1863	108	13,151	49,635		70			62,964
1864	610	9,554	47,515		40			57,719
1865	680	9,015	47,196		40			56,931
1866	626	8,174	45,304	8	30			54,142
1867	1,386	7,714	43,972	32	100			53,203
1868	4,345	7,283	49,345	19	200			61,191
1869	3,829	7,132	45,240	4	750			56,956
1870	3,584	6,816	38,198	27	830			49,456
1871	4,517	9,155	40,091	172	850			54,785
1872	4,835	12,038	38,991	200	200			56,264
1873	5,254	10,224	34,277	135	120			50,008
1874	9,929	7,626	32,146	135	20			49,856
1875	10,971	6,426	31,290	88	100			48,875
1876	10,529	4,490	28,225	329	72			43,645
1877	9,644	3,452	23,712	171				36,978
1878	8,414	3,150	22,200	732	9			34,505
1879	7,572	2,981	22,227	1,691	1			34,471
1880	6,918	3,253	24,282	1,474			579	36,505
1881	7,011	4,200	24,407	1,588	6		820	38,031
1882	5,754	3,855	25,321	1,372	34		591	36,926
1883	5,395	3,357	22,851	1,292	77		565	33,537
1884	7,779	2,900	22,803	1,174	113		571	35,340
1885	7,779	2,772	21,532	1,137	134		516	33,870
1886	8,692	2,682	19,481	858	238	8	462	32,422
1887	10,850	2,889	18,092	1,161	527	136	504	34,158
1888	12,377	2,323	18,305	1,077	250	97	255	34,684
1889	19,736	3,183	18,006	876	273	431	349	42,855
1890	15,980	3,370	17,237	556	152	635	591	38,520
1891	14,865	4,094	16,881	1,065	200	843	723	38,671
1892	15,847	4,212	19,167	1,164	191	1,657	799	43,036
1893	15,872	4,768	19,655	1,035	92	3,085	792	45,298
1894	17,061	8,469	20,997	1,589	245	5,763	803	54,927
1895	15,745	9,635	21,674	1,509	191	6,441	753	55,948
1896	15,617	7,859	23,578	1,739	105	7,825	595	57,318
1897	18,690	8,085	23,803	2,172	286	18,780	594	72,410
1898	20,137	8,799	24,520	2,134	78	29,218	620	85,507
1899	20,782	11,885	25,025	2,398	114	45,736	465	106,406
1900	21,024	7,841	23,646	2,315	107	43,985	497	99,415
1901	18,610	5,397	22,717	2,161	122	52,976	647	102,630
1902	19,918	5,015	22,419	2,208	182	58,189	515	108,447
1903	20,792	7,907	23,863	1,863	210	64,215	511	119,361
1904	19,878	8,391	23,810	2,050	557	61,678	308	116,672
1905	18,431	8,530	23,237	2,287	336	60,810	378	114,008
1906	16,938	7,899	24,018	1,867	198	55,810	360	107,090
1907	14,489	7,693	21,632	2,033	150	52,794	159	98,950
1908	14,464	6,991	20,875	1,775	90	51,250	177	95,622
1909	14,169	6,366	20,346	1,393	221	49,613	228	92,336

Gold Production by State (kg Au)

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1910	13,728	5,873	17,739	1,152	205	45,737	187	84,621
1911	12,010	5,633	15,674	967	110	42,634	226	77,254
1912	10,821	5,141	14,932	1,181	205	39,891	166	72,337
1913	8,264	4,654	13,526	1,039	204	40,867	97	68,651
1914	7,758	3,872	12,851	816	195	38,346	79	63,917
1915	7,766	4,121	10,234	577	189	37,634	28	60,549
1916	6,692	3,363	7,982	491	242	33,009	59	51,838
1917	5,576	2,556	6,278	451	222	30,177	27	45,287
1918	4,154	2,707	4,940	327	192	27,259	16	39,596
1919	3,764	2,048	4,212	239	100	22,829	26	33,218
1920	3,584	1,521	4,752	194	53	19,215	29	29,348
1921	1,256	1,591	3,250	166	82	17,221	8	23,574
1922	2,506	784	3,324	107	31	16,739	4	23,495
1923	2,759	586	2,967	115	30	15,690	5	22,152
1924	3,074	1	2,089	144	27	15,085	22	20,441
1925	1,443	604	1,471	110	26	13,723	14	17,391
1926	322	604	1,526	131	24	13,601	4	16,213
1927	1,181	561	1,199	151	13	12,700	3	15,808
1928	413	399	1,055	112	17	12,235	3	14,234
1929	295	233	817	174	31	11,730	4	13,285
1930	243	389	750	139	41	12,985	0	14,547
1931	409	612	1,357	148	87	15,879	17	18,508
1932	723	869	1,485	185	94	18,833	21	22,210
1933	2,861	910	1,809	208	198	19,817	18	25,821
1934	3,591	1,123	2,183	175	214	20,257	31	27,574
1935	3,203	1,558	2,725	259	228	20,185	158	28,316
1936	3,769	1,889	3,657	547	239	26,317	272	36,690
1937	3,958	2,134	4,534	631	217	31,120	492	43,085
1938	4,710	2,759	4,486	690	165	36,318	385	49,512
1939	4,579	2,712	4,868	622	122	37,763	516	51,181
1940	3,944	3,118	5,616	596	102	37,055	697	51,128
1941	3,392	2,740	4,658	619	52	34,500	587	46,547
1942	2,958	2,402	3,157	571	41	26,378	375	35,883
1943	1,954	1,984	1,757	536	16	16,995	122	23,365
1944	1,593	1,947	1,682	518	17	14,501	171	20,429
1945	1,966	1,341	1,922	406	9	14,572	224	20,439
1946	1,951	995	2,705	478	20	19,188	305	25,641
1947	2,248	1,558	2,634	468	20	21,891	343	29,161
1948	2,166	1,622	2,133	401	63	20,681	472	27,539
1949	2,372	1,611	2,128	378	68	20,166	926	27,650
1950	2,745	1,597	2,109	484	35	18,981	1,090	27,043
1951	2,444	1,521	2,055	449	11	20,160	1,211	27,852
1952	2,667	1,214	2,077	500	14	22,624	1,396	30,492
1953	2,858	823	1,988	528	14	25,597	1,630	33,438
1954	3,046	976	1,638	602	1.7	26,808	1,690	34,762
1955	2,000	935	1,183	525	1.6	25,948	2,033	32,625
1956	1,742	896	1,208	533	1.3	25,301	2,346	32,027
1957	1,971	965	1,423	623	1.1	26,427	2,300	33,711
1958	2,319	582	1,290	676	1.5	27,207	2,258	34,334
1959	2,851	413	1,078	664	0.5	26,776	1,964	33,747
1960	2,434	424	888	746	1.1	27,056	2,247	33,797
1961	2,015	374	816	836	1.7	27,077	2,353	33,473
1962	2,106	349	879	999	1.5	26,747	2,159	33,241
1963	2,133	354	767	1,133	0.5	24,969	2,489	31,845
1964	3,139	329	662	1,069	0.5	22,251	2,524	29,975
1965	2,394	300	599	1,023	0.1	20,413	2,567	27,295
1966	4,329	282	653	1,135	0.2	19,501	2,617	28,518
1967	2,973	333	342	1,167	0.03	17,844	2,387	25,046
1968	2,579	270	344	1,135	1.2	16,046	3,938	24,313
1969	2,237	329	266	1,252	12	13,720	4,016	21,831
1970	2,589	325	253	1,335	16	10,898	3,865	19,281
1971	2,824	305	122	1,793	17	10,734	5,124	20,919
1972	2,357	310	10	2,021	78	10,471	8,032	23,279
1973	1,391	297	100	1,511	70	8,587	5,218	17,174
1974	1,984	282	126	1,585	67	6,584	5,316	15,944
1975	1,395	389	216	1,669	64	7,105	5,548	16,386
1976	1,439	502	61	1,495	42	7,479	4,619	15,637
1977	1,084	430	11	1,891	3	10,747	5,251	19,417

Gold Production by State (kg Au)

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1978	607	422	12	1,892	1	13,332	3,876	20,142
1979	515	471	23	1,747	6	11,582	4,221	18,565
1980	675	573	36	1,311	16	11,233	3,191	17,035
1981	1,510	587	75	1,950	32	11,724	2,495	18,373
1982	579	610	100	1,737	10	20,603	3,322	26,961
1983	1,061	673	113	2,077	5	23,919	2,744	30,592
1984	1,751	1,112	411	1,926	5	32,111	2,993	40,309
1985	9,276	1,536	962	2,334	2	41,196	3,215	58,521
1986	11,123	961	1,148	2,674	2	53,876	5,296	75,080
1987	15,495	4,201	1,206	2,225	1	78,438	9,129	110,695
1988	24,780	5,630	1,770	2,030	12	107,290	11,970	156,940
1989	27,720	8,750	1,840	1,760	442	147,280	17,060	204,081
1990	29,730	8,050	3,930	1,680	811	176,350	19,040	244,094
1991	27,060	6,330	3,760	1,620	911	186,340	17,300	236,224
1992	32,610	5,650	3,350	1,150	1,083	182,100	18,640	243,677
1993	32,430	8,580	4,070	1,320	895	183,470	17,090	247,827
1994	30,670	8,130	3,830	1,390	904	192,980	17,420	254,745
1995	28,760	10,030	4,300	750	941	189,750	18,440	253,090
1996	28,650	11,310	4,520	1,740	1,042	221,184	21,890	289,360
1997	29,400	11,710	4,820	4,150	854	238,335	24,320	313,321
1998	32,380	14,760	4,890	4,180	1,003	231,426	20,380	309,552
1999	34,150	21,040	4,630	4,950	989	211,547	22,290	298,929
2000	37,100	18,580	4,230	6,680	2,155	199,043	23,140	294,996
2001	31,890	17,100	3,500	6,180	3,459	192,204	20,510	277,417
2002	25,060	23,480	3,240	6,050	2,036	188,859	17,950	271,157
2003	26,750	26,040	3,110	9,310	4,442	187,498	23,170	281,792
2004	23,160	29,140	3,460	10,600	4,195	163,709	22,270	257,185
2005	23,990	29,460	5,240	8,340	6,240	173,160	16,550	262,980
2006[P]	21,000[P]	28,000[P]	6,000[P]	5,000[P]	7,000[P]	165,000[P]	13,000[P]	247,000[P]
Total	**1,335.5 t**	**819.8 t**	**2,376.5 t**	**196.5 t**	**55.9 t**	**6,013.0 t**	**514.0 t**	**11,312 t**

Gold Milling : Queensland

Year	**Ore** (t)	**Grade (**g/t)	**Gold** (kg)
1877	90,326	58.07	5,245.3
1878	111,793	46.12	5,156.0
1879	118,281	43.65	5,163.3
1880	107,445	48.21	5,180.4
1881	119,775	48.82	5,847.1
1882	125,634	42.47	5,335.5
1883	136,565	39.23	5,357.5
1884	150,929	53.42	8,062.8
1885	193,036	46.56	8,988.1
1886	213,237	47.49	10,127.3
1887	231,890	54.21	12,571.3

Year	**Ore** (t)	**Grade (**g/t)	**Gold** (kg)
1888	265,197	52.75	13,988.9
1889	391,343	57.92	22,666.2
1890	434,920	42.30	18,396.2
1891	476,550	36.57	17,429.0
1892	453,359	41.06	18,613.9
1893	460,546	40.36	18,586.9
1894	548,524	37.06	20,326.1
1895	575,921	32.56	18,749.9
1896	529,184	35.83	18,960.5
1897	503,370	38.99	19,624.1
1898	598,052	31.75	18,991.0

Year	**Ore** (t)	**Grade** (g/t)	**Gold** (kg)	**Waste Rock** (t)
1899	625,762	29.52	18,473.4	106,728
1900	653,526	30.06	19,642.9	90,870
1901	624,124	30.09	18,781.5	
1902	673,072	36.05	24,266.5	
1903	761,428	29.51	22,467.3	48,768
1904	805,331	22.89	18,434.8	
1905	810,604	21.59	17,502.3	634,874
1906	785,823	19.53	15,349.2	
1907	684,353	17.83	12,199.4	250,952
1908	647,657	16.85	10,915.9	255,164
1909	592,738	18.03	10,687.5	
1910	490,810	19.12	9,381.9	126,392
1911	471,985	17.92	8,459.6	202,831
1912	353,025	18.32	6,466.9	107,290
1913	465,596	15.89	7,399.2	126,248
1914	496,162	14.79	7,337.3	
1915	445,382	16.62	7,400.1	202,323
1916	394,516	16.15	6,371.2	

Year	**Ore** (t)	**Grade** (g/t)	**Gold** (kg)	**Waste Rock** (t)
1917	325,376	16.52	5,374.9	107,023
1918	187,574	20.88	3,916.3	131,342
1919	158,402	23.27	3,686.3	121,083
1920	141,427	23.99	3,392.6	134,223
1921	111,994	10.50	1,176.4	34,043
1922	265,220	9.16	2,429.4	93,637
1923	288,985	9.21	2,662.9	116,605
1924	242,590	11.85	2,875.2	18,176
1925	148,843	8.83	258.0	13,970
1926	3,547	52.52	185.2	
1927	60,619	17.01	170.3	
1928	5,281	26.47	139.8	
1929	5,514	26.36	145.4	
1930	3,321	32.31	107.3	
1931	5,862	31.79	186.4	
1932	24,697	16.84	415.9	
1933	206,642	11.04	2,281.8	
1934	281,005	11.29	3,171.2	230,899

Gold Milling : Queensland

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1935	299,590	9.55	2,862.0	
1936	437,031	7.75	3,385.3	339,882
1937	719,124	4.93	3,545.8	237,899
1938	961,845	4.52	4,345.4	702,855
1939	1,078,230	3.97	4,277.2	1,478,705
1940	1,160,414	3.10	3,599.7	1,016,000
1941	1,126,773	2.71	3,056.2	1,609,076
1942	949,488	2.87	2,725.0	1,805,512
1943	897,109	2.10	1,884.8	1,354,635
1944	794,594	1.95	1,549.0	879,909
1945	573,318	3.36	1,927.1	980,375
1946	768,649	2.83	2,172.6	923,574
1947	728,598	2.87	2,088.5	1,103,406
1948	730,497	2.86	2,088.5	1,842,705
1949	888,015	3.65	2,256.1	1,075,860
1950	857,018	4.74	2,647.2	1,531,137
1951	960,173	3.76	2,332.8	1,337,161
1952	953,287	3.68	2,543.5	1,981,291
1953	861,267	4.13	2,133.5	3,070,769
1954	980,041	3.09	3,025.4	2,924,095
1955	921,839	2.16	1,995.4	2,718,103
1956	794,193	3.32	2,155.6	2,552,940
1957	860,416	3.33	1,987.0	1,532,142
1958	889,194	3.45	2,208.9	2,640,397
1959	857,625	4.41	2,829.4	3,824,808
1960	995,552	3.15	2,346.2	3,643,540
1961	1,164,128	2.54	1,807.3	3,437,433
1962	1,203,886	2.20	2,085.2	2,590,140
1963	1,278,025	2.33	2,095.4	2,945,759
1964	1,417,812	3.06	3,165.0	2,811,271
1965	864,381	3.69	2,410.6	3,783,181
1966	1,367,224	4.47	3,950.8	2,477,800
1967	1,453,321	2.95	3,047.5	2,271,260
1968	1,473,424	2.52	2,420.1	2,768,283
1969	1,511,847	2.20	2,257.2	2,973,847
1970	1,504,769	2.53	2,386.2	3,454,064
1971	1,285,148	3.15	1,906.0	3,269,492
1972	1,285,210	3.17	1,906.2	3,269,492
1973	1,158,719	2.73	1,911.1	3,243,676
1974	1,253,133	1.61	1,862.6	2,886,979
1975	1,083,055	2.56	2,265.9	2,763,767
1976	1,234,945	1.71	1,138.3	2,018,888
1977	791,424	2.75	1,781.6	565,739
1978	484,640	3.29	1,077.8	408,480
1979	327,718	2.58	520.3	1,085,515
1980	365,869	2.04	395.9	973,930
1981	619,907	1.81	419.6	1,290,895
1982	554,608	2.11	872.3	1,257,943
1985	3,771,937	2.11	6,644	2,781,003
1986	3,704,920	2.41	7,442	4,978,240
1987	5,670,000	2.47	11,656	7,141,330
1988	5,701,865	1.88	8,568	6,173,543
1989	5,833,165	2.13	13,659	13,365,681
1990	9,031,088	2.18	18,966	20,683,586
1991	11,055,351	2.11	22,009	25,175,594
1992	12,886,282	2.34	27,727	32,918,093
1993	14,461,759	2.22	30,300	46,678,269
1994	15,755,496	1.97	27,887	47,528,277
1995	19,674,080	1.64	28,148	55,287,575
1996	19,844,590	1.49	25,953	45,961,229
1997	23,745,501	1.35	24,508	93,694,712
1998	28,233,479	1.21	28,260	98,987,010
1999	27,681,326	1.29	29,675	66,588,099
2000	27,839,054	1.34	31,876	57,563,925
2001	26,904,827	1.30	29,338	55,932,428
2002	21,002,125	1.27	23,144	53,260,757
2003	21,199,625	1.34	24,628	55,385,220
2004	21,501,765	1.17	21,724	57,513,099
2005	22,771,094	1.18	22,417	46,974,781
Total	**~414 Mt**	**~2.98**	**1,129 t**	**»995 Mt**

Gold Milling : South Australia

Year	Ore (t)	Grade (g/t)	Gold (kg)
1892	46	2.1	0.1
1893	411	9.0	3.7
1894	9,534	5.1	48
1895	9,964	3.5	35
1902	11,251	20.5	230.5
1903	6,746	23.9	161.4
1904	12,463	23.7	295.9
1905	16,111	19.6	316.5
1906	9,232	28.2	260.0
1907	8,361	22.0	183.8
1908	2,278	26.4	60.1
1909	3,992	34.8	138.8
1910	3,457	36.8	127.1
1911	4,137	21.2	87.9
1912	6,713	18.0	120.7
1913	7,804	19.9	155.6
1914	5,231	21.8	113.9
1915	6,651	19.4	128.8
1916	7,043	19.6	137.8
1917	7,146	21.3	152.5
1918	6,348	17.7	112.3
1919	5,134	17.1	88.0
1920	1,544	24.4	37.7
1921	482	36.8	17.7
1922	744	30.4	22.6
1923	645	25.6	16.5
1924	636	44.2	28.1
1925	614	46.6	28.6
1926	703	37.3	26.2
1927	705	21.0	14.8
1928	1,007	17.8	17.9
1929	675	43.6	29.4
1930	934	33.3	31.1
1931	2,049	32.2	65.9
1932	2,623	38.4	100.8
1933	4,180	36.4	152.0
1934	4,544	35.1	159.6
1935	5,421	21.9	118.7
1936	7,483	17.8	132.9
1937	5,639	22.1	124.6
1938	4,142	28.1	116.5
1939	3,080	19.7	60.7
1940	3,140	24.0	75.3
1941	1,969	22.5	44.3
1942	839	28.9	24.3
1943	552	27.2	15.0
1944	525	33.4	17.6
1945	381	19.6	7.5
1946	461	43.4	20.0
1947	845	24.7	20.8
1948	1,374	51.4	70.7
1949	1,318	59.0	77.8
1950	1,665	35.3	58.8
1951	468	32.3	15.1
1952	865	26.5	22.9
1953	695	32.7	22.7
1954	21	80.9	1.7
1955	21	65.8	1.4
1953	3,080	19.7	60.7
1954	3,140	24.0	75.3
1955	1,969	22.5	44.3
1974	161	13.20	2.125
1979	318	15.55	4.946
1980	20	142.1	2.842

Gold Milling : South Australia

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1988	538,678	0.59		43,094
1989	1,361,617	0.61	341.2	108,929
1990	1,611,655	1.10	874.0	128,932
1991	1,750,548	0.53	714.4	140,044
1992	2,238,435	0.67	987.4	179,075
1993	2,355,298	0.48	847.3	188,424
1994	2,380,725	0.52	825.4	190,458
1995	2,728,567	0.56	969.8	218,285
1996	3,097,550	0.55	1,060.4	247,804
1997	3,135,787	0.57	881.3	250,863
1998	3,404,616	0.56	982.4	272,369
1999	6,743,321	0.67	948.9	2,058,000
2000	8,900,946	0.53	2,176.0	712,076
2001	9,335,736	0.55	3,527.1	746,859
2002	8,956,505	0.56	2,316.8	4,569,968
2003	8,822,586	0.66	4,451.6	670,930
2004	9,347,523	0.60	4,234.9	710,967
2005	10,064,891	0.80	4,771.6	771,666
Total	**~87 Mt**	**~0.67**	**30.91 t**	**»25 Mt**

Gold Milling : New South Wales

Year	Ore (t)	Grade (g/t)	Gold (kg)
1875	10,779	37.01	399.0
1876	54,062	20.42	1,103.9
1877	28,706	28.49	817.8
1878	26,416	29.45	804.2
1879	16,728	38.76	648.4
1880	25,059	24.08	603.3
1881	23,603	29.05	685.7
1882	35,176	29.96	1,054.0
1883	41,712	22.43	935.7
1884	53,998	22.01	1,032.9
1885	28,105	31.38	881.8
1886	46,398	18.98	880.8
1887	69,550	14.09	979.9
1888	27,218	31.14	848.6
1889	40,239	30.74	1,236.0
1890	47,551	23.47	1,116.8
1891	66,811	28.38	1,897.5
1892	100,811	30.29	3,059.3
1893	107,580	25.19	2,646.1
1894	151,906	21.94	3,333.5
1895	130,486	41.39	5,405.4
1896	161,379	27.29	4,408.8
1897	192,706	25.19	4,857.4
1898	191,832	23.21	4,449.2
1899	253,715	18.49	5,151.0
1900	398,983	15.42	6,173.8
1901	304,672	13.81	4,208.8
1902	209,998	18.15	3,815.2
1903	374,417	16.23	6,085.1
1904	299,201	17.56	5,246.3
1905	317,607	17.98	5,717.1
1906	303,543	14.98	4,383.8
1907	319,480	14.35	4,366.0
1908	282,200	15.29	4,315.9
1909	210,418	16.11	3,384.1
1910	237,373	10.75	2,554.8
1911	213,283	10.59	2,261.5
1912	204,683	12.28	2,510.0
1913	527,732	6.38	3,359.0
1914	186,584	11.68	2,177.7
1915	183,716	11.59	2,139.5
1916	157,124	11.02	1,723.8
1917	31,554	15.98	504.2
1918	78,156	8.24	643.7
1919	41,754	10.67	445.5
1920	46,241	8.75	404.7
1921	45,069	9.06	408.3
1922	14,992	15.93	238.8
1923	17,768	6.22	110.4
1924	12,088	14.38	173.8
1925	9,821	21.52	211.4
1926	4,352	26.31	114.5
1927	3,285	15.98	52.5
1928	3,170	14.81	46.9
1929	2,134	26.47	56.5
1930	6,244	14.45	90.2
1931	6,432	22.29	143.3
1932	8,554	17.45	149.3
1933	11,689	22.77	266.1
1934	30,395	19.32	587.1
1935	86,724	11.27	977.4
1936	95,982	12.16	1,167.2
1937	133,201	9.89	1,317.3
1938	167,183	10.04	1,678.0
1939	288,247	7.59	1,707.9
1940	374,984	5.78	1,871.7
1941	363,765	5.94	2,156.4
1942	357,377	3.48	1,393.8
1943	398,469	3.80	1,449.4
1944	219,465	1.52	171.6
1945	194,508	4.04	662.6
1946	277,439	3.49	839.1
1947	238,317	4.00	829.7
1948	259,490	5.27	1,278.0
1949	206,513	6.00	1,186.1
1950	337,771	3.88	1,079.3
1951	328,360	3.85	1,038.8
1952	303,970	2.81	694.8
1953	178,054	1.67	148.1
1954	82,482	1.64	59.4
1955	155,692	1.66	139.6
1956	200,920	1.63	170.1
1957	196,108	1.52	158.3
1958	224,947	1.64	172.0
1959	201,845	1.58	145.4
1960	202,280	1.58	157.4
1961	201,623	1.58	139.0
1962	34,619	1.52	22.7
1980	21,766	6.24	135.7
1984	18,920	4.65	88
1985	27,000	9.94	267.4
1986	28,911	5.97	172.6
1987	300,768	3.94	928.8
1988	1,086,703	3.60	3,552.2
1989	2,372,060	2.94	6,039.0
1990	2,777,049	3.25	7,510.9

Gold Milling : New South Wales

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1991	2,318,186	2.99	6,381.6	4,720,000
1992	1,989,987	2.40	5,250.5	
1993	1,879,166	3.94	6,939.2	
1994	1,265,188	4.36	5,140.3	1,999,226
1995	3,856,243	2.53	8,807.4	
1996	5,254,002	2.39	10,491.2	923,195
1997	6,849,346	1.98	11,665.0	935,197
1998	14,575,690	1.26	14,490.4	13,349,622
1999	25,008,529	1.07	21,357.8	50,655,259
2000	24,625,547	0.99	18,294.8	40,594,870
2001	23,747,439	0.93	16,825.6	41,189,409
2002	27,129,726	1.07	23,223.9	51,305,205
2003	28,400,100	1.26	29,166.9	63,184,000
2004	28,125,400	1.28	29,691.5	59,260,000
2005	27,543,672	1.25	27,820.2	53,388,000
Total	**~243 Mt**	**~1.87**	**396 t**	**»382 Mt**

Gold Milling : Victoria

Year	Ore (t)	Grade (g/t)	Gold (kg)
1857	4,213	50.05	211
1858	15,881	41.23	655
1859	39,659	37.27	1,478
1860	87,980	28.95	2,547
1861	356,016	26.16	9,314
1862	576,283	16.77	9,664
1863	531,598	18.91	10,051
1864	857,012	15.75	13,497
1865	716,416	18.20	13,041
1866	875,252	16.34	14,303
1867	964,032	16.09	15,509
1868	900,409	16.29	14,663
1869	898,980	16.00	14,387
1870	926,294	15.30	14,173
1871	943,119	16.22	15,296
1872	974,933	18.51	18,044
1873	1,013,198	17.84	18,077
1874	994,453	18.88	18,779
1875	972,279	18.63	18,116
1876	1,036,099	20.17	20,895
1877	989,101	14.64	14,478
1878	894,174	14.98	13,396
1879	853,165	13.93	11,884
1880	984,386	14.74	14,505
1881	1,057,872	13.40	14,181
1882	1,044,272	13.80	14,414
1883	939,222	14.59	13,705
1884	890,719	15.12	13,466
1885	856,743	15.39	13,183
1886	844,677	14.43	12,191
1887	793,225	14.41	11,430
1888	746,063	14.92	11,132
1889	744,181	15.00	11,162
1890	764,437	14.08	10,766
1891	785,331	14.09	11,063
1892	870,240	15.29	13,304
1893	918,837	14.22	13,062
1894	912,882	12.77	11,654
1895	889,750	12.86	11,446
1896	885,274	14.80	13,106
1897	976,777	13.57	13,258
1898	1,016,915	13.99	14,230
1899	1,013,953	14.63	14,833
1900	1,019,472	13.44	13,704
1901	969,958	13.26	12,861
1902	985,496	13.84	13,643
1903	1,102,452	14.23	15,683
1904	1,030,349	14.64	15,085
1905	1,121,842	12.90	14,477
1906	1,095,288	14.08	15,423
1907	1,050,489	12.31	12,927
1908	1,114,505	11.43	12,734
1909	1,128,660	11.98	13,526
1910	952,519	11.54	10,996
1911	864,564	12.23	10,576
1912	795,916	12.64	10,062
1913	719,789	11.58	8,338
1914	708,527	11.72	8,306
1915	619,387	10.57	6,550
1916	535,044	9.88	5,287
1917	333,694	10.90	3,638
1918	229,847	9.77	2,246
1919	214,926	11.19	2,406
1920	218,474	15.63	3,414
1921	181,263	13.06	2,367
1922	151,176	17.04	2,576
1923	111,090	20.13	2,237
1924	106,048	15.84	1,680
1925	64,154	16.09	1,032
1926	72,069	16.19	1,167
1927	51,012	17.13	874
1928	50,901	15.37	782
1929	36,445	17.25	629
1930	35,378	15.42	546
1931	41,775	16.37	684
1932	65,838	12.85	846
1933	76,500	13.87	1,061
1934	109,576	9.90	1,085
1935	155,504	10.40	1,617
1936	170,773	11.99	2,047
1937	229,963	10.44	2,402
1938	204,825	9.82	2,012
1939	179,840	12.52	2,252
1940	207,587	14.30	2,969
1941	207,720	12.24	2,542
1942	120,565	13.06	1,575
1943	71,876	16.26	1,169
1944	68,804	19.87	1,367
1945	87,560	19.28	1,689
1946	102,113	20.73	2,117
1947	106,427	19.96	2,125
1948	89,149	18.99	1,693
1949	91,095	17.13	1,561
1950	89,281	14.90	1,330
1951	85,751	15.69	1,345
1952	80,812	15.72	1,271
1953	73,372	17.16	1,259
1954	73,606	14.99	1,103
1955	78,620	12.54	986.0
1956	45,775	10.61	485.8
1957	57,980	11.36	658.6
1958	92,328	13.75	1,269.2
1959	87,914	12.22	1,074.0
1960	81,548	10.23	834.6
1961	72,047	10.99	791.7
1962	90,041	9.81	883.4
1963	66,937	11.32	757.5
1964	52,875	12.31	651.1
1965	47,424	11.86	562.4
1966	41,919	14.25	597.4
1967	42,505	8.04	341.8
1968	38,782	8.53	330.9
1969	9,994	26.76	267.4
1970	6,671	37.97	253.3
1971	5,993	18.01	107.9
1972	9,081	17.01	154.5
1974	7,839	15.09	118.3
1975	8,674	22.39	194.2
1976	4,400	13.83	60.9
1983	13,323	5.27	63.4

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1984	116,385	2.81	290.0	
1985	217,360	3.98	792.7	
1986	285,404	4.11	986.7	
1987	253,826	3.86	731.8	
1988	316,443	3.68	923.3	
1989	337,436	3.69	940.5	
1990	2,472,791	1.54	2,488.9	9,172,857
1991	3,176,178	1.40	3,222.8	3,817,598
1992	2,526,523	1.97	3,791.5	2,276,552
1993	3,280,592	1.72	4,276.4	3,286,165
1994	1,672,625	2.47	3,773.7	2,463,502
1995	2,177,301	2.23	4,057.8	4,160,885
1996	2,181,008	2.42	4,349.2	4,573,873
1997	2,516,811	1.98	4,054.3	4,771,746
1998	1,973,604	2.45	4,239.0	3,364,005
1999	1,924,602	2.61	4,242.9	4,391,756
2000	1,333,600	3.69	4,796.6	2,127,289
2001	1,236,250	3.38	3,529.4	720,273
2002	1,021,093	3.76	3,331.6	
2003	843,094	4.20	3,065.8	
2004	799,185	4.80	3,421.2	
2005	1,234,507	5.34	5,183.8	15,940,600
Total	**~88 Mt**	**~10.2**	**881 t**	**»61 Mt**

Gold Milling : Tasmania

Year	Ore (t)	Grade (g/t)	Gold (kg)
1887	66	38.15	2.5
1888	1,904	27.31	52.0
1889	1,554	14.80	23.0
1890			
1891	485	40.94	19.8
1892	198	32.49	6.4
1893	2,955	16.22	47.9
1894	3,913	19.61	76.7
1895	1,965	17.27	33.9
1896	8,360	5.93	49.5
1897	113,117	3.68	416.6
1898	188,042	8.41	1,578.6
1899 [§]	232,314 [§]	6.33	1,444.9
1900	201,284	4.43	865.8
1901	270,088	3.34	1,218.3
1902	439,623	3.27	1,363.8
1903	454,258	2.88	1,307.6
1904	438,494	3.64	1,594.5
1905	496,759	4.17	2,072.4

Year	Ore (t)	Grade (g/t)	Gold (kg)
1906	447,784	4.03	1,805.9
1907	450,369	3.96	1,781.8
1908	454,457	3.59	1,629.2
1909	409,405	3.09	1,266.5
1910	465,287	2.28	1,058.8
1911	321,412	3.13	1,007.2
1912	315,886	3.70	1,167.3
1913	336,092	3.21	1,056.5
1914	378,290	2.16	817.4
1915	348,480	1.14	395.9
1916	312,140	0.92	285.9
1917	254,552	0.95	240.6
1918	242,970	1.21	292.8
1919	201,167	1.11	222.7
1920	203,603	0.91	184.9
1921	178,329	0.83	147.5
1922	181,870	0.50	91.3
1923	152,523	0.42	64.8
1924	162,570	0.44	71.5

Year	Ore (t)	Grade (g/t)	Gold (kg)
1925	129,757	0.67	74.8
1926	154,342	1.26	132.9
1927	140,569	1.32	136.5
1928	154,504	1.13	132.8
1929	231,345	0.95	180.3
1930	283,557	0.72	161.2
1931	322,124	0.44	129.5
1932	245,158	0.63	153.3
1933	434,999	0.41	176.7
1934	527,039	0.30	159.3
1935	573,269	0.39	224.2
1936	676,069	0.33	224.4
1937	1,006,674	0.52	524.4
1938	1,206,752	0.52	630.1
1939	1,264,133	0.47	599.6
1940	1,355,067	0.42	574.4
1941	1,544,847	0.37	578.0
1942	1,711,663	0.31	533.9

[§] Waste rock - 292,667 t.

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1943	1,703,875	0.31	520.6	336,321
1944	1,650,780	0.14	223.5	322,899
1945	1,603,183	0.24	383.5	285,310
1946	1,635,979	0.27	441.3	317,026
1947	1,580,841	0.28	444.7	593,723
1948	1,450,330	0.26	378.5	611,267
1949	1,638,073	0.23	370.1	608,898
1950	1,686,393	0.43	512.4	853,996
1951	1,696,264	0.49	475.1	1,107,277
1952	1,643,516	0.30	489.0	1,275,162
1953	1,676,649	0.29	494.0	1,360,424
1954	1,815,793	0.31	567.3	1,346,128
1955	1,795,457	0.27	488.8	1,854,455
1956	1,832,257	0.29	524.0	2,596,130
1957	2,138,849	0.28	598.5	2,206,568
1958	2,192,015	0.30	650.0	1,997,529
1959	2,202,424	0.29	637.3	2,086,281
1960	2,232,845	0.32	714.6	2,339,846
1961	2,251,880	0.39	877.6	2,702,552
1962	2,362,417	0.37	884.2	2,388,872
1963	2,486,312	0.41	1,026.3	2,241,395
1964	2,494,678	0.38	951.3	2,148,897
1965	2,451,434	0.44	921.8	2,333,036
1966	2,481,576	0.48	1,025.5	2,283,284
1967	2,520,104	0.48	1,073.8	2,025,440
1968	2,603,798	0.43	1,016.5	1,447,559
1969	2,492,894	0.51	1,137.5	1,486,498
1970	2,540,107	0.62	1,252.6	593,022
1971	2,792,800	0.71	1,659.2	332,825
1972	2,954,568	0.84	1,780.9	85,121
1973	2,689,286	0.91	1,317.0	567,188
1974	2,823,481	0.86	1,382.8	601,530

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1975	2,716,131	0.71	1,422.6	24,300
1976	2,907,525	0.78	1,313.4	
1977	2,161,834	1.08	1,614.9	
1978	2,264,723	1.05	1,795.7	
1979	2,180,604	1.07	1,743.1	
1980	2,056,638	0.68	1,314.0	
1981	2,079,997	1.01	2,006.6	
1982	2,028,457	1.04	1,766.8	
1983	2,253,971	0.97	1,743.0	
1984	2,312,328	0.92	1,970.0	
1985	2,295,818	1.00	2,818.0	
1986	2,517,842	1.31	2,076.0	
1987	2,041,601	0.95	1,905.0	
1988	2,008,794	0.94	2,172.5	
1989	2,406,783	1.02	1,545.9	
1990	2,112,062	0.98	1,377.0	41,495
1991	1,967,927	1.03	1,276.3	4,462
1992	2,213,189	0.76	1,118.0	
1993	2,305,100	0.72	1,200.0	
1994	2,194,885	0.73	1,239.0	
1995	1,374,335	0.90	886.0	
1996	1,530,952	0.87	935.1	96,587
1997	2,563,271	1.12	971.2	31,120
1998	2,813,770	1.34	868.0	156,506
1999	2,936,169	1.56	1,271.2	337,300
2000	3,433,679	1.89	3,620.8	223,570
2001	3,665,028	2.20	4,868.0	290,896
2002	3,944,757	1.93	5,394.7	346,307
2003	3,890,994	2.35	6,121.7	284,398
2004	3,700,027	3.16	7,320.4	273,168
2005	3,736,643	2.68	6,477.8	315,318
Total	**~168 Mt**	**~1.02**	**~129 t**	**»46 Mt**

Gold Milling : Western Australia

Year	**Ore** (t)	**Grade** (g/t)	**Gold** (kg)
1886	1,219	**29.53**	36
1887	1,219	**29.53**	36
1888	1,219	**29.53**	36
1889	23,455	**17.08**	401
1890	23,455	**17.08**	401
1891	42,218	**26.73**	1,129
1892	42,218	**26.73**	1,129
1893	42,985	**26.97**	1,160
1894	53,660	**35.01**	1,879
1895	55,208	**40.27**	2,223
1896	169,402	**46.19**	7,824
1897	428,760	**45.85**	19,659
1898	774,277	**38.57**	29,864
1899	1,192,653	**40.13**	47,861
1900	1,309,977	**34.97**	45,810
1901	1,597,973	**35.23**	56,300
1902	1,918,718	**33.83**	64,907
1903	2,195,227	**32.73**	71,845
1904	2,471,086	**23.86**	58,948
1905	2,685,718	**21.08**	56,619
1906	2,924,303	**18.21**	53,256
1907	3,056,172	**16.86**	51,535
1908	3,131,133	**15.70**	49,162
1909	3,154,684	**15.35**	48,425
1910	2,930,446	**14.94**	43,794
1911	2,779,718	**14.84**	41,241
1912	2,731,890	**14.28**	39,017
1913	2,831,959	**14.12**	39,998
1914	2,745,327	**13.62**	37,403
1915	2,654,761	**13.84**	36,747
1916	2,207,539	**14.39**	31,774
1917	1,991,818	**14.79**	29,453
1918	1,718,399	**15.38**	26,421
1919	1,310,537	**16.17**	21,194
1920	1,269,601	**15.21**	19,314
1921	871,230	**18.58**	16,184
1922	863,723	**19.16**	16,548
1923	794,278	**19.20**	15,249
1924	796,300	**17.74**	14,129
1925	813,102	**16.52**	13,431
1926	805,642	**16.36**	13,181
1927	707,086	**17.77**	12,565
1928	655,810	**18.44**	12,094
1929	638,455	**18.02**	11,503
1933	655,670	**19.40**	12,722
1934	997,877	**15.59**	15,561
1935	1,348,253	**13.69**	18,456
1936	1,614,403	**12.03**	19,421
1937	1,801,298	**11.05**	19,900
1938	1,940,389	**10.36**	20,095
1939	2,540,000	**10.29**	26,124
1940	3,068,320	**10.14**	31,100
1941	3,810,000	**13.96**	53,181
1942	4,114,800	**9.45**	38,875
1943	4,287,520	**8.63**	37,009
1944	4,246,880	**6.59**	27,990
1945	3,169,920	**8.44**	26,746
1946	2,072,640	**7.95**	16,483
1947	1,838,960	**8.12**	14,928

Year	**Ore** (t)	**Grade** (g/t)	**Gold** (kg)	**Waste Rock** (t)
1948	2,486,706	**8.32**	20,681	
1949	2,507,790	**8.03**	20,133	
1950	2,502,837	**7.53**	18,858	
1951	2,511,226	**8.02**	20,137	
1952	2,668,638	**8.45**	22,558	
1953	3,220,593	**7.94**	25,564	
1954	3,292,224	**7.94**	26,124	
1955	2,910,889	**8.87**	25,830	
1956	2,916,200	**8.67**	25,272	
1957	2,998,227	**8.80**	26,394	
1958	3,069,409	**8.86**	27,190	
1959	3,006,549	**8.89**	26,743	
1960	3,105,348	**8.70**	27,017	
1961	3,032,209	**8.92**	27,038	
1962	3,037,488	**8.80**	26,727	
1963	2,814,489	**8.86**	24,937	
1964	2,688,291	**8.27**	22,231	
1965	2,570,648	**7.91**	20,322	
1966	2,660,920	**7.33**	19,492	
1967	2,572,131	**6.93**	17,834	
1968	2,344,661	**6.84**	16,036	
1969	2,038,824	**6.71**	13,673	
1970	1,767,860	**6.16**	10,885	
1971	1,701,911	**6.30**	10,722	
1972	1,668,600	**6.41**	10,696	
1973	1,629,519	**5.26**	8,574	
1974	1,378,991	**4.76**	6,559	
1975	1,270,168	**5.40**	6,865	4,152,200
1976	951,028	**7.46**	7,091	
1977	1,071,980	**10.03**	10,747	
1978	1,280,532	**10.41**	13,332	
1979	1,370,878	**8.45**	11,582	
1980	1,883,737	**5.96**	11,233	
1981	2,412,377	**4.99**	12,047	
1982	3,452,504	**6.01**	20,757	
1983	4,428,167	**5.39**	23,881	
1984	6,412,878	**5.01**	32,111	
1985	9,733,488	**4.23**	41,196	
1986	14,225,120	**3.74**	53,189	
1987	23,940,308	**3.28**	78,438	
1988	36,709,768	**2.92**	107,290	
1989	57,630,904	2.56	147,281	37,949,996
1990	81,293,678	2.17	176,347	106,739,694
1991	88,513,163	2.02	178,988	134,610,806
1992	88,761,903	2.04	181,286	178,439,306
1993	88,571,971	2.07	183,473	131,852,654
1994	93,799,368	2.06	192,979	151,374,792
1995	96,660,334	1.96	189,353	179,067,585
1996	107,522,942	2.06	221,184	199,514,444
1997	113,318,717	2.12	240,245	150,769,889
1998	102,100,361	2.27	231,364	156,876,975
1999	85,325,000	2.47	210,938	198,037,955
2000	77,374,357	2.58	199,496	151,155,960
2001	68,414,450	2.81	192,204	143,222,297
2002	48,377,594	3.90	188,859	183,050,392
2003	64,145,353	2.93	187,928	243,809,592
2004	59,033,268	2.74	161,975	163,299,496
2005	70,974,963	2.39	169,415	173,495,810
Total	**1,673 Mt**	**~3.48**	**5,828 t**	**»2,700 Mt**

Gold Milling : Northern Territory

Year	Ore (t)	Grade (g/t)	Gold (kg)
1875	1,629.0	**64.7**	105.4
1876	124.1	**62.7**	7.8
1884	8,294.1	**31.7**	263.3
1885	6,263.6	**18.0**	112.9
1886	1,583.2	**56.5**	89.4
1887	2,072.6	**79.6**	165.1
1888	959.6	**33.5**	32.1
1889	2,129.5	**27.7**	59.1
1890	1,858.0	**45.1**	83.9
1891	9,453.4	**23.5**	222.4
1892	13,049.0	**30.9**	402.7
1893	25,393.4	**26.4**	671.4
1894	44,825.9	**20.7**	925.9
1895	30,714.7	**29.3**	900.3
1896	30,996.1	**21.7**	673.3
1897	18,700.5	**24.7**	462.0
1898	18,432.9	**23.5**	432.6
1899	18,753.2	**23.3**	437.7
1900	17,272.3	**21.7**	374.4
1901	28,525.8	**12.8**	363.9
1902	38,713.7	**10.5**	405.1
1903	14,750.1	**23.5**	347.2
1904	9,790.2	**24.5**	239.9
1905	12,770.1	**21.2**	270.7
1906	10,221.2	**19.3**	197.0
1907	4,475.6	**25.5**	114.0
1908	6,081.3	**19.2**	116.6
1909	15,216.1	**10.1**	153.2
1910	7,261.5	**19.1**	138.3

Year	Ore (t)	Grade (g/t)	Gold (kg)
1911	3,538.1	**53.1**	188.0
1912	2,523.2	**33.4**	84.3
1913	1,205.5	**35.2**	42.4
1914	935.7	**23.5**	22.0
1915	70.7	**38.8**	2.7
1916	43.2	**38.8**	1.7
1917	38.1	**38.8**	1.5
1918	13.6	**30.6**	0.4

Year	Ore (t)	Grade (g/t)	Gold (kg)
1933	9.1	**110.2**	1.0
1934	73.0	**188.7**	13.8
1935	2,344	**39.8**	93.3
1936	7,253	**35.2**	255.1
1937	9,795	**27.0**	264.7
1938	14,344	**19.2**	276.0
1939	17,133	**32.3**	552.7
1940	26,949	**20.6**	555.9
1941	25,244	**17.7**	448.0
1942	25,307	**19.3**	489.5
1943	7,374	**30.3**	223.5
1944	5,481	**19.6**	107.4
1945	5,238	**42.7**	223.7
1946	5,012	**28.6**	143.3
1947	9,563	**32.5**	310.9
1948	23,501	**33.4**	784.7
1949	27,218	**38.5**	1,047.5
1950	30,682	**36.6**	1,123.5
1951	27,043	**45.2**	1,222.9
1952	34,130	**33.6**	1,145.2
1953	50,732	**29.7**	1,505.1

Year	Ore (t)	Grade (g/t)	Gold (kg)
1954	39,789	**39.1**	1,554.2
1955	92,187	**22.5**	2,075.1
1956	68,127	7.23	205.3
1957	107,215	7.98	364.0
1958	114,021	4.74	658.1
1959	128,330	3.66	301.8
1960	139,628	4.25	359.7
1961	184,926	4.13	362.3
1962	191,891	3.97	553.8
1963	159,683	4.01	432.1
1964	180,579	3.93	406.4
1965	187,860	3.82	503.2
1966	178,483	2.43	525.0
1967	213,844	10.73	434.0
1968	221,041	12.92	2,294.6
1969	235,366	11.73	2,856.8
1970	244,532	10.08	2,761.4
1971	355,594	8.09	2,464.1
1972	241,526	11.24	2,877.0
1973	594,501	5.09	2,715.1
1974	520,046	4.31	3,025.3
1975	248,337	5.06	2,243.1
1976	233,224	4.91	1,256.0
1977	255,213	4.61	1,144.0
1978	211,349	3.12	1,176.8
1979	303,002	2.63	660.0
1980	615,189	5.93	2,609.6
1981	736,528	4.23	2,263
1982	564,470	6.39	2,583

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1983	573,419	6.35	2,597	202,415
1984	343,885	7.60	2,052	
1985	501,086	5.65	2,142	
1986	1,036,916	2.98	2,449	
1987	3,132,913	2.58	7,398	1,979,198
1988	2,223,828	3.14	6,162	1,895,696
1989	3,239,770	3.70	10,349	1,929,858
1990	5,432,493	3.12	15,928	6,479,119
1991	5,488,578	2.91	14,657	8,694,777
1992	5,367,831	3.06	14,758	9,034,122
1993	4,649,347	3.37	14,350	8,774,692
1994	6,124,001	2.76	14,893	12,866,000

Year	Ore (t)	Grade (g/t)	Gold (kg)	Waste Rock (t)
1995	5,496,339	2.74	13,532	28,750,000
1996	6,104,621	2.89	16,010	46,806,838
1997	8,091,228	2.62	20,434	47,330,367
1998	7,585,027	2.71	19,462	52,848,317
1999	6,523,195	2.98	17,908	40,436,978
2000	7,770,500	2.55	19,200	42,838,000
2001	6,032,515	3.25	18,869	17,792,000
2002	10,524,832	3.80	25,341	47,342,928
2003	8,215,220	3.51	25,889	26,908,752
2004	4,733,519	4.83	21,801	8,134,096
2005	4,272,785	3.98	16,262	
Total	**~122 Mt**	**~3.54**	**~385 t**	**»430 Mt**

World Gold Production (t Au)

1851	107.2	1882	148.9	1913	692.0	1944	687.0	1975	952.9
1852	198.3	1883	141.7	1914	660.7	1945	657.0	1976	968.9
1853	234.0	1884	143.4	1915	705.2	1946	670.0	1977	969.8
1854	191.8	1885	155.2	1916	683.4	1947	688.0	1978	975.3
1855	203.3	1886	149.3	1917	631.1	1948	701.0	1979	959.6
1856	222.0	1887	159.1	1918	573.2	1949	731.0	1980	946.3
1857	200.6	1888	165.8	1919	550.4	1950	751.0	1981	961.6
1858	187.6	1889	182.2	1920	507.1	1951	735.0	1982	1,340
1859	187.9	1890	181.2	1921	496.4	1952	757.0	1983	1,400
1860	164.5	1891	188.5	1922	480.0	1953	755.0	1984	1,460
1861	171.2	1892	204.8	1923	553.0	1954	797.0	1985	1,530
1862	162.2	1893	235.7	1924	586.0	1955	840.0	1986	1,610
1863	161.0	1894	271.8	1925	592.0	1956	871.0	1987	1,660
1864	170.0	1895	305.4	1926	600.0	1957	905.0	1988	1,870
1865	180.9	1896	302.7	1927	604.0	1958	934.0	1989	2,010
1866	182.2	1897	357.4	1928	578.0	1959	1,002.0	1990	2,180
1867	156.5	1898	431.7	1929	609.3	1960	1,047.0	1991	2,160
1868	165.1	1899	461.5	1930	604.0	1961	1,080.0	1992	2,260
1869	159.8	1900	383.0	1931	645.0	1962	1,155.0	1993	2,280
1870	160.8	1901	392.7	1932	697.0	1963	1,205.0	1994	2,282
1871	161.0	1902	445.5	1933	707.0	1964	1,255.0	1995	2,276
1872	149.8	1903	489.8	1934	724.0	1965	1,282.0	1996	2,361
1873	144.5	1904	522.7	1935	775.0	1966	1,284.0	1997	2,494
1874	136.1	1905	568.2	1936	861.0	1967	1,243.0	1998	2,542
1875	146.7	1906	602.4	1937	932.0	1968	1,257.0	1999	2,574
1876	166.0	1907	621.4	1938	1,006.0	1969	1,260.0	2000	2,574
1877	171.5	1908	666.6	1939	1,071.0	1970	1,273.4	2001	2,616
1878	179.2	1909	683.2	1940	1,104.5	1971	1,235.8	2002	2,592
1879	163.7	1910	685.0	1941	1,122.0	1972	1,181.8	2003	2,590
1880	160.2	1911	695.0	1942	986.0	1973	1,116.3	2004	2,470
1881	155.0	1912	701.4	1943	774.0	1974	1,004.6	2005	2,519
								2006[P]	2,500[P]

Economic Gold Resources (t Au) – Australia and World

	Australia	World		Australia	World		Australia	World
1955	208.6		1980	332.39		1993	2,889	41,985
			1981	282.07		1994	3,434	44,007
1960	250		1982	342.7		1995	4,263	44,007
			1983	394.06		1996	4,454	
1968		10,978	1984	728		1997	4,352	
			1985	959.25		1998	4,404	
1973		31,100	1986	1,026		1999	5,018	
1974		40,430	1987	1,274	42,296	2000	4,959	48,959
1975	155.7	41,985	1988	1,378	44,038	2001	5,156	50,156
1976	161.38	34,832	1989	1,486	41,985	2002	5,415	42,500
1977	129.57	37,787	1990	2,129	42,389	2003	5,382	43,000
1978	153.7	37,320	1991	2,145	43,011	2004	5,589	42,000
1979	277.9		1992	2,466	44,007	2005	5,225	42,225
						2006[P]	5,480[P]	42,480[P]

19. Lead-Zinc-Silver

- *Lead Production by State : 1850-2006*

  Data Sources/References : (ABARE, var.-a, var.-b; Blockley, 1971; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; NSWDMR, var.-b; NTDME, var.; QDM, var.; QNRME, var.; SADM, var.-a, var.-b; TDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)

  Note : Data prior to 1903 is approximate only, as most lead was transported to smelters interstate or exported to overseas smelters. Accurate accounts of contained lead production were not able to be compiled by state agencies. For Western Australia, data from 1850-1900 is the Northampton field only (Blockley, 1971; WADM, var.), which is often neglected by studies of the Australian lead mining sector. ***All production data prior to 1903 is therefore the best estimate possible.***

- *Zinc Production by State : 1889-2006*

  Data Sources/References : (ABARE, var.-a, var.-b; Blockley, 1971; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; NSWDMR, var.-b; NTDME, var.; QDM, var.; QNRME, var.; SADM, var.-a, var.-b; TDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)

- *Silver Production by State : 1851-2006*

  Data Sources/References : (ABARE, var.-a, var.-b; Blockley, 1971; BMR, var.; Kalix *et al.*, 1966; NSWDM, var.; NSWDMR, var.-b; NTDME, var.; QDM, var.; QNRME, var.; SADM, var.-a, var.-b; TDM, var.; VDPI, var.; WADM, var.; WADoIR, var.)

- *World Lead Production : 1900-2006*

  Data Sources/References : (ABARE, var.-b; Kelly *et al.*, 2004)

- *World Zinc Production : 1900-2006*

  Data Sources/References : (ABARE, var.-b; Kelly *et al.*, 2004)

- *World Silver Production : 1900-2006*

  Data Sources/References : (ABARE, var.-b; Kelly *et al.*, 2004)

- *Australian and World Economic Lead and Zinc Resources*

  Data Sources/References : (Andrews, 1922; Anonymous, 1940; Berry *et al.*, 1998; Blockley, 1971; BMR, var.; David, 1950; Forrestal, 1990; GA, var.; Hills, 1919; Hooper & Black, 1953; Logan *et al.*, 1990; McLeod, 1965a, 1998; MIM, var.; NSWDM, var.; QDM, var.; Raggatt, 1953; Raggatt, 1968; TDM, var.; Wallis, 2005)

  Note : Resources data prior to 1975 is approximate only, and is only included when data is available for all major mines/fields. The pre-1975 data is provided for indicative purposes only. For specific mine/field resources, please refer to the data tables for that mine in the appendix or the references provided.

Lead Production by State (t Pb)

Year	WA	Year	WA	Year	WA	Year	WA	Year	WA	Year	WA	Year	WA
1850	2.8	1859	6.9	1863	116.8	1867	659.8	1871	256	1875	1,329	1879	1,692
		1860	50.0	1864	40.6	1868	670.9	1872	222	1876	1,207		
1855	11.6	1861	40.1	1865	428.5	1869	426.4	1873	589	1877	3,215	1881	569
		1862	4.6	1866	166.7	1870	737.3	1874	1,307	1878	2,205	1882	729

Year	NSW	WA	Australia	Year	NSW	WA	Australia	Year	NSW	WA	Australia
1880	61	877	938	1885	3,142	165	**3,307**	1889	28,937	127	**29,064**
				1886	3,590	217	**3,807**	1890	34,346	108	40,854
1883	0	369	1,682	1887	11,162	239	11,792	1891	70,379	13	**70,392**
1884	193	247	2,641	1888	24,973	270	**25,243**	1892	70,329	8	**70,337**

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1890	*Total 1880-1902 : 18,687 t*	34,346	*Total by 1902 : 403 t*	*Total 1888-1902 : 132,140 t*	*Total 1841-1902 : 12,799 t*	108	*Total 1886-1902 : 1,254 t*	40,854
1891		70,379				13		**70,392**
1892		70,329				8		**70,337**
1893		**86,363**		**>224.7**				**86,587**
1894		55,403		**>191.6**				81,835
1895		57,061		**>269.9**				72,059
1896		90,492		**>536.9**				91,256
1897		106,123		**>642.0**				114,476
1898		102,686		**>1,118.5**		1.7		108,609
1899		191,761		**>1,001.3**		55.5		192,818

Lead Production by State (t Pb)

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1900		168,552		**>1,068.5**		51.8		**169,673**
1901		149,390		**>1,293.2**		9.2		154,468
1902		134,896		**>1,385.1**		19.1		164,028
1903	3,856	123,951		11,670	567			140,043
1904	2,079	168,194		14,620			170	185,062
1905	2,461	164,822		24,645	31		99	192,058
1906	2,854	140,826		23,384	30		238	167,332
1907	5,241	194,767		22,374	610	6	441	223,439
1908	7,223	175,638		15,276	549	486	10	199,181
1909	5,324	157,610		25,499	47	268		188,747
1910	2,430	191,649		8,314	27	139		202,560
1911	1,799	209,826		12,360		1,284	2	225,272
1912	3,158	233,415		18,357		1,352	46	256,328
1913	3,661	243,946		8,008	93	2,864	127	258,699
1914	736	194,356		5,550	11	2,580		203,233
1915	495	157,745		4,741	36	1,744	33	164,793
1916	625	140,782		5,054	148	3,732	49	150,389
1917	488	156,982		4,650	379	5,034	9	167,542
1918	225	189,583		3,531	307	6,765	13	200,422
1919	137	63,500		2,395		1,216	4	67,252
1920	1,736	7,787		3,918	50	5,154	8	18,653
1921	1,074	78,554		1,458		1,216		82,302
1922	2,846	143,148		5,005		3,090		154,089
1923	5,575	154,954		4,861	1	2,273		167,663
1924	3,754	141,826		4,632	4	3,075		153,292
1925	5,319	175,079		5,614	22	3,512	19	189,566
1926	3,795	171,984		5,987	17	2,506	14	184,304
1927	929	191,868	6	5,672	3	833	19	199,330
1928	43	173,273		4,864		35	1	178,215
1929	395	188,082		6,079	3	351	5	194,915
1930	235	192,789		4,306		37	3	197,369
1931	17,459	131,126		2,224			5	150,814
1932	48,479	161,299		2,737				212,516
1933	45,872	175,794		2,686		2	12	224,367
1934	43,141	187,182		1,531		3	1	231,858
1935	33,481	189,677		1,512				224,670
1936	36,335	189,141		7,684	6	123		233,289
1937	39,090	199,626		9,779	7	353		248,854
1938	41,855	224,950		11,440	1	42	20	278,308
1939	46,017	226,687		11,796				284,499
1940	48,888	230,106		14,373				293,367
1941	43,965	239,206		12,561				295,732
1942	34,048	221,346		10,490				265,884
1943	8,716	190,640		9,318		112		208,786
1944		182,256		9,603				191,859
1945		158,026		6,902	4			164,931
1946	12,959	163,761		7,536	1	28		184,284
1947	30,063	157,493		8,407	21	17		196,003
1948	31,271	172,716		8,031	108	1,431	17	213,574
1949	38,300	166,170		8,644	101	2,004	7	215,225
1950	40,286	178,384		9,780	60	1,323	14	229,849
1951	34,600	171,259		8,382	42	1,944		216,226
1952	42,391	176,208		8,677	52	5,583		232,910
1953	38,433	221,055		10,199	20	4,775		274,483
1954	42,866	234,078		11,718	14	1,521	2	290,199
1955	49,595	238,612		11,447	0.2	1,023		300,679
1956	43,790	242,132		12,412	17	5,922		304,274
1957	52,089	271,199	4	12,644	20	3,136		339,093
1958	66,852	250,846		14,006	13	1,883		333,600
1959	55,286	250,392		14,264	8	1,404		321,354
1960	58,438	239,642		13,247		1,767		313,094
1961	46,004	215,066		12,449		440	11	273,970
1962	63,672	297,059		14,990		311		376,032
1963	67,778	333,717		15,222		138		416,856
1964	62,918	301,705		15,644		630	7	380,854
1965	50,468	301,409		14,646	4	1,401	4	367,931
1966	66,590	287,573		15,827	7	717	22	370,736
1967	77,662	286,688		15,376		699	1,342	381,791

Lead Production by State (t Pb)

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1968	118,546	253,480		15,149	44	316	1,240	388,794
1969	150,097	284,863		15,145	49	662	1,223	452,040
1970	162,939	279,209		13,912	4	163	517	456,743
1971	129,296	257,609		16,617	7	21	4	403,557
1972	119,985	249,259		26,756	1			396,001
1973	136,266	246,191		20,236	3	100		402,796
1974	128,210	227,558		19,017	516		3	375,304
1975	142,633	244,638		19,552	733		245	407,801
1976	160,734	218,268		18,034	367			397,403
1977	174,761	234,627		22,800	14		2	432,204
1978	146,928	230,574		22,754	24		11	400,291
1979	155,021	244,357		22,160	12		31	421,582
1980	141,293	240,668		15,511	8		11	397,491
1981	141,529	221,045		25,527	8		13	388,122
1982	179,531	245,124		30,621	12		50	455,338
1983	202,254	243,293		34,777	9		293	480,626
1984	193,397	214,719		32,493	11			440,620
1985	205,288	252,920		37,975	15		1,771	497,954
1986	192,841	210,696		37,754	4		6,378	447,673
1987	213,035	229,758		35,969	3		10,385	489,150
1988	190,000	223,953		42,267			15,845	465,545
1989	192,000	231,964		45,649		7,846	16,138	495,000
1990	230,000	227,798		67,020	13	13,606	16,737	565,000
1991	244,000	232,107		64,880		10,698	21,664	579,000
1992	**206,979**	209,411		73,853		20,964	14,419	580,000
1993	**214,274**	221,498		66,459		32,276	10,365	510,000
1994	**204,201**	216,375		71,752		20,287	5,422	505,000
1995	**163,634**	210,318		54,453		15,642	7,265	455,000
1996	**167,693**	197,000		38,565		17,080	31,527	527,000
1997	200,000	192,000		65,274		23,201	43,601	526,000
1998	**280,873**	166,000		57,041		39,518	55,430	618,000
1999	**320,964**	162,000		65,153		55,281	44,964	677,000
2000	**368,363**	151,000		65,416		73,081	42,509	699,000
2001	447,000	125,000		30,290		91,383	38,441	759,000
2002	429,000	115,000		26,950		70,397	40,959	694,000
2003	451,000	116,000		28,727		56,492	39,000	688,000
2004	502,000	98,000		30,619		1,174	35,000	678,000
2005	549,000	117,000		32,426		28,111	34,000	760,537
2006[P]	430,000[P]	102,000[P]		37,126[P]		74,845[P]	30,000[P]	673,971[P]
Total	**~10.63 Mt**	**~22.48 Mt**	**0.4 kt**	**2.22 Mt**	**18.1 kt**	**760.9 kt**	**569.5 kt**	**~36.5 Mt**

Zinc Production by State (t Zn)

Year	NSW	SA	Australia
1889	35	496	530
1890	75	17	92
1891	78	24	103
1892	160	53	212
1893		74	74
1894		46	46
1895		26	26
1896		36	36
1897	10,329	11	10,340
1898	13,946	18	13,964

Year	NSW	SA	Australia
1899	17,863	19	17,883
1900	7,258		7,258
1901	227		227
1902		19	19
1903	7,342	22	7,364
1904	22,394		22,394
1905	42,076		42,076
1906	41,723		41,723
1907	96,012		96,012
1908	112,139		112,139

Year	NSW	Australia
1909	151,958	151,958
1910	209,224	209,224
1911	241,880	241,880
1912	232,723	232,723
1913	219,628	219,628
1914	168,387	168,387
1915	133,601	133,601
1916	120,583	120,583
1917	160,103	160,103
1918	184,653	184,653

Year	QLD	NSW	TAS	Australia
1919		66,098	290	66,387
1920		10,237	9	10,246
1921		141,691		141,691
1922		198,662		198,662
1923		145,505		145,505
1924	130	109,951	2,793	112,874
1925	174	141,004	3,163	144,340
1926	203	145,772	5,464	151,439
1927		166,097	6,427	172,524

Year	QLD	NSW	TAS	Australia
1934		138,948		138,948
1935	4,482	143,959		148,441
1936	30,930	143,427	19,069	193,426
1937	28,040	149,300	29,649	206,989
1938	24,115	167,577	31,888	223,580
1939	29,556	159,138	31,605	220,299
1940	30,057	183,230	32,855	246,142
1941	27,876	192,224	31,085	251,185
1942	21,372	173,959	28,816	224,146

Zinc Production by State (t Zn)

Year	NSW	TAS	Australia
1928	141,923	7,226	149,149
1929	148,387	7,089	155,475
1930	121,527	958	122,485

Year	NSW	Australia
1931	75,399	75,399
1932	117,523	117,523
1933	125,682	125,682

Year	QLD	NSW	TAS	Australia
1943	5,158	152,134	26,853	184,145
1944		149,731	26,738	176,469
1945		132,546	20,172	152,718
1946	11,543	140,170	23,041	174,754
1947	25,619	135,799	24,017	185,435

Year	QLD	NSW	TAS	WA	Australia
1948	21,938	147,918	23,741	153	193,751
1949	21,581	146,901	26,152	36	194,670
1950	36,647	158,923	30,648	3	226,221
1951	30,834	156,891	26,916	9	214,650

Year	QLD	NSW	TAS	WA	Australia
1952	34,321	160,764	27,711	48	222,844
1953	28,740	205,514	30,249	69	264,620
1954	30,286	219,811	33,176	75	283,348
1955	27,791	228,496	30,752		287,039

Year	QLD	NSW	TAS	SA	WA	Australia
1956	25,732	246,917	35,842	7		308,499
1957	29,979	260,376	33,500	99		323,954
1958	30,011	231,079	37,183	115	20	298,407
1959	23,843	220,465	35,509			279,818

Year	QLD	NSW	TAS	SA	Australia
1960	35,331	252,135	35,067	36	322,569
1961	33,751	241,639	40,733	12	316,136
1962	45,419	248,781	48,685	48	342,933
1963	37,942	269,887	49,265		357,094

Year	QLD	NSW	TAS	SA	WA	NT	Australia
1964	38,178	260,097	50,957	43	838		350,968
1965	31,471	275,271	47,051	0	1,026		354,819
1966	44,285	279,594	50,649	330	654	12	375,250
1967	51,851	303,451	49,632	201	699	1,968	406,935
1968	85,435	284,703	49,519	2,743	316	1,894	422,374
1969	105,687	348,993	51,013	8,636	662	1,619	509,903
1970	114,203	325,507	46,895	254	163	526	487,207
1971	106,418	293,480	52,749	0	21		452,647
1972	111,967	309,508	85,580	0			507,055
1973	125,698	290,992	63,792	0	100		480,482
1974	119,282	263,249	65,311	25,603			464,358
1975	130,234	288,831	67,476	36,184			510,035
1976	125,128	274,799	62,004	17,515			461,931
1977	123,866	289,337	78,405	0			491,608

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1978	127,980	267,925		77,388	4,173			473,293
1979	128,647	325,281		75,229	0			529,157
1980	113,634	327,404		54,274	0			495,312
1981	**124,302**	**311,560**		**74,413**	0	3,613		518,297
1982	**173,610**	**373,033**		**79,493**	11,987	48,018		664,800
1983	**201,075**	**382,819**		**82,285**	6,886	13,158		699,032
1984	214,929	329,136		83,403	46,397	35,640		676,532
1985	227,072	393,681		98,778	30,566	51,977	4,318	759,083
1986	252,734	320,716		95,267	62,708	23,969	18,157	711,958
1987	253,004	401,673		86,142	43,725		20,077	778,386
1988	245,000	373,520		101,226	21,718	20,250	25,508	759,191
1989	226,000	368,010		166,602	3,083	38,064	27,724	803,000
1990	288,000	378,108		150,413	10,061	51,704	41,793	933,000
1991	312,000	372,491		176,804		112,015	47,429	1,023,000
1992	**273,407**	316,813		210,853		141,385	40,702	1,019,000
1993	**297,325**	323,013		233,837		141,096	31,193	990,000
1994	**304,737**	331,764		165,934	2,691	123,621	11,819	955,000
1995	**216,472**	330,247	5,947	177,263	387	126,336	32,035	937,000
1996	**246,747**	304,000	13,575	198,376	0	106,855	122,802	1,070,000
1997	208,000	315,000		186,406	928	117,198	164,985	1,011,000
1998	**214,216**	270,000		183,198	3,188	149,330	186,895	1,063,000
1999	**213,419**	273,000		190,676	4,984	222,540	158,860	1,162,000
2000	**517,820**	266,000		161,883	9,925	257,712	166,500	1,419,000
2001	742,000	269,000		77,430	26,996	210,837	161,356	1,517,000
2002	760,000	236,000		81,023	31,191	218,803	173,000	1,469,000
2003	773,000	263,000		86,815	875	174,550	173,000	1,480,000
2004	824,000	209,000		94,560		75,146	159,000	1,334,000
2005	862,000	193,000		89,075		59,510	153,000	1,356,585
2006[P]	824,000[P]	173,000[P]		87,029[P]		138,842[P]	136,000[P]	1,358,871[P]
Total	**~12.2 Mt**	**~22.7 Mt**	**20 kt**	**5.35 Mt**	**415 kt**	**2.67 Mt**	**2.06 Mt**	**45.49 Mt**

Silver Production by State (kg Ag)

Year	Aust.	Year	WA	Year	WA	Year	WA	Year	WA	Year	WA
1870	3,110	1875	4,354	1880	5,909	1885	51,626	1890	456,237	1895	302,914
1871	3,110	1876	4,665	1881	8,086	1886	87,391	1891	597,120	1896	329,038
1872	3,421	1877	4,976	1882	8,086	1887	109,161	1892	415,496	1897	315,665
1873	3,732	1878	5,287	1883	18,349	1888	193,131	1893	526,834	1898	316,598
1874	4,043	1879	5,598	1884	32,344	1889	314,110	1894	442,242	1899	372,267

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1900	*Total by 1900 : 57,471 kg*	*Total by 1900 : 4,889,967 kg*	*Total by 1900 : 32,061 kg*		*Total by 1900 : 304 kg*	*Total by 1900 : 25,480 kg*		455,304
1901	17,776	367,652	2,586					388,014
1902	21,811	321,131	1,483					344,425
1903	19,970	255,835	896		220			276,921
1904	20,368	332,668	891					353,928
1905	18,713	319,879	1,014					339,606
1906	24,354	270,148	1,092		25			295,619
1907	28,659	377,855	985		182			407,681
1908	36,147	372,692	798					409,637
1909	31,143	329,187	673		52	4,112		365,167
1910	26,783	398,225	585		194	3,872		429,659
1911	17,074	451,856	595		44	3,677		473,247
1912	17,702	420,293	542		84	3,432		442,052
1913	18,815	451,102	502		83	3,696		474,198
1914	7,898	415,512	419		93	3,557		427,480
1915	7,456	218,081	363		77	4,047		230,024
1916	7,560	252,155	272		107	36,875		296,968
1917	7,515	265,780	239		57	3,862		277,453
1918	4,743	287,985	197		50	3,693		296,668
1919	2,863	196,080	190	16,338	17	2,897		218,385
1920	8,529	21,003	194	19,386	31	2,978		52,121
1921	6,075	131,923	162	10,843	45	2,772		151,820
1922	8,491	308,292	217	24,712	78	3,049		344,840
1923	14,595	375,313	196	19,861	1	2,367		412,334
1924	8,604	287,882	131	19,971	32	2,063		318,683
1925	11,989	286,747	65	22,709	45	1,882		323,437
1926	7,854	301,973	74	23,843	11	1,377		335,131
1927	2,616	318,503	46	23,069	6	971		345,211
1928	685	259,029	45	20,816	0	1,152		281,727
1929	1,638	262,969	28	26,881	38	1,085		292,639
1930	2,171	271,224	25	22,131	33	1,073		296,658
1931	33,852	206,467	47	12,183	2	1,344		253,895
1932	71,585	188,908	65	14,414	0	1,809		276,782
1933	69,938	255,682	76	15,218	0	2,038		342,951
1934	70,273	255,254	97	8,854	0	1,423		335,900
1935	74,925	282,760	123	10,073	0	1,572		369,453
1936	95,913	266,148	248	28,191	49	2,389		392,936
1937	101,541	304,174	169	32,990	11	5,175		444,060
1938	109,892	297,271	183	37,928	16	7,119		452,408
1939	120,853	298,086	195	39,749	17	7,845		466,746
1940	135,778	266,766	241	50,030	84	7,959		460,858
1941	120,217	290,998	543	41,262	145	7,794		460,959
1942	95,024	283,175	530	37,011	112	6,098		421,951
1943	24,105	243,506	542	34,726	11	3,917		306,806
1944	3,491	219,772	477	31,976	74	4,048		259,838
1945	3,505	207,945	462	25,382	101	3,937		241,333
1946	30,495	185,285	422	27,875	19	5,036		249,131
1947	65,340	196,190	315	28,580	23	6,198		296,647
1948	71,744	187,514	310	28,214	50	6,027		293,859
1949	89,337	186,590	383	31,443	54	6,373		314,180
1950	88,007	212,963	295	32,370	42	6,385	11	340,073
1951	83,851	201,512	259	30,502	14	6,119	0.03	322,257
1952	104,207	210,119	182	35,830	20	6,518	134	357,011
1953	92,699	250,946	195	38,583	22	7,515	8	389,967
1954	112,458	269,952	107	41,095	19	7,391	110	431,132
1955	136,704	274,402	51	36,272	4	6,243	517	454,194
1956	116,049	288,906	70	42,694	20	5,990	851	454,580
1957	133,913	310,039	98	40,401	30	5,832	1,412	491,726

Silver Production by State (kg Ag)

Year	QLD	NSW	VIC	TAS	SA	WA	NT	Australia
1958	177,582	279,660	94	43,379	19	5,890	1,545	508,168
1959	154,045	266,067	63	42,578	12	5,586	3,145	471,496
1960	159,285	261,174	18	43,490		6,119	2,637	472,723
1961	120,755	231,631	20	44,660		6,592	2,556	406,214
1962	174,176	308,797	15	52,872		6,791	3,269	545,920
1963	192,884	355,313	17	52,952		6,869	2,829	610,864
1964	173,278	333,853	20	55,361		7,518	3,050	573,079
1965	144,173	330,773	1	52,190	6	7,631	2,661	537,434
1966	192,561	327,930	1	57,019	7	7,362	2,527	587,407
1967	212,483	333,210	3	55,925	0	6,953	8,516	617,090
1968	299,322	296,101	8	54,351	41	5,828	9,700	665,350
1969	358,914	334,340	1	54,233	36	4,195	8,976	760,795
1970	407,438	339,290	0	53,296	31	3,241	5,148	808,445
1971	303,984	303,892	10	63,404	38	3,202	3,886	678,418
1972	276,414	297,025	3	99,261	1,093	3,063	3,931	680,790
1973	326,575	296,320	0	76,903	1,473	2,261	3,882	707,414
1974	319,107	264,735	0	80,179	1,700	1,653	2,580	669,954
1975	365,069	280,062	0	76,402	1,670	1,998	1,017	726,218
1976	444,938	258,802	0	71,309	1,100	2,111	398	778,658
1977	502,489	266,623	0	84,772	6	1,825	395	856,110
1978	417,377	306,936	0	86,192	0	1,678	341	812,524
1979	456,734	296,451	0	76,662	10	1,819	534	832,210
1980	405,489	301,494	1	57,160	6	1,850	816	766,817
1981	366,614	279,410	6	78,177	8	17,813	1,529	743,557
1982	481,368	303,235	7	84,697	7	36,890	659	906,863
1983	556,186	343,733		94,929	8	37,073	966	1,032,895
1984	514,799	323,514	44	93,209	8	40,249	480	972,303
1985	576,756	353,859	72	110,191	16	36,496	8,559	1,085,933
1986	492,098	402,200	171	100,592	1.8	9,096	18,602	1,022,761
1987	552,250	414,862	178	112,949	2.1	11,353	27,706	1,119,300
1988	487,531	437,591		126,884	0	21,782	38,544	1,113,569
1989	505,000	427,134		120,039	0.1	41,377	33,727	1,075,000
1990	572,000	367,150		154,369	1,737	34,216	37,952	1,173,000
1991	606,000	313,035		165,120	18,233	39,306	46,193	1,180,000
1992	584,000	260,600		164,837	15,360	65,929	31,117	1,218,000
1993	548,000	269,039		95,322	11,640	78,384	23,210	1,152,000
1994	**~484,072**	235,520		140,442	11,472	58,799	3,000	1,045,000
1995	419,000	246,250		146,172	10,455	53,430	7,000	939,000
1996	442,000	201,000		143,774	11,487	47,817	28,618	974,000
1997	574,000	200,000		165,811	10,968	51,252	28,546	1,107,000
1998	985,000	151,000		138,764	10,430	52,858	40,673	1,473,000
1999	1,187,000	147,000		141,836	7,697	81,853	48,441	1,715,000
2000	1,576,000	146,000		156,005	19,443	157,639	51,696	2,059,000
2001	1,545,000	133,000		100,544	27,503	122,780	48,944	1,970,000
2002	1,760,000	88,000		89,925	18,924	98,896	51,913	2,070,000
2003	1,582,000	82,000		74,189	20,597	68,576	36,511	1,868,000
2004	1,910,000	91,000		72,588	24,240	62,481	33,495	2,209,000
2005	2,065,000	101,000		93,642	27,723	126,699	43,229	2,407,000
2006[P]	1,385,000[P]	94,000[P]		89,000[P]	30,000[P]	96,000[P]	35,000[P]	2,065,000[P]
Total	**~32,066 t**	**~33,942 t**	**55 t**	**~5,573 t**	**~288 t**	**~1,911 t**	**~799 t**	**~75,618 t**

World Lead Production (kt Pb)

1900	749	1918		1936	1,470	1954	2,000	1972	3,585	1990	3,110
1901		1919	764	1937		1955	2,010	1973	3,673	1991	3,097
1902		1920	804	1938	1,700	1956	2,400	1974	3,642	1992	3,047
1903		1921	783	1939	1,740	1957	2,380	1975	3,570	1993	2,700
1904		1922	972	1940		1958	2,350	1976	3,464	1994	2,707
1905		1923	1,080	1941		1959	2,320	1977	3,646	1995	2,750
1906	1,040	1924	1,220	1942		1960	2,372	1978	3,622	1996	3,006
1907	993	1925	1,410	1943		1961	2,392	1979	3,589	1997	3,030
1908	1,280	1926		1944		1962	2,531	1980	3,495	1998	2,990
1909	1,060	1927	1,540	1945	1,250	1963	2,543	1981	3,342	1999	2,966
1910	1,100	1928	1,680	1946	1,030	1964	2,604	1982	3,366	2000	3,046
1911	1,110	1929	1,610	1947	1,310	1965	2,784	1983	3,265	2001	3,008
1912	1,160	1930	1,520	1948	1,380	1966	2,937	1984	3,126	2002	2,830
1913	1,150	1931	1,260	1949	1,370	1967	2,961	1985	3,248	2003	3,111
1914		1932	1,050	1950	1,640	1968	3,034	1986	3,082	2004	3,129
1915		1933	1,040	1951	1,600	1969	3,295	1987	3,152	2005	3,298
1916		1934	1,200	1952	1,810	1970	3,443	1988	3,151	2006[P]	3,360[P]
1917		1935	1,380	1953	1,870	1971	3,476	1989	3,110		

World Zinc Production (kt Zn)

1900	479	1918	747	1936	1,330	1954	1,880	1972	5,866	1990	5,166
1901	510	1919	598	1937	1,470	1955	2,660	1973	6,070	1991	7,214
1902	547	1920	655	1938	1,420	1956	2,810	1974	6,129	1992	7,208
1903	574	1921	428	1939	1,500	1957	2,900	1975	6,176	1993	6,758
1904	629	1922	647	1940	1,470	1958	2,730	1976	6,249	1994	6,812
1905	660	1923	858	1941	1,590	1959	2,740	1977	6,567	1995	6,982
1906	704	1924	910	1942	1,630	1960	3,384	1978	6,401	1996	7,296
1907	738	1925	1,030	1943	1,670	1961	3,476	1979	6,299	1997	7,337
1908	723	1926	1,110	1944	1,470	1962	3,600	1980	6,108	1998	7,569
1909	775	1927	1,190	1945	1,180	1963	3,660	1981	6,004	1999	8,065
1910	810	1928	1,270	1946	1,260	1964	4,083	1982	6,275	2000	8,839
1911	895	1929	1,320	1947	1,450	1965	4,352	1983	6,289	2001	8,933
1912	971	1930	1,260	1948	1,550	1966	4,550	1984	6,523	2002	8,892
1913	915	1931	904	1949	1,660	1967	4,958	1985	6,651	2003	9,520
1914	795	1932	709	1950	1,970	1968	5,113	1986	6,534	2004	9,733
1915	760	1933	892	1951	2,140	1969	5,472	1987	6,885	2005	10,114
1916	882	1934	1,060	1952	2,230	1970	5,590	1988	6,714	2006[P]	10,000[P]
1917	901	1935	1,210	1953	2,360	1971	5,675	1989	6,785		

World Silver Production (t Ag)

1900	5,400	1922	6,530	1944	5,740	1966	8,300	1988	15,500
1901	5,380	1923	7,650	1945	5,040	1967	8,030	1989	16,400
1902	5,060	1924	7,450	1946	3,970	1968	8,560	1990	16,600
1903	5,220	1925	7,650	1947	5,220	1969	9,200	1991	15,600
1904	5,110	1926	7,890	1948	5,440	1970	9,360	1992	14,900
1905	5,360	1927	7,900	1949	5,570	1971	9,170	1993	13,608
1906	5,130	1928	8,020	1950	6,320	1972	9,380	1994	13,428
1907	5,730	1929	8,120	1951	6,210	1973	9,700	1995	14,379
1908	6,320	1930	7,740	1952	6,700	1974	9,260	1996	14,802
1909	6,600	1931	6,080	1953	6,900	1975	9,430	1997	15,959
1910	6,900	1932	5,130	1954	6,670	1976	9,840	1998	16,677
1911	7,040	1933	5,340	1955	7,000	1977	10,300	1999	17,208
1912	6,980	1934	5,990	1956	7,020	1978	10,700	2000	17,747
1913	7,010	1935	6,890	1957	7,190	1979	10,800	2001	18,815
1914	5,240	1936	7,920	1958	7,430	1980	10,700	2002	19,047
1915	5,730	1937	8,640	1959	6,910	1981	11,200	2003	18,470
1916	5,250	1938	8,320	1960	7,320	1982	11,500	2004	18,725
1917	5,420	1939	8,300	1961	7,370	1983	12,100	2005	19,344
1918	6,140	1940	8,570	1962	7,650	1984	13,100	2006[P]	19,500[P]
1919	5,490	1941	8,140	1963	7,780	1985	13,100		
1920	5,390	1942	7,780	1964	7,730	1986	13,000		
1921	5,330	1943	6,380	1965	8,010	1987	14,000		

Economic Lead & Zinc Resources (Mt Pb & Zn) – Australia and World

	Australia	
	Pb	Zn
1904	1.62	1.64
1905	1.56	1.49
1906	2.03	1.93
1913	1.66	1.45
1922	1.74	1.43
1933	3.23	3.42
1953	6.12	5.28
1959	4.29	3.87
1960	4.09	3.90
1961	4.11	3.99

	Australia	
	Pb	Zn
1962	4.46	4.18
1963	4.30	4.04
1964	4.23	3.94
1965	4.37	4.36
1966	4.70	4.85
1967	4.72	4.91
1968	4.93	5.44
1969	8.46	9.61
1970	9.28	10.07
1971	8.94	10.40
1973	18.18	31.51
1974	18.42	32.72
1975	13.9	19.3
1976	16.68	24.32

	Australia	
	Pb	Zn
1977	16.33	23.78
1978	16.15	23.53
1979	16.84	24.84
1980	15.83	22.84
1981	14.58	21.34
1982	13.31	18.82
1983	13.21	18.34
1984	12.64	18.24
1985	14.45	21.2
1986	15.76	24.92
1987	15.55	23.99
1988	15.92	26.28
1989	11.5	20.4
1990	10.7	17.9
1991	10.03	16.93

	Australia		World	
	Pb	Zn	Pb	Zn
1992	8.9	15		
1993	19.4	37.6		
1994	19.7	42.6		
1995	18.2	38.8		
1996	18.7	39.9		
1997	17.5	36.3		
1998	17.2	34		
1999	14.6	32		
2000	14.6	33	64	190
2001	17.3	35.1	64	190
2002	17.2	33.2	70	200
2003	19.3	34.8	71	222
2004	22.9	41.0	70	222
2005	23.8	41.8	75	228
2006[P]	23.5[P]	40.6[P]	75[P]	228[P]

20. Nickel

- *Nickel Production by State : 1913-2006*

  Data Sources/References : Tasmania (TDM, var.); Queensland – production data as supplied by Queensland Nickel International Ltd[32] (QNI, a subsidiary of BHP Billiton Ltd) plus supporting data from (ABARE, var.-a, var.-b; BMR, var.; QDM, var.; QNRME, var.); Western Australia – no actual contained nickel production data available, with the data below estimated as difference from Australian and Queensland data supported by (ABARE, var.-a, var.-b; BMR, var.; WADM, var.; WADoIR, var.; WMC, var.-b) and other nickel companies in WA (see appendix for individual mine site production).

- *Nickel Production by Ore Type*

  Data Sources/References : Queensland – QNI data (all QLD nickel has been laterite); Western Australia – estimated based on individual mine data (see specific mines in appendix)

Nickel Production by State (t Ni)

	TAS
1913	224
1914	224
1928	10
1929	87
1930	12
1931	
1932	1
1933	9
1934	
1935	
1936	
1937	
1938	20
Total	**~0.6 kt**

	QLD	WA	Australia
1967		**2,600**	2,600
1968		**4,600**	4,600
1969		**11,200**	11,200
1970		**29,800**	29,800
1971		**35,500**	35,500
1972		**35,500**	35,500
1973		**40,100**	40,100
1974	2,745	**43,155**	45,900
1975	11,562	**64,238**	75,800
1976	19,995	**62,505**	82,500
1977	19,035	**66,865**	85,900
1978	21,171	**61,229**	82,400
1979	20,460	**49,240**	69,700
1980	20,603	**53,697**	74,300
1981	21,519	**52,781**	74,300
1982	22,692	**64,908**	87,600
1983	15,005	**61,595**	76,600
1984	14,796	**62,104**	76,900
1985	20,106	**65,694**	85,800
1986	22,327	**54,373**	76,700

	QLD	WA	Australia
1987	21,117	**53,483**	74,600
1988	18,783	**39,217**	58,000
1989	17,172	**45,928**	63,100
1990	11,303	**56,497**	67,800
1991	8,566	**59,034**	67,600
1992	5,099	**52,801**	57,900
1993	5,329	**60,071**	65,400
1994	3,010	**72,890**	75,900
1995	4,990	**97,710**	102,700
1996		**113,000**	113,000
1997		**123,900**	123,900
1998		**143,900**	143,900
1999		**119,000**	119,000
2000		**170,200**	170,200
2001		**197,000**	197,000
2002		**188,200**	188,200
2003		**191,200**	191,200
2004		**186,800**	186,800
2005		**189,300**	189,300
2006[P]		**185,000[P]**	185,000[P]
Total	**327 kt**	**~3,267 kt**	**3,594 kt**

Nickel Production by Ore Type – Laterite or Sulphide (kt Ni)

	Laterite	Sulphide
1967	0.0	2.1
1968	0.0	5.5
1969	0.0	11.0
1970	0.0	32.7
1971	0.0	37.7
1972	0.0	38.6
1973	0.0	40.0
1974	2.7	49.2
1975	11.6	45.3
1976	20.0	46.3
1977	19.0	47.6
1978	21.2	47.1
1979	20.5	45.9

	Laterite	Sulphide
1980	20.6	50.5
1981	21.5	36.2
1982	22.7	41.9
1983	15.0	48.9
1984	14.8	48.9
1985	20.1	37.6
1986	22.3	42.2
1987	21.1	46.9
1988	18.8	39.3
1989	17.2	42.0
1990	11.3	51.6
1991	8.6	54.0
1992	5.1	47.0

	Laterite	Sulphide
1993	5.3	59.6
1994	3.0	65.6
1995	5.0	88.9
1996	0.0	112.4
1997	0.0	121.3
1998	0.2	146.9
1999	7.6	118.4
2000	26.1	152.8
2001	30.2	168.2
2002	32.5	155.6
2003	27.9	159.7
2004	28.5	154.7
2005	27.8	161.5

[32] Brian Watt, QNI Ltd, Email 13 February 2004.

- *World Nickel Production*
  Data Sources/References : (ABARE, var.-b; Kelly *et al.*, 2004)
- *Nickel Resources : Australia and World*
  Data Sources/References : (GA, var.; Marston, 1984; Pratt, 1996)

World Nickel Production (t Ni)

1900	9,290	1921	10,400	1942	158,000	1963	393,000	1984	815,000
1901	11,400	1922	11,800	1943	167,000	1964	422,000	1985	879,000
1902	12,200	1923	31,100	1944	157,000	1965	462,000	1986	844,000
1903	10,200	1924	35,300	1945	145,000	1966	443,000	1987	889,000
1904	10,500	1925	37,100	1946	123,000	1967	508,000	1988	928,000
1905	15,600	1926	33,900	1947	140,000	1968	580,000	1989	970,000
1906	16,000	1927	34,500	1948	151,000	1969	547,000	1990	983,000
1907	16,300	1928	50,300	1949	146,000	1970	702,000	1991	946,000
1908	14,900	1929	56,300	1950	145,000	1971	718,000	1992	897,000
1909	17,000	1930	54,200	1951	132,000	1972	662,000	1993	908,000
1910	23,100	1931	36,300	1952	146,000	1973	719,000	1994	877,000
1911	25,200	1932	21,800	1953	198,000	1974	792,000	1995	1,007,000
1912	27,900	1933	46,300	1954	216,000	1975	794,000	1996	1,051,000
1913	32,200	1934	71,600	1955	239,000	1976	814,000	1997	1,073,000
1914	30,000	1935	77,400	1956	259,000	1977	830,000	1998	1,117,000
1915	39,100	1936	93,400	1957	286,000	1978	684,000	1999	1,058,000
1916	45,500	1937	120,000	1958	224,000	1979	721,000	2000	1,177,000
1917	46,200	1938	115,000	1959	285,000	1980	786,000	2001	1,216,000
1918	47,600	1939	122,000	1960	361,000	1981	765,000	2002	1,228,000
1919	23,100	1940	140,000	1961	404,000	1982	687,000	2003	1,275,000
1920	35,700	1941	162,000	1962	398,000	1983	718,000	2004	1,327,000
								2005	1,386,000

Economic Nickel Resources (Mt Ni) – Australia and World

	Australia		Australia		Australia		Australia	World
1966	0.080	1976	1.82	1986	1.1	1996	6.4	
1967	0.104	1977	1.54	1987	1.1	1997	6.7	
1968	0.412	1978	1.36	1988	1.04	1998	9	
1969	0.789	1979	1.72	1989	1.1	1999	10.6	
1970	0.704	1980	2.15	1990	3	2000	20	58.2
1971	0.995	1981	2.2	1991	3.4	2001	21.9	59.9
1972	1.734	1982	1.95	1992	2.7	2002	22.2	61.2
1973	1.933	1983	1.91	1993	2.9	2003	22.8	62.8
1974	1.989	1984	1.92	1994	2.9	2004	22.6	61.8
1975	1.9	1985	1.65	1995	3.7	2005	23.9	64.1
						2006[P]	23.7[P]	63.8[P]

APPENDIX B :

MINE PRODUCTION TABLES

21. Mine Production Tables

- *Broken Hill Field, New South Wales*
- *Miscellaneous New South Wales Small Lead-Zinc-Silver Mines*
- *Zeehan Field, Tasmania*
- *Stanthorpe-Texas, Queensland*
- *Redbank, Northern Territory*
- *Yerranderie Field, New South Wales*
- *Horseshoe Lights, Western Australia*
- *Northampton Field, Western Australia*
- *Miscellaneous Western Australian Small Lead-Silver Mines*
- *Kimberley and West Kimberley Fields, Western Australia*
- *Herberton-Chillagoe Field, Queensland*
- *Ravensthorpe-Phillips River Field, Western Australia*
- *Nifty, Western Australia*
- *Magellan, Western Australia*
- *Miscellaneous Western Australian Small Copper Mines*
- *Miscellaneous Northern Territory Copper Mines*
- *Tennant Creek Field, Northern Territory*
- *Hellyer, Tasmania*
- *Moline/Mt Evelyn and Plenty River, Northern Territory*
- *Mt Diamond/Moline, Northern Territory*
- *Rosebery-Hercules and Que River, Tasmania*
- *Que River, Tasmania*
- *Mt Isa, Queensland*
- *Century Zinc, Queensland*
- *Mt Garnet-Surveyor, Queensland*
- *Elura-Enterprise, New South Wales*
- *Cannington, Queensland*
- *Mt Cuthbert, Queensland*
- *Clonclurry Copper Field, Queensland*
- *OK and Mt Molloy, Queensland*
- *Great Australia, Queensland*
- *Ernest Henry, Queensland*
- *Cadia Hill and Ridgeway, New South Wales*
- *Northparkes, New South Wales*
- *Mineral Hill, New South Wales*
- *Girilambone, New South Wales*
- *Eloise, Queensland*
- *Selwyn Field, Queensland*
- *Osborne, Queensland*
- *Red Dome, Queensland*
- *Highway-Reward, Queensland*
- *Beltana-Aroona, South Australia*
- *Teutonic Bore, Western Australia*
- *McArthur River-HYC, Northern Territory*
- *Cadjebut and Pillara (Lennard Shelf Field), Western Australia*
- *Nabarlek, Northern Territory*
- *Rum Jungle, Northern Territory*

- *Olympic Dam, South Australia*
- *Ranger, Northern Territory*
- *Moline and Rockhole, Northern Territory and Radium Hill, South Australia*
- *Mary Kathleen, Queensland*
- *Radium Hill and Mt Painter (Radium Mining), South Australia*
- *CSA, New South Wales*
- *Peak, New South Wales*
- *Golden Grove, Western Australia*
- *Mt Morgan, Queensland*
- *Mt Lyell Field, Tasmania*
- *Moonta-Wallaroo Field, South Australia*
- *Burra, South Australia*
- *Kapunda, South Australia*
- *Blinman, South Australia*
- *Kanmantoo, South Australia*
- *Mt Gunson-Cattlegrid, South Australia*
- *Gunpowder-Mt Gordon, Queensland*
- *Cobar Field, New South Wales*
- *Captain's Flat, New South Wales*
- *Woodlawn, New South Wales*
- *Thalanga, Queensland*
- *Woodcutters, Northern Territory*
- *Kambalda Field, Western Australia*
- *Mt Keith and Leinster (Agnew), Western Australia*
- *Greenvale-Brolga, Queensland*
- *Forrestania, Western Australia*
- *Cosmos and Radio Hill, Western Australia*
- *Scotia, Carr Boyd, Redross, Spargoville and Sally Malay, Western Australia*
- *Nepean and Mt Windarra-South Windarra, Western Australia*
- *Murrin Murrin, Western Australia*
- *Cawse and Bulong, Western Australia*
- *Black Swan, Rav8 and Emily Ann-Maggie Hays, Western Australia*
- *Diamonds : Argyle, Bow River, Ellendale, Merlin*

21.1 Broken Hill Field, New South Wales

- *Broken Hill Field – Ore Milled (Total) : 1883-2006*

  Data Sources : (Andrews, 1922; Anonymous, var.; BHP, var.; BMR, var.; Clark, 1904; Curtis, 1908; Jaquet, 1894; NSWDM, var.; Pasminco, var.; Perilya, var.; SADM, var.-a; Zinifex, var.)

Broken Hill Lead-Zinc-Silver Field : Ore Milled & Grades

Year	Ore	%Pb				%Zn				g/t Ag			
	Milled (t)	Avg	Min	Max	Recov	Avg	Min	Max	Recov	Avg	Min	Max	Recov
1883 – 108 t ore, **2,196** g/t Ag; **1884** – 9,314 t ore, **3,825** g/t Ag; **1885** – 11,505 t ore, **21.7**[†] %Pb, **2,334** g/t Ag													
1886 – 14,986 t ore, **20.8** %Pb, **2,741** g/t Ag; **1887** – 53,447 t ore, **19.9** %Pb, **1,472** g/t Ag													
1888	128,000	**17.6**	**17.4**	**34.0**						**1,282**	**511**	**3,214**	
1889	**»164,084**[†]	**17.4**	**17.4**	**18.0**						**1,261**	**582**	**1,316**	
1890	**»195,627**[†]	**17.4**	**9.6**	**21.2**						**1,287**	**570**	**1,795**	
1891	478,639	**14.7**[‡]	**2.8**	**40.0**						**1,086**[‡]	**681**	**2,958**	
1892	409,582	**17.2**	**0.9**	**24.5**						**1,422**	**711**	**4,220**	
1894	653,108	**»9**								**~781**			
1895	>525,846[†]	**»14**	**1893** – *No data known/available.*							**~513**			
1896	833,492	**»14**	*Full data set not known.*							**731**			
1897	1,028,152	**»14**								**~572**			
1898	905,062	**»14**				**»4**				**~591**			
1899	1,283,317	**~15.7**				**»4**				**~412**			
1900	1,446,812	13.63	15.2	20.0	85.4	7.70	8.1	21.2	31.9	280	272	611	77.7
1901	1,299,080	15.40	14.9	20.9	74.6	14.13	10.3	19.4	20.4	333	292	598	57.8
1902	1,134,927	17.28	16.9	38.0	68.8	16.51	13.5	19.8	16.0	343	255	480	49.4
1903	1,131,591	17.04	9.4	17.7	72.2	16.72	1.4	18.9	19.3	355	40	433	60.6
1904	1,363,752	**16.8**[§]	9.6	17.9	**70.6**[§]	**17.7**[§]	1.4	19.0	**13.5**[§]	**350**[§]	154	422	**49.6**[§]
1905	1,480,595	**16.2**[§]	14.0	26.5	**68.0**[§]	**15.3**[§]	9.95	18.7	**13.4**[§]	**313**[§]	205.1	765.3	**48.9**[§]
1906	1,286,331	**10.90**	15.6	26.0		**3.28**	11.3	18.4		**212**	124	361	
1907	1,679,337	**11.40**	11.3	16.0		**5.72**	1.1	13.0		**225**	184	432	
1908	1,470,965	**11.74**	16.0	16.0		**7.63**	12.2	12.2		**253**	171	171	
1909	1,047,814	**14.80**	16.8	17.4		**14.52**	4.5	16.5		**314**	214	413	
1910	1,263,583	**14.69**	15.2	15.2		**16.55**	12.8	12.8		**258**	196	196	
1911	1,508,147	**13.67**	11.0	15.9		**16.01**	9.1	13.0		**256**	196	238	
1912	1,665,894	**13.61**	5.3	15.9		**13.94**	1.1	19.5		**244**	23	363	
1913	1,821,943	14.62	10.8	25.2	71.6	12.50	4.2	16.7	29.8	260	85	1,417	55.3
1914	1,465,037	15.00	11.4	55.0	75.5	13.31	9.3	17.1	33.7	259	80	1,092	57.9
1915	1,528,677	14.75	12.2	31.6	85.6	13.30	9.1	17.3	32.4	272	80	1,531	67.9
1916	1,036,347	14.43	12.1	29.0	79.7	12.53	0.1	16.4	43.0	254	86	391	63.8
1917	1,048,952	14.60	12.5	26.1	82.6	12.66	1.6	23.0	47.1	264	84	510	73.7
1918	1,285,386	14.10	11.6	16.4	81.5	12.39	7.2	17.0	49.9	261	92	401	69.1
1919	422,046	14.32	10.5	18.6	84.2	12.37	7.2	17.0	56.5	266	86	413	69.6
1920	45,455	12.04	9.0	17.0	80.3	9.73	6.6	12.8	66.8	253	86	367	73.6
1921	323,223	14.39	13.3	19.5	83.4	13.93	6.0	15.7	61.9	290	223	449	74.7
1922	650,305	14.20	13.2	15.2	85.5	13.02	11.6	16.6	57.8	250	199	355	75.1
1923	892,594	14.55	10.9	16.4	84.6	11.56	1.2	16.5	48.1	208	95	373	71.8
1924	1,067,485	13.78	12.2	23.5	85.7	10.82	9.4	12.6	70.8	207	98	506	63.9
1925	1,315,039	14.12	9.7	15.3	88.7	11.03	8.7	16.2	77.4	225	101	392	75.7
1926	1,317,498	13.80	9.7	15.2	90.0	11.10	8.5	18.1	79.9	221	107	519	81.5
1927	1,417,245	13.49	9.6	14.4	90.9	10.65	3.0	14.3	80.2	214	104	447	82.8
1928	1,196,658	14.32	8.0	15.7	90.7	11.18	3.0	15.6	79.5	205	104	389	84.6
1929	1,248,856	14.42	7.2	15.3	92.2	11.14	3.0	14.2	79.6	206	104	357	86.7
1930	1,330,508	14.91	13.6	15.3	93.3	11.93	10.0	17.9	81.6	216	98	367	87.4
1931	888,073	15.31	14.9	15.7	94.8	11.83	10.1	12.7	82.8	210	116	306	89.8
1932	1,115,984	14.94	13.0	15.6	94.1	11.51	9.7	14.3	83.9	207	104	349	88.6
1933	1,219,784	14.94	13.3	15.4	94.0	11.25	10.0	13.4	83.1	211	116	321	89.2
1934	1,273,674	15.24	12.8	16.1	94.5	11.81	10.1	13.5	84.2	219	110	337	89.3
1935	1,328,528	14.80	12.4	15.7	94.3	11.59	10.6	13.3	85.1	211	126	340	88.8
1936	1,377,286	14.48	9.9	25.6	94.7	11.54	9.9	13.1	85.5	217	122	635	88.0
1937	1,517,604	14.32	10.8	27.0	94.7	11.04	9.7	13.1	87.9	216	119	573	85.7
1938	1,608,700	14.84	11.8	27.9	94.2	11.35	8.3	12.8	86.3	220	122	466	88.3
1939	1,447,036	15.34	14.6	33.9	95.3	11.92	11.0	15.0	86.0	210	119	393	89.4
1940	1,452,688	**15.70**	Grades based on			**12.90**	Grades based on			**219**	Grades based on		
1941	1,492,073	**15.91**	production and			**13.37**	production and			**218**	production and average		
1942	1,346,791	**16.10**	average recovery data.			**13.02**	average recovery data.			**212**	recovery data.		

[†] BHP ore production data only (others missing); [‡] Based largely on BHP estimated ore grades – other mines missing.
[§] Missing BHP ore grades, actual average grades and recoveries likely to be slightly different.

Broken Hill Lead-Zinc-Silver Field : Ore Milled & Grades

Year	Ore Milled (t)	%Pb Avg	%Pb Min	%Pb Max	%Pb Recov	%Zn Avg	%Zn Min	%Zn Max	%Zn Recov	g/t Ag Avg	g/t Ag Min	g/t Ag Max	g/t Ag Recov
1943	1,191,467	**15.48**	*Grades based on production and average recovery data.*			**12.47**	*Grades based on production and average recovery data.*			**199**	*Grades based on production and average recovery data.*		
1944	1,185,013	**15.11**				**12.57**				**200**			
1945	1,082,009	**14.63**				**12.72**				**192**			
1946	1,145,227	14.21	7.6	14.4	96.7	11.29	11.1	11.9	89.7	177	49	239	90.2
1947	1,135,825	13.96	8.7	15.1	96.7	11.81	11.5	13.0	89.2	168	58	233	90.8
1948	1,253,870	13.75	9.0	25.1	96.8	11.67	10.7	16.5	89.3	152	58	427	92.3
1949	1,286,567	13.30	8.2	23.0	96.5	11.74	11.1	13.1	89.1	150	55	413	93.8
1950	1,260,399	13.60	9.1	15.7	96.7	11.78	11.0	12.9	89.3	160	65	245	92.0
1951	1,289,240	12.50	8.5	14.3	96.8	11.46	10.4	12.3	91.6	148	59	232	90.2
1952	1,363,076	12.23	8.5	13.5	96.6	11.19	10.5	12.4	90.0	148	59	273	92.7
1953	1,676,293	12.73	8.8	15.4	96.1	11.84	10.5	13.7	89.6	145	62	296	89.6
1954	1,858,177	12.57	9.4	14.7	97.2	11.95	10.9	14.4	95.6	145	66	333	91.8
1955	1,949,390	11.88	8.9	13.7	97.6	11.50	10.4	13.8	95.9	134	61	377	91.5
1956	2,096,576	11.22	8.7	12.9	95.7	11.53	10.1	12.9	89.1	134	67	389	92.2
1957	2,272,084	11.63	9.0	13.0	97.8	11.17	2.3	12.0	95.3	133	80	450	94.5
1958	1,930,551	12.74	11.8	14.4	96.2	11.46	10.1	12.7	89.1	143	92	300	92.0
1959	1,914,312	13.02	12.1	14.5	96.4	11.26	10.0	12.6	89.4	139	98	288	92.4
1960	2,033,322	11.32	9.2	14.6	96.0	11.82	10.7	13.5	90.6	123	75	317	91.2
1961	1,938,791	10.97	8.5	14.5	96.1	12.13	11.2	13.5	91.2	118	64	237	90.6
1962	2,260,196	13.27	11.7	14.7	96.9	11.23	10.3	12.2	88.8	136	98	231	94.1
1963	2,497,625	13.50	12.6	15.2	96.8	11.21	10.0	12.6	89.0	138	95	244	92.8
1964	2,400,874	13.02	12.2	15.0	96.8	11.53	9.9	12.8	90.6	142	91	252	92.9
1965	2,530,471	12.24	11.6	14.0	96.7	11.74	10.3	13.2	90.0	133	85	242	92.0
1966	2,497,484	11.96	10.8	13.6	96.4	11.84	9.9	14.4	90.3	133	89	235	91.3
1967	2,601,473	10.95	9.3	13.0	96.1	11.63	9.8	14.0	90.6	118	70	352	90.9
1968	2,428,051	10.44	1.8	13.0	95.2	11.76	4.9	14.3	89.3	117	26	266	89.3
1969	2,745,139	10.26	0.4	13.3	95.1	12.51	1.3	16.1	90.0	110	25	226	89.0
1970	2,813,426	10.10	0.3	13.2	**97.0**	12.23	1.0	15.6	**82.7**	108	25	223	**105.3**
1971	2,604,046	9.77	0.3	12.6	**99.6**	11.33	1.0	13.3	**103.2**	109	25	211	**103.4**
1972	2,859,829	9.44	0.6	13.1	91.0	11.06	1.6	13.6	94.8	109.9	20.6	212.0	91.2
1973	2,429,307	10.17	1.8	12.4	98.2	11.32	5.2	13.8	101.9	111.1	26.0	250.0	105.9
1974	2,466,983	9.41	0.8	13.2	97.0	10.59	0.7	13.6	98.0	111.1	24.0	218.5	93.4
1975	2,835,084	9.36	0.7	13.3	91.3	10.34	0.7	14.2	95.7	108.0	23.0	227.0	87.9
1976	2,791,762	8.29	0.5	13.0	93.4	9.80	1.7	12.7	97.2	101.3	21.0	223.0	88.2
1977	2,673,148	9.00	0.8	12.7	96.1	10.09	0.7	12.3	101.5	94.6	22.0	230.0	102.2
1978	2,697,671	8.77	1.3	12.9	94.6	9.37	0.7	11.6	99.2	95.5	26.0	598.4	98.6
1979	2,800,480	8.26	1.3	12.3	97.1	9.68	0.9	12.1	99.4	90.8	23.0	210.0	99.7
1980	2,730,202	7.78	1.0	11.9	98.7	9.33	2.7	11.1	98.2	86.8	23.0	200.0	123.2
1981	2,715,026	7.32	1.4	11.3	95.4	8.44	2.5	10.0	98.0	84.1	21.0	190.0	98.8
1982	3,023,170	7.28	0.8	11.0	98.6	9.61	2.4	11.5	98.8	84.5	24.0	180.0	98.8
1983	2,958,723	6.95	0.8	10.9	95.8	9.29	1.9	11.0	97.5	82.6	24.0	179.0	95.8
1984	2,550,968	6.46	1.1	9.6	99.4	8.27	2.9	8.8	100.1	79.4	24.0	160.0	99.5
1985	2,979,566	6.14	0.9	10.0	98.7	8.01	2.3	9.4	97.3	75.1	23.0	161.0	99.2
1986	1,946,697	6.93	0.9	11.7	101.5	7.72	3.8	9.1	97.8	90.4	21.0	182.0	103.3
1987	2,539,297	6.10	0.5	11.3	90.1	9.27	3.9	11.5	90.3	75.5	22.0	182.0	98.7

	Ore Milled (t)	%Pb Avg	%Pb Recov	%Zn Avg	%Zn Recov	g/t Ag Avg	%Ag Recov	Open Cut (%)
1988	2,535,606	6.67	91.5	9.25	88.7	81.9	87.6	8.00
1989	2,545,619	6.46	94.1	9.41	91.2	74.0	88.9	6.13
1990	2,488,949	6.42	92.1	9.67	92.5	66.0	96.5	5.82
1991	2,554,807	6.62	92.4	9.74	91.7	71.3	86.3	5.65
1992	2,569,445	6.93	92.0	8.97	89.2	75.8	86.8	4.86
1993	2,397,899	7.06	94.2	8.67	90.2	69.7	90.7	0.00
1994	2,489,315	6.10	93.4	8.56	90.3	56.4	86.8	0.00
1995	2,506,628	5.68	92.6	7.39	88.5	54.0	86.9	0.00
1996	2,627,139	5.57	92.5	8.11	89.2	55.1	86.1	0.00
1997	2,729,692	5.16	91.2	7.92	88.5	48.1	82.4	7.33
1998	2,769,186	4.11	69.1	7.44	89.7	42.7	81.1	7.22
1999	2,760,226	4.18	89.6	7.83	88.2	42.8	79.8	5.43
2000	2,861,269	3.80	86.1	7.16	88.1	41.9	77.8	0.00
2001	2,737,539	3.25	84.7	7.30	89.5	36.9	74.5	0.00
2002	1,767,411	2.96	85.4	6.99	90.7	30.4	76.8	0.00
2003	2,171,000	3.38	84.2	8.68	90.4	34.9	78.2	0.00
2004	1,994,000	3.25	82.8	7.26	90.6	34.9	75.8	0.00
2005	1,940,000	4.17	86.9	7.58	88.4	44.9	74.8	0.00
2006	2,075,800	4.22	86.5	6.89	92.0	43.9	**72.2**	0.00
Total	**205.2 Mt**	**10.45**	**~91%**	**10.14**	**~80%**	**159**	**~87%**	**»2.3**

Broken Hill Lead-Zinc-Silver Field : Open Cut Ore Mined & Waste Rock

Year	Open Cut (%)	Waste Rock (m^3)	Year	Open Cut (%)	Year	Open Cut (%)	Year	Open Cut (%)
1896		347,658	1973	0.00	1981	9.06	1989	6.13
1897	4.97	382,278	1974	0.52	1982	7.88	1990	5.82
1898		275,818	1975	2.02	1983	8.30	1991	5.65
1899	10.81	279,946	1976	0.00	1984	10.33	1992	4.86
1900	12.51	482,824	1977	5.81	1985	9.08	1993	0.00
1901	10.74	267,141	1978	9.48	1986	14.96	1994	0.00
1902	8.21	219,102	1979	9.40	1987	10.39	1997	7.33
1903	2.01	149,829	1980	8.23	1988	8.00	1998	7.22
1904	1.11	193,925	1918	29,053 waste rock (m^3)			1999	5.43

Broken Hill Lead-Zinc-Silver Field : Metal Production

	t Pb	t Zn	kg Ag	t Cu	kg Au
1883 - **236** kg Ag; 1884 - **35,628** kg Ag					
1885 - **26,855** kg Ag; 1886 - 2,023 t Pb, 31,218 kg Ag					
1887	**»10,073**		**»73,454**		
1888	**~18,453**		**~136,634**	25	
1889	**~27,704**		**~200,826**	33	
1890	**~33,380**		**~246,320**	178	
1891	69,614		536,282	481	164.1
1892	61,839		403,342	579	157.0
1893	73,372		487,565	187	116.0
1894	**~54,403**		**~509,916**	725	126.9
1895	57,061		269,606	453	144.6
1896	90,492		609,341	579	136.5
1897	106,123	10,329	**~418,207**	1,204	126.4
1898	102,686	**~6,198**	380,114	18	32.3
1899	191,761	48,043	375,540	30	14.8
1900	168,432	35,519	315,226	3	23.4
1901	149,263	37,519	250,146		11.6
1902	134,664	29,903	191,739		0.5
1903	137,572	36,063	240,508	3	66.4
1904	167,739	22,394	332,668		63.4
1905	164,211	42,076	319,879	51	95.6
1906	138,704	41,723	270,148	71	63.5
1907	191,465	96,012	377,855		64.3
1908	172,593	112,139	372,692	7	57.5
1909	154,922	151,955	329,187	6	47.2
1910	185,626	209,183	325,429	15	57.6
1911	206,127	241,397	385,462		71.4
1912	226,710	232,281	405,947	3	51.8
1913	239,887	219,628	399,645		63.7
1914	192,412	168,387	321,886		71.0
1915	155,566	133,601	256,381	2	26.3
1916	139,148	120,583	241,174		280.5
1917	155,764	160,103	315,963		293.4
1918	188,641	184,653	391,731		380.9
1919	62,232	66,098	134,273	9	151.9
1920	6,825	10,237	17,346		
1921	77,982	141,691	219,399	457	7.7
1922	141,978	198,662	347,462	467	51.3
1923	153,204	145,505	283,831	1,016	124.9
1924	140,539	109,951	209,084	535	98.2
1925	174,713	141,004	261,692	318	63.3
1926	171,547	145,772	257,879	727	104.5
1927	191,318	166,097	301,561	1,099	99.9
1928	172,674	141,923	253,255	1,224	127.0
1929	187,848	148,384	268,039	1,158	112.0
1930	192,554	121,527	271,126	1,250	112.6
1931	131,126	75,399	174,470	640	86.1
1932	161,299	117,523	218,137	745	90.3
1933	175,794	125,682	242,149	1,139	145.0
1934	187,150	139,050	261,714	1,182	126.5
1935	189,536	143,959	263,517	1,093	133.8
1936	188,948	143,427	264,145	2,085	157.5
1937	199,494	149,300	279,960	1,610	225.9

	t Pb	t Zn	kg Ag	t Cu	kg Au
1938	224,900	167,577	314,878	1,761	163.4
1939	218,641	147,530	291,343	1,632	162.9
1940	217,851	164,032	284,797	1,614	152.9
1941	226,844	174,622	291,841	1,270	152.5
1942	207,228	153,546	256,070	1,072	132.8
1943	176,177	130,141	212,621	2,066	111.1
1944	171,039	130,438	212,556	1,762	148.1
1945	151,273	120,463	186,419	2,164	157.8
1946	154,846	124,740	186,427	1,331	141.1
1947	150,018	122,929	168,859	1,930	217.7
1948	167,279	138,322	188,249	1,454	138.1
1949	163,215	141,743	180,136	1,471	148.0
1950	169,027	142,642	202,129	1,790	205.5
1951	162,203	140,960	191,320	1,752	176.8
1952	167,115	144,615	201,662	1,817	178.5
1953	211,816	189,064	244,365	2,652	235.4
1954	229,810	212,702	266,629	2,745	255.0
1955	229,719	213,905	266,465	2,617	230.6
1956	230,425	227,407	276,691	3,135	241.2
1957	260,158	241,724	297,509	3,324	283.4
1958	238,752	209,302	271,831	2,893	263.8
1959	240,157	201,881	259,423	2,691	253.0
1960	228,958	232,390	254,334	2,591	230.2
1961	205,898	224,553	224,454	2,464	211.7
1962	295,413	245,788	307,321	3,527	335.9
1963	333,717	269,887	355,312	3,807	344.4
1964	301,071	260,097	333,340	3,399	308.5
1965	300,580	274,716	316,614	3,222	295.2
1966	284,379	275,796	303,439	3,084	276.8
1967	283,445	297,883	320,470	3,582	305.7
1968	249,176	275,522	285,249	3,346	265.6
1969	281,595	339,981	318,241	3,752	317.2
1970	275,647	284,506	321,011	4,099	319.6
1971	253,573	304,504	293,305	3,683	303.9
1972	245,524	299,709	286,525	3,665	274
1973	242,676	280,176	285,857	3,583	285
1974	225,063	255,984	255,921	3,348	265
1975	242,370	280,490	268,964	3,424	303
1976	216,151	265,763	249,558	3,323	166
1977	231,106	273,639	258,468	3,782	319
1978	223,694	250,838	254,050	3,783	**303**
1979	224,745	269,601	253,518	3,451	**340**
1980	209,653	250,367	291,856	3,596	**337**
1981	189,684	224,421	225,692	3,576	301
1982	217,072	286,879	252,194	3,927	**290**
1983	196,938	267,911	233,914	3,531	260
1984	163,713	211,207	201,620	3,179	**~300**
1985	180,397	232,288	221,845	3,605	**~300**
1986	136,890	146,898	181,819	2,649	**~300**
1987	139,615	212,603	189,130	3,126	**~300**
1988	154,696	208,113	182,018	**~3,000**	**~300**
1989	154,724	218,473	167,530	3,203	313
1990	147,128	222,442	158,446	3,469	310

Broken Hill Lead-Zinc-Silver Field : Metal Production

	t Pb	t Zn	kg Ag	t Cu	kg Au
1991	156,150	228,173	157,224	3,505	336
1992	163,720	205,498	169,089	3,203	368
1993	159,502	187,455	151,638	3,267	484
1994	141,747	192,317	121,933	3,055	500
1995	131,726	163,967	117,647	3,834	550
1996	135,447	189,964	124,479	4,065	661
1997	128,396	191,376	108,096	3,943	700
1998	78,656	184,723	95,910	3,787	311

	t Pb	t Zn	kg Ag	t Cu	kg Au
1999	103,323	190,765	94,286	3,273	562
2000	93,642	180,420	93,243	3,731	807
2001	75,424	178,974	75,228	3,782	700
2002	44,620	112,027	41,258	3,622	802
2003	61,800	170,400	59,284	3,735	834
2004	53,700	131,100	52,811	4,155	800
2005	70,300	130,000	65,217	4,138	599
2006	70,300	130,000	65,217	4,138	599
Total	**20.08 Mt**	**18.99 Mt**	**30,145 t**	**227 kt**	**~27 t**

- *Broken Hill Field – Ore Resources (Total) : 1896-2006*

  Data Sources : 1904-1987 (Andrews, 1922; BMR, var.; NSWDM, var.); 1988-2001 (Pasminco, var.); 2002-2006 (Perilya, var.). ***Notes – next page***.

Broken Hill Lead-Zinc-Silver Field : Total Ore Resources ‡

Year	Mt ore	%Pb†	%Zn†	g/t Ag†	Mt Pb†	Mt Zn†	t Ag†	Notes
1904	9.798	16.8	17.0	335	1.64	1.67	3,283	Total estimated ore reserves.
1904 §	***12 §***	***16.8 §***	***17.0 §***	***335 §***	2.0	2.0	4,100	Speculative assessment.
1905	9.547	16.6	15.9	327	1.58	1.52	3,120	Missing Blocks 10 & 14, BHJ.
1906	12.800	16.1	15.3	321	2.07	1.96	4,108	Total estimated ore reserves.
1913	11.390	14.8	13.0	234	1.69	1.48	2,665	Missing BHP.
1921	13.237	14.9	12.4	216	1.97	1.64	2,865	Missing BHP.
1922	11.831	14.9	12.3	215	1.77	1.45	2,544	Missing BHP.
1922 §	***13 §***	***14.9 §***	***12.3 §***	***215 §***	1.91	1.6	2,800	Speculative assessment.§
1922 §	***20 §***	***14.9 §***	***12.3 §***	***215 §***	3.0	2.5	4,400	Speculative assessment.§
1931	11.663	15.3	11.9	216	1.78	1.38	2,519	NBH, BHS, ZC, BHJ.
1935	11.68	14.8	11.6	211	1.73	1.35	2,460	Total estimated ore reserves.
1936	12.09	15.0	11.5	204	1.81	1.39	2,465	Total estimated ore reserves.
1937	11.873	14.7	10.9	200	1.74	1.29	2,378	Total estimated ore reserves.
1938	11.267	14.9	11.2	205	1.68	1.27	2,311	Total estimated ore reserves.
1939	11.736	15.0	11.3	197	1.76	1.33	2,315	Total estimated ore reserves.
1946	11.870	13.9	11.5	178	1.65	1.36	2,109	NBH, BHS, ZC.
1948	12.336	-	-	-	-	-	-	NBH, BHS, ZC.
1949	12.671	-	-	-	-	-	-	NBH, BHS, ZC.
1950	12.736	14.5	11.4	168	1.84	1.45	2,145	NBH, BHS, ZC.
1951	14.766	12.9	11.2	147	1.91	1.65	2,176	NBH, BHS, ZC, NBHC.
1952	15.273	13.2	10.9	145	2.02	1.67	2,219	NBH, BHS, ZC, NBHC.
1953	14.907	13.7	11.3	152	2.04	1.68	2,260	NBH, BHS, ZC, NBHC.
1954	15.384	13.4	11.4	149	2.06	1.75	2,295	NBH, BHS, ZC, NBHC.
1955	17.980	12.5	11.2	135	2.24	2.02	2,430	NBH, BHS, ZC, NBHC.
1956	15.782	12.0	11.1	142	1.89	1.75	2,241	NBH, BHS, ZC, NBHC.
1957	16.303	12.1	11.3	140	1.97	1.84	2,277	NBH, BHS, ZC, NBHC, BC.
1958	16.041	12.9	11.5	142	2.07	1.84	2,279	NBH, BHS, ZC, NBHC.
1959	16.250	13.2	11.2	143	2.15	1.83	2,317	NBH, BHS, ZC, NBHC.
1960	16.315	12.0	11.7	130	1.96	1.90	2,125	NBH, BHS, ZC, NBHC.
1961	16.640	11.9	12.0	122	1.98	2.00	2,035	NBH, BHS, ZC, NBHC.
1962	16.647	13.7	11.5	143	2.27	1.91	2,385	NBH, BHS, ZC, NBHC.
1963	16.862	12.8	11.8	135	2.15	1.99	2,274	NBH, BHS, ZC, NBHC.
1964	16.929	12.5	11.6	131	2.11	1.97	2,223	NBH, BHS, ZC, NBHC.
1965	17.035	12.1	11.6	127	2.06	1.98	2,171	NBH, BHS, ZC, NBHC.
1966	17.314	11.9	11.6	128	2.05	2.01	2,218	NBH, BHS, ZC, NBHC.
1967	17.546	11.6	11.5	123	2.04	2.02	2,162	NBH, BHS, ZC, NBHC.
1968	17.509	11.5	11.5	122	2.01	2.02	2,131	NBH, BHS, ZC, NBHC.
1969	17.434	11.4	11.5	120	1.99	2.00	2,097	NBH, BHS, ZC, NBHC.
1970	17.343	11.3	11.5	119	1.96	1.99	2,068	NBH, BHS, ZC, NBHC.
1971	17.445	11.0	11.3	114	1.92	1.97	1,986	NBH, BHS, ZC, NBHC.
1972	17.611	11.0	11.4	112	1.94	2.01	1,975	NBH, BHS, ZC, NBHC.
1973	19.872	9.7	10.2	96	1.93	2.03	1,899	NBH, MMM, ZC, NBHC.
1974	20.072	9.8	10.4	99	1.98	2.09	1,994	NBH, MMM, ZC, NBHC.
1975	20.170	9.8	10.4	101	1.98	2.10	2,033	NBH, MMM, ZC, NBHC.
1976	18.770	10.9	11.3	117	2.04	2.13	2,198	NBH, MMM, ZC, NBHC.

Notes : Next page.

Broken Hill Lead-Zinc-Silver Field : Total Ore Resources

Year	Ore Resources				Contained Metals			Notes
	Mt	%Pb	%Zn	g/t Ag	Mt Pb	Mt Zn	t Ag	
1977	18.440	10.8	11.3	117	1.98	2.08	2,162	NBH, MMM, ZC, NBHC.
1978	17.600	10.7	11.4	112	1.88	2.01	1,964	NBH, MMM, ZC, NBHC.
1979	17.600	10.2	11.3	108	1.79	1.98	1,909	NBH, MMM, ZC, NBHC.
1980	19.200	10.2	11.1	117	1.96	2.13	2,239	NBH, MMM, ZC, NBHC.
1981	47.000	8.4	11.4	82	3.93	5.34	3,858	NBH, MMM, ZC, NBHC.
1982	50.550	8.0	10.3	89	4.02	5.21	4,515	NBH, MMM, ZC, NBHC.
1983	51.450	7.8	9.5	86	3.99	4.87	4,403	NBH, MMM, ZC, NBHC.
1984	50.950	7.9	9.7	83	4.02	4.94	4,249	NBH, MMM, ZC, NBHC.
1985	48.900	7.8	10.3	79	3.80	5.04	3,864	NBH, MMM, ZC, NBHC.
1986	50.420	7.6	10.2	82	3.82	5.15	4,146	NBH, MMM, ZC, NBHC.
1987	48.845	7.6	10.0	81	3.71	4.88	3,944	NBH, MMM, ZC, NBHC.
1988/89	54.7	7.5	11.5	70	4.10	6.29	3,829	Pasminco Ltd.
1989/90	54	7.5	11.5	70	4.05	6.21	3,780	Pasminco Ltd.
1990/91	52.4	8	11.5	70	4.19	6.03	3,668	Pasminco Ltd.
1991/92	51.6	7.5	11.5	70	3.87	5.93	3,612	Pasminco Ltd.
1992/93	50.9	7.5	11	70	3.82	5.60	3,563	Pasminco Ltd.
1993/94	45.7	7	10.5	70	3.20	4.80	3,199	Pasminco Ltd.
1994/95	43.8	6.90	10.49	69.1	3.02	4.59	3,027	Pasminco Ltd.
1995/96	44.6	6.89	10.35	69.1	3.07	4.62	3,082	Pasminco Ltd.
1996/97	41.7	6.42	9.49	64.2	2.68	3.96	2,678	Pasminco Ltd.
1997/98	40.7	5.5	9.3	59	2.24	3.79	2,401	Pasminco Ltd.
1998/99	31.4	5.23	8.98	57.9	1.64	2.82	1,819	Pasminco Ltd.
1999/00	20.6	5.06	8.99	53.9	1.04	1.85	1,110	Pasminco Ltd.
2000/01	110	4.53	6.70	50.5	4.99	7.37	5,560	Pasminco Ltd.
2001/02	26.25	5.5	9.6	57	1.44	2.52	1,496	Perilya Mines Ltd.
2002/03	24.47	5.4	9.4	55	1.32	2.30	1,346	Perilya Mines Ltd.
2003/04	21.13	5.7	10.2	60	1.20	2.16	1,268	Perilya Mines Ltd.
2004/05	17.73	5.9	9.9	63	1.05	1.76	1,117	Perilya Mines Ltd.
2005/06	19.214	8.5	10.4	102	1.63	2.00	1,968	Perilya Mines Ltd.

BHP – Broken Hill Proprietary Co Ltd; NBH – North Broken Hill Ltd; BHS Broken Hill South Ltd; ZC – Zinc Corporation; BHJ – Broken Hill Junction; NBHC – New Broken Hill Consolidated Ltd; BC – Barrier Central; MMM – Minerals Mining & Metallurgy Ltd.

‡ Only years which are complete or near complete are included; most years include the smaller mines or resources.

† In general, the ore grades of resources were not reported until around the 1960's onwards; the data above generally assumed from mill grades for that year. This is ***indicative only*** to calculate contained metals in resources.

§ Speculative estimate of ore resources only (from references cited); ore grades assumed to be the same as known ore resources. Values included for comparison only.

21.2 Miscellaneous New South Wales Small Lead-Zinc-Silver Mines

All Mines – Data Sources : (NSWDM, var.); some data also extracted from various “Mine Records” (available online through the ‘DIGS’ publication database).

Note : A number of smaller mines are included in the “Misc. State” section (eg. Condoblin, Mineral Hill, Kangiara, Tingha, Yass, Tumbarumba, Lithgow, Hillgrove, Armidale, amongst others).

Year	Ore (t)	Value (£)
1876	68	
1877	20.9	325
1878	5.1	238
1879	18.9	535
1880	28.1	890
1881	53.5	1,625
1882	12.1	360
1883	30.9	450

Year	Ore (t)	%Pb	g/t Ag	g/t Au	%Cu	t Pb	kg Ag	kg Au	t Cu	Value (£)	Mine
1884	396		**2,670**	**18.4**			1,058	7.3			Borook
1884							1,162				Sunny Corner
1885	25,400	**0.76**	**816**			194	20,726				
1886	27,941		**609**				17,030				
1887	16,736		**591**				9,890				
1888	25,372	**5.33**	**391**	**2.82**	**1.24**	1,353	9,931	71.5	314		
1889										48,638	
1890										72,643	
1891	39,671	**0.06**	**317**	**3.17**	**0.88**	25	12,565	125.9	350		
1892						21	3,373	47.2	78		
1893	5,184				**0.73**				38		
1894	21,084				**2.82**				595	34,065	
1895	15,180				**2.38**				361	21,300	
1918	3,050									28,000	
1919	3,050		**612**	**3.1**	**1.17**		1,866	9.3	36		
1886	2,529		**430**				1,087				Silver King
1889	11,277	**~0.11** [§]	**1,073** [§]			**~13** [§]	**12,101** [§]			43,419	Silver King
1890										10,128	
1887						105	933				Mt Costigan
1888	3,050	**10.0**	**98**			305	299				
1888	237	**6.9**	**1,229**	**10.1**		16	291	2.4			New Lewis Ponds
1890	8,246	**1.4**	**395**	**4.8**		112	3,257	39.6			
1892	1,767	**2.8**	**629**	**10.8**		49	1,112	19.1			
1888	406		**1,009**				410				Glenn Innes
1889	635		**2,143**				1,361				
1953	75	**66.2**	**1,158**			50	87.1				
1888	41	**66**	**2,235**			27	91				Webbs Concols
1890	7,173	**0.55**	**420**			39	3,011				
1891	1,439		**650**				936				
1894	2,032		**735**				1,493			5,700	
1895	2,032									3,899	
1888	43		**1,500**				64				Pyes Creek
1890	4,064		**129**				525				
1892	81		**5,624**				454				
1894	112	27.27	**3,005**			**30.5**	336				
1888	9,450	**2.44**	**273**	**1.33**	**2.37**	231	2,575	12.6	224		Cordillera

§ No actual data given, values estimated based on production value or other data (eg. average metal values in state totals).

Year	Ore (t)	%Pb	g/t Ag	g/t Au	%Cu	t Pb	kg Ag	kg Au	t Cu	Misc.
1917	1,191	**12.7**	**448**			151	534			
1918	1,900	**4.9**	**67.9**			94	129			1.1% Zn, 21 t Zn
1919	437	**31.5**	**2,070**	**2.2**		137	904	0.95		
1931	30.5		**3,065**				96.5			
1936	787	**10.8**	**105**	**16.5**	**1.3**	85	82.4	13.0		
1937	241	**18.6**		**0.13**		45	37.5	0.03		
1949	1,723	**16.9**	**255**			291	439			
1950	973	**37.5**	**571**			365	556			
1951	675	**28.5**	**356**	**3.27**	**0.40**	192	240	2.21	2.7	6.5% Zn, 44 t Zn
1952	482	**26.2**	**397**	**1.37**	**1.14**	126	191	0.66	5.5	9.4% Zn, 45 t Zn
1953	175	**4.3**	**465**	**0.71**		7.6	81.5	0.12		2.3% Zn, 4.1 t Zn
1965	1,626	**16.4**	**240**		**<1**	267	389		8.2	~7% Zn, 114 t Zn

21.3 Zeehan Field, Tasmania

- *Magnet : 1909-1940* Data Sources : (Nye, 1923; TDM, var.)

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1909	13,076	**3.74**	**348.9**	489	4,562
1910	31,126	**4.39**	**405.6**	1,366	12,624
1911	36,385	**3.17**	**284.7**	1,155	10,359
1912	28,217	**3.22**	**298.0**	908	8,408
1913	25,212	**5.16**	**376.7**	1,301	9,497
1914	13,504	**5.96**	**431.2**	805	5,823
1915	13,662	**6.23**	**436.3**	851	5,961
1916	15,539	**9.91**	**578.9**	1,541	8,995

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1917	11,950	**8.98**	**547.5**	1,073	6,543
1918	13,683	**6.96**	**396.3**	952	5,423
1919	8,653	**6.24**	**336.1**	540	2,908
1920	8,193	**6.61**	**332.3**	541	2,723
1921	412	**9.04**	**454.5**	37	187
1922	13,095	**7.57**	**367.9**	992	4,818
1933	11,125	**8.82**	**399.1**	981	4,440
1936	1,883	**7.66**	**430.7**	144	811

Year	Ore Milled (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag
1938	3,920	**7.52**		**281.5**	295		1,103
1939	1,483	**9.33**	**4.56**	**418.3**	138	68	620
1940	1,892	**9.11**	**7.30**	**470.3**	172	138	820
Total	**253,012**	**5.64**	**>0.1**	**382.2**	**14,281**	**206**	**96,694**

- *Murchison River : 1907*
  Data Sources : (Nye, 1923)

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1907	1,534.5	8	321	**122.8**	**493.2**

- *Zeehan-Oceana : 1954-1960* Data Sources : (TDM, var.)

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1954	8,105	**11.19**	**158.3**	907	1,282.8
1955	15,931	**12.95**	**158.9**	2,062	2,530.8
1956	15,689	**11.21**	**141.4**	1,759	2,218.5
1957	18,203	**10.93**	**131.2**	1,989	2,389.0

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1958	22,984	**10.76**	**129.4**	2,473	2,974.6
1959	30,821	**10.36**	**135.2**	3,192	4,167.8
1960	18,455	**11.31**	**150.9**	2,088	2,784.0
Total	130,187	**11.12**	**140.9**	14,244	18,347

- *Montana : 1893-1958* Data Sources : (Nye, 1923; TDM, var.; Twelvetrees & Ward, 1910)

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1893	337.92	66.5	3,679	**213**	**1,181**
1894	1,999.23	**9.58**	**376**	192	751
1895	3,249.42	**8.31**	**303**	270	985
1896	6,183.48	**8.68**	**336**	537	2,078
1897	8,850.73	**7.25**	**276**	642	2,442
1898	16,455	**6.80**	**265**	1,119	4,368
1899	16,713	**5.99**	**239**	1,001	3,987
1900	16,779	**6.37**	**240**	1,068	4,021
1901	19,226	**6.73**	**260**	1,293	5,001
1902	20,871	**6.64**	**257**	1,385	5,358
1903	17,732	**6.41**	**206**	1,137	3,648
1904	17,123	**7.44**	**252**	1,273	4,309
1905	15,406	**6.63**	**221**	1,022	3,405
1906	15,938	**7.67**	**256**	1,223	4,074
1907	17,082	**6.95**	**224**	1,186	3,818
1908	13,600	**6.56**	**235**	892	3,196

Year	Ore Milled (t)	%Pb	g/t Ag	t Pb	kg Ag
1938	82	**20.12**	**726.2**	17	59.8
1940	866	**9.37**	**340.9**	81	295.1
1948	87	**64.28**	**3,039**	56	263.5
1949	1,715	**8.45**	**414.7**	145	711.1
1950	1,295	**7.64**	**363.1**	99	470.2
1951	2,196	**7.95**	**330.2**	175	725.1
1952	2,685	**7.83**	**329.0**	210	883.5
1953	9,287	**6.45**	**232.9**	599	2,163.5
1954	8,050	**4.50**	**146.5**	362	1,179.5
1955	6,320	**3.42**	**122.5**	216	774.4
1956	4,019	**5.01**	**144.8**	201	582.1
1957	3,333	**6.16**	**195.4**	205	651.1
1958	508	**4.80**	**132.8**	24	67.5
Total	**247,987**	**6.80**	**248.0**	**16,856**	**61,512**

- *Five Mile/Dundas-Cuni Group : 1913-1914*
  Data Sources : (McIntosh Reid, 1925)

Year	Ore Milled (t)	%Ni	%Cu	t Ni	t Cu
1913	1,208	11.56	5.47	**140**	**66**
1914	2,820	10.1	5.1	**285**	**144**
Total	**4,028**	**10.5**	**5.2**	**425**	**210**

- *North Mt Farrell (NMF) / Mt Farrell (MF) : Various*
  Data Sources : 1904-1907 (Ward, 1908); 1936-1964 (Anonymous, 1940; BMR, var.; TDM, var.)

Year	**Ore Milled** (t)	%Pb	g/t Ag	t Pb	kg Ag
1904	6,458.5	**8.40**	**289.3**	543	1,868.2
1905	14,301.3	**7.19**	**239.3**	1,028	3,421.9
1906	22,744.6	**6.46**	**187.1**	1,470	4,255.2
1907	26,200.8	**6.97**	**203.1**	1,826	5,320.4
1936	10,412	**15.95**	**557.4**	1,661	5,803.8
1937[§]	**11,176**[§]	**13.81**[§]	**472.8**[§]	1,543[§]	5,284.3[§]
1938	**12,700**	18.13	473.2	2,302	6,010.1
1939	13,958	17.87	**581.8**	2,495	8,120.6
1940	17,473	24.09	**871.0**	4,209	15,219.9
1941	16,802	17.99	653.4	3,023	10,978.4
1942	11,013	17.29	615.4	1,904	6,778.2
1943	9,802	17.91	644.8	1,756	6,320.5
1944	7,806	16.11	602.4	1,257	4,702.3
1945	7,230	17.00	617.6	1,229	4,465.0
1946	8,995	13.73	489.3	1,235	4,401.5
1947	9,737	13.28	472.6	1,293	4,602.3
1948	7,686	10.53	350.6	810	2,694.9

Year	**Ore Milled** (t)	%Pb	g/t Ag	t Pb	kg Ag
1949	7,094	11.14	356.7	791	2,530.6
1950	7,012	13.49	439.0	946	3,078.6
1951	7,072	12.91	459.4	913	3,249.3
1952	6,914	17.04	642.2	1,178	4,440.3
1953	6,383	18.77	748.2	1,198	4,775.1
1954	5,870	15.09	549.2	886	3,224.0
1955	4,169	11.45	370.2	477	1,543.3
1956	3,663	11.73	390.5	430	1,430.3
1957	4,242	14.70	472.3	623	2,003.4
1958	4,431	14.00	438.9	620	1,944.9
1959	4,973	13.90	476.8	691	2,371.5
1960	4,577	14.91	487.2	683	2,230.0
1961	4,572	13.45	448.1	615	2,048.5
1962	4,467	14.59	518.0	652	2,314.1
1963	5,089	10.81	351.7	550	1,789.9
1964	3,939	11.04	346.3	435	1,363.9
Total	**298,963**	**13.80**	**470.2**	**41,271**	**140,585**

[§] Zinc – **2.50%** Zn, 280 t Zn.

- *Mt Stewart : 1905-1908; Mt Wright : 1918-1922*
  Data Sources : (Nye, 1923); (Nye, 1923; Ward, 1908)

Mt Stewart					
Year	**Ore Milled** (t)	%Pb	g/t Ag	t Pb	kg Ag
1905	1,005.2	8.1	2,421	**81.4**	**2,433.9**
1906	197.5	6.4	2,284	**12.6**	**451.0**
1907	229.9	10	2,969	**23.0**	**682.5**
1908	43.9	14	3,398	**6.1**	**149.2**
Total	**1,477**	**8.3**	**2,517**	**117**	**3,530**

[§] Zinc – 7% Zn, **0.3** t Zn.

Mt Wright					
Year	**Ore Milled** (t)	%Pb	g/t Ag	t Pb	kg Ag
1918	5.4	56	2,204	**3.0**	**11.9**
1919[§]	4.0[§]	54[§]	2,296[§]	**2.1**[§]	**9.1**[§]
1920	3.5	66	2,663	**2.3**	**9.2**
1921	10.0	67	2,908	**6.7**	**29.1**
1922	13.9	58	2,449	**8.1**	**34.1**
Total	**37**	**60.5**	**2,542**	**22.2**	**93.4**

21.4 Stanthorpe-Texas, Queensland

- *Stanthorpe-Texas Silver Mine : 1850-1967*
  Data Sources : (QDM, var.)

Year	**Ore Milled** (t)	g/t Ag	kg Ag
1895	3,184	**1,018**	3,241
1896	116	**22,040**	2,553

21.5 Redbank, Northern Territory

- *Redbank : 1994-1996*
  Data Sources : (RIU, var.)

Note : Production data averaged due to the lack of actual data.

Year	**Ore** (t)	%Cu	t Cu
1994	~133,333	~4	~5,067
1995	~200,000	~4	~7,600
1996	~66,667	~4	~2,533
Total	**~0.4 Mt**	**~4**	**~15 kt**

21.6 Yerranderie Field, New South Wales

- *Yerranderie Field : 1884-1953* Data Sources : (NSWDM, var.)

Year	Ore Milled (t)	%Pb	g/t Ag	g/t Au	t Pb	kg Ag	kg Au
1884	396		**2,670**	**18.4**		1,058	7.3
1900	626	**19.2**	**2,908**	**5.0**	120	1,820	3.1
1901	967	**13.1**	**2,766**	**5.6**	127	2,675	5.4
1902	1,578	**14.7**	**2,878**	**6.0**	233	4,541	9.5
1903	1,314	**16.8**	**3,438**	**7.3**	221	4,518	9.6
1904	3,793	**12.0**	**2,162**	**4.5**	455	8,199	17.1
1905	3,583	**12.8**	**2,112**	**6.1**	458	7,570	22.0
1906	2,513	**17.8**	**2,767**	**6.9**	446	6,953	17.3
1907	4,541	**22.5**	**3,283**	**5.7**	1,021	14,904	25.9
1908	7,520	**25.6**	**3,425**	**5.3**	1,922	25,755	40.2
1909	6,756	**24.9**	**3,311**	**5.7**	1,680	22,369	38.3
1910	7,455	**25.5**	**3,267**	**5.8**	1,903	24,360	43.5
1911	6,712	**25.3**	**3,375**	**4.7**	1,701	22,651	31.9
1912	7,168	**27.0**	**2,933**	**6.2**	1,936	21,027	44.7
1913	5,246	**28.2**	**2,821**	**6.3**	1,481	14,799	33.3
1914	4,718	**27.3**	**3,433**	**7.0**	1,289	16,199	33.0
1915	7,133	**18.5**	**2,072**	**3.2**	1,323	14,778	22.9
1916	1,675	**35.5**	**3,236**	**4.3**	594	5,421	7.3
1917	4,730	**25.8**	**1,815**	**2.8**	1,222	8,585	13.3
1918	6,281	**15.8**	**1,572**	**3.3**	991	9,873	20.8
1919	6,021	**16.8**	**1,482**	**3.7**	1,012	8,924	22.2
1920	6,994	**10.7**	**1,330**	**2.0**	752	9,303	13.7
1921	2,959	**19.0**	**2,638**	**3.5**	561	7,805	10.4
1922	3,701	**28.4**	**2,477**	**5.2**	1,052	9,167	19.3
1923	5,233	**32.3**	**3,420**	**5.5**	1,689	17,898	28.9
1924	5,504	**22.5**	**2,625**	**4.4**	1,237	14,446	24.4
1925	1,230	**26.2**	**2,819**	**5.5**	322	3,469	6.7
1926	1,886	**22.6**	**1,567**	**6.8**	426	2,955	12.8
1927	1,997	**27.0**	**3,315**	**4.9**	538	6,622	9.8
1928	1,922	**31.1**	**3,339**	**3.5**	598	6,418	6.7
1929	782	**28.1**	**3,439**	**5.4**	219	2,690	4.2
1930	455	**41.7**	**5,773**	**4.0**	190	2,628	1.8
1934	105	**25** ND	**3,825** ND	**3.1** ND	26 ND	402 ND	0.3 ND
1934	445	**25** ND	**3,825** ND	**3.1** ND	111 ND	1,703 ND	1.4 ND
1936	517	**14.8**	**4,078**	**7.5**	110	2,208	3.7
1937	558	**23.1**	**4,370**	**8.0**	129	2,437	4.5
1938	200	**24.9**	**4,333**	**0.0**	50	867	0.0
1946	112	**25.2**	**3,089**	**6.1**	28	345	0.7
1947	152	**23.0**	**3,061**	**0.5**	35	496	2.2
1948	176	**25.0**	**2,847**	**4.3**	44	500	0.8
1949	117	**20.3**	**2,297**	**5.7**	25	285	0.7
1950	738	**2.5**	**1,598**	**3.6**	18	1,180	2.7
1951	264	**13.0**	**1,333**	**3.1**	34	352	0.8
1952	237	**3.6**	**908**	**1.6**	9	215	0.4
1953	34	**24.6**	**2,933**	**6.3**	8	101	0.2
Total	**127,047**	**22.31**	**2,687**	**4.94**	**28,350**	**341,372**	**627**

21.7 Horseshoe Lights, Western Australia

- *Horseshoe Lights Gold-Copper-Silver Mine : 1998-1994*
  Data Sources : (Loxton, 1993; RIU, var.)

Year	Ore	Grades			Production		
	Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1987/88	343,252	**0.81**	**0.78**	**11.04**	2,787	269.1	3,790.9
1988/89	316,290	6.57	9.85	61	8,099	616.0	13,723.7
1989/90	**136,511**	**3.69**	**3.81**	**46.85**	**4,026**	**291.6**	**7,271.2**
1993/94	1,689,000	**3.24**	**1.73**	**54**	54,800	2,923	91,061
Total	**2.485 Mt**	**~3.5**	**~3**	**~50**	**~69 kt**	**~4.1 t**	**~116 t**

21.8 Northampton Field, Western Australia

- *Northampton Field : 1850-1967*

Data Sources : (Blockley, 1971; Maitland, 1900; WADM, var.)

Note : The Northampton Field was generally very low in silver, with an approximate total yield of 1,013 kg Ag for an average grade of <0.01 g/t Ag (Blockley, 1971). In the master state tables, a value of 2 g/t has been adopted to reflect the low grade and generally inefficient recovery of of silver. Additionally, the often high grades of lead observed (eg. >30% Pb) are most likely due to the reporting of concentrate only, or ore that has been hand-picked or beneficiated and does not reflect the true grade of as-mined ore.

Year	Ore (t)	%Pb	t Pb
1850	5	55	2.8
1855	25	45.8	11.6
1859	14	50.0	6.9
1860	100	50	50.0
1861	80	50	40.1
1862	9	50	4.6
1863	234	50	117
1864	81	50	40.6
1865	714	60	429
1866	278	60	167
1867	916	72.0	660
1868	1,118	60	671
1869	711	60	426
1870	1,229	60	737
1871	427	60	256
1872	370	60	222
1873	981	60	589
1874	2,178	60	1,307
1875	2,326	57.1	1,329
1876	2,227	54.2	1,207
1877	4,019	80.0	3,215
1878	3,675	60	2,205
1879	2,819	60	1,692

Year	Ore (t)	%Pb	t Pb
1880	1,952	44.9	877
1881	1,423	40.0	569
1882	1,822	40	729
1883	1,055	35	369
1884	707	35	247
1885	472	35	165
1886	621	35	217
1887	479	50.0	239
1888	541	50.0	270
1889	254	50	127
1890	217	50	108
1891	25	50	12.7
1892	29	25.9	7.6
1898	5	33	1.7
1899	84	66.0	55.5
1900	272	19.0	51.8
1907	10.2	65.0	6.6
1908	57.9	73.0	42.3
1910	188	73.8	139
1911	8,326	15.4	1,284
1912	11,276	12.0	1,352
1913	27,015	10.3	2,785

Year	Ore (t)	%Pb	t Pb
1914	15,580	13.5	2,107
1915	15,929	9.7	1,544
1916	35,132	10.4	3,666
1917	47,551	10.5	5,008
1918	47,833	13.8	6,614
1919	7,504	14.3	1,073
1920	28,160	18.3	5,154
1921	10,496	11.6	1,217
1922	30,077	10.3	3,089
1923	21,981	10.3	2,273
1924	37,338	8.2	3,075
1925	38,472	9.0	3,458
1926	24,357	10.1	2,465
1927	5,902	13.1	771
1928	114	18.8	21
1929	1,092	32.1	351
1930	482	5.4	26
1934	5.1	60.0	3.0
1936	1,560	6.2	96
1937	6,262	4.5	282
1938	356	11.7	42
1943	1,270	8.8	112

Year	Ore Milled (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag
1946	36.8	72.2			26.5		
1947	6.0	78.1			4.7		
1948	1,367	77.7			1,062		
1949	1,941	68.5	1.93	13.24	1,330	37.5	25.7
1950	1,082	70.8	0.16	2.47	766	1.7	2.7
1951	1,546	77.9	0.13	3.26	1,205	2.1	5.0
1952	5,791	77.0	0.02	2.24	4,459	1.0	13.0
1953	4,853	76.8		0.88	3,727		4.3
1954	1,360	74.9		0.31	1,019		0.4
1955	1,086	71.3			774		
1956	6,432	78.3			5,034		
1957	3,376	75.4			2,545		
1958	2,350	75.4			1,771		
1959	1,464	75.0			1,098		
1960	2,296	76.8			1,764		
1961	607	72.6			440		
1962	450	69.0			311		
1963	188	73.5			138		
1965	1,274	71.2			907		
1966	655	71.5			468		
1967	924	75.6			699		
Total	**497,493**	**19.5**	**<0.1**	**<0.1**	**97,034**	**42**	**1,013**

21.9 Miscellaneous Western Australian Small Lead-Silver Mines

- *Miscellaneous Western Australian Mines : 1901-1967*

  Data Sources : (Blockley, 1971; BMR, var.; WADM, var.)

  Note : The very high grades of lead observed (eg. >30% Pb) are most likely due to the reporting of beneficiated concentrate only, or ore that has been hand-picked, and does not reflect the true grade of as-mined ore.

Year	**Ore Milled** (t)	%Pb	t Pb	Field
1917	44.7	**50.0**	22.4	West
1918	63.6	**40.5**	25.8	Pilbara
1949	2.1	**45.4**	1.0	West
1950	15.6	**52.0**	8.1	Pilbara
1951	2.3	**46.4**	1.1	West
1952	18.4	**71.4**	13.2	Pilbara
1953	31.3	**69.5**	21.8	West
1954	3.3	**38.9**	1.3	Pilbara
1958	1.7	**70.6**	1.2	West P.
1925	51.8	**70.1**	36.3	Pilbara
1926	91.9	**45.2**	41.5	Pilbara
1927	36.6	**69.5**	25.4	Pilbara
1947	16.7	**75.0**	12.6	Pilbara
1949	239	**67.8**	162	Pilbara
1950	452	**69.3**	314	Pilbara
1951	307	**70.7**	217	Pilbara
1952	427	**62.5**	267	Pilbara
1953	496 §	**70.1** §	348 §	Pilbara §
1954	158	**69.9**	110	Pilbara
1955	336	**70.4**	237	Pilbara
1956	1,136	**67.2**	763	Pilbara
1957	668	**64.2**	429	Pilbara
1958	71.2 #	**34.4** #	24.5 #	Pilbara #
1959	428	**64.9**	278	Pilbara
1952	21,133	**18.1**	3,832	Protheroe
1955	12,426	***18.1***	2,253	Protheroe
1957	7,702	***18.1***	1,397	Protheroe

Year	**Ore Milled** (t)	%Pb	Ag (g/t)	t Pb	kg Ag	Field
1901	21.4	**43.2**		9.2		Ashburton
1902	36.4	**52.3**		19.1		Ashburton
1908	739	**60.0**		443		Ashburton
1909	447	**60.0**		268		Ashburton
1913	128	**62.0**		79.1		Ashburton
1914	727	**65.0**		472		Ashburton
1915	304	**66.0**		200		Ashburton
1916	68.9	**63.1**		43.5		Ashburton
1918	241	**63.3**		153		Ashburton
1919	218	**65.7**		143		Ashburton
1925	30.5	**60.0**		18.3		Ashburton
1927	61.0	**60.0**		36.6		Ashburton
1948	128.8	**66.0**	**290**	84.9	37.4	Ashburton
1949	731.4	**65.3**	**382**	478	279.1	Ashburton
1950	351.1	**70.4**	**580**	247	203.7	Ashburton
1951	658.5	**73.8**	**338**	486	222.8	Ashburton
1952	994.9	**70.2**	**311**	698	309.7	Ashburton
1953	724.7	**70.6**	**386**	512	279.8	Ashburton
1954	399.8	**74.2**	**296**	297	118.1	Ashburton
1955	16.6	**71.9**		11.9		Ashburton
1956	159.1	**74.7**		119		Ashburton
1957	210.7	**76.4**		161		Ashburton
1958	111.2	**78.1**		86.8		Ashburton
1959	42.2	**69.1**		29.1		Ashburton
Total	7,550	**67.5**	**281**	5,096	2,118	Ashburton
Total	4,914	**66.4**	**186**	3,264	916	Pilbara
Total	186	**52.3**	**234**	97	44	West Pilbara

§ Plus 4.5 t Zn, **0.90%** Zn. # Plus 20.4 t Zn, **28.6%** Zn.

Kimberley and West Kimberley Lead-Zinc-Silver Fields

Year	**Ore Milled** (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag
1948	729	**38.8**	**21.03**	**204**	282.9	153.3	148.5
1949	36.4	**59.4**		**164**	21.6	0.0	6.0
1950	8.0	**44.4**	**10.98**	**188**	3.5	0.9	1.5
1951	49.8	**45.0**	**14.17**	**218**	22.4	7.1	10.8
1952	324.3	**42.2**	**14.41**	**219**	136.9	46.7	71.1
1953	452	**41.4**	**14.34**	**358**	187.1	64.8	161.5
1954	284	**33.3**	**26.16**	**232**	94.5	74.2	65.9
1964	3,408	**18.5**	**24.60**		629.4	838.3	
1965	3,682	**13.4**	**27.87**		494.3	1,026.3	
1966	2,070	**12.0**	**31.62**		248.9	654.4	
Total	**11,043**	**19.2**	**26.0**	**105**	**2,122**	**2,867**	**1,163**

21.10 Herberton-Chillagoe Field, Queensland

- *Herberton-Chillagoe Field : 1883-1942*

  Data Sources : (Connah, 1965; QDM, var.)

  Note : To the extent possible, the data has been separated into primarily Pb-Ag ore and Cu ore for the purposes of milling. Production includes both principal ore types and fields. Although this introduces a degree of double accounting, for analysis purposes of this report, each ore type is treated separately in any case.

Year	**Pb-Ag Ore** (t)	%Pb	g/t Ag	**Cu-Ag Ore** (t)	%Cu	t Cu	t Pb	kg Ag	kg Au
1883	101.6	**18.5**	**1,415.7**				18.8	143.8	
1885	2,641.4	**1.62**	**2,204.1**				42.7	5,822.0	
1886	1,890.2	**18.28**	**1,817.3**				345.5	3,435.1	
1887	4,926.6	**21.47**	**1,722.5**				1,057.7	8,486.0	
1888	5,432.6	**20.26**	**1,312.7**				1,100.8	7,131.5	
1889	6,429.1	**14.17**	**1,539.2**	535.3	**18.98**	101.6	910.9	9,895.8	
1890	4,643.0	**19.44**	**1,547.3**				902.5	7,183.9	
1891	1,864.8	**24.52**	**1,824.1**	100.0	**27.24**	27.2	457.2	3,401.6	
1892	6,741.2		**915.7**				0.0	6,173.1	
1893	11,706.5		**762.2**	100.7	**20.47**	20.6	0.0	8,922.9	
1894	2,726.9	**11.77**	**893.5**	4,119.0	**7.83**	322.5	321.1	2,436.5	
1895	2,069.6	**13.65**	**900.3**	3,559.0	**10.28**	365.8	282.4	1,863.2	
1896	1,288.3	**5.28**	**482.7**	2,788.7	**15.02**	418.7	68.1	621.8	
1905	38,869.0	**4.14**	**190.7**	65,629.4	**7.47**	4,899.3	1,610	7,412	3.8
1906	46,515.5	**3.75**	**233.6**	71,442.1	**6.09**	4,350.4	1,743	10,867	2.4
1907	58,308.9	**7.61**	**260.8**	89,834.4	**4.74**	4,255.1	4,440	15,208	11.4
1908	78,634.6	**8.21**	**252.4**	101,608.4	**3.84**	3,897.9	6,457	19,847	3.2
1909	49,405.2	**9.40**	**351.7**	64,011.2	**4.58**	2,934.0	4,642	17,376	3.5
1910	29,617.9	**3.38**	**358.3**	29,617.9	**5.63**	1,666.2	1,001	10,612	1.0
1911	12,832.4	**7.33**	**273.4**	21,628.2	**3.52**	761.0	941	4,007	2.7
1912	20,039.7	**9.42**	**260.7**	19,326.0	**2.23**	431.8	1,888	5,466	4.2
1913	22,871.9	**12.08**	**275.9**	55,468.2	**3.74**	2,073.7	2,763	7,877	71.4
1914	5,884.1	**4.49**	**142.9**	5,884.1	**3.05**	179.2	264	841	5.3
1915	8,263.9	**0.21**	**124.2**	8,263.9	**7.29**	602.2	18	1,026	23.9
1916	727.4	**0.87**	**202.1**	727.4	**13.19**	95.9	6	147	1.6
1917	1,357.9	**1.23**	**381.1**	1,357.9	**15.27**	207.3	17	517	0.2
1918				407.8	**15.19**	61.9		94	2.9
1919				4.8	**22.60**	1.1		4	0.1
1920	7,620.5	**14.27**	**263.9**	9,871.4	**2.24**	221.4	1,088	2,254	
1921	10,610.9	**8.44**	**254.2**	12,791.9	**0.81**	103.5	895	2,964	
1922	19,358.7	**13.15**	**312.3**	19,358.7	**0.33**	64.2	2,546	6,045	0.1
1923	49,697.7	**10.30**	**237.0**	49,697.7	**1.33**	661.7	5,118	11,777	3.1
1924	31,081.2	**12.18**	**178.5**	31,081.2	**1.54**	479.7	3,786	5,549	1.0
1925	28,972.4	**11.01**	**201.7**	28,982.0	**0.65**	187.5	3,190	5,844	0.3
1926	32,556.3	**11.45**	**225.4**	32,680.1	**0.34**	112.3	3,729	7,338	20.2
1927	4,220.7	**13.33**	**254.5**	4,220.7	**0.19**	7.9	562	1,074	0.5
1928				17.9	**20.05**	3.6		17	
1929	7,270.5	**13.99**	**291.1**	7,950.9	**1.11**	88.0	1,017	2,388	5.2
1930	1,340.5	**18.33**	**470.7**	16,668.0	**14.28**	2,380.1	246	2,041	4.4
1931	218.3	**30.37**	**692.3**	24,700.6	**10.43**	2,577.0	66	1,761	2.8
1932	596.9	**19.72**	**515.5**	27,675.4	**11.66**	3,227.3	118	2,059	9.9
1933	1,101.6	**19.31**	**482.6**	26,935.4	**10.73**	2,889.7	213	2,579	13.3
1934	37.2	**45.28**	**1,069.7**	27,730.0	**8.04**	2,228.1	17	1,403	0.2
1935	64.0	**54.06**	**887.9**	17,450.8	**9.82**	1,713.1	35	1,330	0.5
1936	73.7	**37.63**	**561.8**	7,818.3	**2.08**	162.9	28	1,217	2.2
1937	483.3	**39.09**	**571.4**	10,530.1	**4.90**	516.2	189	1,644	14.8
1938	67.0	**47.26**	**515.9**	12,723.0	**5.34**	678.8	32	1,256	5.2
1939	37.2	**48.09**	**703.1**	19,888.1	**3.46**	688.7	18	1,415	12.5
1940				10,217.0	**4.93**	503.6		962	506.2
1941				10,289.1	**5.90**	607.0		1,196	474.4
1942				10,826.0	**6.06**	655.7		1,202	432.3
Total	**Approx. (~) : 0.9 Mt at 6% Pb, 4.6% Cu, 265 g/t Ag**					**41.6 kt**	**54.2 kt**	**238.5 t**	**4.3 t**

21.11 Ravensthorpe-Phillips River Field, Western Australia

- *Ravensthorpe-Phillips River Field : 1850-1967*
  Data Sources : (BMR, var.; Ellis, 1953; Ellis & Lord, 1965; Low, 1963; Marston, 1979; WADM, var.)

Year	**Ore** (t)	%Cu	t Cu	**Year**	**Ore** (t)	%Cu	t Cu
1900	35	**30.0**	10.4	1914	4,919	**12.7**	623.0
1901	1,306	**20.7**	270.9	1915	5,515	**8.9**	490.5
1902	313	**7.6**	23.7	1916			
1903	1,586	**13.7**	218.0	1917	5,340	**10.3**	549.4
1904	3,524	**14.6**	513.1	1918	2,948	**12.9**	379.6
1905	2,366	**13.2**	312.6	1919	218	**24.5**	53.6
1906	2,931	**10.0**	291.8	1920	221	**20.4**	45.0
1907	10,581	**6.3**	669.3	1921	97	**18.4**	17.9
1908	2,048	**9.1**	185.4	1922	32	**11.1**	3.6
1909	7,448	**7.3**	541.5	1923	26	**32.4**	8.6
1910	26,286	**6.5**	1,712.0	1924	4	**17.9**	0.7
1911	13,781	**6.3**	867.6				
1912	1,339	**16.6**	222.1	1929	34	**17.3**	5.8

Year	**Ore** (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Ag	kg Au
1957	**16,289**	**2.05**	**0.8**	**1**	**334**	13.0	16.3
1958	53,853	1.53	**0.8**	**1**	699.0	43.1	53.9
1959	59,773	2.0	**0.74**	**0.22**	1,057.9	44.0	13.2
1960	69,172	1.88	**0.71**	**0.20**	927.6	49.4	13.9
1961	80,430	1.37	**0.73**	**0.18**	1,033.1	58.9	14.4
1962	75,904	**1.31**	**1.22**	**1.71**	994.3	92.9	129.6
1963	54,729	**2.52**	**1.44**	**3.91**	1,378.0	79.1	214.2
1964	65,666	**1.65**	**1.05**	**2.61**	1,086.0	68.7	171.1
1965	49,204	**0.96**	**0.67**	**1.98**	472.6	33.1	97.5
1966	53,115	**1.19**	**0.81**	**2.60**	633.9	43.2	138.1
1967	51,079	**1.32**	**0.73**	**3.12**	672.6	37.3	159.6
1968	62,365	**1.57**	**0.69**	**2.29**	978.5	43.0	142.6
1969	58,148	**0.93**	**0.50**	**1.47**	538.4	29.3	85.4
1970	45,225	**1.26**	**0.68**	**1.99**	570.6	30.6	89.8
1971	**15,893**	**1.4**	**0.67**	**4.89**	222.5	10.6	77.8
Total	**810,847**	**1.52**	**~0.83**	**~1.75**	**11,599**	**676**	**1,417**

21.12 Nifty, Western Australia

- *Nifty Copper Mine : 1993-2006* (Note : Sold in late 2002, still operating, limited data available since this time).
  Data Sources : (ABML, 2006; RIU, var.; Straits, var.; WMC, var.-a, var.-b)

Year	**Ore** (t)	%Cu	t Cu
1993	162,585	4.17	1,072
1994	369,076	3.80	7,202
1995	481,102	3.07	9,540
1996	877,006	2.86	9,964
1997	871,089	3.55	13,163
1998	878,541	3.08	16,496
1999	724,945	2.5	15,309

Year	**Ore** (t)	%Cu	t Cu	**Waste Rock** (t)
2000	1,100,000	2.3	17,318	11,200,000
2001	1,800,000	1.32	22,111	14,280,000
2002	1,900,000	1.34	21,574	18,760,000
2003	~2,400,000	**1.28**	25,130	
2004	~1,650,000	**1.54**	15,660	
2005	~1,980,000	**1.22**	16,896	~2,100,000
2006#	1,790,000	1.24	17,240	
Total	**~15.2 Mt**	**~1.9**	**191,435**	**»46 Mt**

Open cut ore 58.7%.

21.13 Magellan, Western Australia

- *Magellan Lead Mine : 2005-2006* Data Sources : (IWI, var.).

Year	**Ore Milled** (t)	%Pb	t Pb	**Waste Rock** (t)	**Open Cut** (%)
2005	743,900	6.5	31,300	5,454,327	100
2006	1,060,100	7.9	63,200	5,405,213	100
Total	**1,804,000**	**7.3**	**94,500**	**10,859,540**	**100**

21.14 Miscellaneous Western Australian Small Copper Mines

- *Miscellaneous Western Australian Mines : 1901-1967*
  Data Sources : (Campbell, 1965; Low, 1963; Marston, 1979; Reynolds *et al.*, 1975; WADM, var.)

Year	**Ore** (t)	%Cu	t Cu	Field
1900	5.2	37.86	**1.98**	Day Dawn
1901	10.7	**11.43**	1.22	Day Dawn
1914	3.5	**12.65**	0.44	Day Dawn
1906	4.8	**8.94**	0.43	Menzies
1907	33.7	**11.83**	4.0	Menzies
1908	191.0	**19.57**	37.4	Ashburton
1909	10.9	**40.09**	4.4	Ashburton
1915	2.7	**10.34**	0.3	Ashburton
1917	3.8	**14.02**	0.5	Ashburton
1911	5.1	**44.40**	2.3	Nullagine
1920	9.1	**52.78**	4.8	Nullagine
1899	138.2	23.9		Northampton
1901	39.1	**29.6**		Northampton
1922	1,015	**20.9**	212.1	Northampton
1923	9,780	**9.2**	897.3	Northampton
1924	10,843	**5.2**	563.1	Northampton
1925	2,509	**5.6**	140.7	Northampton
1929	117.9	**10.4**	12.3	Northampton
1911	26	**13.98**	3.6	Marble Bar
1915	64	**17.69**	11.4	East Murchison
1917	76	**15.60**	11.9	East Murchison
1918	84	**14.74**	12.3	East Murchison
1906	32	**3.07**	1.0	Yalgoo
1907	13	**24.92**	3.3	Yalgoo
1908	68	**13.49**	9.2	Yalgoo
1914	39	**23.92**	9.4	Miscellaneous
1915	4	**10.37**	0.4	Miscellaneous
1909	618	**7.24**	44.7	Murchison
1914	15	**25.21**	3.9	Murchison
1917	84	**22.52**	19.0	Murchison
1918	80	**19.72**	15.7	Murchison
1919	17	**20.76**	3.5	Murchison
1906	135.6	**29.7**	40.2	Gabanintha
1907	2.9	**10.2**	0.3	Dreadnought
1908	135.7	**14.7**	20.0	Yandanooka

Year	**Ore** (t)	%Cu	t Cu	Field
1914	114.5	**41.9**	48.0	Peak Hill
1915	254.9	**29.2**	74.5	Peak Hill
1917	292.4	**29.9**	87.3	Peak Hill
1918	77.5	**33.4**	25.9	Peak Hill
1919	14.6	**31.5**	4.6	Peak Hill
1920	36.0	**40.7**	14.6	Peak Hill
1899	277	24.8	68.7	Murrin Murrin
1900	4,612	**8.88**	409.4	Murrin Murrin
1901	7,783	**7.51**	584.5	Murrin Murrin
1902	1,985	**6.37**	126.5	Murrin Murrin
1903	19,268	**4.17**	803.1	Murrin Murrin
1904	508	**4.00**	20.3	Murrin Murrin
1905	61	**24.50**	14.9	Murrin Murrin
1906	4,431	**13.18**	583.9	Murrin Murrin
1907	5,225	**23.60**	1,232.8	Murrin Murrin
1908	4,475	**15.18**	679.1	Murrin Murrin
1898	2,032	28	**569**	West Pilbara
1899	2,596	18.5	**480.9**	West Pilbara
1900	979	13.5	132.1	West Pilbara
1901	1,242	19.3	239.6	West Pilbara
1907	3,419	**21.6**	738.1	West Pilbara
1908	1,510	**20.6**	311.2	West Pilbara
1909	7,250	**14.6**	1,058.2	West Pilbara
1910	8,615	**12.7**	1,097.9	West Pilbara
1911	9,227	**13.2**	1,222.4	West Pilbara
1912	12,481	**12.1**	1,506.9	West Pilbara
1914	7,888	**8.2**	648.8	West Pilbara
1915	964	**17.6**	169.4	West Pilbara
1917	796	**16.4**	130.4	West Pilbara
1918	1,874	**15.7**	294.0	West Pilbara
1919	1,047	**18.0**	188.6	West Pilbara
1920	1,728	**18.4**	318.7	West Pilbara
1921	1,072	**25.9**	277.9	West Pilbara
1922	167	**22.3**	37.1	West Pilbara
1923	225	**22.6**	50.8	West Pilbara
1924	80	**20.9**	16.8	West Pilbara
1928	46	**13.9**	6.4	West Pilbara

21.15 Miscellaneous Northern Territory Copper Mines

- *Miscellaneous Northern Territory 'Top End' Mines : 1886-1977*
  Data Sources : 1886-1952 (Balfour, 1990); 1967-1977 (QDM, var.)

  Note : Early production data (1886-1909) estimated from the price of copper. Includes small mines from the Agicondi, Waggaman, Daly River, Katherine and Wollogorang fields.

Year	**Ore** (t)	%Cu	t Cu
1886	821.9	**20.2**	163.7
1887	575.6	**17.9**	101.5
1888	82.3	**67.2**	54.5
1889	890.3	**22.8**	199.4
1890	417.1	**19.3**	79.3
1891	272.6	**25.6**	68.7
1892	170.9	**24.2**	40.7
1893	137.2	**16.6**	22.5
1894	158.5	**14.6**	22.7
1895	53.4	**14.7**	7.7
1898	101.6	**7.72**	7.7
1899	13.2	**25.7**	3.3
1900	444.9	**44.0**	192.8
1901	301.0	**30.8**	91.3

Year	**Ore** (t)	%Cu	t Cu
1902	143.8	**24.4**	34.6
1903	2.9	**32.6**	0.9
1904	10,672.1	**2.72**	286.0
1905	414.8	**28.8**	117.5
1906	551.7	**6.86**	37.3
1907	816.9	**3.51**	28.3
1908	430.8	**23.7**	100.5
1909	116.9	**68.7**	79.0
1913	58.3	**31.4**	18.0
1948	281	15	42.2
1949	4,492	20.6	923.2
1950	1,450	22.4	324.8
1951	805	24.1	194.0

Year	**Ore** (t)	%Cu	t Cu
1967	948.1	**12.92**	122.5
1968	1,061.5	**12.59**	133.6
1969	1,323.9	**9.04**	119.6
1970	4,187.3	**6.01**	251.9
1971	398.0	**9.80**	39.0
1972	89.6	**9.32**	8.4
1973	87.6	**11.00**	9.6
1974	115.5	**10.89**	12.6
1975	6.5	**10.00**	0.7
1976	95.5	**11.84**	11.3
1977	86.5	**12.57**	10.9
Total	**33,077**	**12.0**	**3,962**

21.16 Tennant Creek Field, Northern Territory

- *Miscellaneous Tennant Creek Copper Mines : 1948-1951*
  Data Sources : (Balfour, 1989; BMR, var.; NTDME, var.)

Year	**Ore** (t)	%Cu	t Cu	**Notes**	**Year**	**Ore** (t)	%Cu	t Cu	**Notes**
1948	496	**15.1**	75	Fertilizer	1950	186	**23.5**	44	Fertilizer
1949	2,450	22.5	**551**	Home of Bullion	1951	409	**27.0**	111	Fertilizer

- *Warrego Creek Copper-Gold-Silver : 1970-1990*
  Data Sources : (BMR, var.; Normandy, var.; NTDME, var.; RIU, var.; Wedekind & Love, 1990)

Year	**Ore Milled** (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1970	789	**2.23**	**1.56**		16.3	1.2	
1971	1,570	**2.47**	**1.40**		35.8	2.2	
1972	59,011	1.31	0.96		**714**	**39.7**	
1973	402,915	**2.17**	**1.16**	**3.87**	8,076	467.1	**1,559.1**
1974	448,887	**2.30**	**1.83**		9,541	819.9	
1975	144,600	**1.45**	**4.17**	**2.16**	1,938	603.0	**312.6**
1976	215,935	**1.94**	**4.47**	**4.47**	3,872	964.5	**964.5**
1977	243,089	**1.72**	**4.47**	**1.43**	3,860	1,086.8	**346.9**
1978	211,349	**1.96**	**3.12**	**1.37**	3,831	660.0	**288.5**
1979	303,002	**1.99**	**2.63**	**1.57**	5,577	796.0	**477.0**
1980	519,906	2.38	6.65	4.11	11,975	**2,420.2**	**1,282.1**
1981	644,980	2.90	4.4	7.3	17,649	**1,986.5**	**2,825.0**
1982	487,284	1.88	7	3.2	8,720	**2,387.7**	**935.6**
1983	504,970	2.2	6.9	4.2	10,735	**2,439.0**	**1,272.5**
1984	343,885	1.9	7.6	3.2	6,179	**1,829.5**	**660.3**
1985	299,430	1.9	7.7	4.1	5,011	**1,613.9**	**736.6**
1986	247,560	1.3	8.2	10.9	2,615	**1,421.0**	**1,619.0**
1987	104,713	1.49	7.24		412	**530.7**	
1988/89	226,561	**2.87**	**1.88**		6,006	426.0	
1989/90	25,557	**3.46**	**2.88**		816	73.6	
Total	**5,435,993**	**~2.1**	**~5**	**»3**	**107,578**	**20,568**	**13,280**

- *Juno Creek Copper-Gold-Silver : 1967-1977*
  Data Sources : (BMR, var.; NTDME, var.)

Year	**Ore Milled** (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1967	1,660	**0.39**			6.5		
1968	26,750	**0.40**			107.7		
1969	26,491	**0.53**	**92.50**		140.7	2,450.3	
1970	40,909	**0.26**	**53.34**		104.6	2,181.9	
1971	68,837	**0.14**	**20.94**		94.8	1,441.3	
1972	71,922	0.22	90.6		**126.6**	**3,258.1**	
1973	70,710	**0.36**	**15.83**	**3.24**	252.0	1,119.7	229.1
1974	71,159	**0.80**	**13.38**		570.6	952.1	
1976	17,289	**0.29**	**10.4**		49.6	179.5	
1977	12,124	**0.31**	**7.4**	**3.40**	37.1	90.0	41.3
Total	**407,852**	**~0.4**	**~37**	**»3 (?)**	**1,490**	**11,673**	**270**

- *Orlando Creek Copper-Gold-Silver : 1962-1975*
  Data Sources : (Balfour, 1989; BMR, var.; NTDME, var.)

Year	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1962	15,423	0.72	16.52		104	101.6	
1963	47,132	0.88	6.92		373	325.9	
1964	55,258	1.24	9.45	2.49	598	522.4	137.3
1965	32,083	1.14	12.53	2.11	322	360.6	67.8
1966	31,780	0.77	7.22	1.74	219	229.5	55.5
1967	29,757	0.75	15.99	1.21	200	475.7	36.1
1968	24,110	0.72	16.09	1.56	155	387.9	37.6

Year	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1969	24,599	0.78	13.77	1.49	173	338.7	36.6
1970	23,044	3.77	5.95	10.36	778	137.2	238.7
1971	5,572	4.82	3.46	11.03	240.4	19.3	61.5
1972	11,063	5.8	4.36		584	31.4	
1973	12,647	7.31	3.47	14.55	841	43.9	184.0
1974	12,481	4.53	2.57		515	32.1	
1975	913	9.54	2.60	2.94	79	2.4	2.7
Total	**325,862**	**~1.8**	**~10**	**»3**	**5,183**	**3,008**	**»858**

- *Gecko Creek Copper-Gold : 1971-1993*
  Data Sources : (BMR, var.; Normandy, var.; NTDME, var.; RIU, var.)

Year	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au
1971	1,215	2.29	1.84	27.8	2.2
1972	1,887	0.82	1.0	15.4	1.9
1973	5,001	1.36	0.32	68.1	1.6
1974	23,625	1.58	0.13	373.3	3.0
1975	1,452	2.40	0.05	34.9	0.1
1979	13,076	1.24	0.45	162.0	5.9
Total	**2,750,013**	**~5.1**	**~1.2**	**118,583**	**3,337**

Year	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au
1989/90	237,910	4.17	1.83	8,663	435.1
1990/91	396,328	4.59	0.60	15,910	235.9
1991/92	50,139	5.99	1.13	2,623	56.7
1992/93	54,056	8.55	0.65	4,040	26.4
1995/96	362,634	3.5	2.2	11,309	598
1996/97	428,145	4.0	0.6	15,687	508
1997/98	587,732	3.7	0.9	20,135	538
1998/99	586,813	8.84	1.58	39,534	924.6

- *Peko Creek Copper-Gold-Silver : 1948-1975*
  Data Sources : (Balfour, 1989; BMR, var.; NTDME, var.)

Year	Ore Milled (t)	%Cu	t Cu
1948	508	24.7	117
1949	4,068	22.8	864
1950	1,473	24.1	330

Year	Ore Milled (t)	%Cu	t Cu
1951	632	25.9	152
1952	1,488	23.5	325
1953	145	32.6	48

Year	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1955	38,445	8.10	6.63	16.18	2,897	205.3	622.0
1956	63,243	8.39	6.79	34.42	4,935	311.0	2,177.0
1957	96,419	7.76	5.86	25.80	6,959	368.0	2,488.0
1958	114,021	6.32	4.74	21.82	6,697	301.8	2,488.0
1959	128,330	6.32	3.66	19.39	7,544	359.7	2,488.0
1960	139,628	5.43	4.25	17.82	7,205	362.3	2,488.0
1961	159,175	5.0	4.65	15.63	7,711	530.2	2,488.0
1962	166,024	4.99	4.26	15.82	7,638	377.6	2,626.4
1963	159,683	5.06	4.01	19.55	7,343	406.4	3,121.1
1964	168,775	5.57	3.74	19.69	8,662	424.5	3,322.6
1965	167,540	3.51	3.21	12.67	5,347	345.4	2,122.1
1966	178,483	3.36	3.83	10.35	5,585	434.0	1,847.1
1967	199,117	3.19	3.10	11.45	5,903	391.6	2,279.2
1968	194,211	3.24	2.42	9.35	5,860	298.5	1,815.9
1969	208,874	2.70	2.34	9.68	5,240	311.1	2,022.3
1970	202,833	2.25	2.18	8.70	4,254	280.9	1,764.5
1971	198,268	2.47	2.22	9.24	4,562	279.0	1,831.5
1972	182,235	2.26	1.54	9.90	3,831	279.9	1,803.8
1973	171,962	2.81	2.51	10.53	4,498	273.9	1,810.7
1974	126,273	2.91	3.21	12.31	3,416	257.7	1,555.0
1975	12,633	2.68	1.43	11.15	315	11.5	140.9
Total	**3,084,487**	**~4.1**	**~3.4**	**~14**	**118,238**	**6,810**	**43,302**

- *Ivanhoe Creek Copper-Gold-Silver : 1965-1971* Data Sources : (BMR, var.; NTDME, var.)

Year	**Ore Milled** (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1965	31,872	4.01	9.11	**14.64**	1,126	229.1	466.5
1966	51,773	**3.72**	**5.62**	**10.76**	1,695	229.5	557.3
1967	55,510	**3.93**	**3.37**	**15.13**	1,921	147.7	839.6
1968	54,572	**3.38**	**1.92**	**9.05**	1,625	82.4	493.8
1969	36,782	**2.98**	**1.85**	**9.99**	964	53.6	367.5
1970	45,393	**2.40**	**1.55**	**8.68**	960	55.5	394.0
1971	36,551	**2.61**	**1.75**	**9.23**	840	50.5	337.3
Total	**312,454**	**~3.3**	**~3.4**	**~11**	**9,131**	**848**	**3,456**

21.17 Hellyer, Tasmania

- *Hellyer : 1985-1999* Data Sources : (BMR, var.; TDM, var.)

Year	**Ore Milled** (t)	%Pb	%Zn	Ag g/t	%Cu	Au g/t	t Pb	t Zn	kg Ag	t Cu	kg Au
1985	6,700										
1986	85,786	**8.97**	**18.2**	**210**			7,698	15,632	18,073		**78**
1987	217,027	5.36	11.25	128		0.5	11,627	24,417	27,687		109
1988	423,096	**2.70**	14.3	**78**	**0.20**		11,425	21,381	33,102	833	36
1989	900,000	7.1	13.3	166	0.04		25,126	49,333	39,552	342	200
1990	1,170,000	6.4	14.2	146	0.11		49,809	122,152	88,591	1,233	
1991	1,330,000	7.2	13.0	149			59,179	148,535	103,452	1,101	
1992	1,310,000	7.1	13.1	167			52,601	125,857	88,166	772	
1993	1,130,000	6.7	13.5	173	0.07		49,545	141,603	96,280	1,189	
1994	1,320,000	6.6	13.4	168			50,012	149,362	92,562	1,189	
1995	1,340,000	6.1	12.6	165			37,821	137,288	60,549	1,247	
1996	1,390,000	6.6	11.9	166			48,848	138,567	60,236	1,376	
1997	1,440,000	5.2	10.6	141			41,231	124,655	50,049	1,252	
1998	1,492,000	5.1	10.5	114	0.3	2	43,774	128,281	39,749	1,171	
1999	1,370,000	4.6	8.6	114			37,073	97,358	63,616	999	
Total	14.925 Mt	6.2	12.2	148	~0.2	~2.1	525,768	1,424,423	861,663	12,704	»500
Tailings at end-of-mine life (TDM, var.) :											
2000/01	10.88	3.0	2.8	88	0.16	2.6	0.326	0.305	957	17.4	28,300

21.18 Mt Evelyn/Moline and Plenty River, Northern Territory

- *Mt Evelyn/Moline : 1967-1970 / Plenty River : 1983* Data Sources : (BMR, var.)

Note : Ore was mined at Mt Evelyn and milled nearby at Moline.

Year	**Ore Milled** (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag	Mine
1967	23,222	**6.87**	**8.86**	**270**	**1,596**	**2,057**	**6,270**	Mt Evelyn/Moline
1968	26,422	4.9	7.5	281.6	**1,273**	**1,585**	**7,441**	Mt Evelyn/Moline
1969	23,754	5.4	7.4	281.6	**1,319**	**1,481**	**6,689**	Mt Evelyn/Moline
1970	9,328	5.8	6.1	260.2	**598**	**475**	**2,427**	Mt Evelyn/Moline
1983	20,440	**~4.0**		**~57**	650		934	Plenty River

21.19 Mt Diamond/Moline, Northern Territory

- *Mt Diamond/Moline : 1956-1958, 1971-1973*

Data Sources : (BMR, var.; MB-NTA, var.; Mudd, 2007)

Note : Ore was mined at Mt Diamond and milled nearby at Moline.

Year	**Ore Milled** (t)	%Cu	t Cu
1956	4,884	**0.03**	1.6
1957	10,796	**0.10**	11.2
1958			5.1

Year	**Ore Milled** (t)	%Cu	g/t Ag	t Cu	kg Ag
1968	19,677	**4.7**	71	924	1,397.8
1969	26,894	4.9	73	1,321	1,955.2
1970	1,335	4.4	65.5	59	87.7
Total	**63,586**	**3.64**	**~55**	**2,321**	**3,441**

21.20 Rosebery-Hercules and Que River, Tasmania

- *Rosebery-Hercules : 1913-2006; Que River : 1981-1991*

  Data Sources : (BMR, var.; Finucane, 1932; TDM, var.)

  Note : Data between 1936-1938, 1940-1950 and 1952-1964 has been corrected to account for approximate yield or recovery based on data for 1939, 1951 and 1965-1972. For Hercules, all ore was milled at Rosebery and has been included in Rosebery's statistics. Additional Hercules data below is provided for comparison. **All Hercules and Que River production is included in Rosebery totals.**

Year	Ore	Grade					Production					%Open
	Milled (t)	%Pb	%Zn	g/t Ag	%Cu	g/t Au	t Pb	t Zn	kg Ag	t Cu	kg Au	Cut
1913	10,082	7.3	26.3	315.3	~0.05	4.62	589	2,121	2,543	5	23	
1919	~1,100	8.1	28.5	322.3	~0.5	4.83	81	285	354.5	5	5.3	
1924/25	2,044	7.1	23.3	278.6		4.3	116	381	456		4	
192526	30,359	6.7	23.3	257.1		4.0	1,627	5,659	6,245		61	
1926/27	28,981	6.7	23.8	232.6		3.4	1,553	5,518	5,394		49	
1927/28	24,713	6.5	22.1	217.3		3.4	1,285	4,369	4,297		42	
1928/29	28,849	5.9	21.7	226.5	0.57	2.8	1,362	5,008	5,228	82	40	
1929/30	26,295	6.4	21.3	260.2	0.5	3.29	1,346	4,481	5,473	66	43	
1930/31	8,230	6.0	21.0	214.3	0.5	2.8	395	1,383	1,411	21	11	
1936	~48,000	7.8	21.4				3,000	7,737			50	
1937	151,784	6.27	21.24	217.0		3.08	7,611.9	23,856.7	24,702.5		327.2	
1938	158,110	6.89	21.79	243.8		3.45	8,713.2	25,499.6	28,915.2		382.3	
1939	160,825	6.4	21.3	260.2		3.29	8,651.2	25,420.3	29,163.6		364.3	
1940	161,099	7.32	22.27	268.2		3.09	9,431.5	26,544.0	32,404.7		348.7	
1941	169,922	6.60	19.77	229.5		2.76	8,970.8	24,860.1	29,245.7		328.1	
1942	161,196	5.96	18.29	243.6	0.67	2.72	7,682.4	21,815.7	29,445.6	538.0	307.4	
1943	154,394	5.74	18.74	236.1	0.61	2.74	7,085.1	21,416.1	27,342.7	471.8	296.0	
1944	151,276	5.91	18.91	232.0	0.51	0.22	7,151.1	21,166.5	26,325.8	387.9	23.2	
1945	110,547	5.90	19.39	245.9	0.51	3.01	5,219.6	15,859.1	20,387.2	279.9	232.6	
1946	126,556	5.74	19.52	238.4	0.39	2.83	5,815.2	18,277.9	22,629.9	249.8	250.3	
1947	123,533	6.61	20.54	249.8	0.47	3.20	6,536.6	18,773.8	23,142.2	290.9	276.7	
1948	124,909	6.53	20.10	258.7	0.40	2.89	6,526.5	18,580.9	24,238.3	252.1	252.5	
1949	142,757	6.17	19.51	258.4	0.44	2.76	7,049.8	20,610.5	27,666.2	310.6	276.2	
1950	162,366	6.01	19.63	253.0	0.43	2.90	7,800.1	23,585.1	30,812.0	349.0	329.2	
1951	153,016	5.8	18.9	217	0.43	3.05	6,898.6	20,762.1	26,020.7	293.2	297.3	
1952	165,750	5.79	17.87	225.7	0.32	2.90	7,197	22,211	28,061.4	319.8	312.1	
1953	183,452	5.71	17.49	219.7	0.37	2.72	7,859.2	24,059.0	30,223.4	401.8	324.2	
1954	194,038	6.06	18.21	228.2	0.47	3.10	8,825.6	26,495.9	33,208.2	544.5	390.7	
1955	181,558	5.85	17.93	215.1	0.47	2.92	7,972.3	24,420.7	29,284.2	511.4	344.4	
1956	205,915	5.97	18.51	222.5	0.45	2.77	9,221.7	28,588.6	34,368.9	553.9	370.7	
1957	202,626	5.91	17.50	211.7	0.52	3.09	8,984.9	26,597.3	32,167.2	636.4	406.6	
1958	208,810	6.85	18.83	229.7	0.47	2.77	10,016	29,487	35,977.2	680	462.9	
1959	202,225	6.77	18.71	221.3	0.36	2.61	9,579	28,375	33,569.0	516	422.2	
1960	215,449	6.39	16.47	220.5	0.41	2.85	9,636	26,610	35,633.2	619	491.1	
1961	237,809	5.92	18.11	203.2	0.47	3.43	9,852	32,303	36,248.0	782	652.4	
1962	299,090	5.33	17.29	178.3	0.49	2.73	11,164	38,779	39,990.7	1,030	652.4	
1963	298,597	5.53	17.51	183.5	0.56	2.95	11,550	39,206	41,095.9	1,176	705.8	
1964	299,961	5.52	18.10	190.2	0.52	2.95	11,595	40,714	42,791.9	1,092	707.4	
1965	294,149	6.05	17.64	207.9	0.52	2.81	11,304	38,706	41,413.7	1,095	667.4	
1966	299,457	5.79	17.51	198.8	0.57	3.10	12,357	41,558	45,018.6	1,233	754.8	
1967	304,479	5.84	16.44	191.8	0.66	2.98	12,121	40,875	44,409.9	1,241	781.5	
1968	306,735	5.24	15.60	179.3	0.57	2.75	11,942	40,702	43,132.0	1,324	752.6	
1969	287,969	5.30	16.00	172.6	0.62	3.33	11,918	41,779	42,909.2	1,358	814.4	
1970	299,255	5.19	16.49	171.7	0.65	3.84	10,705	38,299	40,517.1	1,276	823.2	
1971	329,910	5.50	16.51	198.0	0.72	4.77	12,451	41,842	48,249.1	1,669	1,238.7	
1972	542,628	5.44	15.99	200.2	0.58	3.68	20,302	66,808	72,467.9	2,478	1,299.5	
1973	485,413	5.03	14.67	184.1	0.59	3.36	14,362	52,149	55,473	1,746	876	
1974	492,427	4.54	14.34	177.7	0.80	3.15	12,635	53,803	56,422	2,555	890	
1975	559,700	4.29	12.81	133.5	0.71	1.92	11,380	54,326	51,451	2,174	975	
1976	603,491	3.55	11.63	137.4	0.73	2.56	12,070	49,697	50,087	2,709	896	11.66
1977	608,929	4.00	13.00	144.3	0.70	2.91	16,017	63,070	63,209	2,966	1,235	12.73
1978	656,858	3.69	11.66	135	0.66	2.75	22,754	77,388	93,527	4,004	1,363	
1979	698,395	3.55	11.31	119	0.64	2.48	22,160	75,229	73,989	3,883	1,318.3	11.33
1980	451,272	3.12	10.12	109	0.58	2.12	15,511	54,273	53,359	2,790	872.5	11.26
1981	508,691	4.12	11.24	124	0.67	2.91	25,527	74,413	75,285	3,950	1,540	
1982	591,191	4.42	10.73	123	0.62	2.67	30,621	79,493	82,210	4,109	1,368	
1983	468,182	5.49	12.54	147	0.56	3.07	34,777	82,285	90,378	3,270	1,338	
1984	534,017	4.78	11.43	132	0.51	2.62	32,670	84,016	65,857	3,510	1,400	

Rosebery Lead-Zinc-Silver-Copper-Gold Mine

Year	Ore Milled (t)	Grade					Production					%Open Cut
		%Pb	%Zn	g/t Ag	%Cu	g/t Au	t Pb	t Zn	kg Ag	t Cu	kg Au	
1985	550,905	4.74	11.49	134	0.56	2.77	37,959	98,777	106,444	4,268	2,313	
1986	898,112	4.9	11.6	129	0.7	2.80	37,569	95,042	91,116	4,322	1,562	
1987	457,391	5.40	12.06	162	0.59	3.06	30,735	79,422	91,662	3,372	1,362	
1988	506,236	4.5	10.52	129	0.56	2.7	35,524	86,722	101,650	3,944	1,661	
1989	772,877	4.43	11.31	120.0	0.58	2.61	24,041	74,742	64,280	3,091	1,111	
1990	764,702	4.27	10.26	112.1	0.58	2.24	23,437	69,732	61,727	3,064	1,017	
1991	576,921	3.72	11.12	102.4	0.53	2.74	15,809	56,458	44,152	1,814	830	
1992	533,420	2.93	9.57	84.5	0.62	2.08	11,228	45,549	31,239	1,694	552	
1993	575,828	3.23	9.88	103.7	0.35	2.00	13,956	51,164	43,900	1,070	704	
1994	494,831	3.62	10.60	108.3	0.43	1.94	13,564	47,878	39,942	1,373	604	
1995	579,103	3.13	10.72	101.0	0.37	1.65	12,979	56,409	42,097	1,145	603	
1996	607,091	3.04	10.85	103.4	0.40	1.71	12,308	60,207	45,645	1,382	733	
1997	687,941	2.63	9.92	95.7	0.40	1.28	12,752	61,055	44,705	1,256	514	
1998	630,632	2.91	10.11	79.0	0.40	1.42	12,967	44,253	30,507	1,221	431	4.27
1999	701,163	3.95	12.47	115.3	0.40	1.56	21,744	78,591	68,168	605	753	2.75
2000	654,529	4.16	11.58	144.5	0.37	1.97	22,142	68,673	75,826	1,368	819	
2001	761,983	4.36	11.99	157.0	0.35	2.08	26,635	81,927	90,284	1,513	1,072	1.94
2002	796,474	3.79	10.88	110.1	0.30	1.52	25,085	77,702	64,514	1,223	891	1.27
2003	766,086	4.15	12.24	101.5	0.37	1.88	26,332	74,048	67,269	1,621	1,194	0.56
2004	712,189	5.19	14.90	138.7	0.50	2.07	31,093	98,620	88,804	2,193	1,256	0.0
2005	709,130	4.38	13.25	130.5	0.37	1.52	25,145	88,555	83,581	1,717	1,056	0.0
2006	641,262	4.93	14.22	154.9	0.35	1.89	24,410	86,940	88,381	1,278	1,224	0.0
Total	**29.02 Mt**	**~4.6**	**~13.4**	**~149**	**~0.5**	**~2.5**	**1.10 Mt**	**3.49 Mt**	**3,542 t**	**106 kt**	**54.3 t**	**»1.3**

Hercules Lead-Zinc-Silver-Copper-Gold Mine

Year	Ore Milled (t)	Grade					Waste Rock (m^3)	Notes
		%Pb	%Zn	g/t Ag	%Cu	g/t Au		
1995/96								
1996/97	18,371	1.8	10.1	34	0.3	0.91		Hercules, underground
1997/98	59,844	2.0	8.8	34.9	0.3	0.8		Hercules, underground
1998/99	100,510	1.8	9.3	30	0.5	0.9		Hercules, underground
1999/00	35,412		8.8					Hercules, underground
2000/01	14,100	7.88	11.89	55	1.25	8.86	92,000	Burns Peak, open cut
2001/02	4,400	7.0	18.4	220	0.36	7.21	50,000	Rosebery North, open cut
2002/03	4,406	3.18	12.95	129	0.21	4.9	2,300	Rosebery North, open cut

Note : See above – all ore milled and production included in Rosebery statistics.

Que River Lead-Zinc-Silver-Copper-Gold Mine

Year	Ore Milled (t)	%Pb	%Zn	g/t Ag	%Cu	g/t Au
1981	101,309	7.7	14.4	203	0.3	4.7
1982	192,341	8.4	15.3	196	0.6	4.0
1983	217,919	8.7	15.5	217	0.4	3.7
1984	196,230	8.6	14.9	231	0.4	4.0
1985	258,889	8.1	14.2	231	0.4	4.1
1986	290,651	7.5	13.7	191	0.5	4.1

Year	Ore Milled (t)	%Pb	%Zn	g/t Ag	%Cu	g/t Au
1987	312,568	8.4	14.6	248	0.4	4.3
1988	254,389	6.9	12.28	197	0.4	3.1
1989	289,260	6.6	11.7	170	0.5	2.9
1990	135,386	5.8	11.5	142	0.5	2.2
1991	72,981	5.29	11.02	149	0.52	1.3
Total	**2,321,923**	**7.6**	**13.7**	**204**	**0.4**	**3.6**

- *Rosebery : 1913-2006 Ore Resources*

  Data Sources : 1919 (Hills, 1919); 1939 (Anonymous, 1940); 1951 (Hooper & Black, 1953); 1950-1987 (BMR, var.); 1989/90-2005/06 (Berry *et al.*, 1998; Pasminco, var.; TDM, var.; Zinifex, var.)

Year	**Ore** (Mt)	%Pb	%Zn	g/t Ag	%Cu	g/t Au	Mt Pb	Mt Zn	t Ag	kt Cu	kg Au
1919	2.637	7.4	27.3	294	**0.3**	3.89	0.195	0.720	775	**8**	10,250
1939	1.52	6.4	21.3	260	0.50	3.29	0.098	0.325	395	7.6	5,014
1950	1.52										
1951	2.03	5.6	19.1	199	0.44	2.90	0.114	.388	404	8.9	5,893
1952	2.03										
1953	2.03										
1954	4.06										
1955	2.03										
1956	2.34										
1957	2.34										
1958	2.95										
1962	3.56	6	20	184	0.95	3.26	0.213	0.711	653.1	33.8	12
1965	5.59	4.11	14.89				0.230	0.832			
1967	7.62	4.23	15.05				0.322	1.147			
1968	8.49	5.65	18.52				0.480	1.573			
1969	9.66	5.65	18.52				0.546	1.789			
1970	9.26	5.65	18.52				0.523	1.714			
1971	9.56	5.65	18.52				0.540	1.770			
1972	9.65										
1973	8.850	5.65	18.52	163.0	0.88	3.48	0.500	1.639	1,442	78.2	30,761
1974	9.018	4.55	17.9	143	0.82	3.2	0.410	1.614	1,290	73.9	28,858
1975	10	**5**	**16**	**160**	**0.5**	**3.5**	0.500	1.600	1,600	50.0	35,000
1976	8.692	5.0	16.9	143	1.02	2.9	0.435	1.469	1,243	88.7	25,207
1977	8.194	5.0	16.9	143	1.0	2.9	0.410	1.385	1,172	81.9	23,762
1978	8.049	5.0	16.9	143	1.02	2.9	0.402	1.360	1,151	82.1	23,343
1979	7.780	5.0	16.9	143	1.02	2.9	0.389	1.315	1,112	79.4	22,561
1980	7.780	5.0	16.9	143	1.02	2.9	0.389	1.315	1,112	79.4	22,561
1981	8.044	5.0	16.5	137	0.80	3.0	0.402	1.327	1,102	64.4	24,132
1982	7.755	5.0	15.6	133	0.79	3.0	0.388	1.210	1,031	61.3	23,266
1983	6.659	5.0	15.6	133	0.79	3.0	0.333	1.039	886	52.6	19,977
1984	6.777	5.3	12.3	130	0.6	3.1	0.359	0.834	881	40.7	21,007
1985	6.8	4.64	15.42	125.6	0.74	2.9	0.315	1.048	854	50.2	19,600
1986	7.7	5.02	15.97	122.0	0.65	2.8	0.386	1.230	939	50.2	21,210
1987	8.155	3.92	12.72	119.9	0.53	2.6	0.319	1.038	978	43.1	20,807
1989/90	6.5	3.28	10.41	109	0.48	2.09	0.213	0.677	709	31.2	13,590
1990/91	5.5	3.59	11.33	124	0.50	2.41	0.198	0.623	684	27.4	13,250
1991/92	4.8	3.51	11.11	129	0.45	2.33	0.169	0.533	619	21.6	11,189
1992/93	8.3	3.68	11.18	145	0.47	2.48	0.305	0.928	1,205	38.8	20,584
1993/94	4.0	3.6	11.16	127	0.42	2.21	0.144	0.446	508	16.8	8,840
1994/95	3.3	3.39	10.83	121	0.45	2.26	0.112	0.357	400	14.7	7,470
1995/96	3.245	3.48	10.60	116	0.47	2.40	0.113	0.344	376	15.2	7,785
1996/97	3.824	3.63	11.79	115	0.48	2.70	0.139	0.451	438	18.3	10,331
1997/98	15.923	3.96	11.38	132	0.36	2.12	0.631	1.812	2,109	56.7	33,763
1998/99	14.793	4.76	12.82	151	0.38	2.38	0.704	1.897	2,230	56.0	35,268
1999/00	10.126	4.93	14.09	159	0.41	2.56	0.499	1.427	1,610	41.2	25,908
2000/01	9.568	5.21	15.65	159	0.39	2.39	0.498	1.498	1,525	37.0	22,852
2001/02	9.300	5.01	15.31	159	0.40	2.37	0.466	1.424	1,481	36.8	21,999
2002/03	8.904	4.62	15.21	164	0.43	2.45	0.411	1.355	1,458	38.7	21,781
2003/04	7.2	4.7	16.1	188	0.52	2.72	0.338	1.157	1,357	37.2	19,560
2004/05	6.46	4.59	15.20	186	0.44	2.73	0.296	0.982	1,202	28.2	17,632
2005/06	7.1	4.7	15.6	180	0.5	2.5	0.334	1.108	1,278	35.5	17,750

21.21 Mt Isa, Queensland

- *Mt Isa Copper & Lead-Zinc-Silver - Milling and Total Ore Resources : 1931-2006*
  Data Sources : (Bennett, 1965; Berkman, 1996; BMR, var.; David, 1950; Forrestal, 1990; Mathias & Clark, 1975; MIM, var.; Moyses, 1965; QDM, var.; Raggatt, 1968; Smith, 1975; Wallis, 2005; Xstrata, var.)

Mt Isa Lead-Zinc-Silver Mine

Year	**Ore** (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag	**%Open Cut**
1931	240,641	10.7	4.1	168.4	17,402	0	31,737	
1932	600,336	10.5	4.4	162.2	48,426	0	69,378	
1933	641,982	10.6		165.3	45,759	0	67,148	
1934	550,048	10.3		168.4	43,116	0	68,187	
1935	563,481	8.23	11.06	180.9	33,426	4,482	73,120	
1936	623,733	8.0	10.56	203.9	36,300	30,930	93,727	
1937	610,438	8.6	9.9	211.2	38,731	28,040	98,832	
1938	570,804	9.38	9.28	231.1	41,805	24,115	107,654	
1939	683,864	8.7	8.6	217.3	48,448	29,573	116,224	
1940	755,066	8.9	8.6	229.6	48,888	30,058	133,858	
1941	652,675	8.7	8.8	220.4	42,699	27,879	114,915	
1942	539,184	8.9	8.4	229.6	34,049	21,372	93,262	
1943	111,513	8.3	8.7	205.1	8,793	5,161	23,578	
1946	258,125	8.0	8.8	171.4	15,487	11,450	28,998	
1947	565,942	7.5	8.9	156.1	30,836	25,413	61,911	
1948	572,169	**7.22**	**7.86**	166.9	30,640	21,938	70,362	
1949	552,083	**7.94**	**8.01**	188.7	32,545	21,581	76,780	
1950	635,657	7.4	7.5	162.2	36,951	26,213	85,271	
1951	557,766	7.3	7.1	177.5	32,052	22,091	82,285	
1952	669,952	7.5	6.7	183.7	38,139	24,062	100,257	
1953	636,084	7.1	6.2	165.3	34,396	20,264	83,696	
1954	648,035	7.7	6.3	186.7	38,821	19,929	97,162	
1955	720,663	7.9	5.7	209.7	37,711	17,425	105,837	
1956	626,975	8.10	6.2	214.3	41,531	16,592	114,437	
1957	718,276	8.23	6.25	206.0	47,976	19,756	122,709	
1958	930,423	8.3	5.65	211.2	58,376	17,764	155,272	
1959	806,072	8.0	4.8	205.1	50,348	14,207	136,588	
1960	803,298	8.2	5.6	202.0	56,449	24,784	145,234	
1961	621,322	8.2	6.3	189.8	45,725	33,751	118,924	
1962	889,554	8.0	6.0	192.8	64,578	33,924	179,297	
1963	938,679	8.1	6.5	153.1	67,350	25,695	199,362	
1964	863,020	7.9	5.2	183.7	59,249	26,677	169,122	
1965	839,982	6.6	4.7	153.1	47,696	23,037	139,045	
1966	954,956	7.5	5.5	189.8	66,573	44,285	190,402	
1967	1,054,388	7.8	5.7	189.8	85,630	40,712	223,605	
1968	1,655,792	7.6	6.0	180.6	105,554	67,663	268,879	
1969	1,956,957	7.8	6.0	186.7	137,592	84,794	339,279	
1970	2,368,745	7.5	5.7	192.8	151,774	96,120	383,223	
1971	2,069,028	6.8	6.0	162.2	128,047	90,467	314,254	
1972	1,957,753	6.6	6.8	157	115,133	96,258	270,201	
1973	2,216,855	6.8	6.7	155	126,023	108,109	302,874	
1974	2,208,124	6.4	6.3	150	120,214	103,051	328,988	
1975	2,367,655	6.6	6.6	166	133,394	114,532	345,925	2.19
1976	2,296,655	7.7	5.9	203	135,068	104,644	378,148	1.49
1977	2,395,629	8.0	6.0	215	132,392	103,537	398,855	2.08
1978	2,348,400	7.0	6.4	188	128,886	109,076	376,548	0.10
1979	2,499,845	7.0	6.0	192	144,053	111,142	420,543	0.70
1980	2,477,499	6.5	5.4	174	141,293	113,634	403,282	
1981	2,651,717	6.2	6.1	153	140,028	124,302	362,492	
1982	2,884,247	7.1	7.3	181	178,171	173,610	479,225	
1983	3,564,591	6.8	7.3	180	200,117	201,075	555,601	
1984	2,804,478	7.8	9.1	201	190,893	214,921	511,999	
1985	4,420,499	7.9	9.4	215	201,800	227,102	571,486	
1986	4,650,502	7.2	10.0	178	191,641	252,760	485,385	
1987	4,766,520	7.0	5.0	123	205,700	241,900	450,789	
1988	4,655,826	5.3	6.5	132	**182,000**	**176,000**	**486,746**	
1989	4,636,468	5.2	6.4	126	167,372	204,846	434,646	
1990	4,641,767	5.2	6.5	126	178,484	209,223	460,677	
1991	5,528,720	5.3	6.7	129	165,969	238,830	433,044	

Mt Isa Lead-Zinc-Silver Mine

Year	**Ore** (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag	**%Open Cut**
1992	5,256,624	5.4	6.9	138	196,322	228,372	515,828	
1993	5,179,324	5.6	7.0	141	201,055	247,824	549,833	
1994	4,955,415	5.4	7.2	144	191,800	255,595	484,072	
1995	3,496,381	5.3	6.7	135	150,583	169,924	366,695	
1996	4,139,220	5.6	6.8	147	156,263	203,493	393,012	
1997	3,606,703	5.8	7.0	149.3	161,800	173,725	367,293	
1998	2,891,802	6.6	7.2	176	146,040	147,033	346,092	
1999	2,921,123	6.1	7.2	164	128,010	149,666	301,755	
2000	3,007,225	5.8	6.6	155	137,190	144,029	331,252	
2001	3,002,770	5.9	7.4	151	176,417	118,807	269,738	
2002	3,152,437	5.4	7.5	138	189,494	160,385	375,739	
2003	3,013,599	5.11	7.10	123.2	134,779	169,398	321,543	
2004	3,181,527	4.71	7.50	108.9	139,538	191,433	329,069	
2005	4,355,765	4.7	7.0	111.9	231,167	159,557	353,358	6.89
2006	4,566,808	3.9	6.6	80.4	127,434	209,914	233,032	**~80**
Total	**153.9 Mt**	**6.40**	**6.84**	**158**	**7.676 Mt**	**7.029 Mt**	**19,079 t**	**»2.7**

Mt Isa Copper Mine

Year	**Ore** (t)	%Cu	t Cu	kg Ag	**Waste Rock** (Mt)
1943	162,164	**3.71**	6,018		
1944	282,981	4.7	12,559		
1945	275,620	4.19	10,800	2,046.5	
1946	53,807	4.5	2,264		
1953	209,682	3.56	528		
1954	574,951	4.16	19,056		
1955	582,857	3.75	22,125		
1956	737,350	3.7	26,713		
1957	745,082	4.4	25,726		
1958	857,059	3.8	39,108		
1959	1,377,862	4.1	59,081		
1960	1,945,290	3.7	74,172		
1961	2,101,367	3.6	58,641		
1962	1,836,855	3.2	75,971		
1963	2,425,433	2.9	74,705		~5 Mt
1964	2,254,480	3.1	64,787		~4 Mt
1965	1,751,252	3.29	56,318		~3.25 Mt
1966	1,698,370	2.57	65,156		
1967	2,454,335	2.04	44,472		
1968	2,721,592	2.30	60,726		
1969	3,344,537	2.4	78,225		
1970	3,727,574	2.7	95,489		
1971	4,085,053	3.0	114,658		
1972	4,173,545	2.9			
1973	5,069,024	2.91	137,309		
1974	5,034,847	3.4	165,695		
1975	4,335,889	3.3	138,877		
1976	4,514,319	3.2	140,934		
1977	5,018,591	3.1	152,390		
					»12.25 Mt

[§] Financial year data only.

Year	**Ore** (t)	%Cu	t Cu	kg Ag
1978	4,831,957	3.4	159,637	
1979	4,619,000	3.8	169,110	
1980	4,585,583	3.6	158,732	
1981	4,802,188	2.88	136,421	
1982	5,209,626	3.19	155,157	
1983	5,429,625	3.24	164,607	
1984	4,664,542	3.55	159,714	
1985	5,191,718	3.61	179,905	
1986	5,706,167	3.24	175,582	
1987	6,142,625	3.25	189,117	
1988	5,430,636	3.0	160,850	
1989	5,855,071	3.1	174,150	20,201 [§]
1990	5,980,710	3.1	179,260	22,176 [§]
1991	5,772,349	3.2	179,304	22,036 [§]
1992	5,260,484	3.1	170,903	28,315 [§]
1993	6,022,438	3.3	157,803	29,609 [§]
1994	5,941,932	3.3	185,916	23,525 [§]
1995	4,892,674	3.3	156,863	19,925 [§]
1996	5,718,596	3.3	210,581	30,974 [§]
1997	5,460,023	3.5	186,691	38,280 [§]
1998	4,177,133	3.78	146,950	18,591
1999	5,032,311	3.83	179,248	22,798
2000	5,273,168	3.74	183,124	22,840
2001	5,767,301	3.60	192,778	12,978
2002	5,583,273	3.50	177,695	
2003	5,186,464	3.49	199,337	
2004	5,481,698	3.37	170,197	
2005	5,638,312	3.36	177,482	
2006	6,129,366	3.42	194,135	
Total	**220.9 Mt**	**3.27**	**6.895 Mt**	**»321 t**

Mt Isa Copper : Total Underground Ore Resources

Year	**Ore** (Mt)	%Cu	Mt Cu
1941	~0.500	3.0	0.015
1942	1.546	3.0	0.046
1943	2.461	3.2	0.079
1944	2.399	3.75	0.090
1945	2.768	3.95	0.109
1946	2.910	3.9	0.113
1953	3.974	3.9	0.155
1954	3.759	4.2	0.158
1955	5.182	4.0	0.207
1956	7.925	3.75	0.297
1957	13.005	3.75	0.488
1958	16.916	3.75	0.634
1959	20.422	3.7	0.756
1960	24.587	3.7	0.910
1961	24.892	3.7	0.921
1962	27.432	3.63	0.997
1963	29.972	3.52	1.055
1964	34.544	3.52	1.215
1965	34.036	3.51	1.196

Year	**Ore** (Mt)	%Cu	Mt Cu
1966	42.164	3.32	1.399
1967	44.196	3.22	1.423
1968	47.244	3.03	1.430
1969	77.724	3.02	2.344
1970	123.444	3.01	3.716
1971	133.604	3.01	4.020
1972	141.5	3.01	4.257
1973	141.5	3.01	4.257
1974	139.5	3.01	4.197
1975	141.5	3.01	4.257
1976	136.5	3.21	4.377
1977	132.5	3.21	4.249
1978	127.5	3.21	4.089
1979	122.5	3.21	3.929
1980	122.5	3.21	3.929
1981	180.0	3.06	5.510
1982	175.0	3.06	5.355
1983	157.0	3.31	5.198
1984	157.0	3.31	5.198
1985	155.0	3.32	5.150

Year	**Ore** (Mt)	%Cu	Mt Cu
1986	155.0	3.32	5.145
1987	155.0	3.32	5.145
1989/90	135	3.39	4.575
1990/91	130.0	3.34	4.340
1991/92	140.0	3.26	4.570
1992/93	131.0	3.24	4.242
1993/94	134.0	3.36	4.504
1994/95	144.6	3.37	4.871
1995/96	125.9	3.43	4.316
1996/97	117.8	3.50	4.125
1997/98	97.5	3.55	3.457
1998/99	92.8	3.63	3.366
1999/00	93.7	3.57	3.344
2000/01	88.9	3.55	3.157
2001/02	116	3.28	3.799
2002/03	192	2.66	5.111
2003/04	174	2.42	4.211
2004/05	172	2.65	4.554
2005/06	233.1	2.09	4.874

Mt Isa : Potential Cu Open Cut Only	**Year**	**Ore** (Mt)	%Cu	Mt Cu
	1994/95 to 1999/00	85	1.6	1.36
	2000/01	112	1.6	1.79
	2001/02	260	1.15	3.00
	2002/03	291	1.16	3.36
	2003/04 to 2005/06	277	1.19	3.30

Mt Isa Lead-Zinc-Silver (Underground & Open Cut) : Total Ore Resources

Year	Mt Isa				Hilton				George Fisher				Total Metals
	Ore Mt	Pb %	Zn %	Ag g/t	Ore Mt	Pb %	Zn %	Ag g/t	Ore Mt	Pb %	Zn %	Ag g/t	Pb-Zn-Ag Mt-Mt-t
1928	21.3	6.1	8.1	115									1.30-1.73-2,456
1942	29.0	8.7											2.56-???-???
1949	9.818	8.7	7.3	196									0.85-0.72-1,923
1950													
1951	9.651	8.8	7.1	205									0.85-0.69-1,979
1952													
1953													
1954	9.1	8.7	6.1	193									0.80-0.56-1,763
1955													
1956													
1957	21.0	7.9	6.0	178									1.66-1.26-3,734
1958	24.6	7.8	6.0	174									1.92-1.48-4,290
1959	25.6	7.8	5.8	171									2.00-1.48-4,389
1960	26.0	7.8	5.8	171									2.03-1.51-4,458
1961	26.0	7.8	5.8	171									2.03-1.51-4,458
1962	26.0	7.8	5.8	171									2.03-1.51-4,458
1963	26.4	7.8	5.9	171									2.06-1.56-4,528
1964	26.4	7.75	5.86	172									2.05-1.55-4,540
1965	27.5	7.8	5.9	171									2.15-1.62-4,720
1966	32.1	7.46	5.40	163									2.40-1.73-5,243
1967	33.1	7.37	5.50	163									2.44-1.82-5,411
1968	35.2	7.17	5.50	157									2.52-1.93-5,536
1969	46.3	7.18	5.53	158	35.6	7.7	9.6	178					6.07-5.98-13,652
1970	53.4	7.87	5.83	152	**35.6**	**7.7**	**9.6**	**178**					6.94-6.53-14,454
1971	56.5	6.88	6.03	149	**35.6**	**7.7**	**9.6**	**178**					6.63-6.82-14,755
1972	56	6.90	6.30	149	**35.6**	**7.7**	**9.6**	**178**					6.61-6.95-14,681
1973	55.6	6.88	6.33	149	37.4	7.70	9.50	179					6.71-7.07-14,972
1974	53.5	6.89	6.44	152	37.4	7.70	9.50	179					6.56-7.00-14,825
1975	51.5	7.08	6.44	152	37.4	7.70	9.50	179					6.53-6.87-14,519
1976	55.5	6.79	6.44	149	37.4	7.70	9.50	179					6.65-7.13-14,966
1977	57.5	6.59	6.44	149	37.4	7.70	9.50	179					6.67-7.26-14,266
1978	54.5	6.39	6.44	149	37.4	7.70	9.50	179					6.36-7.06-14,816
1979	56.5	6.39	6.44	149	37.4	7.70	9.50	179					6.49-7.19-15,116
1980	56.5	6.39	6.44	149	37.4	7.70	9.50	179					6.49-7.19-15,116

Mt Isa Lead-Zinc-Silver (Underground & Open Cut) : Total Ore Resources

Year	**Mt Isa[#]**				Hilton				George Fisher				Total Metals
	Ore Mt	Pb %	Zn %	Ag g/t	Ore Mt	Pb %	Zn %	Ag g/t	Ore Mt	Pb %	Zn %	Ag g/t	Pb-Zn-Ag Mt-Mt-t
1981	55.0	6.32	6.58	150	45	6.6	9.6	150					6.45-7.94-14,982
1982	54.0	6.16	6.64	150	45	6.6	9.6	150					6.29-7.92-14,834
1983	53.0	6.05	6.66	150	45	6.58	9.64	149					6.17-7.87-14,650
1984	49.0	5.89	6.77	149	45	6.58	9.64	149					5.85-7.66-14,039
1985	49.0	5.84	6.80	148	49	6.59	9.53	151	53	6.06	11.76	88.5	9.30-14.23-19,355
1986	49.0	5.85	6.79	147	49	6.59	9.53	151	53	6.06	11.89	88.5	9.31-14.30-19,300
1987	49.0	5.85	6.79	147	49	6.47	9.26	151	**53**	**6.06**	**11.76**	**88.5**	9.25-14.09-19,302
1989/90	47	5.4	6.6	135	124	5.52	10.50	103					9.38-16.12-19,121
1990/91	45	5.4	6.6	132	124	5.51	10.34	103					9.26-15.80-18,717
1991/92	40	5.2	6.4	128	123	5.52	10.52	102					8.87-15.50-17,667
1992/93	37	5.2	6.4	128	121	5.52	10.51	102					8.60-15.09-17,039
1993/94	33	5.0	6.6	135	124	5.60	10.46	103					8.60-15.14-17,182
1994/95	38.4	5.99	6.75	144	45.6	6.19	8.93	132	68	5.8	12.5	92	9.07-15.16-17,817
1995/96	43.4	6.17	6.65	146	41.5	6.07	9.69	124	81	5.47	12.04	92	9.63-16.66-18,965
1996/97	27.0	6.47	6.91	159	28.2	7.01	10.09	143	107.8	5.40	11.15	93	9.54-16.73-18,366
1997/98	23.9	6.36	7.14	156	20.3	7.20	10.01	156	101.2	5.31	11.17	89	8.35-15.04-15.885
1998/99	17.7	6.36	7.17	153	19.5	7.76	9.88	150	97.2	5.05	11.10	89	7.55-13.98-14,292
1999/00	16.8	6.31	7.12	152	20.2	7.04	8.78	150	97.0	5.18	11.09	89	7.51-13.72-14,240
2000/01	16.5	6.10	6.93	147	50.0	6.13	8.84	138	121.8	4.32	9.25	86	9.33-16.83-19,847
2001/02	36.0	5.84	6.12	152	35.0	6.25	8.87	139	98.0	4.15	9.23	80	10.80-18.17-23,709
2002/03	23.5	6.81	6.04	180	36.0	6.15	8.69	137	97.0	4.14	9.19	78	9.64-16.43-30,299
2003/04[#]	41.1	4.54	5.46	105	26.4	6.67	4.71	141	67.0	4.99	9.57	88	6.97-9.90-13,946
2004/05[#]	29.5	3.26	5.18	65	41.0	6.30	9.11	135	86.0	4.76	9.24	83	7.64-13.21-14,569
2005/06[#]	34.5	3.40	5.29	66	45.9	6.63	9.65	137	87.4	4.20	9.39	82	**7.89-14.46-15,664**

From 2004 onwards, Mt Isa resources are mostly the Black Star open cut and are excluded from the 'Isa Pb-Zn-Ag mega pit'.

Pb-Zn-Ag – Potential Open Cut	**Ore** (Mt)	%Pb	%Zn	g/t Ag	Mt Pb	Mt Zn	t Ag
2002/03	287	3.2	4.3	74.4	9.22	12.44	21,350
2003/04	314	3.2	4.0	71	10.12	12.65	22,208
2004/05	312.1	3.22	4.03	70.4	10.06	12.57	21,980
2005/06	336.7	2.66	4.01	64.4	8.946	13.486	21,693

21.22 Century Zinc, Queensland

- *Century Zinc : 2000-2006* Data Sources : (Pasminco, var.; Zinifex, var.)

	Ore Milled (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag
2000	3,786,306	2.94	11.66	73.5	20,164	306,858	9,498
2001	4,950,691	2.35	11.83	44.0	92,756	451,167	210,829
2002	4,937,694	1.91	13.01	53.5	60,482	503,213	186,689
2003	5,185,551	2.12	12.06	60.2	71,661	502,870	223,486
2004	5,507,309	1.87	11.74	61.0	77,137	516,912	252,486
2005	5,195,730	2.03	12.10	56.4	70,914	501,053	219,430
2006	5,405,061	1.62	11.77	57.0	54,517	496,038	186,500
Total	**34,968,342**	**2.1**	**12.0**	**57.5**	**447,631**	**3,278,111**	**1,288,918**

21.23 Mt Garnet-Surveyor, Queensland

- *Mt Garnet-Surveyor : 2003-2006* Data Sources : (KZ, var.)

	Ore Milled (t)	%Pb	%Zn	g/t Ag	%Cu	g/t Au	t Pb	t Zn	kg Ag	t Cu	kg Au
2003[§]	309,778	1.5	8.1	36.5	0.51	0.3	2,299	23,539	5,699	728	26
2004	288,651	6.6	16.5	136.7	0.9	1.2	14,411	41,233	27,551	1,564	190
2005	324,899	5.2	15.0	107.5	2.0	0.9	10,609	42,399	22,310	2,986	149.6
2006	483,550	3.9	9.6	66.9	1.1	0.6	11,958	40,323	18,300	3,649	130.4
Total	**1,406,878**	**4.2**	**11.9**	**83.9**	**1.13**	**0.73**	**39,277**	**147,494**	**73,860**	**8,927**	**495.7**

[§] Waste rock for September quarter 2.767 Mt; no other quarters or data available.

21.24 Elura-Enterprise, New South Wales

- *Elura-Enterprise Lead-Zinc-Silver-Copper - 1983-2006*
  Data Sources : (BMR, var.; CBH, var.; Pasminco, var.; Zinifex, var.)

Year	Ore Milled (t)	Grade			Production				
		%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag	t Cu	kg Au
1983	638,524	5.1	8.5	195	22,268	39,896	67,321	273	28
1984	869,319	5.3	8.8	212	32,029	58,971	92,748	363	
1985	1,139,993	5.5	8.8	158	49,936	87,073	102,724	623	
1986	1,221,587	5.3	8.8	193	51,517	87,520	184,861	1,062	
1987	1,278,363	5.5	8.8	149	49,269	88,730	103,108	804	
1988	1,188,314	5.6	8.3	179.1	49,269	88,730	103,108		
1989	1,180,682	5.46	8.39	152.8	45,268	76,268	99,827		
1990	1,170,294	6.01	8.73	116.4	48,750	76,901	63,293		
1991	533,797	6.43	8.74	148.7	28,082	49,574	47,772		
1992	627,041	6.24	8.81	84.8	26,820	42,335	23,831		
1993	722,356	5.81	8.64	93.0	25,540	46,463	22,641		
1994	900,452	5.95	9.13	110.6	37,796	62,444	38,450		
1995	1,162,561	5.78	8.85	87.9	48,249	77,407	43,528		
1996	1,008,069	5.99	8.52	62.0	44,606	65,975	27,315		
1997	1,018,407	5.25	8.21	116.7	37,330	52,266	38,844		
1998	1,083,547	5.17	7.62	64.5	42,963	61,488	29,836		
1999	1,018,066	5.46	8.24	56.9	43,460	67,529	28,484		
2000	1,008,763	5.23	8.43	56.1	39,325	72,612	27,526		
2001	1,164,010	5.50	8.64	55.9	45,967	83,226	28,637		
2002	1,179,004	5.30	8.68	54.7	45,146	85,364	22,136		
2003	1,199,455	5.18	8.57	53.5	44,256	85,957	19,160		
2004	1,170,262	4.66	7.80	50.7	38,405	73,743	29,541		
2005	871,094	4.37	7.30	47.3	28,612	53,202	22,181		
2006	651,800	3.87	6.70	33.9	20,360	37,600	13,350		
Total	**24.01 Mt**	**5.41**	**8.44**	**105**	**941 kt**	**1,611kt**	**1,300 t**	**»3,125**	**»28**

21.25 Cannington, Queensland

- *Cannington : 1997-2006* Data Sources : (BHP, var.; BHPB, var.)

	Ore Milled (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag
1997	164,000	13.58	4.45	717	13,019	2,128	59,805
1998	1,202,000	12.56	5.05	580	126,977	37,648	604,491
1999	1,653,058	12.65	4.27	561	192,428	59,415	867,472
2000	1,707,000	14.00	5.05	643	211,009	66,933	1,003,006
2001	1,946,000	12.79	5.27	571	219,192	69,154	997,190
2002	2,305,000	12.47	4.27	598	246,298	57,416	1,187,491
2003	2,336,000	11.46	4.23	534	230,103	63,010	1,069,778
2004	2,977,000	10.60	3.24	507	271,729	52,006	1,285,052
2005	3,156,000	10.32	3.33	500.1	287,611	60,885	1,368,618
2006	2,354,000	10.24	3.76	422.7	209,692	55,043	861,937
Total	**19,800,058**	**11.65**	**4.12**	**538**	**2,007,058**	**523,638**	**9,304,840**

21.26 Mt Cuthbert, Queensland

- *Mt Cuthbert Copper Mine : 1997-2002* Data Sources : (MM, var.; MU, var.; Stuart, 2000)

Year	**Ore Milled** (t)	%Cu	t Cu
1996/97	329,318	1.38	1,127
1997/98	359,811	2.12	4,820
1998/99	400,021	2.00	2,771

Year	**Ore Milled** (t)	%Cu	t Cu
1999/00	204,039	1.60	1,278
2000/01	320,105	2.23	3,400
2001/02	64,598	2.57	1,855
Total	**1,677,892**	**1.92**	**15,251**

21.27 Clonclurry Copper Field, Queensland

- *Clonclurry Copper Field : 1883-1981* Data Sources : (Anonymous, var.; QDM, var.)

  Note : Excludes mines detailed separately below.

	Ore Milled (t)	%Cu	t Cu		Ore Milled (t)	%Cu	t Cu		Ore Milled (t)	%Cu	t Cu
1883	1,026	18.8	193	1926	6,266	17.81	1,116	1955	12,613	9.92	1,251
1898	5	43.2	2.2	1927	20,417	14.57	2,951	1956	17,854	8.79	1,570
1899	2	98.4	1.97	1928	12,054	19.71	2,376	1957	15,026	6.86	1,031
1900	13	82.1	10.8	1929	19,000	18.06	3,431	1958	10,692	3.19	341
1901	240	94.1	225.6	1930	11,086	19.88	2,204	1959	2,616	9.56	250
1902	52	95.4	49.4	1931	12,929	17.53	2,267	1960	3,699	8.51	315
1903	150	99.7	149.5	1932	15,389	16.39	2,523	1961			
1904	1,358	30	405.5	1933	13,652	15.54	2,121	1962	2,730	14.25	389
1905	1,546	30	463.9	1934	14,396	13.25	1,908	1963	2,718	11.94	325
1906	2,565	23.37	599	1935	10,105	14.25	1,440	1964	1,852	9.12	169
1907	2,381	27.19	647.4	1936	13,216	14.31	1,891	1965	1,402	7.93	111
1908	14,204	9.45	1,342	1937	20,872	13.24	2,764	1966			
1909	17,809	13.47	2,398	1938	12,580	12.62	1,587	1967	8,595	6.09	523
1910	21,893	15.91	3,484	1939	13,686	12.92	1,768	1968	18,908	8.32	1,574
1911	65,880	13.30	8,763	1940	12,540	13.67	1,715	1969	17,775	6.51	1,158
1912	83,104	12.73	10,583	1941	10,745	12.23	1,314	1970	14,912	5.10	760
1913	90,559	10.96	9,926	1942	10,327	12.63	1,304	1971	3,601	5.80	209
1914	81,864	10.19	8,346	1943	10,258	10.03	1,029	1972	4,299	6.73	289
1915	96,561	10.40	10,038	1944	7,768	9.11	707	1973	5,138	5.12	263
1916	106,673	9.44	10,066	1945	1,987	12.94	257	1974	3,444	3.82	132
1917	126,305	8.20	10,352	1946	623	12.61	79	1975	573	4.61	26
1918	193,923	6.29	12,195	1947	510	11.35	57.9	1976	358	3.74	13
1919	57,367	7.70	4,416	1948	110	15.06	16.5	1977	150	3.58	5
1920	35,829	7.14	2,558	1949	281	11.58	32.5	1978	116	26.91	31
1921	0		0	1950	299	11.33	33.9	1979	225	22.40	50
1922	468	23.66	111	1951	228	12.06	27.6	1980	439	3.08	14
1923	1,133	23.42	265	1952	54	15.47	8.3	1981	8	1.25	0
1924	1,133	23.42	265	1953	7,798	8.23	642				
1925	8,376	11.91	998	1954	6,245	8.77	548	**Total**	**1.43 Mt**	**10.4**	**148 kt**

21.28 OK and Mt Molloy, Queensland

- *OK and Mt Molloy Copper Mines : 1883-1923* Data Sources : (QDM, var.)

	OK			Mt Molloy		
Year	**Ore Milled** (t)	%Cu	t Cu	**Ore Milled** (t)	%Cu	t Cu
1905	12,088	19.4	2,349	14,672	10.1	1,479
1906	14,089	10.8	1,520	10,838	10.5	1,139
1907	16,882	8.7	1,469	14,643	5.0	739
1908	20,464	7.3	1,494	2,510	8.0	201
1909	14,606	5.2	764	14,672	10.1	1,479
1930	244	6.7	16			
Total	**78,373**	**9.7**	**7,612**	**42,663**	**8.34**	**3,558**

21.29 Great Australia, Queensland

- *Great Australia Copper Mine : 1996-1998*

  Data Sources : (CMC, var.; QNRME, var.; RIU, var.)

Year	**Ore Milled** (t)	%Cu	t Cu	**Waste Rock** (t)
1996	662,059	1.68	4,057	743,145
1997	446,898	1.84	4,654	1,187,204
1998			1,384	
Total	**1,108,957**	**1.74**	**10,095**	**1,930,349**

21.30 Ernest Henry, Queensland

- *Ernest Henry : 1997-2006* Data Sources : (MIM, var.; SR, var.; Xstrata, var.)

	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au	**Waste Rock** (t)
1997	2,443,484	1.10	0.71	19,415	780	**~43,000,000**
1998	8,700,061	1.09	0.55	78,384	3,048	**~43,000,000**
1999	9,733,394	1.20	0.59	99,075	3,491	**~43,000,000**
2000	9,819,746	1.14	0.52	97,598	3,495	45,327,321
2001	10,343,100	1.11	0.52	101,996	3,872	52,998,431
2002	10,098,312	1.23	0.63	113,596	4,510	47,896,069
2003	10,279,221	1.05	0.53	99,422	3,812.2	55,177,732
2004	10,799,276	1.14	0.56	114,007	4,435.4	46,974,781
2005	11,425,284	1.21	0.60	129,010	5,201	46,974,781
2006	10,300,686	0.89	0.44	83,968	3,283	48,463,362
Total	**93,942,564**	**1.12**	**0.55**	**936,471**	**35,928**	**~483 Mt**

21.31 Cadia Hill and Ridgeway, New South Wales

- *Cadia Hill : 1998-2006; Ridgeway : 2000-2006*
  Data Sources : (Newcrest, var.; Suppel & Clarke, 1990; Welsh, 1975)

	Cadia						**Ridgeway**				
	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au	**Waste Rock** (t)	**Ore Milled** (t)	%Cu	g/t Au	t Cu	kg Au
1998	7,376,000	0.19	0.68	10,611	3,166.6	13,624,000					
1999	15,314,000	0.18	0.86	23,272	9,762.4	49,386,000					
2000	16,336,000	0.22	0.86	28,431	9,961.2	39,764,000	493,000	0.99	2.12	3,974	975.5
2001	15,586,000	0.17	0.72	21,469	8,064.4	40,534,000	1,031,000	0.95	2.19	7,405	1,838.9
2002	16,392,000	0.17	0.74	23,713	9,015.2	50,708,000	3,783,000	0.95	2.34	33,198	7,680.3
2003	17,416,000	0.22	0.70	30,671	8,765.3	63,184,000	5,142,000	1.02	3.16	48,816	14,265.8
2004	16,740,000	0.24	0.66	35,843	8,451.1	59,260,000	5,550,000	0.88	2.65	44,775	12,461.3
2005	15,712,000	0.19	0.79	24,461	9,492.2	53,388,000	5,525,000	0.86	2.50	42,260	11,609.0
2006	16,316,000	0.14	0.45	20,530	5,576.1	37,115,000	5,621,000	0.74	2.18	38,065	10,529.7
Total	**137.2 Mt**	**0.19**	**0.72**	**219 kt**	**72,255**	**407 Mt**	**21.15 Mt**	**0.89**	**2.55**	**218 kt**	**59,361**

21.32 Northparkes, New South Wales

- *Northparkes : 1994-2006*
  Data Sources : (Heithersay, 1986; LP & Minmet, var.; North, var.; RIU, var.; RT, var.)

  Note : Most production has come from underground mining, although a series of open cuts are also involved. In general, no waste rock data has (apparently) been reported for Northparkes.

	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au	**%Open Cut**
1994	190,466		0.75		142	100
1995	1,322,088		1.42		1,876	100
1996	2,647,000	0.93	0.92	14,354	1,633	<50 (?)
1997	4,452,000	1.24	0.77	46,888	2,514	0 (?)
1998	4,917,000	1.73	0.88	77,277	3,373	0 (?)
1999	6,326,000	1.46	0.57	82,631	2,762	0 (?)
2000	6,075,000	1.16	0.34	62,971	1,184	0 (?)
2001	5,425,000	1.16	0.32	55,100	1,291	0 (?)
2002	5,364,000	0.86	0.35	38,400	1,269	0 (?)
2003	5,168,000	0.67	0.44	27,100	1,511	0 (?)
2004	5,008,000	0.79	0.66	30,000	2,469	0 (?)
2005	5,453,000	1.12	0.46	54,000	1,773	0 (?)
2006	5,789,000	1.53	0.64	83,300	2,945	0 (?)
Total	**56.62 Mt**	**1.17**	**0.55**	**572,021**	**22,724**	**~5 (?)**

21.33 Mineral Hill, New South Wales

- *Mineral Hill : 1988-2005*

  Data Sources : (LP & Minmet, var.; NSWDMR, var.; RIU, var.; Triako, var.)

	Ore Milled (t)	g/t Au	%Cu	kg Au	t Cu	**%Open Cut**
1988/89	101,406	1.48	**0.33**	149.6	335.2	100.0
1989/90	167,720	1.67	1.31	**190.5**	**1,977**	100.0
1993/94	57,967	4.0	1.54	136.4	787	100.0
1995/96	124,374	2.43	1.93	204.7	2,255	0.0
1996/97	197,825	2.66	1.79	359.6	3,824	0.0
1997/98	193,682	5.40	1.82	781.5	3,332	0.0
1998/99	181,877	8.28	1.46	1,208.0	2,523	0.0
1999/00	146,938	8.08	0.66	1,000.8	785	0.0
2000/01	184,000	9.53	0.52	1,535.2	732	0.0
2001/02	190,000	8.49	0.43	1,430.6	535	0.0
2002/03	181,000	9.90	0.50	1,578.3	580	0.0
2003/04	164,000	12.21	0.79	1,810.6	972	0.0
2004/05	181,000	5.37	1.51	797.2	2,366	0.0
Total	**2.072 Mt**	**6.45**	**1.12**	**11,183**	**21,004**	**~15.8**

21.34 Girilambone, New South Wales

- *Girilambone : 1993-2002*

  Data Sources : (Fogarty, 1998; Kenny, 1923; NSWDMR, var.; Straits, var.; Suppel & Clarke, 1990)

	Ore Milled (t)	%Cu	t Cu
1913	16	**6.25**	1
1917	93	**10.3**	9.7
1918	119	**11.1**	13
1920	1,020	**10.8**	110
1950	13	**8.3**	1.1
1993	740,000	0.60	6,325
1994	1,536,000	1.31	11,765
1995	1,483,000	2.07	12,784

	Ore Milled (t)	%Cu	t Cu
1996	1,326,000	2.32	16,281
1997	625,861	1.35	17,702
1998	986,720	0.70	17,565
1999	1,700,000	0.9	13,844
2000	400,000	1.7	12,939
2001	*(residual production from*		3,999
2002	*heap leaching)*		1,858
Waste Rock – 17.3 Mt			
Total			

21.35 Eloise, Queensland

- *Eloise : 1995-2004* Data Sources : (BR, var.; RIU, var.)

  Note : Still in production in late 2004 but no data available since this time.

	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag
1995/96	38,038	3.29	0.83	**10.0**	1,183	14.3	380.2
1996/97	345,723	4.28	0.95	**12.2**	14,011	228.9	4,217.5
1997/98	474,490	4.60	1.05	**12.1**	20,479	317.0	5,762.4
1998/99	472,450	4.53	1.27	**10.2**	20,292	406.3	4,799.3
1999/00	519,212	4.29	1.19	**10.6**	21,190	385.8	5,478.2
2000/01	503,779	3.92	1.04	**10.9**	18,761	315.7	5,483.6
2001/02	461,364	3.68	0.97	**~9.9**	16,173	266.3	**~5,500**
2002/03	551,590	3.85	0.97	14.4	20,265	292.5	6,462.5
2003/04	356,652	3.18	0.87	10.2	10,066	151.2	**~3,500**
Total	**3.723 Mt**	**4.05**	**1.05**	**~12**	**143,021**	**2,378**	**~41,600**

21.36 Selwyn Field, Queensland

- *Selwyn : 1988/89-1997/98*
  Data Sources : (AR, var.; Fortowski & McCracken, 1998; RIU, var.)

	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au	%Open Cut
1988/89	699,045	**1.35**	3.81	9,424	2,666.0	100
1989 D½	414,681	**0.83**	3.47	3,455	1,438.6	100
1990/91						
1991/92	894,816	1.97	4.73	15,898	3,724.8	20
1992/93	903,820	1.92	4.56	15,824	3,585.1	20
1993/94	921,156	1.79	4.47	15,189	3,603.6	8
1994/95	938,601	1.75	2.90	14,136	2,390.3	5
1995/96	982,887	2.29	2.68	21,501	2,450.0	5
1996/97	933,658	2.48	2.71	22,038	2,237.3	0
1997/98	950,474	2.54	1.85	22,424	1,442.0	0
1998 D½	473,371	2.58	1.99	11,074	747	0
Total	**>8.1 Mt**	**~2.0**	**~3.4**	**>151 kt**	**>24,284**	**~20**

21.37 Osborne, Queensland

- *Osborne : 1995-2006*
  Data Sources : (Adshead *et al.*, 1998; Barrick, var.; Kaesehagen & Boffey, 1998; PD, var.; PP, var.)

	Ore Milled (t)	%Cu	g/t Au	t Cu	kg Au	**%Open Cut**	**Waste Rock** (t)
1995	446,000	4.37	1.74	15,180	542	100	~5,000,000
1996	1,268,000	3.69	1.68	44,026	1,568	60.4	~9,900,000
1997	1,465,000	2.9	0.9	36,595	766	0	
1998	1,493,000	2.6	0.9	35,989	970	0	
1999	1,512,000	2.9	0.9	42,247	1,010	0	
2000	1,470,000	3.4	0.9	47,401	1,075	0	210,900
2001	1,487,000	3.5	1.1	49,205	1,341	0	120,000
2002	1,461,000	3.3	1.0	46,101	1,227	0	164,688
2003	1,485,000	3.0	1.0	42,466	1,201	0	207,488
2004	1,533,000	2.7	1.0	39,639	1,339	0	
2005	1,687,000	2.3	0.9	39.514	1,385	0	
2006	1,598,000	1.85	1.1	26,757	964.6	0	7,168,694
Total	**16,906,000**	**~2.9**	**~1.0**	**465,120**	**13,388**	**7.2**	**~23 Mt**

21.38 Red Dome, Queensland

- *Red Dome : 1991-1997*
  Data Sources : (Nethery & Barr, 1998; Niugini, var.; RIU, var.)

	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag	**Waste Rock** (t)
1987								
1988								
1989								
1990								
1991	887,319	0.58	2.72	**8.34**	3,107	2,394.4	7,397.4	1,836,269
1992	1,047,737	0.63	3.15	**13.51**	5,489	3,203.6	14,151.5	2,243,065
1993	1,063,802	0.64	1.78	**8.93**	4,317	1,484.0	9,498.9	12,150,003
1994	1,172,885	0.79	1.41	**8.75**	5,718	1,346.9	10,257.3	8,285,374
1995	1,152,310	0.48	3.17	**17.00**	4,917	3,465.2	19,586.7	1,985,371
1996	1,301,694	0.35	2.18	**13.18**	4,150	2,672.6	17,155.4	307,741
1997	1,032,144	0.54	1.69	**10.58**	3,708	1,541.8	10,915.8	
Total	**7,657,891**	**0.57**	**2.29**	**11.62**	**31,406**	**16,108**	**88,963**	**26,807,823**

21.39 Highway-Reward, Queensland

- *Highway-Reward Copper-Gold-Silver Mine: 1998-2005* (Note : Milled at the Thalanga mill.)
  Data Sources : (GR, var.; QDM, var.; QNRME, var.; RIU, var.)

	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	kg Au	kg Ag	%Open Cut	**Waste Rock** (Mt)
1998	238,738	12.45	1.92	32.77	27,093	304.7	5,934.6	100	~21.9
1999§	451,201§	6.08§	1.17§	14.99§	24,654§	236.5§	4,201.5§	100§	~26.4§
2000	564,881	4.74	1.19	10.61	23,718	104.2	1,737.3	100	~1.8
2001	837,268	6.05	1.01	10.41	47,414	165.5	2,818.2	100	
2002	309,373	5.90	**1.01**	**10.33**	16,898	58.8	1,046.9	68.88	
2003	670,155	4.37	**0.65**	**7.99**	25,892	77.1	1,637.9	0	
2004	476,034	3.79	**0.59**	**7.27**	15,832	49.8	1,059.2	0	
2005	169,739	3.93	**0.63**	**7.74**	6,085	18.9	401.8	0	
Total	3.717 Mt	5.56	**~1.0**	**~11.5**	187,584	**1,016**	**18,837**	~62	~50

§ Includes Cu-Zn ore, from both the Highway and Reward deposits, totalling 18,924 t ore gradung 6.01% Zn, 2.42% Cu, 3.01 g/t Au and 19.7 g/t Ag, producing approximately 820 t Zn (Cu-Au-Ag included above).

21.40 Beltana-Aroona, South Australia

- *Beltana-Aroona : Various*
  Data Sources : (Carmichael, 1993; Pasminco, var.; Rangott, 1980; RIU, var.; SADM, var.-a)

	Ore Milled (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag	**Waste Rock** (Mt)
1903	752	40			**286**			
1905	12	**64.6**						
1906	92	**66.4**		**~237**	**~58**		**~21.9**	
1907	2,142	20		163	**~407**		**~350**	
1908	1,223	**11.7**			136			
1974	25,603	2.2	39		**563**	**9,985**		~0.5
1975	36,184	2.2	39		**796**	**14,112**		
1976	17,515		39			**6,489**		
1978	4,137		39			**1,533**		
1982	11,987		39			**4,441**		
1983	6,886		39			**2,551**		
1984	46,397		39			**17,190**		
1985	30,566		39			**11,325**		
1986	62,708		39			**23,233**		
1986/87	57		36.8			**20**		
1987/88	39		41			**15**		
1989	57,200		37			**20,106**		
1990	31,177		41			**12,143**		
1997	66,869	2.2	~38.3			25,602		
Total	401,546	**~2**	**~38**	**>10**	>3,650	~150,000	>400	>2

21.41 Teutonic Bore, Western Australia

- *Teutonic Bore Copper-Zinc-Silver - Milling : 1981-1985*
  Data Sources : (BMR, var.; WADM, var.)

Year	**Ore**	**Grade**			**Production**			**Waste**	%Ore
	Milled (t)	%Cu	%Zn	g/t Ag	t Cu	t Zn	kg Ag	**Rock** (t)	Open Cut
1981	180,230	3.58	11.49	186	9,481	18,638	26,818	~2,670,000	100
1982	298,669	4.45	14.63	171	11,035	39,326	40,858	~2,670,000	100
1983	312,616	4.16	12.62	158	11,347	35,507	39,515		0
1984	331,755	2.97	11.52	143	9,162	34,396	37,953		0
1985	317,800	3.27	11.60	135.5	10,381	36,589	43,067		0
Total	**1.441 Mt**	**3.68**	**12.42**	**156**	**51,406**	**164,456**	**188,211**	**5.34 Mt**	

21.42 McArthur River-HYC, Northern Territory

- *McArthur River-HYC : 1997-2006*
  Data Sources : (MIM, var.; Xstrata, var.)

	Ore Milled (t)	%Pb	%Zn	g/t Ag	t Pb	t Zn	kg Ag	**%Open Cut**
1995/96	759,519	5.3	12.6	52.2	17,836	62,701	21,618	
1996/97	1,026,150	5.3	14.4	59.1	27,200	107,984	28,546	
1997/98	1,139,753	5.9	16.1	64.0	37,543	136,116	40,673	
1998/99	1,220,957	6.1	16.4	**72**	44,964	158,860	**48,441**	
1999/00	1,262,639	6.2	16.3	**74**	42,509	166,500	**51,696**	
2000/01	1,270,319	6.1	15.4	**70**	38,441	161,356	**48,944**	
2001/02	1,404,539	6.5	14.9	**67**	40,959	173,000	**51,913**	
2003	1,184,590	5.6	13.5	**56**	28,670	130,011	**36,511**	
2004	1,184,822	5.5	12.7	52	26,212	120,465	**33,495**	
2005	1,676,535	4.9	11.9	52	34,483	153,644	43,229	~10
2006	1,781,553	4.2	10.9	**36.5**	30,089	135,538	35,734	~90
Total	**13,911,375**	**5.5**	**14.0**	**~59**	**368,906**	**1,506,175**	**~441 t**	**~12.7%**

21.43 Cadjebut and Pillara (Lennard Shelf Field), Western Australia

- *Cadjebut-Pillara (Lennard Shelf) : 1988-2004*
  Data Sources : (BHP, var.; LP & Minmet, var.; RIU, var.; WM, var.)

	Cadjebut Mill			**Pillara Mill**			**Total Production**	
	Ore Milled (t)	%Pb	%Zn	**Ore Milled** (t)	%Pb	%Zn	t Pb	t Zn
1988								
1989	443,600	3.2	14.6				**11,356**	**51,812**
1990	**500,000**	**3**	**14**				**12,000**	**56,000**
1991	**525,000**	**3**	**13**				**12,600**	**54,600**
1992	575,670	5.17	12.49				**23,810**	**57,521**
1993	**550,000**	**3**	**12**				**13,200**	**52,800**
1994	**550,000**	**3**	**12**				**13,200**	**52,800**
1994/95	561,191	2.83	11.81				13,498	62,754
1995/96	744,618	2.8	9.10				18,175	64,625
1996/97	837,856	2.70	8.2				19,680	66,362
1997/98	914,429	3.54	7.37	12,039	2.69	5.62	28,323	64,703
1998/99	885,558	4.22	6.72	1,285,605	2.39	6.72	61,241	139,127
2000				1,581,774	2.44	7.51	63,870	163,715
2001				2,190,283	2.89	7.2	77,373	183,899
2002				2,723,851	3.02	7.07	69,833	182,237
2003				2,924,138	2.7	6.3	69,610	176,263
2004				725,318	2.3	6.4	14,458	44,367
Total	**~7 Mt**	**~3.3**	**~10.4**	**11.443 Mt**	**2.72**	**6.88**	**~522 kt**	**~1,474 kt**

21.44 Nabarlek, Northern Territory

- *Nabarlek Uranium Production Statistics* Data Sources : (Mudd, 2007; OSS, var.)

Year	**Ore Milled** (t)	**Heap Leach** (t) §	**Grade** (%U_3O_8)	**Prod.** (t U_3O_8)	**Waste Rock** (t)
1979/80					2,330,000
1980/81	72,573		2.35	1,660.0	
1981/82	78,724		1.93	1,479.0	
1982/83	76,248		1.626	1,211.1	
1983/84	75,567		1.691	1,274.1	
1984/85	80,374		1.673	1,328.1	
1985/86	79,512	3,844	1.720	1,384.0	
1986/87	74,769	25,558	1.874	1,387.1	
1987/88	60,190	41,678	1.932	1,151.2	
1988/89		85,290	0.094	80.4	
Total	597,957	156,370	1.84	10,955	2,330,000

§ This was the low grade ore mined in 1979 but stockpiled. This was experimentally heap leached from late 1985 to mid-1989.

21.45 Rum Jungle, Northern Territory

- *Rum Jungle Uranium-Copper Production Statistics*
  Data Sources : (Barlow, 1965; Lowson, 1975; Mudd, 2007)

Year	Uranium Ore		Purchased Ores		Copper Ore		Production		LGO &
	(t)	(% U_3O_8)	(t)	(% U_3O_8)	(t)	(%Cu)	(t U_3O_8)	(t Cu)	**WR** (t)
1954	22,489	0.23	418.1	0.4	444	2.2	27.8	89.4	1,890,000
1955	51,534	0.38	1,413.3	0.76	2,856	2.7	148.9	668.6	1,890,000
1956	72,778	0.41	2,374.5	0.38		2.5	241.8	1,429	1,890,000
1957	72,036	0.31	4,170.9	0.65		2.6	198.1	1,409	2,680,000
1958	74,660	0.23	1,294.4	0.97	25,881	2.3	149.9	1,820	2,940,000
1959	76,863	0.23	18.29	3.42	66,830	2.6	145.8	2,729	0
1960	74,456	0.28	96.01	9.18	96,593	2.2	174.8	3,099	0
1961	79,976	0.35	244.77	8.22	91,678	2.2	246.2	1,553	1,664,333
1962	73,263	0.41			10,330	2.77	250.2	539	1,664,333
1963	73,570	0.37					257.7		1,664,333
1964	74,000	**0.35**			121,000	**1.8**	259.4	2,161	0
1965	79,000	**0.35**			144,000	**2.0**	274.7	2,862	0
1966	79,000	**0.32**			103,000	**2.1**	249.9	2,190	0
1967	91,000	**0.28**					257	577.3	0
1968	109,000	**0.23**					246.4	494.5	20,000
1969	150,000	**0.16**					200		0
1970	150,000	**0.12**					150		0
1971	50,000	**0.12**					50		0
Total	**1,453,625**	**0.27**	**10,030**	**0.90**	**662,612**	**2.12**	**3,529**	**21,621**	**16,303,000**

21.46 Olympic Dam, South Australia

- *Olympic Dam : 1984-2006*
  Data Sources : (BHPB, var.; Hall, 1988; Milazzo, 1988; Mudd, 2007; WMC, var.-a, var.-b)

Year	Ore	Grade				Production				Waste [#]
	Milled (t)	(%Cu)	(% U_3O_8)	(g/t Ag)	(g/t Au)	(t Cu)	(t U_3O_8)	(kg Ag)	(kg Au)	**Rock** (t)
1984 [§]	19,870	**3.32**	**0.045**			660	9.0			1,888,925
1988	538,678	3.83	0.142	23.60	0.59	4,834	452	0.0	0.0	43,094
1989	1,361,617	3.39	0.108	19.55	0.61	31,707	1,020.5	0.0	341.2	108,929
1990	1,611,655	2.92	0.107	14.65	1.10	42,002	1,269	5,565.4	874.0	128,932
1991	1,750,548	3.21	0.107	11.80	0.53	53,396	1,333	15,397.4	714.4	140,044
1992	2,238,435	3.19	0.097	9.62	0.67	69,942	1,392.1	14,003.1	987.4	179,075
1993	2,355,298	3.02	0.080	8.90	0.48	66,575	1,304.1	12,290.5	847.3	188,424
1994	2,379,554	2.97	0.073	6.68	0.52	64,070	1,133.2	10,810.9	825.4	190,364
1995	2,728,567	3.02	0.073	6.71	0.56	78,284	1,356.4	10,908.7	969.8	218,285
1996	3,097,550	3.05	0.084	6.68	0.54	81,324	1,719.6	12,571.7	1,060.4	247,804
1997	3,135,787	2.88	0.078	5.96	0.57	77,204	1,681	10,059.4	881.3	250,863
1998	3,404,616	2.72	0.079	5.28	0.56	73,645	1,740	9,537.7	982.4	272,369
1999	6,743,321	2.68	0.089	5.49	0.67	138,272	3,198	7,621.9	948.9	2,058,000
2000	8,900,946	2.53	0.074	5.03	0.53	200,423	4,500	19,441.9	2,176.0	712,076
2001	9,335,736	2.47	0.072	4.50	0.55	200,523	4,355	38,151.7	3,527.1	746,859
2002	8,874,597	2.58	0.069	4.29	0.53	178,120	2,881	20,028.1	1,999.4	709,968
2003	8,386,629	2.42	0.063	4.63	0.47	160,079	3,176	18,703.4	2,678.2	670,930
2004	8,887,088	2.26	0.064	4.53	0.45	224,731	4,370	26,797	2,756	710,967
2005	9,645,820	2.33	0.062	**4.73**	**0.55**	211,719	4,362	21,555	2,626	771,666
2006	9,085,000	2.10	0.057	5.66	0.58	182,900	3,377	25,689	2,928	726,800
Total	**86.97 Mt**	**2.57**	**0.073**	**5.88**	**0.55**	**2,140,410**	**44,611**	**279,132**	**28,123**	**~11 Mt**

[#] Actual waste rock (or mullock) production is rarely reported. Figures based on a reported ore:mullock ratio of about 12.5:1 (Steve Green, pers. comm., Olympic Dam, WMC, 13 February 2002). Additional data sourced from (WMC, 1999), (Milazzo, 1988) and (Hall, 1988). All mullock is eventually returned as backfill in the underground mine.

[§] Pilot milling and metallurgical research only; [#] waste rock from underground exploration and development (see above note).

21.47 Ranger, Northern Territory

- *Ranger Uranium Production Statistics*
  Data Sources : (ERA, var.; Mudd, 2007; OSS, var.)

Financial Year	**Ore Milled** (t)	**Grade** (%U_3O_8)	**Production** (t U_3O_8)	**Low Grade Ore** (t)	**Waste Rock** (t)
1980-81				0	~5,000,000
1981-82	859,000	0.308	2,322.5	0	1,786,000
1982-83	1,044,000	0.318	3,000.0	600,000	1,800,000
1983-84	1,003,000	0.343	3,098.7	711,000	974,500
1984-85	1,021,000	0.317	3,037.0	1,269,000	1,818,700
1985-86	968,000	0.350	3,067.0	870,000	1,590,000
1986-87	869,000	0.379	3,123.8	920,000	2,120,000
1987-88	782,000	0.423	3,041.5	2,840,000	1,160,000
1988-89	975,000	0.408	3,595.8	1,735,000	1,399,000
1989-90	1,089,000	0.314	3,084.0	862,000	957,000
1990-91	1,090,000	0.295	2,908.0	569,000	1,002,000
1991-92	986,000	0.324	2,980.0	792,000	0
1992-93	426,000	0.348	1,335.1	1,942,000	1,102,000
1993-94	437,000	0.389	1,461.8	1,771,000	980,000
1994-95	578,000	0.345	1,548.2	1,324,000	404,000
1995-96	1,201,000	0.349	3,453.3	14,000	245,000
1996-97	1,570,800	0.311	4,236.9	2,772,000	1,849,000
1997-98	1,843,000	0.260	4,162.0	4,141,000	1,730,000
1998-99	1,826,500	0.267	4,375.0	4,158,000	1,185,000
1999-00	1,468,300	0.299	4,144.0	2,867,000	1,657,000
2000-01	1,840,000	0.287	4,612.0	3,392,000	2,443,000
2001(½)	665,000	0.299	1,952	1,483,000	1,001,000
2002	1,784,000	0.281	4,470	195,000	2,624,000
2003	2,068,000	0.281	5,065	419,000	3,830,000
2004	2,086,000	0.278	5,137	**~8,500,000**	
2005	2,293,000	0.288	5,910	**14,910,000**	
2006	2,072,136	0.261	4,748	**9,900,000**	
Total	**32.844 Mt**	**0.290**	**89,869**	**»35,646,000**	**»38,657,200**

21.48 Moline and Rockhole, Northern Territory and Radium Hill, South Australia

- *Moline, Rockhole and Radium Hill Uranium Production Statistics*
  Data Sources : (MB-NTA, var.; Mudd, 2007)

Year	**Moline**			**Rockhole**			**Radium Hill**		
	Ore (t)	**Grade** (%U_3O_8)	**Prod.** (t U_3O_8)	**Ore** (t)	**Grade** (%U_3O_8)	**Prod.** (t U_3O_8)	**Ore** § **Conc.** (t)	**Grade** (%U_3O_8)	**Prod.** (t U_3O_8)
1955	240	63.4	152						
1956	70	45.6	32				56,896	0.119	66.2
1957	4,687	0.68					122,936	0.119	143.1
1958							140,818	0.119	163.9
1959	18,288	0.44	70	1,621	1.32	20.49	149,347	0.119	173.9
1960	40,551	0.35	122	2,851	1.46	39.74	176,755	0.119	205.8
1961	25,751	0.396	93	4,318	0.94	38.81	85,344	0.119	99.4
1962	25,867	0.39	91	4,628	0.97	40.66			
1963	15,324	0.691	96						
1964	11,804	0.558	60						
Total	**142,582**	**0.57**	**716**	**13,418**	**1.11**	**140**	**975,090** §	**0.119**	**852.3**

§ This is the total ore concentrated at Radium Hill, with the concentrate chemically processed at Port Pirie; actual as-milled annual ore grades never reported.

21.49 Mary Kathleen, Queensland

- *Mary Kathleen Uranium Production Statistics*
  Data Sources : (MKU, var.; Mudd, 2007; QDM, var.)

Year	**Ore Milled** (t)	**Grade** (%U_3O_8)	**Production** (t U_3O_8)	**Low Grade Ore** (t)	**Waste Rock** (t)
1956				1,651	33,403
1957				130,481	319,571
1958	205,027	0.154	254.92	19,752	290,115
1959	435,447	0.168	658.68	95,890	794,610
1960	434,210	0.171	669.42	66,672	923,971
1961	550,348	0.178	873.48	85,301	656,187
1962	561,617	0.182	907.3	96,876	513,921
1963	481,446	0.165	727.96	69,751	331,612
1976	384,545	0.110	423		2,750,000
1977	381,818	0.110	420		2,750,000
1978	552,182	0.110	607.4		2,750,000
1979	779,000	0.107	832.0		2,600,000
1980	680,000	0.123	834.5	280,000	2,440,000
1981	749,727	0.110	824.7	619,174	1,291,426
1982	781,273	0.110	859.4		2,100,000
Total	**6,976,640** [§]	**0.135**	**8,893**	**1,465,548** [#]	**20,544,815** [#]

[§] This is the ore chemically processed after radiometric sorting. In total, some 9.1 Mt of 0.13% U_3O_8 ore was milled.
[#] The total figure for low grade ore and waste rock is some 31 Mt.

21.50 Radium Hill and Mt Painter (Radium Mining), South Australia

- *Radium Hill and Mt Painter Radium Mining : 1906-1934*
  Data Sources : (Mudd, 2005, 2006; SADM, var.-a)

Year	Radium Hill	Mt Painter	Value
1949		~0.45 t ore to USA	??
1934		18.0 mg Ra	£240
1932		72.0 mg Ra; 0.152 t '$NaUO_3$' [#]	£1,050
1927 Dec ½		45 mg Ra (£450); 0.187 t '$NaUO_3$' [#] (£118)	£1,088
1927 June ½		52 mg Ra; 2.5 t ore conc	
1926	no Ra	DC - 18.3 t (0.75%), 3 t ore conc. (2.6-3.8%); MP - 2.17 t ore conc. (6.2%); 700 t ore at surface; no Ra	
1925	3 t ore concentrate; 7.01 mg Ra; 0.23 t '$NaUO_3$' [#]		£172.17
1918			£686
1915 June ½	215 t ore milled, 41 t ore concentrate		
1914 Dec. ½	406 t ore milled, 41 t ore concentrate	6.1 t ore 'high' grade	£5,215
1914 June ½	132 t ore milled; >239 mg Ra	20.3 t @ 3.24%, 61 t @ ~1%, 3 t @ 0.8% & 0.8 t @ 5-20% to Europe	
1913 Full Yr	167 t mined @ 1.4%U_3O_8	466 mg Ra	£3,620
1913 June ½		127 t ore to England @ ~2.6%	
1912 Dec. ½	RH mill @ 10 t/week HH - 122 t smelted HH - 96.5 t treated RHN - 7.1 t ore mined 350 mg Ra	2.3 t ore 2.02% to Europe 7 t ore ~2% to Europe 0.5 t @ 25% (prior to 1913)	~£50 ??
1911 June ½	610 t ore at surface, 44 t ore to Bairnsdale, VIC	5.1 t ore to Europe	
1909 Dec ½	31 t ore to Europe; ~3 t to USA		
Approximate Totals	>2,150 t ore milled, ~1,800 mg Ra, up to 7 t U_3O_8 by-product (?) Total Value ~£8,800	~933 t ore mined @ ~2.1%, 194.01 mg Ra (£2,338), ~3 t U_3O_8 (£213), Total Value ~£10,000	~£18,800

Notes : RH/MP - Radium Hill/Mt Painter onsite mills; RHN - Radium Hill North mine; HH - Hunters Hill radium refinery, Woolwich, Sydney, NSW; DC - Dry Creek radium refinery, Adelaide, SA. Grades in %U_3O_8. [#] sodium uranate (~$Na_2U_2O_7$).

21.51 CSA, New South Wales

- *CSA Copper-Silver-Zinc-Lead - Milling : 1905-2004*

Data Sources : (Andrews, 1911a, 1911b; BMR, var.; Brown, 1983; Carne, 1908; CRA, var.; GSM, var.; Kenny, 1923; NSWDM, var.; RIU, var.; Seaton, 1980; Shi & Reed, 1998b; Thompson, 1980)

Note : Data was also supplied by Cobar Mines Pty Ltd; Letter, R Morland, 31 March 2005.

Year	Ore	Grade				Production				
	Milled (t)	%Cu	g/t Ag	%Pb	%Zn	t Cu	kg Ag	t Pb	t Zn	kg Au
1905	305		61	50			19	152		1
1906	4,068		32	23.5			128	957		~7.3
1907	1,258	~0.4	36.4	34.7		5	212	390		~1.9
1911	499	4.58				23				
1912	2,559		122	32.0			313.4	819		~7.8
1913	4,118			24.7				1,016		
1914	1,523	~7.6				~115	~71	~51		
1915	4,420	10.5				462				
1916	2,570	15.0				386				
1917	12,848	3.50				450				~2.3
1918	55,908	4.06				2,268				~17.4
1919	15,876	2.53				402				~1.3
1920	8,000	2.95				236				~2.6
1963	6,315	1.47				93				
1964	16,158	2.36	11.41			314	143.1			
1965	201,917	2.16	14.55			3,956	1,449.7			
1966	426,294	2.00	15.49			7,793	4,582.1			
1967	470,239	1.84	13.13			8,257	6,085.8			
1968	634,705	1.81	26.9	1.80	4.89	10,885	6,980.0	2,107		
1969	704,528	1.75	26	0.26	0.83	11,921	5,788	1,837	5,823	
1970	635,325	1.69	26	0.31	1.11	10,616	9,160	1,978	7,029	
1971	431,825	1.58	26	0.47	1.54	7,138	8,259	2,042	6,646	
1972	681,760	1.77	26	0.39	1.03	11,297	8,900	2,634	7,028	
1973	660,130	1.72	26	1.8	5.2	10,912	~9,700	2,506	8,480	
1974	607,430	1.70	24	0.81	2.01	10,004	7,609	1,665	5,465	
1975	594,430	1.54	23	0.67	2.18	9,665	8,161	1,447	6,576	
1976	557,720	1.35	21	0.46	1.71	8,890	7,105	1,263	6,805	
1977	518,650	1.67	22	0.81	3.17	8,262	6,649	3,450	13,660	
1978	446,630	1.53	26	1.29	3.46	7,025	6,856	4,629	13,984	
1979	512,150	1.42	23	1.33	3.33	7,943	5,873	2,002	6,776	
1980	616,710	1.56	23	0.98	2.67	9,460	6,039	3,629	11,305	
1981	422,340	1.24	21	1.41	4.24	6,458	5,464	4,658	12,757	
1982	540,420	1.65	24	0.78	2.36	8,263	7,627	3,247	11,392	
1983	625,200	1.70	24	0.77	1.93	9,572	9,313	3,523	10,840	
1984	543,910	1.55	24	1.05	2.89	8,284	7,887	4,164	13,617	
1985	349,120	2.23	23	0.89	2.25	7,521	5,594	2,022	6,661	
1986	825,020	1.68	21	0.87	3.76	13,389	12,473	4,965	29,281	
1987	887,250	1.84	22	0.50	3.91	15,770	11,800	2,000	28,200	
1988	908,920	2.33	24	0.6	2.3	20,458	13,363	2,030	14,752	
1989	902,320	1.77	17	0.9	2.8	15,428	10,109	4,654	19,201	
1990	910,820	2.06	19	0.74	2.13	18,037	11,005	3,376	13,635	
1991	915,215	2.71	17	0.47	1.42	23,959	11,301	2,417	9,875	
1992	896,246	3.46	19	0.07	0.12	29,956	13,060		51	
1993	452,647	3.93	21.4	0.03	0.72	17,184	15,012		4,111	
1994	1,044,237	2.97	19.2		0.21	29,761	14,925		1,461	
1995	1,020,387	3.43	17.3		0.29	33,918	12,863			
1996	961,274	3.39	17			31,799	11,927			
1997	1,114,519	3.16	18			34,160	14,129			
1999	239,317	4.65				10,279				
2000	440,753	6.75	27			29,010				
2001	627,774	4.77	58			28,689				
2002	637,915	4.49				28,004				
2003	641,633	6.06				37,285				
2004	629,280	6.48				39,653				
Total	**25.373 Mt**	**~2.6**	**~20**	**~0.5**	**~1.6**	**645.6 kt**	**»300 t**	**~72 kt**	**~275 kt**	**»50 kg**

21.52 Peak, New South Wales

- *Peak Gold-Copper-Silver-Zinc-Lead - Milling : 1937-1942, 1992-2006*
  Data Sources : (Goldcorp, var.; NSWDM, var.; RIU, var.; RT, var.)

Year	Ore	Grades					Production				
	Milled (t)	g/t Au	%Cu	g/t Ag	%Pb	%Zn	kg Au	kg Ag	t Cu	t Pb	t Zn
1937	113	**47.63**		**639.4**			5.4	72.4			
1940	203	**5.05**					1.0				
1941	193	**9.22**					1.8				
1942	219	**9.25**					2.0				
1992	215,911	3.68	1.53	11.37	2.18	1.59	722.0	114.0	**2,411**	**2,810**	**2,103**
1993	455,769	10.41	1.81	13.86	1.72	1.21	4,554.1	752.5	6,565	0	0
1994	499,073	7.70	1.07	17.96	1.16	0.79	3,734.6	644.3	4,073	528	533
1995	519,906	8.75	1.06	9.52	1.14	0.67	4,314.4	529	3,919	1,651	1,024
1996	530,000	9.32	0.68	5.74	0.91	0.77	4,758	560	2,277	1,755	1,223
1997	548,000	8.79	0.68	5.43	0.8	0.78	4,603	529	2,400	600	1,000
1998	528,400	6.92	0.43	4.87	0.65	0.73	3,474	404	1,350	**1,700 Pb+Zn**	
1999	598,000	7.6	0.51	5.34	0.63	0.61	4,354	373	1,700	**2,100 Pb+Zn**	
2000	589,000	7.23	0.4	5.38	0.82	0.9	4,043	498	2,500	**6,600 Pb+Zn**	
2001	594,000	5.88	0.43	9.91	0.8	1.44	3,141	746	900	**4,600 Pb+Zn**	
2002	610,000	5.52	0.29	3.05	0.22	0.28	3,017	373	400	0	
2003	637,000	6.74	0.52				3,498.8		1,590	0	
2004	663,441	7.40	0.58				4,438.1		3,038	0	
2005	672,672	7.09	0.50				4,149.1		2,546	0	
2006	>527,700	5.49	0.60				2,553.3		2,332	0	
Total	**8.19 Mt**	**7.31**	**0.68**	**~6.0**	**0.63**	**0.58**	**55.36 t**	**»5.6 t**	**38.0 kt**	**~10 kt**	**~8 kt**

21.53 Golden Grove, Western Australia

- *Golden Grove Copper-Zinc-Silver-Gold - Milling : 1991-2006*
  Data Sources : (Newmont, var.; Normandy, var.; Oxiana, var.; RIU, var.)

Year	Ore	Grade					Production				
	Milled (t)	%Cu	%Pb	%Zn	g/t Ag	g/t Au	t Cu	t Pb	t Zn	kg Ag	kg Au
1991	639,025	0.7		15.1	109	1.1	1,834		84,871	18,555	141
1992	758,520	0.6		14.1	**21.8**	**0.17**	1,747		96,397	16,536	127
1993	851,500	1.2		11.2	**22.8**	**0.16**	4,775		79,354	19,378	139
1994	901,146	1.4		11.3	**26.4**	**0.14**	6,495		85,593	23,781	124
1995	863,079	1.8		8.6	**18.3**	**0.09**	9,827		58,358	15,826	82
1996	864,191	1.6		9.4	**21.9**	**0.21**	9,899		69,695	18,903	183
1997	907,901	1.9		7.5	**21.8**	**0.19**	12,794		55,085	19,790	173
1998	865,156	1.3		10.6	**32.9**	**0.31**	8,336		78,795	28,423	270
1999	1,053,300	0.6	0.6	11.9	**~30**	**~0.3**	3,100	900	110,355	**~31,599**	**~316**
2000	1,208,900	0.5	0.8	11.0	**40.9**	**0.50**	2,300	5,273	118,700	49,449	602
2001	1,167,300	4.8		12.1	**~30**	**~0.3**	11,500		97,172	**~35,019**	**~350**
2002	1,293,368	4.7		13.9	**27.0**	**0.33**	27,220		51,253	34,922	423
2003	1,429,001	4.56		12.40	**32.1**	**0.29**	25,803		53,761	45,891	417
2004	1,387,856	3.12		10.45	**24.5**	**0.43**	18,451		46,221	34,005	600
2005	1,281,277	~1.88	**~0.50**	~5.89	**~52.6**	**~0.67**	23,067	6,393	72,761	67,361	~859
2006	1,366,540	1.03	**~0.50**	11.09	**52.1**	**1.06**	13,142	11,634	138,795	71,197	1,451.8
Total	**~16.84 Mt**	**2.2**	**»0.1**	**11.0**	**~35**	**~0.4**	**180.3 kt**	**»24 kt**	**1,297 kt**	**~531 t**	**~6.3 t**

21.54 Mt Morgan, Queensland

- *Mt Morgan Gold-Copper : 1887-1990*

  Data Sources : (Anonymous, 1965; BMR, var.; Carne, 1908; Frets & Balde, 1975; MML, 1980; QDM, var.; RIU, var.; Staines, 1953; Taube, 1990a, 1990b)

  Note : No data exists for Mt Morgan prior to 1887. All mining from 1933-1982 is by open cut (1983-1990 is tailings reprocessing).

Year	Ore Milled (t)		Grades			Production			%Open	Waste
	Gold	Copper	(g/t Au)†	(%Cu)	(g/t Ag)	(kg Au)	(t Cu)	(kg Ag)	Cut	Rock (t)
1887	13,280		**135.9**			1,804.6				
1888	17,517		**160.9**			2,818.4				
1889	76,622		**131.3**			10,062.2				
1890	77,434		**104.0**			8,053.3				
1891	85,709		**52.2**			4,472.0				
1892	75,292		**50.3**			3,783.6				
1893	64,025		**58.2**			3,727.7				
1894	77,011		**44.3**			3,410.7				
1895	90,179		**45.9**			4,140.6				
1896	108,200		**43.8**			4,736.2				
1897	129,203		**41.0**			5,293.1				
1898	189,181		**27.5**			5,203.3				
1899	219,846		**24.4**			5,361.3				106,728
1900	246,549		**26.1**			6,427.8				90,870
1901	207,069		**23.3**			4,834.5				
1902	221,722		**20.4**			4,520.3	25.4 P			
1903	242,622		**15.1**			3,652.7	136.8 P			**»48,800**
1904	235,765	6,672	**17.2**	**4.42** ‡		4,176.9	294.6	+ 169.7 t Cu P		
1905	263,117		**16.0**			4,222.1	239.9 P			634,874
1906	235,329	70,570	**13.6**	**3.70** ‡		4,171.3	2,608			
1907	237,270	86,553	**14.3**	**5.09** ‡		4,639.7	4,402		**~31**	250,952
1908	251,867	187,053	**10.7**	**3.42** ‡		4,695.2	6,402	2.1	35.34	255,164
1909	187,274	211,821	**11.1**	**3.00** ‡		4,438.6	6,362		30.09	
1910	129,242	190,358	**11.2**	**3.38** ‡		3,577.1	6,435		12.43	126,392
1911	103,816	168,446	**14.7**	**3.18** ‡		4,007.4	5,348		12.76	202,831
1912	34,365	206,328	**17.8**	**3.48** ‡		4,289.7	7,182		4.73	107,290
1913	228,114		**14.5**	**3.41**		3,317.2	7,770		0.79	126,248
1914	260,317		**12.7**	**3.04**	**4.05**	3,296.8	7,921	1,055.4	0	
1915	241,079		**15.6**	**3.38**	**3.97**	3,754.5	8,146	957.2	0	202,323
1916	213,962		**14.8**	**3.63**	**21.63**	3,158.0	7,768	4,628.4	0	
1917	181,470		**16.0**	**3.90**	**8.65**	2,910.4	7,083	1,570.6	4.00	107,023
1918	117,818		**20.9**	**5.74**	**6.74**	2,459.1	6,761	794.6	2.25	131,342
1919	119,154		**23.5**	**4.55**	**5.66**	2,796.0	5,418	674.9	2.50	121,083
1920	111,476		**25.3**	**5.73**	**6.82**	2,821.3	6,384	760.1	0.43	134,223
1921	75,599		**7.2**	**0.00**	**3.19**	544.1		241.3	0.87	34,043
1922	210,141		**7.3**	**0.99**	**1.92**	1,541.6	2,075	403.1	0.11	93,637
1923	252,401		**7.9**	**1.95**	**2.02**	2,001.7	4,926	509.5	0.06	116,605
1924	231,560		**10.3**	**2.13**	**2.28**	2,379.8	4,943	527.1		18,176
1925	140,716		**7.5**	**1.90**	**2.26**	1,056.8	2,677	317.5		13,970
1926						1.1		23.3		
1927	54,948		**15.7**	**1.50**	**3.55**	860.8	825	195.3		
1928						136.1	437	165.2		
1929						3.0	183			
1930						28.6	244	2.5		
1931						39.1	116	2.0		
1932						28.9	14	1.9		
1933	114,183		**7.67**	**0.39**		876.0	441		100	
1934	174,247		**5.51**	0.5		960.0	757		100	230,899
1935	218,923		**5.18**	**0.54**		1,133.3	1,185		100	
1936	296,822		**3.91**	0.67		1,160.2	1,537		100	339,882
1937	591,438		**2.69**	0.66		1,588.6	1,835	1.1	100	237,899
1938	790,262		**2.54**	0.71		2,004.6	2,391	0.3	100	702,855
1939	906,909		**2.48**	0.73		2,245.0	3,022	0.3	100	1,478,705
1940	992,466		**1.78**	**0.48**		1,766.6	4,774	0.3	100	1,016,000
1941	973,554		**1.42**	**0.53**		1,386.0	5,208	4.7	100	1,609,076
1942	864,718		**1.84**	0.63		1,590.0	4,774	5.2	100	1,805,512
1943	868,477		**1.66**	0.54		1,439.4	3,825	1.1	100	1,354,635
1944	773,176		**1.61**	0.49	**0.65**	1,245.3	3,196	505.0	100	879,909

† Grade of total ore milled (gold and copper). P Copper precipitates only. ‡ Grade of copper ore only.

Mt Morgan Gold-Copper Mine

Year	Ore Milled (t)	Gold (g/t)	Copper (%Cu)	Silver (g/t)	Gold (kg)	Copper (t)	Silver (kg)	Waste Rock (t)
1945	547,776	**2.86**	0.67	**0.83**	1,569.1	3,053	456.6	980,375
1946	739,648	**2.07**	0.49	**0.74**	1,529.1	2,966	545.9	923,574
1947	690,423	**2.41**	0.48	**0.68**	1,662.9	2,611	469.1	1,103,406
1948	689,764	**2.38**	0.55	**0.62**	1,642.0	3,010	428.4	1,842,705
1949	853,240	3.31	0.53	**0.53**	1,840.8	3,770	451.5	1,075,860
1950	820,337	4.58	0.66	**0.63**	2,343.7	3,752	513.0	1,531,137
1951	925,546	3.53	0.63	**0.62**	1,993.2	5,040	570.3	1,337,161
1952	886,673	3.39	0.81	**0.77**	2,047.1	6,187	679.6	1,981,291
1953	801,853	3.80	0.98	**0.95**	1,624.3	6,926	764.4	3,070,769
1954	938,159	**2.67**	0.88	**0.76**	2,508.9	7,392	717.0	2,924,095
1955	892,079	**1.67**	**0.77**	**0.63**	1,490.6	6,861	566.3	2,718,103
1956	760,527	2.76	0.93	**1.02**	1,617.7	6,232	776.5	2,552,940
1957	825,856	2.48	0.81	**0.75**	1,425.7	6,563	622.8	1,532,142
1958	854,151	2.99	0.88	**0.65**	1,698.2	7,862	557.9	1,856,067
1959	819,099	3.95	1.07	**0.09**	2,326.1	8,191	70.4	3,824,808
1960	961,441	3.34	1.05	**0.90**	1,922.2	8,527	869.8	3,643,540
1961	1,129,995	2.18	0.89	**0.80**	1,356.3	8,472	905.5	3,340,405
1962	1,169,060	1.83	0.80	**1.07**	1,650.9	7,740	1,253.2	2,680,299
1963	1,247,750	2.17	0.77	**1.08**	1,634.1	8,606	1,352.2	2,945,759
1964	1,353,434	2.36	0.63	**0.96**	2,660.0	7,543	1,298.5	2,811,271
1965	794,634	2.96	0.67	**0.99**	1,966.7	4,795	788.6	3,783,181
1966	1,362,680	4.23	0.67		3,557.1	7,932		3,511,811
1967	1,415,227	3.40	0.55	**0.63**	2,601.0	6,748	886.3	2,271,260
1968	1,434,707	2.33	0.63	**0.71**	1,958.5	7,304	1,020.2	2,768,283
1969	1,509,230	2.12	0.62	**0.81**	1,791.4	8,186	1,221.4	2,973,847
1970	1,465,039	2.23	0.59	**0.90**	1,877.6	7,058	1,311.9	3,454,064
1971	1,248,619	2.75	0.86	**0.55**	1,452.5	6,252	683.8	3,269,492
1972	1,139,782	2.42	0.80	**0.91**	1,504.70	6,698	1,037.62	3,243,676
1973	1,186,900	1.43	0.76	**1.16**	1,538.06	9,370	1,375.73	2,886,979
1974	1,044,080	2.37	1.00	**1.45**	1,962.49	9,745	1,517.91	2,763,767
1975	1,133,775	1.68	0.72	**1.23**	933.53	6,829	1,388.91	2,018,888
1976	771,345	2.73	0.82	**2.16**	1,708.60	7,224	1,663.48	565,739
1977	484,640	3.29	1.01	**1.78**	1,076.30	4,487	863.66	408,480
1978	327,060	2.58	0.94	**1.43**	517.80	2,273	467.98	1,085,515
1979	360,699	2.06	0.87	**3.77**	392.50	1,750	1,360.90	973,930
1980	614,808	1.80	0.80		404.822	2,520		1,290,895
1981	494,236	2.29	1.45		834.475	5,465		1,257,943
1982	**98,521**	**2.34**	**1.76**		**161.6**	**1,520**		
Total	**~49.74 Mt**	**~5.3**	**~0.85**	**»1**	**242.6 t**	**374 kt**	**»45 t**	**~100 Mt**

§ Includes additional production from tailings reprocessing (below).

Mt Morgan Gold-Copper Mine : Tailings Re-processing 1983-1990

Year	**Ore** (Mt)	kg Au	kg Ag
1983/84	2.96	1,217.5	403.0
1984/85	3.1069	1,634.0	530.2
1986/87	3.25	1,864.0	628.9
1988/89	3.12	2,085.7	637.6

Year	**Ore** (t)	%Cu	g/t Au	t Cu	kg Au
1976	61,260	0.24	1.28	35	18.5
1977	24,610	0.24	1.37	15	8.1
1983					298

Year	kg Au
1984	1,379
1985	1,634
1986	1,542
1987	2,054

21.55 Mt Lyell Field, Tasmania

- *Mt Lyell Copper-Silver-Gold : 1887-2006* (Note : Includes North Lyell data where available; eg. 1898-1902).

  Data Sources : (Alexander, 1953; Anonymous, 1940, var.; BCGLO, 1956; Blainey, 2000; BMR, var.; Carne, 1908; Clark, 1904; David, 1950; Dunkin, 1953; Harcourt Smith, 1897; Hills, 1990; Jillett, 1980; McLeod, 1965; MLMRCL, 1902; Moyses, 1965; Nye & Blake, 1938; Raggatt, 1968; Reid, 1975; RGC, var.; TDM, var.)

Year	Ore Milled (t)	%Cu	g/t Ag	g/t Au	t Cu	kg Ag	kg Au	Waste Rock (t)	Open Cut (%)
1888	1,904		13.9	27.3		26.5	52.0		
1889	1,554		14.8	14.8		23.0	23.0		
1894	481	23.73	36,952		114	17,758.1			
1895	393	16.47	22,701		65	8,926			
1896	8,360	6.04	136.0	5.93	491	1,137.0	49.5		
1897	112,400	4.96	75.0	3.61	4,826	8,429.2	405.4		92.7
1898	155,600	3.92		4.72	5,297		732.2		
1899	211,775	3.80	108.5	3.76	6,125	22,223.4	769.0	292,667	87.9
1900	181,319	3.39	60.7	2.18	11,170	10,320.6	370.7		
1901	249,850	4.35	52.6	1.65	15,468	19,621.1	729.2		
1902	419,890	2.88	54.3	2.33	12,101	21,106.1	907.5		89.4
1903	405,556	2.17	39.2	2.26	5,717	18,811.1	917.7		
1904	412,936	2.03	61.5	2.33	8,398	25,397.6	963.2		73.1
1905	433,684	2.25	52.5	1.92	8,642	22,765.8	831.5		
1906	398,940	2.19	54.6	1.96	8,751	21,801.7	782.3		
1907	389,022	2.13	56.0	1.96	8,274	21,772.7	763.4		
1908	383,061	1.32	29.2	1.79	8,862	21,458.5	686.8		37.1
1909	354,757	2.44	61.9	1.65	8,671	21,956.9	587.0		72.3
1910	392,866	2.09	52.0	0.95	8,224	20,426.3	372.5		63.9
1911	265,747	2.28	45.5	0.94	6,046	12,093.2	248.9		63.2
1912	263,157	1.96	43.0	1.91	5,154	11,321.1	501.5		62.0
1913	271,337	1.69	40.0	1.38	4,583	10,854.3	373.8		64.9
1914	344,380	2.19	42.6	0.90	7,539	14,677.0	308.7		61.8
1915	346,309	2.29	40.6	0.89	7,939	14,077.3	309.6		61.8
1916	311,397	2.03	32.8	0.88	6,337	10,222.6	274.8		61.5
1917	254,002	2.31	37.4	0.91	5,871	9,501.2	230.5		61.6
1918	235,295	2.37	41.5	0.84	5,578	9,767.2	198.0		59.8
1919	198,655	2.56	35.8	0.86	5,094	7,111.1	170.0		58.1
1920	202,617	2.40	26.1	0.82	4,868	5,285.4	165.4		55.4
1921	178,316	3.52	31.9	0.82	6,269	5,691.9	146.6		47.1
1922	180,431	3.16	20.6	0.36	5,706	3,722.6	65.8		11.9
1923	152,422	4.03	25.0	0.42	6,149	3,810.6	63.3		6.6
1924	162,570	5.96	32.1	0.44	6,805	4,583.4	71.5		6.8
1925	127,713	6.06	32.4	0.61	6,644	4,142.2	70.4		6.3
1926	123,982	5.67	33.76	0.58	7,026	4,185.7	71.7		3.9
1927	111,587	5.29	28.21	0.78	5,904	3,147.5	87.0		0.8
1928	129,791	5.8	25.22	0.70	6,524	3,273.9	90.7		0.4
1929	202,496	4.95	22.95	0.69	8,807	4,647.1	140.1		0.7
1930	257,262	3.93	22.12	0.46	10,100	5,690.6	118.0		0.0
1931	313,894	3.50	14.74	0.38	10,277	4,627.1	118.1		0.0
1932	245,158	3.35	20.50	0.63	11,164	5,026.8	153.3		0.0
1933	434,662	2.79	9.13	0.40	10,699	3,967.2	175.3		
1934	526,821	2.5	5.31	0.29	8,339	2,797.2	152.1		
1935	573,269	2.22	7.74	0.39	14,303	4,436.2	224.2		
1936	676,069	2.06	4.75	0.33	13,249	3,209.2	224.4		60
1937	854,890	1.67	3.03	0.23	13,089	2,588.5	197.1		77
1938	1,048,642	1.43	1.99	0.24	12,980	2,089.2	247.8		83.1
1939	1,103,308	1.34	1.98	0.21	13,606	2,189.8	235.4		82.3
1940	1,193,968	0.98	1.53	0.19	11,757	1,824.9	225.8		83.0
1941	1,374,925	0.86	0.82	0.18	11,828	1,126.1	249.9		85.8
1942	1,550,468	0.74	0.73	0.15	11,435	1,126.1	226.5		87.8
1943	1,549,480	0.70	0.89	0.14	10,855	1,378.4	224.5	336,321	89.4
1944	1,499,503	0.67	0.79	0.13	9,988	1,183.3	200.4	322,899	91.0
1945	1,492,636	0.49	0.50	0.10	7,312	753.1	151.0	285,310	94.7
1946	1,509,423	0.61	0.70	0.13	9,280	1,063.4	191.0	317,026	94.2
1947	1,457,308	0.53	0.60	0.12	7,790	867.4	168.0	593,723	93.6
1948	1,325,421	0.60	0.53	0.10	6,427	707.9	126.0	611,267	94.9
1949	1,495,316	0.64	0.36	0.06	5,002	542.7	93.9	608,898	90
1950	1,524,027	0.631	1.53	0.26	7,615	813.3	183.2	853,996	90
1951	1,543,248	0.648	1.35	0.23	8,473	758.8	177.8	1,107,277	93
1952	1,477,766	0.62	0.66	0.12	7,500	974.2	176.9	1,275,162	93

Mt Lyell Copper-Silver-Gold Mine

Year	Ore Milled (t)	%Cu	g/t Ag	g/t Au	t Cu	kg Ag	kg Au	Waste Rock (t)	Open Cut (%)
1953	1,493,197	0.66	0.60	0.11	8,465	892.6	169.8	1,360,424	92.4
1954	1,621,755	0.60	0.66	0.11	9,812	1,070.3	176.6	1,346,128	
1955	1,613,899	0.51	0.60	0.09	8,270	975.8	144.3	1,854,455	
1956	1,626,343	0.50	0.70	0.09	8,119	1,133.1	153.3	2,596,130	
1957	1,936,223	0.53	0.59	0.10	10,220	1,139.7	191.9	2,206,568	
1958	1,983,205	0.53	0.54	0.09	10,520	1,070.1	187.1	1,997,529	
1959	2,000,199	0.57	0.49	0.11	11,347	974.0	215.1	2,086,281	
1960	2,017,396	0.54	0.73	0.11	10,905	1,464.6	223.5	2,339,846	99.5
1961	2,014,071	0.59	0.67	0.11	11,847	1,346.8	225.2	2,702,552	99.3
1962	2,063,327	0.63	0.83	0.11	12,956	1,721.0	231.8	2,388,872	98.8
1963	2,187,714	0.69	0.85	0.15	15,158	1,853.8	320.5	2,241,395	98.9
1964	2,194,717	0.61	0.75	0.11	13,369	1,636.2	243.9	2,148,897	97.9
1965	2,157,285	0.63	0.72	0.12	13,590	1,551.1	254.4	2,333,036	94.3
1966	2,182,119	0.69	0.85	0.12	15,068	1,860.5	270.8	2,283,284	95.3
1967	2,215,625	0.71	1.06	0.13	15,699	2,344.4	292.2	2,025,440	96.8
1968	2,297,062	0.65	1.07	0.11	14,851	2,467.2	263.9	1,447,559	95.4
1969	2,204,925	0.74	1.07	0.15	16,370	2,364.5	323.0	1,486,498	85.9
1970	2,240,852	0.95	1.57	0.19	21,337	3,514.2	429.5	593,022	74.4
1971	2,462,890	0.92	1.49	0.17	22,601	3,672.2	420.6	332,825	62.4
1972	2,411,940	1.13	1.67	0.20	24,288	4,081.0	481.4	85,121	34.8
1973	2,203,873	1.17	3.2	0.367	22,834	3,944	441	567,188	14.4
1974	2,331,054	1.23	3.9	0.38	25,357	5,217.4	492.764	601,530	14.5
1975	2,156,431	1.19	3.6	0.40	22,955	4,402.0	447.556	24,300	8
1976	2,304,034	1.03	2.9	0.31	21,246	3,916.7	417.388		11
1977	1,552,905	1.26	2.68	0.36	17,690	2,621.6	379.895		4.35
1978	1,607,865	1.29	2.17	0.36	19,454	2,644.9	432.659		1.25
1979	1,482,209	1.348	2.57	0.40	18,255	2,673.3	424.779		0
1980	1,605,366	1.325	3.37	0.28	19,835		441.5		0
1981	1,571,306	1.225	2.87	0.40	17,884	3,874.9	467		0
1982	1,437,266	1.21	2.50	0.37	16,467				0
1983	1,785,789	1.44	3.43	0.42	23,847	2,040	405		1.99
1984	1,778,311	1.36	3.95	0.41	21,919	4,813	570		
1985	1,744,913	1.40	3.23	0.44	22,428	14,761	505		
1986	1,619,730	1.57	3.26	0.49	23,619	3,252	514		
1987	1,584,210	1.57	2.03	0.34	23,117	3,214	543		
1988	1,502,558	1.55	1.84	0.34	21,638	2,761.45	511.480		
1989	1,633,906	1.24	1.77	0.27	18,678	2,887.66	434.659		
1990	1,347,360	1.28	1.50	0.27	15,712	2,020.63	360.170	41,495	
1991	1,391,006	1.56	1.84	0.32	19,970	2,557.1	446.3	4,462	
1992	1,679,769	1.52	2.06	0.34	23,540	3,460	566		
1993	1,729,272	1.59	1.88	0.29	25,528	3,257	496		
1994	1,700,054	1.91	2.62	0.37	30,416	4,446	635		
1995	795,232	1.55	2.11	0.36	12,316	1,680	283		
1996	910,533	1.12		0.22	9,571		202	96,587	
1997	1,802,673	1.30	1.85	0.25	21,700	3,331	457	31,120	
1998	2,080,838	1.28		0.21	24,500		436	65,525	
1999	2,100,000	1.35		0.25	26,505		518		
2000	2,471,302	1.24	1.77	0.26	28,907	4,368	632	27,226	
2001	2,504,694	1.16			26,664			116,510	
2002	2,720,483	1.26			31,661			93,624	
2003	2,608,000	1.25		0.3	30,229		561.2	28,504	
2004	2,465,398	1.22		0.3	27,478		479.9	53,054	
2005	~2,500,000	~1.2		~0.3	27,697	3779.1	508.6	77,500	
Total	**~135.24 Mt**	**~1.20**	**~5**	**~0.4**	**1.489 Mt**	**~650 t**	**~40 t**	**»45 Mt**	**~47%**

Mt Lyell Copper-Silver-Gold Mine : Ore Resources

Year	**Ore** (Mt)	%Cu	g/t Ag	g/t Au	t Cu	kg Ag	kg Au	**Reference**
1897	4.6	4.5	92	3.83	205,740	419,850	17,494	(Harcourt Smith, 1897)
1898	2.5							(Blainey, 2000)
1902	1.653	2.35	61	2.3	38.838	100,814	3,801	(MLMRCL, 1902)
1908	4.196	1.31	57	0.80	54,795	239,831	3,343	(Carne, 1908)
1910	3.76							(TDM, var.)
1936	8.966	1.9	4.29	0.49	170,358	38,424	4,391	(TDM, var.)
1937	10.052	1.69	3.98	0.49	169,884	40,001	4,923	
1938	11.324	1.52	3.37	0.46	172,130	38,130	5,200	(Nye & Blake, 1938)
1939	10.625	1.52	3.37	0.46	161,505	35,777	4,879	(Anonymous, 1940)
1951	30.5	0.73	1.5	0.26	222,504	46,650	7,837	
1952	29.0	0.73	1.55	0.26	211,379	44,849	7,445	(BMR, var.)
1953	47.2	0.73	1.5	0.24	344,881	70,861	11,569	
1954	48.4	0.73			353,040			
1955	46.725	0.73			341,091			(BCGLO, 1956)
1956	44.020	**0.73**			**321,348**			
1957	44.020	0.73			321,348			
1958	42.0	0.74			310,510			(BMR, var.)
1959	38.845	0.71			275,798			
1960	27.8	0.8			222,707			
1961	25.882	0.79			204,465			
1962	23.879	0.80	2.58	0.25	191,125	61,504	6,077	(McLeod, 1965)
1963	21.93	0.81			177,595			
1964	23.24	0.93			216,094			(BMR, var.)
1965	21.392	0.94			201,084			
1966	19.3	0.99			191,110			(Raggatt, 1968)
1967	16.9	1.026			173,041			
1968	42.538	1.4			595,530			(BMR, var.)
1969	38.861	1.42			551,826			
1970	38.861	1.42	1.84	0.37	551,826	71,373	14,275	
1971	42.574	1.45	2.15	0.35	616,478	91,387	14,946	(TDM, var.)
1972	41.867	1.46	2.04	0.35	609,490	85,485	14,449	
1973	44.1	1.44	1.85	0.29	634,340	81,485	12,980	
1974	40.577	1.46	1.80	0.29	592,056	72,855	11,943	
1975	39.117	1.44	2.76	0.39	564,104	107,799	15,253	
1976	37.281	1.45	2.83	0.39	539,269	105,504	14,621	
1977	32.222	1.46	2.78	0.38	471,024	89,686	12,388	
1978	30.708	1.45	2.77	0.37	446,180	85,204	11,512	
1979	28.841	1.47	2.80	0.37	422,558	80,706	10,611	
1980	28.386	1.47	2.82	0.38	415,959	80,101	10,839	(BMR, var.)
1981	26.82	1.45	2.78	0.38	390,210	74,492	10,259	
1982	26.92	1.49	2.80	0.39	401,750	75,376	10,447	
1983	26.92	1.49	2.80	0.39	401,750	75,376	10,447	
1984	28.841	1.47	2.80	0.37	422,558	80,706	10,611	
1985	28.386	1.47	2.82	0.38	415,959	80,101	10,839	
1986	26.82	1.45	2.78	0.38	390,210	74,492	10,259	
1987	26.92	1.49	2.80	0.39	401,750	75,376	10,447	
1990/91	6.8927	1.74	3.13	0.65	118,601	21,385	4,464	
1991/92	4.9471	1.76	3.07	0.51	87,285	15,205	2,504	
1992/93	3.34	1.71	3.1	0.49	57,114	10,354	1,637	
1993/94	0.811	1.75	3.4	0.57	14,193	2,757	462	
1994/95	22.496	1.64			368,934			
1995/96	21.4	1.19		0.3	254,940		6,420	
1996/97	20.0	1.25		0.3	249,480		6,000	
1997/98	27.6	1.25			345,430			
1998/99	22.22	1.26		0.34	279,972		7,555	(TDM, var.)
1999/00	20.06	1.25		0.34	250,780		6,871	
2000/01	43.95	1.35		0.32	592,838		13,917	
2001/02	34.81	1.36		0.36	473,416		12,532	
2002/03	32.95	1.37		0.34	451,415		11,203	
2003/04	36.09	1.26		0.34	454,734		12,271	
2004/05	29.761	1.37		**~0.3**	402,412			
2005/06	29.732	1.34		**~0.3**	399,275			
1991/92	396	0.6	***Estimated ore potential only – additional to above.***					(TDM, var.)
1996/97	201	0.8	*Inferred Ore Only.*		1,608,000			
1997/98	195	0.82		**0.26**	1,599,000		50,700	(TDM, var.)
1998/99	192	0.81		0.26	1,555,200		49,920	
1999/00	189.56	0.80		0.26	1,517,600		48,427	

21.56 Moonta-Wallaroo Field, South Australia

- *Moonta-Wallaroo Mines : 1890-1923*

  Data Sources : (Austin, 1863; Cumming & Drew, 1987; Flint, 1983; SADM, var.-a, var.-b; Ward, 1924)

Year	Moonta			Wallaroo			Total		
	Ore Milled	Copper		Ore Milled	Copper		Ore Milled	Copper	
	(t)	(%Cu)	(t Cu)	(t)	(%Cu)	(t Cu)	(t)	(%Cu)	(t Cu)
1861	~8,100	**~25**	**~2,025**	16,165	**~15**	**~2,425**	24,265	**~18**	**~4,450**
1862	3,944	19.24	759						
1863	6,389	21.11	1,349						
1864	6,259	21.66	1,356						
1865	6,769	23.98	1,623						
1866	6,573	22.20	1,459						
1867	6,294	25.68	1,616						
1868	5,596	21.78	1,219						
1869	1,759	20.92	368						
1871	5,441	27.90	1,518						
1872	6,564	23.39	1,535						
1873	3,411	19.61	669						
1881	10,333	19.75	**2,041**						
1890	86,000	**4.17**	3,586	42,000	**4.35**	1,825	128,000	**4.23**	5,411
1891	66,000	**4.02**	2,653	42,000	**3.82**	1,603	108,000	**3.94**	4,256
1892	84,000	**3.35**	2,810	26,000	**4.40**	1,144	110,000	**3.59**	3,954
1893	81,000	**3.80**	3,081	38,000	**4.47**	1,698	119,000	**4.02**	4,779
1894	71,000	**4.19**	2,978	38,000	**4.74**	1,801	109,000	**4.38**	4,779
1895	66,000	**3.97**	2,623	48,000	**4.66**	2,236	114,000	**4.26**	4,859
1896	71,000	**3.68**	2,616	51,000	**4.44**	2,262	122,000	**4.00**	4,878
1897	81,000	**3.68**	2,984	5,248	**41.35**	2,170	86,248	**5.98**	5,154
1898	74,000	**3.42**	2,531	71,000	**3.74**	2,657	145,000	**3.58**	5,188
1899	112,341	**1.88**	2,113	75,849	**3.23**	2,452	188,190	**2.43**	4,565
1900	111,752	**1.93**	2,152	101,323	**2.39**	2,420	213,075	**2.15**	4,572
1901	102,628	2.78	2,184	106,835	4.06	3,461	209,463	3.43	5,645
1902	56,773	4.11	1,933	86,278	3.93	2,799	143,051	4.00	4,732
1903	62,189	3.67	1,929	105,314	4.30	3,662	167,503	4.07	5,591
1904	66,569	3.62	1,850	89,590	3.52	2,468	156,159	3.56	4,318
1905	48,962	3.47	1,303	127,063	3.58	3,566	176,025	3.55	4,869
1906	56,873	4.15	1,729	149,545	3.68	4,383	206,418	3.81	6,112
1907	78,940	3.47	1,972	154,409	3.65	4,950	233,349	3.59	6,922
1908	49,409	4.04	1,485	120,132	3.63	3,798	169,541	3.75	5,283
1909	43,939	4.02	1,355	111,815	4.10	4,076	155,754	4.08	5,431
1910	44,932	3.63	1,257	90,939	4.20	3,377	135,871	4.01	4,634
1911	39,310	4.26	1,412	116,269	4.30	4,479	155,579	4.29	5,891
1912	33,206	3.60	906	152,447	3.90	5,243	185,653	3.85	6,149
1913	29,224	3.37	819	188,873	3.30	5,834	218,097	3.31	6,653
1914	39,476	3.22	1,171	196,756	3.10	5,802	236,232	3.12	6,973
1915	42,443	3.51	1,382	215,052	3.00	6,072	257,495	3.08	7,454
1916	60,725	2.69	1,433	194,370	3.20	5,696	255,095	3.08	7,129
1917	59,127	2.63	1,381	181,495	3.20	5,486	240,622	3.06	6,867
1918	57,364	2.61	1,344	166,027	3.40	5,288	223,391	3.20	6,632
1919	7,909	2.17	152	33,307	4.00	1,260	41,216	3.65	1,412
1919/20	9,047	2.57	203	70,100	3.40	2,250	79,147	3.31	2,453
1920/21	87,422	3.32	537	87,422	3.30	2,022	174,844	3.31	2,559
1921/22	51,583	3.72	526	51,583	3.70	1,152	103,166	3.71	1,678
1922/23	26,775	3.02	698	44,642	3.70	1,539	71,417	3.45	2,237
						Total	**~9.1 Mt**	**~3.7**	**336 kt**

21.57 Burra, South Australia

- *Burra Mine : 1846-1877, 1903 & 1972-1983*

  Data Sources : (Armstrong, 2002; Austin, 1863; Bailey, 2002; BMR, var.; Carne, 1908; Cumming & Drew, 1987; Dickinson, 1942, 1990; Higgins, 1956; Johnson, 1965; McLean, 1980; Robertson, 1995; SADM, var.-a, var.-b; Sidney, 1852; Treloar, 1929; Wright, 1975)

Year	Ore Milled (t)	%Cu	t Cu
1846	6,461	**20.3**[§]	1,313[§]
1847	10,922	**17.0**[§]	1,861[§]
1848	12,996	**25.5**[§]	3,316[§]
1849	7,914	**26.5**[§]	2,097[§]
1850	18,992	**20.1**[§]	3,820[§]
1851	~12,000	**~16**	~1,924
1852	~12,000	**~16**	~1,924
1853	3,765	**16.88**	636
1854	4,077	**8.05**	328
1855	6,195	**11.18**	693
1856	9,083	**14.22**	1,292
1857	10,147	**16.95**	1,719
1858	11,747	**13.28**	1,559
1859	12,516	**16.31**	2,041
1860	14,938	**13.08**	1,954
1861	11,654	21	2,122
1862	9,643	21.5	1,397
1863	8,714	**14.23**	1,240
1864	8,747	**14.42**	1,261
1865	6,127	**14.63**	896
1866	5,919	**13.63**	807
1867	5,598	**14.41**	807
1868	3,897	**8.30**	324
1869	1,206	**15.63**	188

Year	Ore Milled (t)	%Cu	t Cu	Waste Rock (t)
1870	*(no milling)*			
1871				37,259[‡]
1872	2,417	**13.87**	335	
1873	3,446	**12.91**	445	
1874	3,144	**13.09**	411	
1875	2,247	**17.39**	391	
1876	1,874	**22.36**	419	
1877	1,579	**20.00**	316	
Total	**238 kt**	**22**	**52,400**	**~0.47 Mt**
1903	53	27	14.3	
1972	92,079	1.26	**872**[#]	233,337
1973	65,054	1.37	**668**[#]	233,337
1974	94,105	1.43	**1,009**[#]	233,337
1975	196,546	1.37	**2,020**[#]	317,772
1976	131,599	1.67	**1,648**[#]	326,564
1977	181,111	1.59	**2,160**[#]	470,800
1978	182,447	1.78	**2,436**[#]	573,374
1979	196,606	1.78	**2,625**[#]	573,374
1980	188,375	**2.15**[#]	3,035	573,374
1981	186,720	2.3	3,401	573,374
1982	14,700	2.5	3,247	
1983	28,000	2.4	679	
Total	**2.11 Mt**	**1.77**	**~40 kt**	**~4.8 Mt**

[§] Adapted from (Kalix *et al.*, 1966), assuming 80% of SA copper production is from the Burra mine.
[‡] Waste rock from open cut mining for the six months to the end of October 1871 (Treloar, 1929).
[#] Based on recovery/efficiency only, using data from (BMR, var.; SADM, var.-a, var.-b).

Note : Based on numerous references, eg. (Drexel, 1982; Treloar, 1929), Burra's early phase ore grade rarely dropped below 20% Cu, with the overall life-of-mine average being 22% Cu.

21.58 Kanmantoo, South Australia

- *Kanmantoo Mine : 1857-1874, 1972-1976*

  Data Sources : (Anderson, 1980; Austin, 1863; BMR, var.; Both, 1990; Carne, 1908; Dickinson, 1942, 1990; SADM, var.-a, var.-b; Treloar, 1980)

Year	Ore Milled (t)	%Cu	t Cu
1857	292	12.6	36.8
1858	136	10	13.6
1859	1,020	12.3	125.8
1860	458	10.1	46.3
1861	408	9.1	37.3
1862	1,515	9.1	138.1
1863	1,084	**10**	108.4
1864	661	9.8	64.5
1865	775	8.6	66.3
1869	1,033	7.9	81.7

Year	Ore Milled (t)	%Cu	g/t Au	g/t Ag	t Cu	Waste Rock (t)
1871	1,086	6.1			66.7	
1872	609	6			36.5	
1873	819	6.3			51.8	
1874	697	6.7			46.9	
1972	829,842	**0.81**			6,681	
1973	934,582	0.92		2.02	**7,308**	
1973	931,708	0.79		1.64	**6,256**	
1975	916,596	0.74	0.07	1.69	**5,738**	
1976	498,612	0.95		1.93	**4,041**	2,067,250
Total	**4.11 Mt**	**0.83**	**-**	**~2**	**30,025**	**23.556 Mt**

21.59 Kapunda, South Australia

- *Kapunda Mine : 1844-1915*
  Data Sources : (Austin, 1863; Carne, 1908; Dickinson, 1944; Johnson, 1965)

Year	Ore Milled (t)	(%Cu)	(t Cu)
1844	610	23.3	142.0
1845	1,036	23.3	241.4
1846	1,036	23.3	241.4
1847	1,036	23.3	241.4
1848	914	24.44	224.5
1849	1,702	26.82	479.6
1850	1,788	23.34	437.9
1851	3,656	16.94	650.2
1852	831	18.17	158.5
1853	442	20.7	99.6
1854	757	25.75	204.2
1855	2,682	18.72	503.9
1856	2,775	17.3	503.9
1857	4,077	14.5	583.2
1858	3,193	19	609.6
1859	3,085	22.6	698.0
1860	3,203	22	705.1
1861	3,351	17.5	596.4
1862	2,973	16.25	485.6
1863	3,572	17.5	632.0
1864	3,525	18.2	642.8
1865	2,588	14.3	504.7
1866	44.0	**11.53**	5.1
1867	18.8	**15.95**	3.0
1868	37.3	**16.08**	6.0
1869	75.2	**37.03**	27.8
1870	1,185.0	**31.91**	378.1
1871	1,693.9	**25.95**	439.6
1872	1,790.2	**16.23**	290.5
1873	2,026.4	**16.30**	330.4
1874	1,732.5	**16.95**	293.7
1875	1,786.6	**16.17**	288.9
1876	1,708.4	**17.18**	293.5
1877	1,418.5	**21.78**	309.0
1878	411.9	**26.69**	109.9
1879	104.3	**14.36**	15.0
1880	255.8	**17.34**	44.3
1881	104.6	**20.11**	21.0
1882	150.4	**22.03**	33.1
1883	77.6	**23.90**	18.5
1884	118.2	**21.14**	25.0
1885	9.0	**25.99**	2.3
1886	9.2	**38.46**	3.6
1887	21.2	**24.46**	5.2
1888	82.7	**22.50**	18.6
1889	74.5	**19.30**	14.4
1890	24.0	**19.24**	4.6
1891	31.3	**19.48**	6.1
1892	79.7	**24.36**	19.4
1893	100.3	**20.35**	20.4
1894	54.4	**23.93**	13.0
1895	49.2	**20.97**	10.3
1896	40.4	**19.50**	7.9
1897	60.5	**17.97**	10.9
1898	30.7	**13.06**	4.0
1899	94.0	**16.32**	15.3
1900	47.3	**15.77**	7.5
1901	51.8	**14.71**	7.6
1902	167.3	**16.73**	28.0
1903	171.9	**17.09**	29.4
1904	117.4	**21.24**	24.9
1905	138.1	**18.35**	25.3
1906	219.3	**14.92**	32.7
1907	94.3	**11.64**	11.0
1908	41.2	**15.64**	6.5
1909	53.9	**18.36**	9.9
1910	40.9	**19.38**	7.9
1911	8.5	**20.83**	1.8
1912	6.6	**19.23**	1.3
1915	18	19.0	3.4
Total	**65,509**	**~19.6**	**12,872**

21.60 Mt Gunson-Cattlegrid, South Australia

- *Mt Gunson-Cattlegrid Mine : intermittent & 1974-1989*
  Data Sources : (Bampton & Winzar, 1993; BMR, var.; Gelding, 1980; Houston *et al.*, 1982; Johns, 1965; PIRSA, var.; SADM, var.-a, var.-b; Tonkin & Creelman, 1990)

	Ore Milled (t)	(%Cu)	(t Cu)	Waste Rock (t)
1899	51	14	**7**	
1906	610	3.5	**21**	
1917	882	5.0	**44**	
1918	457	3.9	**18**	
1919	328	8.0	**26**	
1941	10,966	3.5	384	
1942	10,966	3.5	384	*452 kg Ag*
1943	10,966	3.5	384	
1974	129,635	2.05	**2,467**	2,715,268
1975	483,365	2.04	**9,178**	5,196,063
1976	466,039	2.06	**8,927**	4,066,438
1977	647,139	1.91	**11,468**	5,707,917
1978	599,633	2.2	**12,268**	**982,750**
1979	575,000	2.0	**10,695**	
1980	586,555	1.5	**8,182**	**7,489,010**
1981	732,190	1.8	12,363	8,440,438
1982	827,793	1.74	13,406	5,119,298
1983	902,260	1.53	12,617	
1984	742,658	1.54	10,401	
1985	762,686	1.45	11,032	
1986	333,502	1.47	4,893	
1987	300,000	1.3	**3,627**	
1988	600,000	1.3	**7,254**	
1989	300,000	1.3	**3,627**	
Total	**9.024 Mt**	**1.7**	**144 kt**	**»40 Mt**

1974-86 – 62,000 kg Ag

21.61 Blinman, South Australia

- *Blinman Mine : 1904-1915* Data Sources : (Dickinson, 1944; SADM, var.-a)

Year	**Ore Milled** (t)	(%Cu)	(t Cu)
1904	4,504	3.4	154
1905	10,273	4.0	407
1906	39,823	4.0	1,593
1907	42,994	4.3	1,827
Total	**97,953**	**4.13**	**4,043**

Year	**Ore Milled** (t)	(%Cu)	(t Cu)
1911	82	10.8	8.9
1912	164	20.0	32.8
1913	59	17.2	10.2
1914	25	15.0	3.8
1915	29	20.7	6.0

21.62 Gunpowder-Mt Gordon, Queensland

- *Gunpowder-Mt Gordon Mine : 1970-1982, 19901/91-2002/03 & 2005-2006*
  Data Sources : (BMR, var.; Brock *et al.*, 1998; Brooks, 1965; Butler, 1980; Mitchell & Moore, 1975; RGC, var.; Richardson & Moy, 1998; RIU, var.; WM, var.)

	Ore Milled (t)	(%Cu)	(t Cu)
1970	75,000	2.8	1,259
1971	224,000	2.9	3,846
1972	102,000	2.7	2,055
1973	250,000	2.8	5,597
1974	294,000	2.9	7,117
1975	333,000	2.8	7,330
1976	351,000	2.9	8,471
1977	471,000	2.6	10,375
1978	120,000	2.8	2,927
1980			420 [§]
1981			1,932 [§]
1982			2,175 [§]
1990/91			4,384 [§]

	Ore Milled (t)	(%Cu)	(t Cu)	**Waste Rock** (t)
1991/92	1,200,000 [§]	**0.52** [§]	6,201 [§]	
1992/93	245,000 [§]	3 [§]	7,297 [§]	
1993/94			5,905 [§]	
1994/95			6,622 [§]	
1995/96			7,932 [§]	
1996/97			7,832 [§]	
1997/98	60,000	10	6,423 [§]	16,800,000
1998/99	320,620	11.55	19,411	
1999/00	481,924	8.35	34,860	
2000/01	537,674	9.56	46,150	
2001/02	613,918	8.99	48,901	
2002/03	676,116	8.3	45,293	
2005	1,178,059	2.88	27,171	
2006	1,291,621	2.10	23,394	
Total	**»8.4 Mt**	**~4.4**	**»350 kt**	**»17 Mt**

[§] For Gundpowder-Mt Gordon, copper production between 1980 to mid-1998 was through in situ leaching of underground stopes, thereby making comparison of actual ore 'mined' and grades processed somewhat problematic. From mid-1998 the newly discovered Esperanza deposit was developed by open cut, being at the high grade of some 8-10% Cu.

21.63 Cobar Field, New South Wales

- *Cobar Field (Numerous Mines) : 1876-1961*
  Data Sources : (Andrews, 1911a, 1911b, 1928; BMR, var.; Brooke, 1975; Brown, 1983; Carne, 1908; CRA, var.; GSM, var.; Haskard & Chaplain, 1993; Kenny, 1923, 1928; NSWDM, var.; NSWDMR, var.; Russell & Lewis, 1965; Scott & Phillips, 1990; Shi & Reed, 1998a; Suppel & Clarke, 1990; Thompson, 1980)

Cobar Field : Great Cobar/Chesney, Nymagee and Burraga/Rogan River Mines

Year	**Great Cobar/Chesney**			**Nymagee**			**Burraga [B] / Rogan River [RR]**		
	Ore Milled	**Copper**		**Ore Milled**	**Copper**		**Ore Milled**	**Copper**	
	t	%Cu	t Cu	t	%Cu	t Cu	t	%Cu	t Cu
1871	175.6	**57.4**	100.8				*Note : Burraga unless specified.*		
1872	307.4	**57.4**	176.4						
1873	395.2	**57.4**	226.8						
1874	282.0	**37.8**	106.6						
1875	406.4	**31.3**	127.0						
1876	1,481	**11.93**	177						
1877	4,958	**10.72**	531						
1878	8,523	**17.37**	1,480						
1879	12,817	**14.99**	1,921						
1880	20,548	**12.70**	2,610				20	**43.10**	8.8
1881	21,897	**11.92**	2,609	6,150	**14.04**	864	2,540	**10.00**	254

Cobar Field : Great Cobar/Chesney, Nymagee and Burraga/Rogan River Mines

Year	Great Cobar/Chesney			Nymagee			Burraga [B] / Rogan River [RR]		
	Ore Milled	Copper		Ore Milled	Copper		Ore Milled	Copper	
	t	%Cu	t Cu	t	%Cu	t Cu	t	%Cu	t Cu
1882	11,889	**15.42**	1,834	6,724	**17.29**	1,162	4,521	**10.45**	472
1883	18,386	**13.35**	2,454	10,400	**16.74**	1,741	6,248	**8.46**	528
1884	24,261	**11.60**	2,813	14,979	**14.97**	2,242	5,913	**10.00**	591
1885	23,935	**9.04**	2,164	16,025	**11.35**	1,820	4,282	**10.44**	447
1886	26,301	**7.90**	2,077	14,680	**10.16**	1,491	2,855	**10.00**	285
1887	20,157	**8.03**	1,618	10,911	**9.65**	1,053	1,219	**10.00**	122
1888	13,132	**7.78**	1,021	13,031	**10.11**	1,318	5,070	**10.00**	507
1889				8,843	**9.60**	849			
1890				8,228	**9.78**	805	4,267	**10.00**	427
1891				9,690	**9.60**	931			
1892				6,338	**11.17**	708	813	**10.00**	81
1894	13,675	**4.94**	676	1,715	**8.77**	150	6,320	**10.00**	632
1895	38,890	**4.43**	1,721	6,955	**7.09**	493	3,364	**10.00**	336
1896	64,196	**4.29**	2,751	3,301	**11.70**	386	4,715	**9.14**	431
1897	65,290	**3.88**	2,532	12,101	**4.28**	518	9,050	**8.28**	749
1898	113,342	**3.07**	3,479	17,427	**4.05**	706	8,654	**6.69**	579
1899	125,815	**3.03**	3,806	15,106	**3.37**	509	10,420	**5.38**	561
1900	116,296	**3.04**	3,531	16,391	**3.30**	542	9,228	**7.34**	678
1901	117,111	**2.90**	3,394	15,769	**3.34**	526	21,852	**4.92**	1,076
1902	91,068	**2.69**	2,454	18,934	**3.48**	659	29,913	**3.84**	1,149
1903	145,208	**2.35**	3,414	22,389	**2.62**	586	66,443	**2.83**	1,882
1904	145,536	**2.50**	3,637	24,546	**3.15**	772	30,823	**2.64**	815
1905	183,427	**2.25**	4,126	24,639	**2.46**	606	61,891	**1.98**	1,226
1906	109,761	**2.88**	3,158	27,075	**2.50**	677	60,960	**2.04**	1,243
1907	241,723	**2.49**	6,011	14,304	**2.17**	311	48,768	**2.40**	1,172
1908	238,635	**2.20**	5,255				20,798 [B,RR]	**3.13** [B,RR]	651 [B,RR]
1909	218,477	**2.36**	5,153				2,598 [RR]	**6.61** [RR]	172 [RR]
1910	312,363	**2.05**	6,405				3,150 [RR]	**4.91** [RR]	155 [RR]
1911	357,783	**1.86**	6,653				4,149 [RR]	**6.37** [RR]	264 [RR]
1912	367,079	**1.84**	6,756				2,438 [RR]	**10.00** [RR]	244 [RR]
1913	339,534	**1.79**	6,081	2,858	**3.59**	103	35,124	**4.04**	1,417
1914	70,805	**2.02**	1,433	1,016	**4.00**	41	18,825	**4.33**	816
1915				18,796	**3.58**	674			
1916	173,566	**1.55**	2,684	32,232	**2.85**	917			
1917	144,761	**1.89**	2,737	27,840	**2.48**	691	8,418	**4.03**	339
1918	115,357	**2.13**	2,454				11,522	**2.29**	264
1919	26,722	**2.05**	549						
1920	244	**18.75**	46						
1921	84	**18.07**	15						
1937	2,981	**29.57**	88.1						
1941	3,257	**6.07**	19.8						
1948				9.1	**21.96**	2.0			
1949				12.2	**22.75**	2.8			
1952				4.4	**62.79**	2.7	20	**22.03**	4
1953				4.4	**62.79**	2.7	15	**19.18**	3
1955				10.7	**6.24**	0.7	4.01	0.72	**17.96**
1956				3.0	**10.33**	0.3	5.28	0.68	**12.88**
1957				1.2	**18.49**	0.2			
1958				4.3	**10.69**	0.5			
1961							194	18.8	**9.69**
Total	**4.486 Mt**	**2.56**	**114,957**	**422.6 kt**	**5.79**	**24,459**	**517.2 kt**	**3.98**	**20,575**

Cobar Field : Queen Bee and Cobar-Gladstone/Mt Hope Mines

Year	Queen Bee		
	Ore Milled	Copper	
	t	%Cu	t Cu
1902	389	**10.70**	42
1903	986	**16.60**	164
1904	1,168	**11.87**	139
1905	5,474	**9.28**	508
1906	7,273	**8.01**	582
1907	6,525	**7.68**	501
1908	10,138	**6.65**	674
1909	8,637	**5.58**	482
1912	1,829	**5.72**	105
1913	305	**6.00**	18
1914	10	**10.00**	1
1915	71	**10.00**	7
1916	231	**11.01**	25
1917	328	**6.00**	20
1918	714	**2.84**	20
1919	27	**6.00**	2
1952	8.6	**16.82**	1.5
1953	13.1	**15.18**	2.0
1956	15.2	**15.48**	2.3
1957	5.9	**14.83**	0.9
1958	4.0	**21.01**	0.8
1959	57.2	**7.27**	4.2
1960	23.6	**9.91**	2.3
Total	**44,233**	**7.47**	**3,304**

[§] 2.83 kg Ag.
[‡] 333.3 kg Ag.

Year	Cobar-Gladstone [CG] / Mt Hope [MH]		
	Ore Milled	Copper	
	t	%Cu	t Cu
1883	2,121	**20.64**	438
1884	6,293	**20.31**	1,278
1885	3,856	**16.73**	645
Note : Mt Hope unless specified.			
1888	1,206	**11.54**	139
1889	1,900	**13.90**	264
1890	1,161	**19.07**	221
1891	1,112	**19.03**	212
1892			193
1894	906	**15.13**	137
1895	872	**16.72**	146
1896	1,109	**12.96**	144
1897	746	**13.26**	99
1898	1,008	**13.27**	134
1899	673	**15.66**	105
1900	1,585	**15.53**	246
1901	3,506	**5.13**	180
1902	938	**5.10**	48
1906	7,061	**2.49**	176
1907	8,636	**3.59**	310
1908	8,446 [CG,MH]	**2.85** [CG,MH]	241 [CG,MH]
1909	29 [§,CG]	**36.52 [§,CG]**	11 [§,CG]
1910	213 [CG]	**13.33 [CG]**	28 [CG]
1911	1,129 [CG]	**8.46 [CG]**	96 [CG]
1913	18,288	**0.58**	107
1914	3,350 [CG]	**7.01 [CG]**	235 [CG]
1915	11,294 [CG]	**5.64 [CG]**	637 [CG]
1916	6,617 [CG]	**3.76 [CG]**	249 [CG]
1917	12,479 [‡,CG,MH]	**4.49 [‡,CG,MH]**	560 [‡,CG,MH]
1918	15,074	**3.51**	529
1919	2,249 [CG]	**4.92 [CG]**	111 [CG]
1920	2,008 [CG]	**6.43 [CG]**	129 [CG]
1952	10,331	**0.51**	52.8
1953	5,080	**1.21**	61.3
Total	**141,276**	**5.78**	**8,161**

Cobar Field : Chesney Gold-Copper Mine

Year	Ore		
	Milled (t)	g/t Au	kg Au
1887	2.0	**137.75**	0.28
1888	60.5	**65.46**	3.96
1889	2,475.0	**10.01**	24.77
1890	894.1	**20.38**	18.22
1891			27.53
1893	333.2	**20.75**	6.92
1894	2,016.8	**15.71**	31.69
1895	1,809.5	**4.95**	8.96
1896	2,479.0	**4.22**	10.45
	4,572.0	**1.53**	7.00
1902	426.7	**0.69**	0.29
1903	1,158.2	**1.43**	1.66

Year	Ore				
	Milled (t)	g/t Au	%Cu	kg Au	t Cu
1943	21,828	**1.88**		41.1	
1945	1,444	**6.51**		9.4	
1946	6,783	**4.54**		30.8	
1947	20,379	**2.86**	**1.93**	58.3	393
1948	47,824	**1.96**	**1.67**	94.0	801
1949	52,309	**1.43**	**1.50**	74.8	786
1950	52,598	2.00	1.67	96.3	852
1951	53,374	2.68	1.73	102.3	880
1952	48,006	1.91	1.53	93.4	695
Total	**320,771**	**2.31**	**1.37**	**742.1**	**4,406**

Cobar Field : Budgery and Budgerygar / Mt Royal Mines

Year	Budgery			Year	Budgerygar / Mt Royal		
	Ore Milled	Copper			Ore Milled	Copper	
	t	%Cu	t Cu		t	%Cu	t Cu
1906	203	**11.50**	23	1907	1,172	**5.98**	70
1907	810	**7.53**	61	1908	1,245	**8.08**	101
1908	257	**4.35**	11	1911	169	**10.99**	19
1909	20	**10.00**	2	1912	264	**6.54**	17
1910	3,261	**6.11**	199	1913	1,480	**4.32**	64
1911	2,776	**8.78**	244	1914	2,565	**2.57**	66
1912	4,456	**1.69**	75	1916	10,747	**4.21**	452
1913	402	**2.78**	11	1917	15,646	**4.36**	682
1914	2,343	**1.34**	31	1918	5,473	**4.12**	226
1915	436	**1.63**	7	1919	3,221	**3.25**	105
1916	57	**12.50**	7	1920	335	**10.00**	34
1917	295	**5.52**	16	1922	792	**2.85**	23
1918	1,402	**5.00**	70	1924	5,360	**2.32**	124
1919	1,118	**4.68**	52	1925	3,497	**2.07**	72
1920	1,395	**3.86**	54	1926	1,508	**2.46**	37
				1927	2,534	**2.72**	69
1923	1,067	**5.00**	53	1929	2,235	**3.04**	68
1924	1,952	**4.75**	93	1930	1,877	**2.68**	50
1925	67	**39.55**	27	1946	390.1	**10.49**	40.9
1930	29	**9.93**	3	1948	5,754	**0.07**	4.1
				1950	8.1	**17.25**	1.4
				1951	97.2	**10.13**	9.8
				1952	9.9	**18.00**	1.8
				1953	3.4	**14.79**	0.5
				1955	11.9	**17.56**	2.1
				1956	16.4	**10.34**	1.7
				1957	1.3	**15.38**	0.2
Total	**22,236**	**4.66**	**1,041**	**Total**	**66,415**	**3.52**	**2,340**

Cobar Field : Crowl Creek-Shuttleton Copper Mine

Year	Ore Milled (t)	%Cu	t Cu	Year	Ore Milled (t)	%Cu	t Cu
1901	858.5	26	**223.2**	1936	19	**9.33**	**1.8**
1902	3,072.4	23.07	**708.8**	1948	16	8.47	**1.4**
1912	4,617	**4.23**	195.3	1949	865	**2.12**	18
1913	4,585	**2.59**	118.9	1953	84	**18.08**	15
1914	30	**13.33**	4.1	1955	12	**6.60**	1
1916	813	**3.50**	28.4	1956	11	**10.48**	1
1917	1,727	**3.65**	63.0	1958	13	**2.90**	0.4
1918	1,016	**7.00**	71.1				
1930	29	**7.65**	2.3				
1931	20	15	**3.0**	**Total**	**17,788**	**8.19**	**1,457**

Cobar Field : New Occidental Gold Mine

Year	Ore Milled (t)	g/t Au	kg Au	Year	Ore Milled (t)	g/t Au	kg Au
1935	34,846	**10.27**	357.7	1945	17,048	**11.15**	190.1
1936	73,531	**10.27**	755.0	1946	39,926	**7.57**	302.2
1937	86,938	**10.13**	880.3	1947	25,726	**17.96**	462.0
1938	97,752	**10.20**	997.2	1948	98,279	**10.73**	1,054.9
1939	99,084	**10.79**	1,069.4	1949	97,448	**10.77**	1,049.9
1940	150,864	**9.87**	1,489.3	1950	94,210	**8.37**	788.4
1941	88,857	**10.46**	929.5	1951	91,651	**8.50**	779.2
1942	108,982	**7.93**	864.1	1952	68,391	**6.76**	462.6
1943	86,487	**10.96**	947.9	**Total**	**1,360,021**	**9.08**	**13,380**

Cobar Field : New Cobar Gold-Copper Mine

Year	Ore Milled (t)	g/t Au	%Cu	kg Au	t Cu
1937	2,757	**9.42**	**1.62**	26.0	44.6
1938	48,159	**9.72**	**0.06**	468.1	28.4
1939	40,411	**10.80**		436.3	
1941	41,475	**9.75**		404.5	
1942	35,589	**7.81**		277.9	
Total	**168,393**	**9.58**	**<0.1**	**1,612.7**	**73.0**

21.64 Woodlawn, New South Wales

- *Woodlawn Lead-Zinc-Silver-Copper-Gold Mine : 1979-1998*
  Data Sources : (BMR, var.; CRA, var.; Denehurst, var.; NSWDM, var.)

Year	Ore Milled	Grade					Production					WR	Open Cut
		Pb	Zn	Ag	Cu	Au	Pb	Zn	Ag	Cu	Au		
	t	%	%	g/t	%	g/t	t	t	kg	t	kg	Mt	%
1978†	80,000†	4.00	5.57	598	5.56		2,148	2,296	45,154	4,095			100
1979	852,887	**3.02**	**8.45**	**76.7**	**1.51**		14,622	49,004	36,386	9,093			100
1980	970,265	**4.13**	**9.47**	**89.2**	**1.36**		27,386	65,733	53,562	8,885		**10**	100
1981	1,063,054	**3.82**	**9.21**	**78.8**	**1.39**	**0.36**	26,703	69,232	47,659	10,052	97	**10**	100
1982	1,090,710	**3.58**	**9.43**	**73.2**	**1.67**	**0.28**	24,805	73,400	42,789	13,434	**75**		100
1983	1,037,759	**3.27**	**8.77**	**64.9**	**1.65**	**0.30**	20,311	62,946	32,097	12,603	78		100
1984	846,000	**3.05**	**8.38**	**64.2**	**1.58**		14,707	48,073	25,515	9,627			100
1985	930,573	**3.34**	**9.77**	**60.4**	**1.81**		18,924	65,820	24,594	12,714			100
1986	871,000	**3.32**	**9.25**	**60.2**	**2.27**		17,470	57,055	22,791	15,938			100
1987	658,000	4.8	11.5	114	1.3	0.7	**18,262**	44,096	**27,537**	8,448			100
1987/88	505,002	4.23	10.25	92.5	1.36	0.71	13,292	40,766	17,010	4,838	75		100
1988/89	559,972	3.49	8.66	87.2	1.66	0.65	11,829	39,870	26,515	6,639	84		100
1989/90	605,018	4.14	9.54	89.1	1.41	0.61	15,235	45,306	29,159	5,520	110		14.8
1990/91	606,489	4.19	10.22	85.4	1.60	0.68	14,944	47,656	29,153	6,313	99		0.0
1991/92	645,517	4.12	10.31	82.5	1.74	0.6	17,018	58,803	33,866	7,700	107		0.0
1992/93	699,043	4.0	9.9	81	1.8	0.5	18,152	64,472	35,836	8,992	109		0.0
1993/94	679,929	4.0	10.8	79	1.8	0.6	17,055	67,237	33,457	8,404	88		0.0
1994/95	593,457	3.7	10.9	54	1.5	**0.33**	13,534	58,522	22,535	5,512	49		0.0
1995/96	505,171	3.4	10.1	48	1.8	**0.67**	11,316	44,812	17,607	6,167	85		0.0
1996/97	486,365	3.0	9.0	47	1.9	**0.28**	8,007	38,606	13,545	6,072	34		0.0
1997/98	293,143	3.1	8.5	46	1.7	**0.33**	4,550	20,522	7,310	3,045	24		0.0
	Mt	(approximately)					kt	kt	t	kt	t		
Total	**14.6**	**3.7**	**9.6**	**77**	**1.7**	**~0.6**	**330.3**	**1,064.2**	**624.1**	**174.1**	**1.11**	**>20**	**~65**

§ Metal production for the years 1991/92 to 1995/96 includes metals derived from re-processing of tailings (below).
† Ore milled assumed based on later recoveries and that the first milling period encountered problems of low recoveries.
WR – waste rock.

Note : Lead-zinc-silver-copper grades from 1979 to 1986 are based on the yield plus the addition of the average grades of the tailings at the end of 1987; namely 6.5 Mt of tailings grading 1.31% Pb, 2.7% Zn, 34 g/t Ag and 0.44% Cu; (1987 Edition; (BMR, var.).

Year	Tailings Re-processed (t)	Grade %Zn	Grade g/t Ag
1991/92	310,745	3.1	35
1992/93	418,930	3.4	44
1993/94	495,454	2.8	37

Year	Tailings Re-processed (t)	Grade %Zn	Grade g/t Ag
1994/95	483,538	2.5	29
1995/96	274,737	2.6	22

21.65 Captain's Flat Field, New South Wales

- *Captain's Flat Mine(s) : 1886-1962*

  Data Sources : (Carne, 1908; NSWDM, var.; Wilkins & LGMPL, 1948)

  Note : Also includes smaller nearby mines such as Vanderbilt-Commodore.

Year	Ore Milled t	Grade Pb %	Grade Zn %	Grade Cu %	Grade Ag g/t	Grade Au g/t	Production Pb t	Production Zn t	Production Cu t	Production Ag kg	Production Au kg	Waste Rock t
1884	3,231					**5.2**					16.8	
1886							102					
1887	2,292	**5.52**		**0.91**	**620**	**5.1**	126		21	1,421.4	11.7	
1888	1,221	**7.72**		**0.17**	**638**	**1.6**	94		2	778.6	2.0	
1889	9,587	**4.00**		**0.74**	**379**	**4.5**	384		71	3,637.5	43.5	
1890	8,988	**0.90**			**117**	**4.9**	81			1,053.0	44.4	
1891	6,012	**1.45**			**449**	**10.7**	87			2,698.1	64.6	
1892	19,530			**6.38**	**146**	**1.5**			1,247	2,857.3	29.3	
1893	12,166	**0.02**		**3.13**	**303**	**2.0**	3		381	3,688.2	24.4	
1894	9,209			**1.71**	**137**	**4.1**			157	1,265.8	38.1	
1895	18,860	**0.34**		**1.89**	**227**	**3.6**	65		356	4,290.3	67.3	
1896	12,988	**0.28**		**1.60**	**169**	**3.0**	37		208	2,192.6	38.9	
1897	25,400			**1.34**	**114**				341	2,903.9		
1898	2,051					**12.0**					24.6	
1899	27,845			**1.51**	**78.6**	**2.2**			419	2,188.8	61.9	
1900	5,080					**20.1**					102.0	
1901	2,647					**10.8**					28.7	
1902												
1903	220					**29.6**					6.5	
1906	70					**30.6**					2.1	
1907	47					**27.3**					1.3	
1930	2,560	7.4	12.7	0.7	61.2	1.84						
1939	136,951	6.6	11.33	0.72	40.7	2.08	8,046	11,608	491	4,480.5		
1940	184,146	7.4	12.3	0.74	49.6	2.34	12,255	19,197	**749**	7,541.8		50,149
1941	180,844	7.62	12.44	0.69	63.4	2.21	12,362	17,602	**686**	9,738.1		55,666
1942	204,790	7.76	12.06	0.71	103.2	0.11	14,117	20,412	**800**	17,479.9		61,012
1943	245,478	6.90	11.36	0.67	83.6	0.88	14,463	21,992	**905**	16,543.6		32,574
1944	218,517	6.48	11.0	0.63	62.1	1.50	11,218	19,293	**757**	11,152.7		43,128
1945	121,012	6.67	11.25	0.65	44.7	1.60	6,752	12,083	**433**	4,277.6		44,690
1946	169,692	6.2	10.7	0.64	46.5	1.47	8,344	13,634	694	6,006.0	120.0	52,096
1947	149,763	5.75	9.89	0.59	42.5	1.63	6,975	11,583	612	4,795.1	119.9	43,086
1948	102,893	5.92	10.4	0.62	41.3	1.78	5,087	8,486	480	3,337.8	94.8	49,917
1949	53,403	6.05	10.83	0.67	46.5	1.75	2,633	4,605	271	2,010.4	39.8	
1950	188,163	5.53	9.66	0.67	44.1	1.71	8,974	16,280	1,103	7,104.4	173.5	
1951	181,371	5.56	9.62	0.63	38.3	1.61	8,829	15,886	979	6,167.6	142.4	
1952	186,843	5.33	9.50	0.65	41.3	1.60	9,584	16,926	1,154	6,467.1	137.5	
1953	177,752	5.88	10.34	0.61	42.9	1.66	9,613	17,093	988	6,190.7	146.3	
1954	82,482	5.63	9.62	0.62	36.7	1.64	4,289	7,449	467	2,571.4	59.4	
1955	155,692	6.15	10.60	0.62	43.2	1.66	8,917	15,307	894	5,693.9	139.6	
1956	200,844	6.17	10.89	0.63	42.5	1.61	10,828	17,726	1,104	7,278.2	165.4	
1957	196,098	5.96	10.56	0.60	43.5	1.52	10,189	17,122	1,028	7,148.5	157.1	
1958	224,947	6.16	10.72	0.58	41.0	1.64	12,094	19,871	1,122	7,678.0	172.0	
1959	201,845	5.81	10.18	0.57	40.4	1.58	10,235	16,912	999	6,522.1	145.4	
1960	202,280	5.97	10.72	0.54	40.1	1.58	10,970	20,093	967	6,708.7	157.4	
1961	201,623	5.20	9.41	0.58	40.7	1.58	9,125	15,624	1,011	6,236.0	139.0	
1962	34,619	5.41	9.48	0.54	33.1	1.52	1,646	2,993	169	931.9	22.7	
Total	**4.147 Mt**	**6.03**	**10.32**	**0.68**	**55.5**	**1.64**	**218,487**	**359,777**	**21,647**	**194,145**	**2,693**	**432,318**

21.66 Thalanga, Queensland

- *Thalanga Lead-Zinc-Silver-Copper Mine : 1989-1999*
  Data Sources : (Breen & Nice, 1993; Pancontinental, var.; QNRME, var.; RGC, var.; RIU, var.)

Year	**Ore Milled**	**Grade**				**Production**					%Ore
		Pb	Zn	Ag	Cu	Pb	Zn	Ag	Cu	Au	Open
	t	%	%	g/t	%	t	t	kg	t	kg	Cut
1988/89	86,835		**4.99**		**3.96**						100
1989/90	192,413		**4.99**		3.97		**6,395**		**6,096**		100
1990/91	459,322	2.21	8.1	**~35**	2.42	1,532	18,238	»7,891	10,057		54.12
1991/92	564,722	2.81	9.52	**~30**	1.75	10,657	45,035	»6,332	9,050		
1992/93	608,502	3.06	9.34		1.69	13,219	49,501		8,400		
1993/94	632,000	2.73	8.82		1.26	12,401	49,142		8,478		
1994/95	633,843	2.58	8.24		1.37	13,051	46,548		6,342		
1995/96	652,950	2.25	7.41		0.99	11,430	43,254		7,907		
1996/97	601,000	2.63	7.99		1.16	12,997	42,265		5,080		
1997/98	460,414	2.24	7.24	**~5.4**	1.93	7,856	29,535	2,482	4,253	6	
1998/99	36,939	5.05	4.76	10.1	1.93	526	1,730		293		
Total	**4,928,940**	**2.45**	**8.16**	**~25**	**1.91**	**83,670**	**334,248**	**»16,705**	**65,956**		**~10.8**

21.67 Woodcutters, Northern Territory

- *Woodcutters Lead-Zinc-Silver Mine : 1985-2002*
  Data Sources : (Aztec, var.; BMR, var.; Nicron, var.; Normandy, var.; NTDME, var.; RIU, var.), including some data provided by NTDPIFM.

Year	**Ore Milled**	**Grade**			**Production**			**Open Cut**
		Pb	Zn	Ag	Pb	Zn	Ag	
	t	%	%	g/t	t	t	kg	%
1985	51,180	**3.11**	**9.62**	**170.7**	954	2,463	5,242	100
1986	140,511	7.4	16.0	158	6,378	10,756	14,717	100
1987	160,532	7.8	15.2	195	9,415	18,977	26,064	50
1988	180,849	**14.60**	**17.63**	**323.6**	15,845	25,508	43,898	
1989	236,446	7.02	13.56	166.0	14,138	27,724	29,137	
1990	348,007	5.87	13.85	111.5	11,709	30,207	30,544	
1991	444,330	6.38	12.40	**104.0**	10,421	24,084	46,193	
1992	553,619	5.5	12.6	**56.21**	14,419	40,702	31,117	
1993	348,729	4.76	11.21	**66.6**	6,139	19,516	23,210	
1994	236,887	**4.88**	**10.29**	18.81	5,422	11,819	11,880	
1995	289,618	4.4	10.3	24.2	7,265	32,035	7,000	
1996	367,127	6.1	14.5	67.2	13,691	60,101	7,000	
1997	538,988	5.3	13.7	**30**	16,401	57,001	0	
1998	502,522	5.2	12.1	**30**	17,887	50,779	0	
1998/99	322,115	5.5	11.4	**30**	11,146	27,558		
Total	4.72 Mt	**~6.0**	**~12.9**	**~80**	161,230	439,230	~276,000	**~5.8**

21.68 Kambalda Field, Western Australia

- *Kambalda Nickel-Copper-Cobalt Field : 1967-2004*

  Data Sources : (AM, var.; BMR, var.; Botica, 1980; Cowden & Roberts, 1990; IG, var.; Marston, 1984; Mincor, var.; Palmer, 1980; Reliance, var.; RIU, var.; Titan, var.; View, var.; WADM, var.; WMC, var.-b)

Year	Ore Milled (t)	Grade			Production			Resources		
		%Ni	%Cu	%Co	t Ni	t Cu	t Co	Ore (Mt)	%Ni	t Ni
1966								1.930	4.15	80,095
1967	67,472	4.57			2,093			2.489	4.18	104,040
1968	156,545	**4.70**	**0.37**	0.37	5,520	572		9.455	3.8	359,290
1969	363,731	3.86	**0.35**		10,973	1,260		15.850	3.7	586,450
1970	944,602	**4.10**	**0.29**		30,961	2,692		17.443	3.4	593,062
1971	1,018,473	**4.11**		**0.064**	33,510		656	20.895	3.4	710,430
1972	1,259,002	**3.26**	**0.21**	0.068	33,646	2,618	605.8	22.7	3.29	746,830
1973	1,203,407	**3.35**	**0.22**	**0.054**	33,861	2,620	652	24.05	3.24	779,220
1974	1,301,178	**3.51**	**0.22**		39,278	2,927		24.55	3.22	790,510
1975	1,371,000	**3.06**			36,964			24.549	3.23	792,933
1976	1,415,000	**2.80**	**0.20**		35,713	2,867		24.334	3.20	778,688
1977	1,464,428	**2.87**			37,783			22.233	3.19	709,233
1978	1,394,000	**3.24**			40,597			21.219	3.24	687,496
1979	1,278,000	3.04	0.23		35,053			21.000	3.28	688,800
1980	1,346,000	2.81	0.21		34,865			21.600	3.28	708,480
1981	1,431,000	2.84	0.21		36,212					
1982	1,429,526	3.30	0.25		41,856	1,305				
1983	1,752,200	3.02	0.27		44,595	3,068				
1984	1,398,552	3.31	0.26		44,304	3,608				
1985	1,288,697	3.19	0.24		31,437	1,307				
1986	1,214,732	3.31	0.23	**0.031**	35,524	2,767	379			
1987	1,232,000	3.21	0.22		39,384	2,716				
1988	1,346,500	2.73	0.21		33,939	1,256		25	3.2	800,000
1989	1,461,296	2.53			33,320			16.000	3.0	480,000
1990	1,370,202	2.49			30,421			15.000	2.8	420,000
1991	1,193,620	2.87			31,128			12.000	3.0	360,000
1992	1,082,144	2.93			28,822			19.4	2.45	475,400
1993	1,182,195	3.07			33,689			29.5	2.32	685,800
1994	1,185,309	2.84			30,361			30.7	2.28	698,600
1995	1,187,196	3.39			36,581			29.7	2.27	675,600
1996	1,196,613	3.10			33,751			30.3	2.32	704,100
1997	1,185,551	2.91			30,955			32.4	2.23	724,000
1998	1,385,761	2.66			33,381			16.6	3.24	538,400
1999	368,659	3.36			11,114			17.3	3.26	563,600
2000	539,577	3.82			19,202			13.244	3.44	455,400
2001	601,470	3.37	**0.36**		18,653	>1,051	>189	6.711	3.33	223,600
2002	688,469	3.79	**0.28**		23,225	>1,292	>260	7.049	3.48	245,400
2003	804,709	3.58	**0.25**		25,913	>1,528	>222	6.340	3.64	230,700
2004	957,117	3.23	**0.18**		28,121	>1,401	>167	15.819	2.22	350,600
Total	**42.066 Mt**	**3.13**	**~0.25**		**1.167 Mt**	**>36.9 kt**	**>3.1 kt**			

21.69 Forrestania, Western Australia

- *Forrestania Nickel Mine : 1992-1999*

  Data Sources : (Frost *et al.*, 1998; Outokumpu, var.; RIU, var.)

Year	Ore Milled (t)	%Ni	t Ni	%Open Cut
1992	110,000	**2.32**	**1,197**	100
1993	430,000	**2.3**	**4,790**	100
1994	600,000	**1.79**	7,500	50
1995	700,000	**1.55**	7,600	0

Note : All mining 1996-1999 by underground mining.

Year	Ore Milled (t)	%Ni	t Ni
1996	660,700	1.78	9,513
1997	450,000	**2.19**	7,900
1998	455,000	**2.54**	9,251
1999	400,000	**2.31**	7,400
Total	**~3.806 Mt**	**~2.0**	**~55.2 kt**

21.70 Mt Keith, Western Australia

- *Mt Keith Nickel Mine : 1994-2004* Data Sources : (WMC, var.-b)

Year	Ore Milled (t)	%Ni	t Ni
1994	1,550,633	0.62	5,870
1995	7,852,360	0.60	29,127
1996	8,684,802	0.60	32,920
1997	10,367,984	0.62	39,729
1998	10,628,406	0.65	42,037
1999	10,435,189	0.65	41,208
2000	10,684,962	0.62	47,532
2001	10,919,862	0.62	47,930
2002	11,054,952	0.58	43,192
2003	11,199,886	0.62	50,004
2004	11,130,038	0.57	43,076
Total	**104.51 Mt**	**0.61**	**422.6 kt**

21.71 Leinster (Agnew), Western Australia

- *Leinster (Agnew) Nickel Field : 1989-2004*
  Data Sources : (BMR, var.; RIU, var.; WADM, var.; WMC, var.-b)

Year	Ore Milled (t)	%Ni	t Ni
1978	26,020	1.61	**346.9**
1979	160,652	3.4	6,332.97
1980	400,538	2.90	9,855.16
1981	416,450	2.55	**8,814.2**
1982	480,000	2.13	**8,490.9**
1983	559,342	2.53	**11,745.6**
1984	566,954	2.36	**11,105.5**
1985	202,893	2.5	5,560
1986	283,604	2.3	5,378
1989	314,044	2.27	4,297
1990	1,213,780	1.94	16,718
1991	1,336,126	2.09	20,891
1992	1,027,111	2.24	18,220
1993	1,406,637	2.25	25,952
1994	1,642,551	2.33	29,360
1995	1,769,650	1.96	23,158
1996	1,945,101	2.18	36,242
1997	2,182,255	2.14	38,386
1998	2,256,177	2.34	44,313
1999	2,098,358	2.08	35,953
2000	2,641,521	1.91	40,724
2001	2,323,671	2.04	38,008
2002	2,570,685	1.99	40,006
2003	2,489,271	2.01	41,806
2004	2,734,267	1.88	44,577
Total	**33.05 Mt**	**2.12**	**~566 kt**

Note : Mining at Leinster-Agnew has included both open cut and underground mines, though no data is known to estimate the proportions of ore derived from either mine type/technique.

21.72 Cosmos and Radio Hill, Western Australia

- *Cosmos Nickel Mine : 2000-2005* Data Sources : (JM, var.)
- *Radio Hill Nickel-Copper-Cobalt Mine : 1998-2005* Data Sources : (Fox, var.; Titan, var.)

	Cosmos				Radio Hill						
	Ore Milled (t)	%Ni	t Ni	%open cut	**Ore Milled** (t)	%Ni	%Cu	%Co	t Ni	t Cu	t Co
1998					134,571	3.01	2.09	0.178	2,673.1	1,726.8	151.9
1999					194,891	**2.76**	**1.74**	**0.157**	4,302.8	3,062.2	228.8
2000	90,240	7.20	5,599	100.0	208,270	**3.02**	**2.20**	**0.189**	5,024.9	3,202.9	295.0
2001	123,018	9.33	11,013	100.0	218,086	**2.72**	**1.92**	**0.161**	4,752.9	3,521.9	263.6
2002	130,232	8.91	11,288	100.0	161,608	**3.01**	**2.17**	**0.174**	3,887.8	3,420.3	210.5
2003	153,858	8.20	12,282	58.5							
2004	159,556	7.92	12,297	0.0	82,445	**1.37**	**0.70**	**0.079**	903	402	48.9
2005	195,856	5.50	10,333	0.0	198,900	**1.57**	**1.43**	**~0.08**	2,205	1,262	»27.4
Total	852,760	7.69	62,813	51.9	**1.199 Mt**	**~2.58**	**~1.85**	**~0.14**	**23,750**	**16,598**	**»1,226**

21.73 Greenvale-Brolga, Queensland

- *Greenvale-Brolga Nickel-Cobalt Mines : 1974-1995*
  Data Sources : (BMR, var.; Parianos *et al.*, 1998), also data provided electronically by Brian Watt (Queensland Nickel International Ltd or QNI), 13 February 2004 (email).

Year	**Ore Milled** (t)	%Ni	%Co	t Ni	t Co	**Overburden** (m^3)
1974	**228,768**	**1.20**	**0.088**	2,745	201	*no data*
1975	1,217,101	1.61	0.115	11,562	384	1,568,205
1976	1,751,585	1.59	0.115	19,995	693	525,000
1977	1,912,940	1.51	0.106	19,035	613	582,000
1978	2,059,888	1.43	0.114	21,171	975	1,072,000
1979	2,041,301	1.33	0.119	20,460	1,344	893,000
1980	2,105,607	1.35	0.116	20,603	1,212	949,000
1981	2,038,368	1.48	0.117	21,519	1,121	882,000
1982	2,159,526	1.47	0.122	22,692	1,119	1,686,000
1983	1,271,533	1.42	0.126	15,005	715	1,148,000
1984	1,370,511	1.45	0.122	14,796	692	977,000
1985	1,989,552	1.34	0.113	20,106	891	1,489,000
1986	1,974,083	1.38	0.119	22,327	1,029	1,701,000
1987	2,059,830	1.32	0.112	21,117	991	1,500,000
1988	1,846,158	1.27	0.111	18,783	849	1,303,000
1989	1,746,187	1.26	0.090	17,172	525	1,626,000
1990	1,261,570	1.21	0.091	11,303	362	1,474,000
1991	867,296	1.27	0.074	8,566	217	1,068,000
1992	501,495	1.39	0.081	5,099	115	686,000
1993	392,788	1.44	0.093	5,329	177	739,000
1994	193,124	2.06	0.177	3,010	156	546,000
1995	269,370	1.77	0.156	4,990	252	252,000
Total	**31.2586 Mt**	**1.40**	**0.11**	**327.4 kt**	**14.6 kt**	**~24 Mm^3**

21.74 Murrin Murrin, Western Australia

- *Murrin Murrin Nickel-Cobalt Mine : 2000-2005* Data Sources : (MR, var.)
  Note : Murrin Murrin has historically not reported **actual** ore milled nor ore grades (only metal production), though some data was reported from the September 2004 quarter onwards. All **red bold** values are estimated from the only available data in quarterly and annual reports.

Year	**Ore Milled** (t)	%Ni	%Co	t Ni	t Co
1999	**136,364**	**1.32**		900	0
2000	**1,397,825**	**1.40**	0.098	13,012	926
2001	**2,205,288**	**1.39**	0.084	24,991	1,451
2002	**2,778,611**	**1.35**	0.083	30,009	1,838

Year	**Ore Milled** (t)	%Ni	%Co	t Ni	t Co
2003	**2,582,407**	**1.35**	0.098	27,890	2,033
2004	**2,642,254**	**1.32**	0.089	28,518	1,975
2005	2,510,582	1.32	0.089	27,783	1,791
Total	**~14.25 Mt**	**~1.35**	**~0.09**	**153,103**	**10,014**

21.75 Carr Boyd, Western Australia

- *Carr Boyd Nickel-Copper-Cobalt Mine : 1971-1978*
  Data Sources : (BMR, var.; Cruickshank, 1980)

	Ore Milled (t)	%Ni	%Cu	%Co	t Ni	t Cu	t Co
1970/71	356	1.36	0.53		4.8	1.9	
1971/72	7,899	1.23	0.45		97.5	35.7	
1973/74	80,090	1.41	0.46		1,124.9	365.8	
1974/75	98,337	1.46	0.46		1,438.0	449.1	
1976/77	12,527	1.44	0.48		180.3	60.5	
1977/78	11,146	1.36	0.45		151.3	50.6	
Total	**210,355**	**1.43**	**0.46**		**2,996.8**	**963.6**	

21.76 Scotia, Redross, Spargoville and Sally Malay, Western Australia

- *Scotia, Redross and Spargoville Nickel-Copper-Cobalt Mines : 1970-1977, 1973-1978 and 1973-1980* Data Sources : (BMR, var.; Cruickshank, 1980)
- *Sally Malay Nickel-Copper-Cobalt Mine : 2004-2006* Data Sources : (SMM, var.)

	Ore Milled (t)	%Ni	%Cu	%Co	t Ni	t Cu	t Co	Mine
1969/70	23,135	2.12	0.15	**0.083**	488.5	35.1	19	Scotia
1970/71	100,709	2.37	0.16	**0.034**	2,391.1	164.2	35	Scotia
1971/72	138,417	2.11	0.14	0.04	2,926.5	187.3	44.8	Scotia
1972/73	130,373	2.51	0.16	**0.018**	3,278.1	216.1	24	Scotia
1973/74	124,397	2.53	0.18		3,149.5	224.5		Scotia
1974/75	64,850	2.13	0.18		1,382.8	114.3		Scotia
1975/76	131,528	1.82	0.12		2,389.4	153.5		Scotia
1976/77	95,111	1.45	0.09		1,379.0	85.8		Scotia
Total	**823,468**	**2.14**	**0.15**	**~0.04**	**18,622.7**	**1,199.0**	**>123**	Scotia
1972					28.49			Redross
1973	675	1.06			7.15			Redross
1974	71,807	2.5	**0.19**		1,713	135		Redross
1975	102,000	3.13	**0.23**		2,909	231		Redross
1976	126,426	3.40			**4,080**			Redross
1977	**76,786**	**4.20**			**3,224**			Redross
1978	25,000	4.20			1,051			Redross
Total	**402,694**	**~3.4**	**~0.2**		**~13,000**	**366**		Redross
1975	68,087	2.71	**0.18**		1,195.46	121		Spargoville
1976	113,053	1.87	**0.17**		1,980.18	192		Spargoville
1977	107,324	2.90			2,864.93			Spargoville
1978	137,600	**2.01**			1,801.86			Spargoville
1979	168,805	2.53			2,059.53			Spargoville
1980	5,803	1.8			2,676.30			Spargoville
Total	**600,672**	**~2.4**	**~0.2**		**12,578**	**313**		Spargoville
2004	260,754	1.31	0.58	0.07	2,697	1,470	154.0	Sally Malay
2005 §	777,419 §	1.17 §	0.53 §	0.06 §	7,642 §	3,884 §	426 §	Sally Malay
2006 #	680,200 #	1.26 #	0.53 §	0.06 §	7,369 §	3,431 §	389 §	Sally Malay
Total	**1,718,373**	**1.23**	**0.54**	**0.06**	**17,708**	**8,785**	**969**	Sally Malay

§,# Open cut mining (ore) was 92.58% and 7.26%, respectively; giving total of 59.9% total to 2006.

21.77 Cawse and Bulong, Western Australia

- *Cawse Nickel-Cobalt Mine : 1998-2000* Data Sources : (CME, var.)
- *Bulong Nickel-Cobalt Mine : 1999-2002* Data Sources : (PR, var.)

Year	**Cawse §**					**Bulong**				
	Ore Milled (t)	%Ni	%Co	t Ni	t Co	**Ore Milled** (t)	%Ni	%Co	t Ni	t Co
1998	55,451	1.12	0.131	175	20	222,397	1.67	0.158	2,480.6	78.9
1999	372,040	1.43	0.256	3,395	735	351,843	1.91	0.141	5,216.8	343.3
2000	700,833	1.28	0.120	6,866	1,035	440,333	1.77	0.132	6,183.8	379.0
2001						218,279	1.75	0.130	3,268.9	219.7
2002						222,397	1.67	0.158	2,480.6	78.9
Total	**1,128,326**	**1.32**	**0.165**	**10,436**	**1,790**	**1,232,852**	**1.79**	**0.139**	**17,150**	**1,021**

§ The Cawse operation was closed in early 2001 and later sold to OM Group Corporation, since this time no production statistics have been publicly reported despite the re-opening of the mine after substantial modification of the mill.

21.78 Nepean and Mt Windarra-South Windarra, Western Australia

- *Nepean Nickel Mine : 1970-1983, 1986-1987* Data Sources : (BMR, var.)
- *Mt Windarra-South Windarra Nickel-Copper Mine : 1974-1979, 1981-1991* Data Sources : (BMR, var.; WMC, var.-b)

	Nepean			Mt Windarra-South Windarra					
	Ore Milled (t)	%Ni	t Ni	**Ore Milled** (t)	%Ni	%Cu	t Ni	t Cu	%Open Cut
1970	40,758	**3.05**	1,243.12						
1971	83,535	**2.23**	1,833.49						
1972			1,955.19						
1973	80,866	**3.05**	2,466.42						
1974	68,791	**3.36**	2,311.38	186,406	0.87	**0.12**	1,615	220	
1975	72,861	**3.23**	2,352.40	1,003,288	1.20	**0.11**	7,903.98	1,061	69.8
1976	73,387	**2.90**	2,141.41	1,000,000	**1.45**	**0.09**	14,499.12	890	64
1977	73,336	**3.21**	2,350.74	986,717	1.23		10,640.64		
1978	66,907	**3.65**	2,441.25				4,295.91		
1979	63,511	**3.67**	2,422.86				376.58		
1980	81,764	**3.70**	3,133.65						
1981	76,374	**3.63**		263,230	1.45				
1982	110,684	**2.81**		440,000	1.17				
1983	7,300	**4.00**		387,864	1.28		4,308		
1984				376,567	1.51		4,621		
1985				463,500	1.67		6,175		
1986	67,170	**3.13**		515,201	1.25		6,645		
1987	20,621	**3.03**		556,500	1.57		7,550		
1988				205,000	1.11		5,398		
1989				447,917	1.45		4,418		
1990				421,970	1.37		4,460		
1991				217,203	1.14		1,951		
Total	**987,864**	**3.18**		**7.471 Mt**	**~1.34**		**~92 kt**	**>2.2 kt**	

21.79 Black Swan, Rav8 and Emily Ann-Maggie Hays, Western Australia

- *Black Swan Nickel Mine : 1997-2005* Data Sources : (MPI, var.)
- *Rav8 Nickel Mine : 2000-2005* Data Sources : (TR, var.)
- *Emily Ann-Maggie Hays Nickel Mine : 2001-2005* Data Sources : (LionOre, var.)

	Black Swan				Rav8				Emily Ann-Maggie Hays		
	Ore Milled (t)	%Ni	t Ni	%Open Cut	**Ore Milled** (t)	%Ni	t Ni	%Open Cut	**Ore Milled** (t)	%Ni	t Ni
1997	75,000	9.1	6,123								
1998	142,000	9.2	12,237								
1999	142,000	9.7	12,936								
2000	418,000	4.7	16,648		72,613	3.18	2,016	100			
2001	542,000	4.6	21,828		134,291	3.66	4,034	91.1	10,664	1.56	107
2002	396,000	4.1	14,360		68,091 [§]	3.58	2,436	0	220,996	3.14	5,301
2003	232,204	5.39	11,288		79,318 [§]	3.83	2,870	0	283,201	3.11	7,145
2004	296,846	3.71	9,844	38.27	69,947 [§]	2.88	2,015	0	331,842	2.90	7,706
2005	503,670	2.00	7,744	72.15	44,091 [§]	2.99	1,321	0	480,487	2.89	11,329
Total	**2.748 Mt**	**4.66**	**113 kt**	**~17.4**	**468,351**	**3.42**	**14,692**	**41.63**	**1.327 Mt**	**2.97**	**31,588**

[§] Milled at Kambalda concentrator.

21.80 Diamonds : Argyle, Bow River, Ellendale, Merlin

- *Diamond Production : Australia 1979-2006* Data Sources : See below.
- *Diamond Production : Argyle 1979-2006*
  Data Sources : (Ashton, var.; CRA, var.; RT, var.; Smith *et al.*, 1990; Yates *et al.*, 1993)
- *Diamond Production : Bow River 1988-1995*
  Data Sources : (Fazakerley, 1990; Normandy, var.; RIU, var.)
- *Diamond Production : Ellendale 1977-1980, 2001-2006*
  Data Sources : (Hughes & Smith, 1990; KDC, var.; RIU, var.)
- *Diamond Production : Merlin 1999-2006* Data Sources : (Ashton, var.; RT, var.)

Australian Diamond Production : Argyle, Bow River, Merlin & Ellendale

Year	Australia (Total)				Argyle, WA			
	Ore Milled t	Grade carats/t	Prod. carats	Waste rock t	Ore Milled t	Grade carats/t	Prod. carats	Waste rock t
1979	2,000	2.54	5,119		2,000	2.54	5,119.5	
1980	181,067	0.08	15,300					
1981	86,415	2.94	253,912		86,415.2	2.94	253,912.18	
1982	183,497	4.47	820,377		183,497	4.47	820,377	
1983	1,070,000	5.93	6,200,000	4,000,000	1,070,000	5.93	6,200,000	4,000,000
1984	1,470,000	3.87	5,689,586	8,000,000	1,470,000	3.87	5,689,586	8,000,000
1985	1,527,729	4.63	7,079,412	8,000,000	1,500,000	4.71	7,070,062	8,000,000
1986	3,299,279	8.86	29,237,832	12,960,000	3,239,467	9.02	29,210,764	12,960,000
1987	3,504,458	8.66	30,332,677	14,030,000	3,504,458	8.66	30,332,677	14,030,000
1988	5,300,000	6.56	35,050,000	15,100,000	4,700,000	7.3	34,600,000	15,100,000
1989	7,633,127	4.58	34,979,938	19,200,000	5,700,000	5.96	34,400,000	19,200,000
1990	9,802,785	3.53	34,589,283	27,300,000	7,000,000	4.74	33,800,000	27,300,000
1991	10,542,292	3.41	35,959,166	28,200,000	7,300,000	4.82	35,000,000	28,200,000
1992	14,077,443	2.84	39,999,764	26,100,000	10,300,000	3.80	39,000,000	26,100,000
1993	14,729,879	2.85	41,907,807	33,300,000	10,900,000	3.78	40,900,000	33,300,000
1994	16,180,052	7.58	43,682,643	34,600,000	12,500,000	9.74	42,800,000	34,600,000
1995	17,704,779	2.30	40,695,449	36,000,000	14,200,000	2.82	39,900,000	36,000,000
1996	18,443,143	2.33	42,376,831	39,000,000	17,000,000	2.47	42,000,000	39,000,000
1997	16,300,000	2.47	40,200,000	29,800,000	16,300,000	2.47	40,200,000	29,800,000
1998	17,500,000	2.35	40,800,000	21,600,000	17,500,000	2.35	40,800,000	21,600,000
1999	15,794,700	1.89	29,783,745	53,000,000	15,400,000	1.90	29,700,000	53,000,000
2000	15,985,562	1.67	26,665,005	63,274,000	15,326,000	1.73	26,475,000	63,274,000
2001	14,942,200	1.75	26,153,056	67,497,000	14,503,000	1.80	26,097,000	67,497,000
2002	14,798,698	2.28	33,778,732	78,048,000	13,752,000	2.45	33,636,000	78,048,000
2003	10,710,716	2.90	31,029,768	68,113,000	9,787,000	3.16	30,910,000	68,113,000
2004	11,035,702	1.88	20,702,039	60,914,000	9,576,000	2.15	20,620,000	60,914,000
2005	11,140,308	2.75	30,647,114	53,970,000	8,969,000	3.40	30,476,000	53,970,000
2006	11,639,897	2.52	29,303,266	36,059,000	8,441,000	3.44	29,078,000	36,059,000
Total	**253.9 Mt**	**2.79**	**738 Mcarats**	**»840 Mt**	**230.2 Mt**	**3.17**	**730 Mcarats**	**~838 Mt**

Year	Bow River, WA		
	Ore Milled t	Grade carats/t	Production carats
1985	27,729	0.34	9,350
1986	59,812	0.45	27,068
1987	1,933,127	0.30	579,938
1988	600,000	0.750	450,000
1989	1,933,127	0.30	579,938
1990	2,802,785	0.282	789,283
1991	3,242,292	0.30	959,166
1992	3,777,443	0.270	999,764
1992	3,777,443	0.270	999,764
1993	3,829,879	0.267	1,007,807
1994	3,680,052	0.243	882,643
1995	3,504,779	0.230	795,449
1996	1,443,143	0.265	376,831
Total	**26.834 Mt**	**0.281**	**7.46 Mcarats**

Year	Merlin, NT		
	Ore Milled t	Grade carats/t	Production carats
1999	394,700	0.212	83,745
2000	659,562	0.288	190,005
2001	431,000	0.128	55,000
2002	787,000	0.149	117,000
2003	237,000	0.262	62,000
Total	**2.509 Mt**	**0.203**	**0.508 Mcarats**
	Ellendale, WA		
1979/80	181,067	0.084	15,300
2001	8,200	0.129	1,055.57
2002	259,698	0.099	25,732
2003	686,716	0.084	57,768
2004	1,459,702	0.056	82,039
2005	2,171,308	0.079	171,114
2006	3,173,443	0.067	213,280
Total	**7.94 Mt**	**0.071**	**0.566 Mcarats**

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