

MINERALS & PETROLEUM SOUTH AUSTRALIA











Government of South Australia

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Front cover captions (from top): Field inspection of a seismic line. (Photo 47682) Field excursion prior to the 2000 BHEI Conference. (Photo 47536) Redman 1 drill stem test, Otway Basin. (Photo 45902) Easterly aerial view of the Olympic Dam processing plant, 1999 (courtesy WMC Copper Uranium). (Photo 47242)

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MINISTER'S COMMENT

South Australia's minerals sector has reached record production levels, with a remarkable 20% increase over the last 18 months — growth that this Government is keen to see replicated in years to come. In order to achieve such growth, and to capitalise on the rich natural resources our State has to offer, we need to ensure the best possible support for exploration and production efforts.

To this end, the past 12 months have seen a significant consolidation of policies for the South Australian minerals sector — through the report of the Premier's Resources Task Force, the Government's response and commitment to implementing that report and finally through the formation of the Minerals Industry Development Board to champion the needs of industry at the highest levels of Government.

My appointment as Minister for Minerals and Energy in February 2000 was also an invaluable step towards focusing Government attention on the issues facing the minerals sector. The appointment has been followed through at a Departmental level, through the creation of the Office of Minerals and Energy Resources, to deal with all matters relating to mineral production and exploration in the State. Dr David Blight, a geologist of some 20-years standing, was appointed as Executive Director of the new Office in May 2000.

The Premier's Resources Task Force, which reported in November 1999, set an ambitious target, predicting that we can increase our minerals production from \$1.43 billion to \$3 billion per year, with processed mineral output of \$1 billion, by 2020.

To achieve the Resources Task Force target, it is critical that a revitalised exploration industry starts making new mineral discoveries. In order for this to occur, we need to focus on improving land access, stimulating exploration and ensuring that Government remains supportive and responsive. Government investment of an additional \$2.2 million in the mining sector this financial year will go a long way towards achieving these goals. This is a substantial funding commitment from the Government, and it demonstrates our resolve to work with business and the community to develop a resurgent and dynamic minerals industry.

Additional funding is being spent on accelerating key information and promotional programs, such as the successful Targeted Exploration Initiative. This program is concentrating on improving our information on a number of underexplored areas in the State, including the Musgrave Block, southern Gawler Craton, eastern Adelaide Geosyncline and Curnamona Province.

This investment on behalf of Government to improve our exploratory efforts, is paying dividends in the field.

The billion dollar SAMAG magnesium project, which proposes to process Leigh Creek magnesite at Port Pirie, is moving ahead with great promise, with the economic and environmental impact studies released in early November 2000. With construction of the Alice Springs to Darwin rail link set to commence next year, value-adding projects such as the SAMAG proposal will have access to a significant export advantage.

The AuIron proposal to utilise iron and coal deposits near Coober Pedy will also benefit from the new rail link. The \$16 million demonstration plant for this project is now up and running at Whyalla, with the first production of pig iron expected by the end of 2000. The demonstration plant will provide data for a billion dollar full-scale commercial plant, expected to create employment for ~500 people. It is predicted that work on a commercial plant could commence as early as 2003.

These major projects have been matched by interest in smaller scale projects, such as the potential of Murray Basin mineral sands deposits. A joint study between industry and the



South Australian, Victorian, New South Wales and Commonwealth Governments was released in August 2000, identifying sites of high potential in the basin, and infrastructure requirements to support development. Murray Bridge, Port Pirie and the Riverland were identified as particular 'hot spots' in the study, and I am encouraged that several companies have already begun work in the area.

The South Australian dimension stone industry is also demonstrating a huge potential for growth. The international stone industry saw annual growth of more than 10% between 1986 and 1996, yet Australia produces only ~0.2% of total international product. While South Australia leads this export effort, there is obviously room for improvement, and I was delighted to support the industry at the world's largest stone expo — Verona Feire 2000, held in September 2000. Following on from our success in Verona, I released a \$250 000 support package in November to assist the industry improve its collaborative marketing, research and training efforts.

Our existing mining operations are also experiencing strong growth, with the most notable success taking place at Olympic Dam, the State's largest mine. With a major expansion of the mine completed in 1999, almost trebling production, Olympic Dam is now producing around 200 000 t of copper, 4300 t of uranium, 850 000 ounces of silver and 80 000 ounces of gold a year. This output means an income of \$650 million for the State, of which \$20 million is returned directly through royalty payments.

Such production makes Olympic Dam a world-class operation, in terms of both professionalism and scale. With a further 20% expansion of refined copper capacity flagged, Olympic Dam is set to be rated as one of the world's top ten copper mining operations.

There are a number of other significant mining opportunities on the horizon for South Australia, including the promising Honeymoon and Beverley uranium prospects, and the recent float of OneSteel providing new impetus for iron ore mining in the Middleback Range.

Overall, the mining industry is one of the most significant sectors in the South Australian economy, providing around 7500 direct jobs to South Australians. I am hopeful that in 2001 we can grow from this strong base to even further improve the South Australian mining and energy industry, and to continue to build job and investment opportunities for our State.

Hon Wayne Matthew MP Minister for Minerals and Energy Minister assisting the Deputy Premier

EXECUTIVE DIRECTOR'S COMMENT

In 1999, PIRSA Mineral Resources Group developed *Minerals South Australia 2000*, a prototype annual review type publication. The success of this venture was such that I have decided to make it a flagship publication of the newly created Office of Minerals and Energy Resources, of which I was appointed Executive Director in July 2000. The Office combines the functions of the Minerals and Petroleum Groups of PIRSA, and this combination is mirrored in the content of *Minerals and Petroleum South Australia 2001*.

As I reflect on my knowledge gained over the last few months about the minerals industry in South Australia, I am buoyed by what I have learnt. Before arriving I had a perception of a State with development potential being held back by that cruel twist of nature — transported cover. While this perception is reality, I have become excited by the advances made by the Office of Minerals and Energy Resources in exposing what lies beneath this cover. And further, I realised that this curse of cover, while retarding South Australia's mineral development in the past, may well provide us with an exciting future because, in essence, the cover has enabled South Australia to save the 'best till last'.

New techniques are being developed that enable explorers to see beneath the cover. I believe that when airborne EM and gravity techniques, which are now becoming available, are coupled with tried and true techniques such as modern geochemical sampling and airborne magnetics, exciting new targets will be generated and discoveries made.

The advances that my Office is making in enhancing the geoscientific framework of South Australia also give great cause for optimism. Ongoing bedrock drilling, coupled with detailed 1:100 000 mapping, is demonstrating that the State contains rocks analogous with those hosting Archaean greenstone gold and nickel deposits, Proterozoic Mount Isa and Broken Hill type base metal deposits, Voisey's Bay and Thompson type nickel deposits, mineral sands deposits and, of course, South Australia hosts the type example Olympic Dam Cu–Fe type deposit. There is also strong evidence that the State hosts a world-class iron ore province that still awaits exploitation.

The minerals exploration industry has been suffering one of its cyclic downturns over the past few years. This downturn has resulted from low commodity prices, land access issues and a flow of risk capital into the e-sector following a loss of investor confidence in the minerals industry. This downturn, coupled with a perception that easy exploration opportunities exist in less-developed countries (e.g. east Africa), has seen exploration expenditure in South Australia fall drastically. It is pleasing to note from recent ABS statistics that the exploration cycle appears to have bottomed out, commodity prices are picking up and that risk capital has retracted from the e-sector. Explorers have commonly encountered problems when operating in poorly developed countries and as a consequence will, I believe, re-orientate their efforts towards more stable and developed jurisdictions such as Australia. As a result of these notions I see that an opportunity exists for South Australia to capture a substantial percentage of a coming resurgent exploration industry. The current work of the Office of Minerals and Energy Resources is targeted at maximising the attraction of that resurgent exploration investment. A substantial part of the budget of the Office is geared toward heritage issues associated with land access.

As the premier onshore petroleum production State, it is fair to assume that the petroleum and gas industry in South Australia is a mature industry. Never-the-less, I am firmly of the opinion that substantial opportunities still exist. Work of the Office of Minerals and Energy Resources



has highlighted the potential of the grossly under-explored Neoproterozoic and Early Phanerozoic basins in South Australia. In addition, Cooper Basin acreage has been opened up to new explorers and, with historically high success rates where almost 50% of wildcats are successful, I believe that we can expect a substantial lift in petroleum and gas reserves in the future. Developments within South Australia will expand energy requirements and the under-explored Otway Basin in the South-East of the State is ideally placed to contribute to that expansion. The existing Ladbroke Grove Power Station fuelled by adjacent gas supplies is a prime example of the opportunities available for capitalising on the deregulated energy market.

While in South Australia we have tended to focus on the onshore petroleum potential, the offshore is increasingly becoming of interest. Recent work by AGSO has highlighted the substantial thickness and prospectivity of Cretaceous age rocks in the Great Australian Bight. This basin is now under exploration permit and I look forward to the excitement these exploration activities will generate.

Finally I would like to touch on a promising concept relating to green energy that the Office of Minerals and Energy Resources is facilitating through release of acreage in northeastern South Australia with a view to exploiting 'hot dry granitic rocks' encountered ~3000 m beneath sediments of the Cooper and Eromanga Basins. Success in this concept would establish South Australia as a leader in sustainable resource development.

With this breadth of exciting opportunities, I believe the future prosperity of South Australia rests firmly with a resurgent minerals and petroleum resources industry, and the Office of Minerals and Energy Resources is committed to promoting and expediting this resurgence.

Dr David Blight Executive Director Office of Minerals and Energy Resources Primary Industries and Resources South Australia

INDUSTRY OVERVIEW

IN BRIEF

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- Record aggregate mineral and petroleum production of \$1.7 billion buoyed by increased production from the Olympic Dam Cu–U–Au–Ag mine expansion and soaring global petroleum prices, highlighted the potential of the mineral industry to substantially boost the wealth of South Australia. Olympic Dam is now the largest underground mine in Australia.
- Several emergent mineral projects are also rapidly advancing to full development, in particular uranium production from the Beverley Mine which commenced in November 2000, and hot commissioning of the SASE pig iron demonstration plant which should commence before the end of 2000.
- Opening up Australia's largest onshore oil and gas province, the Cooper Basin, has attracted national and international interest. The winning bids in the three rounds contain guaranteed exploration commitments of more than \$244 million over the first five years. A total of 120 bids were lodged by 27 different consortia, of which only 12 had previously explored for petroleum in South Australia. Twenty-seven new petroleum exploration licences will be offered after Native title issues have been resolved.
- On the downside, mineral exploration has stalled, due in part to the worldwide impact of low commodity prices and competition for investment funds, but also substantially impacted by difficulties with land access related to Native title and Aboriginal heritage issues.
- In October 2000, establishment of a South Australian Minerals Industry Development Board was announced. The Board will work with Government and industry to promote growth in the minerals sector, in line with recommendations made by the Premier's Resources Task Force in its December 1999 report.
- The Resources Task Force set a target for the South Australian minerals sector of reaching \$3 billion in mineral production and \$1 billion in mineral processing capacity per year by 2020. If the target is met, jobs for South Australians in the mining industry would grow from 20 000 (direct and indirect) at present to 40 000 by 2020.
- Agreement between Native title claimants and the State Government to commence negotiation of Indigenous Land Use Agreements (ILUAs) for Native title claims throughout the State should herald substantial reconciliation of mineral industry land access issues.

Commodity prices

Global commodity prices continue to stagnate and are still well below the moderate levels recorded five years ago. October 2000 prices included gold at US\$270/oz, copper at US\$1800/t, lead at US\$470/t and zinc at US\$1050/t.



New copper smelter at Olympic Dam (courtesy WMC Copper Uranium). (Photo 47635)

Uranium spot prices continue to remain well below contract prices received by Australian uranium producers.

The world oil price dropped to a 10-year low of US\$10–11/barrel (bbl) in late 1997 as a result of the collapse of Asian economies decreasing demand producing a world oil glut. OPEC cut production in 1998 and 1999, but world oil prices have more than tripled since then, driven by strong demand and a strong world economy and low inventories. In 2000, oil prices have increased from US\$23/bbl to a maximum of US\$37/bbl, and in late 2000 were in the low US\$30/bbl range.



Moomba gas and liquids processing plant, Cooper Basin. (Photo 43803)

Mineral exploration

The Australian Bureau of Statistics (*Actual and expected private mineral exploration Australia, June quarter 2000*) recorded that mineral exploration spending in South Australia for the June quarter 2000 was \$5.6 million. This was substantially lower than the \$12.8 million for the same period in 1999.

While low commodity prices and increased competition for investment funds has affected exploration worldwide, a number of exploration programs Australia wide have been curtailed (or abandoned) as a direct result of excessive costs and lost time associated with Native title and Aboriginal heritage issues. South Australia is addressing this issue by progressing the ILUA process.

In September 1999, the central portion of Yumbarra Conservation Park, ~30 km northwest of Ceduna, was reproclaimed by State Parliament to allow mineral exploration and mining access. An exploration licence was granted in January 2000 and exploration is in progress under licence conditions required to achieve environmental outcomes acceptable by the community.

Petroleum exploration and development

The number of petroleum exploration licences and licence applications is at an all time high, with over 75% of the State's prospective areas covered. However, onshore exploration levels in South Australia have fallen largely as a result of the expiry of Petroleum Exploration Licences 5 and 6 (Cooper Basin) in February 1999. Exploration and appraisal drilling decreased in 2000 as the focus shifted to development drilling in the Santos Joint Venture production licences in the basin. Activity levels are expected to increase in 2001 once Native title issues are resolved and new licences can be issued.

In the Otway Basin, Origin Energy is supplying local gas markets from the Katnook, Haselgrove and Redman Fields. Low quality gas in the Ladbroke Grove gasfield has

now found a commercial use in electricity generation at Origin's Ladbroke Grove Power Station. The station began supplying power into the national electricity grid in January 2000 and a second turbine was added in May 2000 to boost generating capacity to 80 MW.

Since 1964, the total petroleum industry investment in South Australia is \$10 billion,



and it is anticipated that the billionth petroleum royalty dollar (in today's dollar terms) will be paid in late 2000.

New Petroleum Act

The legislation governing onshore petroleum exploration and production in South Australia was reviewed through an extensive consultation process which commenced in 1996. The proclamation of the *Petroleum Act 2000* and promulgation of the Petroleum Regulation 2000 occurred on 25 September 2000. The Act was developed through embracing six key principles of certainty, openness, transparency, flexibility, practicality and efficiency.

Environment

The Federal Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) came into force in July 2000 The EPBC Act provides protection for matters of national environmental significance which are: World Heritage properties; Ramsar wetland of international importance; nationally threatened animal and plant species and ecological communities; internationally protected migratory species; Commonwealth marine areas; and nuclear actions.

Intended to establish a modern, streamlined process for environmental assessment, there is some uncertainty as to how and when the Act may be triggered. South Australia is amending its legislation to avoid duplication of environmental procedures and thus reduce the impact on mineral exploration and development programs.

Corporate

The year has seen several significant changes to the corporate makeup of the industry in South Australia. OneSteel was launched as a new company with responsibility for BHP's Long Products business and was listed as an independent company on the Australian Stock Exchange in October 2000. NRG Energy, the world's sixth largest independent electricity generation company, has taken over management of the Leigh Creek coal mine, the 260 km rail line to Port Augusta and the two coal-fired power stations at Port Augusta, as well as other assets and commitments, in a 100-year leasing arrangement with the State Government.

BHP has relocated a major component of its worldwide administrative arm to Adelaide and Unimin Corp. has acquired the operations of Normandy Industrial Minerals, which operates a number of industrial mineral mines in the State.

A very significant boost to the mineral industry support base in South Australia has resulted from establishment of the Data Metallogenic Centre, attached to AMF headquarters in Adelaide, in late 1999. The Centre houses the world's first and only rock library with 60 000 rock samples representing 4000 mineral deposits worldwide. 7

Targeted Exploration Initiative South Australia (TEISA)

Mineral programs

Now into the third year of the four-year program, recent activities have included completion of airborne geophysical surveys over ~50 000 km² covering the Musgrave Block in the Anangu Pitjantjatjara Lands; trial airborne electromagnetic surveys over mineral deposits on the Gawler Craton; and regional bedrock drilling programs on Southern and Western Eyre Peninsula.

Petroleum programs

Recent petroleum-related activities have included scanning and archiving of geological and geophysical company data; completion of a number of projects addressing market failure in the Cooper and Eromanga Basins; and propectivity studies in frontier Cambrian basins.

SOUTH AUSTRALIAN PRODUCTION

The total value of production for 1999–00 (Table 1) shows a substantial increase due largely to impacts of the Olympic Dam expansion which has led to significant increases in production of copper and uranium. Commissioning of the Beverley uranium mine in November 2000 and development of the Honeymoon uranium mine are expected to continue the trend for 2000–01. Gypsum output continued to show a marked increase but total value was static due in part to the increase in production being mainly second grade and agricultural gypsum and in part due to a decline in the price of premium grade gypsum. Table 2 lists the South Australian resources production for the 1999–00 fiscal year. Figure 1 locates selected mines and minerals, and producing petroleum basins in South Australia.

 Table 1
 South Australian minerals output value (\$million) for

 1995–96 to 1999–00.
 1999–00.

	1995–96	1996–97	1997–98	1998–99	1999–00
Metallic minerals	379.4	328.1	354.6	318.8	718.5
Industrial minerals	38.58	41.37	50.24	52.08	51.08
Coal	50.85	63.95	60.81	42.63	43.98
Construction materials	63.95	76.93	82.7	80.8	77.4
Natural sand products	16.10	16.2	17.5	18.3	21.1
Clay products	1.7	1.9	2.4	2.7	2.25
Opal (estimate)	40.5	39.9	38.9	38.0	38.1
Total	591.0	568.38	607.1	553.3	952.4

Table 2 South Australian resources production for 12 monthsended 30 June 2000.

	Quantity (t)	Value (\$)	12 month total(\$)
Petroleum products			
Natural gas (Gm ³)	4.081	387 242 264	
Caroline 1 CO_2 well (t)	25 644	3 866 665	
Ethane (t)	26 144	3 364 727	
Condensate (kL)	389 840	100 645 229	
Crude oil (kL)	466 309	126 028 430	
LPG (t)	311 471	135 106 825	756 254 140
Mineral products — refined			
Copper	183 881	496 980 604	
Gold (kg)	992	14 489 385	
Silver (kg)	9 572	2 527 447	
Uranium oxide	4 082	172 076 522	686 073 958
- mineral ores and c	oncentrates	5	
Iron ore	3 005 162	27 046 458	
Lead ore	_	-	
Zinc ore	13 033	5 416 507	32 462 965
Coal			
Black coal	3 000 000	42 807 483	42 807 483
Industrial minerals			
Barite	13 403	662 597	
Cement shale	9 994	79 952	
Dolomite	865 618	8 764 764	
Feldspar	2 031	69 853	
Foundry sand	47 391	745 845	
Gypsum	1 824 056	4 825 718	
Jade (kg)	1 170	5 850	
Kaolin	2 357	240 916	
Limesand	37 743	450 073	
Limestone			
Agricultural	57 600	583 357	
Cement	1 887 952	14 889 299	
Chemical	631 309	11 731 883	
Fines/whiting	3 583	167 513	
Magnesite	1 017	27 828	
Mica (damourite)	797	102 504	
Micaceous haematite	-	-	
Peat	2 613	117 585	
Phosphate	1 848	4 895	
Salt	631 570	5 175 170	
Semi precious and ornamental stones (k	g) 14	27	
Silica	114 752	1 670 408	
Sillimanite	366	12 424	
Talc	9 410	748 823	51 077 718
Construction materials	10 223 204	77 446 334	77 446 334
Natural sand products	2 682 717	21 104 908	21 104 908
Clay products	394 044	2 245 653	2 245 653
Opal production estimate		38 051 300	38 051 300
Total mineral value		5	\$1 707 524 459



Fig. 1 Selected mines and minerals, and producing petroleum basins, in South Australia.

EMERGING MINERAL PROJECTS IN SOUTH AUSTRALIA

Major new development projects have advanced significantly with commercial production of uranium from the Beverley uranium mine commencing in November 2000 following commissioning of the plant. The Honeymoon uranium project has advanced with public consultation of the EIS and the completion of field leach trials. The SAMAG project has progressed with a trial sample of magnesite taken from Mount Hutton for testing by Amdel; public consultation for the EIS for the haul road was completed, and the EIS for the pilot plant at Port Pirie due is due for release in late 2000.

The Mindarie Mercunda heavy mineral sands project has advanced significantly over the last 12 months, with Murray Basin Minerals recently announcing completion of a first-stage feasibility study.

The current status of these emerging projects is shown in Table 3. Further details are listed below the table together with websites containing detailed information on the individual projects and prospects.

Challenger

Locality:	130 km northwest of Tarcoola (363500mE, 6693500mN, Zone 53).
Reserves:	Total indicated and inferred 1.85 Mt at 8.4 g/t.
Mineralogy:	Disseminated sulphides.
History:	Discovered in July 1995 by follow-up RAB drilling of an anomaly defined by geo- chemical analysis of near-surface calcrete.
Operator:	Gawler Joint Venture (Dominion and Resolute).
Website:	http://www.dml.com.au/

Golf Bore

Locality:	180 km north of Tarcoola (405000mE, 6726500mN, Zone 53).
Reserves:	Inferred 726 195 t at 3.29 g/t.
Mineralogy:	Not available.
History:	Located by drill testing a 4 km long surface calcrete gold anomaly.
Operator:	Gawler Joint Venture (Dominion and Resolute).
Website:	http://resolute-ltd.com.au/Default.htm
Beverley	
Locality:	35 km northwest of Lake Frome (365000mE, 6659000mN, Zone 54).
Reserves:	21 000 t of U_3O_8 with an average grade of 0.27%.
Mineralogy:	The uranium is usually present as uraninite or coffinite coating on sand grains, and the ore is often pyritic and carbonaceous.
History:	Indications of uranium mineralisation at Beverley were first detected in 1969, and the orebody was discovered in July 1970. In 1990, Heathgate Pty Ltd acquired the property and completed ISL trials in 1998. Full regulatory approval was granted in 1999. The commercial plant was finished in 2000.
Operator:	Heathgate Resources Pty Ltd.
Website:	http://www.heathgateresources.com.au/

Table 3 Emerging South Australian mineral projects.

Project	Commodity	Status	Province	Company contact		
Challenger	Gold	Proposed feasibility study on hold.	Gawler Craton	Tony Poustie (08) 9426 6400		
Golf Bore	Gold	Prospect.	Gawler Craton	As above		
Beverley	Uranium	Mine construction completed November 2000.	Callabonna Sub-Basin	Chuck Foldenauer (08) 8212 2155		
Honeymoon	Uranium	Evaluation and feasibility complete. EIS available for comment.	Frome Embayment	Phil Bush (07) 3371 9700		
SASE Project	Pig iron	Completed cold commissioning of trial plant.	Whyalla	Neill Arthur (02) 9357 2044		
Hawks Nest Phillipson	Iron ore Coal	Resource delineation completed. Resource delineation completed.	Gawler Craton Arckaringa Basin	As above As above		
Uley	Graphite	Joint venture discussion continuing.	Gawler Craton	Tony Rechner (08) 9481 3322		
Mindarie-Mercunda	Heavy mineral sands	Resource delineation completed. Feasibility study underway.	Murray Basin	Chris Neal (08) 8410 8884		
SAMAG Project	Magnesium	Feasibility completed. Site selected. EIS under way.	Weeroona, Port Pirie	Ric Horn (08) 8362 2788		
Mount Hutton	Magnesite	Resource delineation completed. Trial mining completed.	Adelaide Geosyncline	As above		



Beverley Mine campsite, 1.5 km north of the new plant. Mount Painter Inlier is in the background (courtesy Heathgate Resources Pty Ltd). (Photo 47401)

Honeymoon

e e	
Locality:	75 km northwest of Broken Hill (467100mE, 6487400mN, Zone 54).
Reserves:	Total resource 5500 t U_3O_8 equivalent with an average grade of 0.15% at depths of 100–120 m.
Mineralogy:	The uranium is usually present as a uraninite or coffinite coating on sand grains, and the ore is often pyritic and carbonaceous.
History:	The Honeymoon deposit was intersected in 1972. A definition drilling program found the deposit to be too small for open cut or underground methods. A trial ISL program is under way.
Operator:	Southern Cross Resources Inc.
Website:	http://www.uic.com.au
SASE Project	
Locality:	Whyalla (demonstration plant).
Description:	The project will use Ausiron submerged lance direct smelting system for pig iron production using iron ore from the Hawks Nest deposits and coal from the Phillipson deposits.
History:	Pre-feasibility studies were completed in 1996. Trial plant commenced operations in November 2000 for 4–6 months. Commercial plant feasibility studies are to commence shortly. Thiess is project manager for the demonstration plant; co-manager is Corus Steel. A commercial plant is expected to be located near Whyalla or Coober Pedy and will co-produce very competitive electricity from waste heat as a by-product.
Operator:	AuIron Energy Ltd.
Website:	http://www.auironenergy.com.au/default.htm



Northwesterly aerial view of the Honeymoon demonstration plant (courtesy Southern Cross Resources Australia Pty Ltd). (Photo 47628)

Hawks Nest

Locality:	400 km by road north of Port Augusta (514600mE, 6680000mN, Zone 53).
Reserves:	Several deposits comprising three types of iron ore. (1) Low-grade magnetite BIF at 36.4% Fe. (2) High-grade magnetite BIF up 69% Fe. (3) High-grade haematite at 60% Fe. Total 600 Mt.
Mineralogy:	Dark grey to black, moderately laminated BIF similar to Wilgena Hill Jaspilite.
History:	As part of the SASE Project, MESA commenced a search for iron deposits on the northern Gawler Craton in 1995. Ten deposits were identified — Giffen Well, Peculiar Knob, Sequoia, and seven at Hawks Nest.
Phillipson	
Locality:	150 km north of Tarcoola (450100mE, 6740200mN, Zone 53).
Reserves:	Total resource of 5000 Mt of coal.
Mineralogy:	Coal interbedded with siltstone, carbonaceous mudstone and minor sandstone.
History:	Coal was discovered in a stratigraphic bore drilled by the Government in 1902. Major exploration of the deposit was completed by Utah Development company between 1971 and 1982. AuIron Energy Ltd obtained the leases to the deposits in 1995.

Uley

Locality:	22 km southwest of Port Lincoln (564066mE, 6148848mN, Zone 53).
Reserves:	Part of the Mikkira Graphite Province, comprising six deposits. Measured and Indicated in situ resource of 2.87 Mt at 13.4% FC (fixed carbon), including 1.49 Mt at 15.3% FC.
Mineralogy:	Disseminated, crystalline, fine to coarse $(0.1-2 \text{ mm})$ flake graphite within Proterozoic biotite–quartz schist. Ore zones grade 6–30% FC.
History:	Graphite was discovered in 1910. The mine was worked briefly during 1927–33 and again in 1940–45. Interest was renewed in 1981 when CRA Exploration Pty Ltd confirmed a major graphite resource at the existing workings and discovered an additional five new prospects.
Operator:	Eagle Bay Resources.
Website:	http://www.ebr.indigo.net.au/
Mindarie-Me	rcunda
Locality:	50 km south-southwest of Loxton (428000mE, 6150000mN, Zone 54).
Reserves:	Total indicated and inferred resource is 65.6 Mt at 3.3% heavy minerals. Exploration is continuing.
Mineralogy:	The assemblage is fine to medium grained and is dominated by rutile $(4-5\%)$, leucoxene $(4-5\%)$, ilmenite (50%) , zircon (20-22%), and non-economic silicates and iron oxides.
History:	Exploration by Aberfoyle comprised preliminary geomorphic mapping using aerial photography, Landsat imagery, aeromagnetics and radiometrics, with RAB and RC drilling. Murray Basin Minerals NL took up the ground almost a decade later. Over 80 000 m of drilling have identi- fied 30 mineralised strandlines, of which nine have been taken to resource status.
Operator:	Murray Basin Minerals NL.
Website:	http://www.murraybasinminerals.com.au/

SAMAG Project

- Locality: Weeroona, 8 km north of Port Pirie (proposed production plant site).
- Description: The SAMAG Project will produce magnesium metal using the Dow Chemical Company's proprietary technology and ore from the Leigh Creek area.

- *History:* SAMAG Ltd purchased Dow Chemical's process technology in August 1999, then entered into a Memorandum of Understanding with the South Australian Government in May 2000 to build the initial plant near Port Pirie.
- *Operator:* SAMAG Ltd Pima Mining NL (80%) and Resource Finance Corp. Ltd (20%).
- Website: http://www.pima.com.au/splash.htm

Mount Hutton

- Locality: 25 km northwest of Leigh Creek (241029mE, 6623610mN, Zone 54).
- *Reserves:* Total measured resource 46 Mt, total indicated 162 Mt, total inferred 308 Mt, for a total resource of 516 Mt averaging 42.8% MgO across the seven deposits drilled.
- Mineralogy: The ore consists predominantly of clastic magnesite horizons (MgO 42%) within the Neoproterozoic Skillogalee Dolomite. The ore has a high geochemical consistency and low variability, mainly between individual beds.
- History: Prior to 1997, MESA identified the need to develop potentially large resources of non-metallic minerals including magnesite, kaolin and graphite. Geological fieldwork by PIRSA in 1997–98 focused on locating closely spaced magnesite beds comprising mineable packages. Following feasibility studies during 1998, Pima Mining NL was able to progress the project and formed SAMAG.



Easterly aerial view of SAMAG Ltd's proposed magnesium plant site near Weeroona Island (foreground), north of Port Pirie (courtesy SAMAG Ltd). (Photo 47668)

RESOURCES TASK FORCE

On 26 February 1999, the Premier of South Australia John Olsen announced that a **Resources Task Force** (RTF) would be formed to address issues facing the resources industry. The Task Force submitted a draft Minerals Resources Plan and Report which was endorsed by Cabinet on 25 October 1999. The Premier launched the Resources Task Force Report, incorporating the Mineral Resources



Plan, November 1999 on 1 December 1999 and, in doing so, announced that the Government would provide a response in the first half of 2000.

GOVERNMENT'S RESPONSE TO THE RTF REPORT

The Government's response was prepared by a working group formed to investigate and respond to recommendations made by the RTF (see MESA Journal 17, p.8). The Task Force, headed by Richard Ryan AO, reported on ways of expanding the State's resources industry and identified increased exploration activity to \$100 million/year by 2007 as being fundamental to achieving minerals and processed mine product output valued at \$4 billion by 2020.

The Government's response was launched by the Minister for Minerals and Energy, and Minister Assisting the Deputy Premier, Wayne Matthew, on Friday 16 June 2000. He confirmed that the Government will spend an additional \$8 million across agencies over the next three years specifically to progress the initiatives announced in the RTF response.

The response clearly supports the majority of the Task Force's recommendations and individually addresses each of the nine main objectives identified in the report. These are:

- making land more accessible
- stimulating vibrant exploration activity
- a supportive and responsive Government
- planning for infrastructure development
- a skilled workforce
- engaging people to recognise the value of the industry
- attracting increased investment and value adding

- strengthening the support and service sector
- fostering innovation and R&D.

The first three issues listed are priority areas identified by the Government that need to be progressed immediately in order to achieve the targets set by the RTF for significant growth in South Australia's resources sector.

Land access

This program is designed to ensure certainty and security for the minerals industry and investors. It is targeted at making land in South Australia more accessible for exploration and mining by finding workable solutions to issues associated with Native title and Aboriginal heritage, environmental requirements and legislation, 'low-impact' exploration, multiple land use planning and policies, and community consultation.

Stimulating vibrant exploration activity

Targeted at stimulating vibrant exploration activity through the provision and promotion of geoscientific information and advice, this program aims to accelerate the rate of mineral exploration (indicated as increased expenditure, drilling and research) and establish the State as a priority destination for mining investment. The focus of the program is to ensure that the latest high-quality data and information are available online, and includes a significant contribution to boost and realign the TEISA program into drilling, geological mapping and new geophysical prospecting techniques.

Supportive and responsive Government

This program is to provide effective and integrated Government support to the resources industry. It aims to establish the Office of Minerals and Energy Resources as the 'window' into government to facilitate applications, approvals and processes for exploration and mining in South Australia. The program includes the creation of the Office, appointment of the new Executive Director, and establishment of the Resources Industry Development Board. The program also will extend, document and/or formalise the wide range of inter-agency agreements, committees and processes that are critical to the growth and sustainability of the mining sector in South Australia.

Planning for infrastructure development

The Government will ensure that mineral industry policies and plans are in place so that infrastructure (including rail, energy and water resources) will be delivered in an integrated, timely and cost-effective manner once resource developments are underway.

A development planning study of the Murray Basin mineral sands province has commenced in collaboration with Victoria, New South Wales and industry under the Commonwealth 'Regional Mineral Program'. A similar study for the Curnamona Province, an area of considerable Cu–Au, base metal and uranium potential in northeastern South Australia, is proposed for RTF funding, to be managed by Infrastructure SA (Department of Industry and Trade, DIT).

A skilled workforce

The Government will actively support education initiatives and training programs through collaboration with the South Australian Chamber of Mines and Energy and Minerals Council of Australia.

Engaging people to recognise the value of the industry

The Government recognises that essential community support for the industry can only be obtained through openness and transparency of process. The Office of Minerals and Energy Resources will work with industry to implement a performance-based, outcome-driven mining regulatory system that will be open to public scrutiny.

Attracting increased investment and value adding

The Government will focus on identifying opportunities in downstream processing and in the service–supply sector, and will extend existing enterprise improvement programs. Through the Industrial Supplies Office (DIT), a number of strategies will be pursued including encouraging local company reinvestment, global promotion of the State's resources industry capacity and capability, and further developing the business-matching program with Northern Territory companies.

Strengthening the support and service sector

The Government will explore opportunities for developing alliances between non-competing agencies for strengthening the support and service sector. A website listing suppliers and service providers for the minerals industry will be online later this year.

Adelaide-based consultants have formed an alliance to bid for interstate and international geoscientific contracts. The project — 'Geoscience alliances' — aims to facilitate the business planning for this alliance to access international markets.

Fostering innovation and R&D

The Government will encourage research facilities to develop a strategic direction for research relevant to South Australian mineral exploration as well as supporting the development of innovative technologies in order to achieve world-class capability.

RESOURCES INDUSTRY DEVELOPMENT BOARD

It was also announced as part of the RTF Response that a Resources Industry Development Board would be established to provide ongoing strategic advice to Government and address issues for both the minerals and petroleum industries. Membership of the Board was to comprise people with expertise in the minerals and petroleum industries as well as in related areas of finance, law, environment, indigenous communities and training. Board membership was sought from a wide range of professional and community based personnel who displayed the following essential qualities and characteristics:

- strong business, management and communication skills
- ability to think strategically and translate strategies into practice
- ability to set aside personal business interest and work collaboratively with colleagues
- experience and/or capability to effectively operate on boards for industry or Government
- a strong commitment to consultation and negotiation
- an appreciation of the business and role of Government.

The South Australian Minerals Industry Development Board that will 'champion the needs of South Australia's growing minerals industry' was announced by Minister Matthew on 26 October 2000. It comprises Dr Ian Gould, Derek Carter, Kate Hobbs, Roger Thomas, Louise Hicks, Bernhard Wheelahan, Dr Jan Carey, Peter Klaosen, Keith Yates, Roger Goldsworthy, George McKenzie and Dr David Blight.

PEOPLE IN THE INDUSTRY

Ross Adler, Managing Director and CEO of Santos Ltd, retired on 30 September 2000, having joined Santos as Managing Director in 1984. Since then, he has facilitated the emergence of Santos from a small and fledgling oil and gas producer into a large and successful organisation. Santos is now the largest onshore oil and gas explorer and producer in Australia.

The Office of Minerals and Energy Resources notes the passing of a number of eminent industry colleagues:

Sir Ben Dickinson 1912–2000 (former Director of Mines, Government Geologist, Supervisor of Boring Operations, Warden and Secretary to the Minister)

Bruce Webb AM 1926–2000 (former Director General of the Department of Mines and Energy)

Peter Hill 1933–2000 (former Director of Mining, Department of Mines and Energy)

Dr David Gravestock 1947–1999 (Principal Geologist, Petroleum Group, PIRSA)

SECTION 1: SOUTH AUSTRALIA'S MINERAL INDUSTRY

MAJOR MINERAL COMMODITIES

METALS

COPPER

Western Mining Corporation (WMC) completed the \$1.94 billion expansion program at the Olympic Dam Cu–U–Au–Ag mine in 1999, more than trebling the annual amount of ore treated to 9.2 Mt and more than doubling the annual production capacity of copper to 200 000 t, uranium oxide to 4600 t, gold to 2430 kg and silver to 26 400 kg. The year 2000 will be the first full year of the expanded operation and the company is on track to achieve predicted production figures. The mine produced 137 010 t of copper in 1999.

Olympic Dam is now Australia's largest capacity underground mine, Australia's largest copper producer and one of the top 15 copper producers in the world. The copper solvent extraction section of the processing plant, damaged by fire in late 1999, has been refurbished. WMC also achieved an impressive 2 million man hours (over 200 days) of lost time injury free operation with a work force of 1400. In October 2000, WMC announced plans for a further \$100 million expansion to increase copper production.

Since 1987, Mount Gunson Mines Pty Ltd has been heap leaching oxidised ore at Mount Gunson, and in 1999 recovered 318 t of high-grade copper cement for production of cupric oxide at the Adchem Australia Pty Ltd processing plant at Burra.

An alliance agreement between BHP Minerals Pty Ltd and Helix Resources NL allows Helix to explore for gold and base metals on BHP's exploration licence over the Middleback Range, and several prospects have been identified (Fig. 1.1). At the Moola prospect, surface calcrete sampling and RAB drilling located Cu-Au mineralisation along 2 km of a 15 km long north-south fault zone. Follow-up RC drilling along the fault has revealed mineralisation associated with a large, 15-60 m wide breccia and alteration zone within felsic volcanics, comprising massive silica, sericite, haematite and chlorite with associated pyrite, chalcopyrite and native copper in fine stockwork veins and as fine-grained disseminations. Drill intersections include 52 m at 0.57% Cu from 32 m, including 12 m at 1.0% Cu (MRC 003); 28 m at 0.25% Cu from 136 m (MRC 012); and 48 m at 0.21% Cu from 96 m, including 16 m at 0.15 g/t Au (MRC 014). The results show, for the first time, the existence of a large epithermal breccia system in the Middleback Range containing primary copper and gold mineralisation associated with massive silica and haematite alteration.

The Curnamona Province continues to be prospective for Cu–Au mineralisation, with the Willyama Supergroup 'Bimba formation' and calc-albite units being major targets. Encouraging prospects include White Dam, Vertigo, Kalkaroo and Dome Rock.

The Pasminco Australia Ltd – Werrie Gold Ltd joint venture over the Benagerie Ridge Magnetic Complex has extended the known mineralised system by ~15 km (Fig. 1.2). High-grade copper intersections include 12 m at 3.67% Cu and 1.93 g/t Au from 318 m (BEN 1051) at North Portia prospect; 12 m at 2.6% Cu from 98 m (BEN 1322) at Lorenzo prospect; 3 m at 1.39% Cu from 128 m (BEN 1378) at G3 prospect; and 3 m at 1.27% Cu (BEN 1395) at G6 prospect.

GOLD

Olympic Dam is the State's major producer, yielding 989 kg in 1999. Small amounts (<0.6 kg) were also produced from the alluvial Teetulpa Goldfield.

On the Gawler Craton, the Gawler Joint Venture has outlined indicated and inferred resources totalling 503 362 oz of gold at the Challenger prospect; the most



Fig. 1.1 Middleback Range gold and base metal targets (courtesy Helix Resources NL).

cost-effective option for developing the resources is being investigated.

Other significant prospects on the Gawler Craton include:

- Barnes (Adelaide Resources NL Newcrest Mining Ltd) — RAB and limited RC drilling of an extensive gold-in-calcrete anomaly has identified significant gold mineralisation hosted by fractured and hydrothermally altered Hiltaba Suite granite. Drill intersections (RBN 50) include an oxide zone with 8 m at 3.0 g/t Au from 35 m and a primary zone with 7 m at 1.8 g/t from 69 m. Two nearby scissored RC holes returned 5 m at 3.1 g/t Au from 42 m and 6 m at 4.4 g/t from 80 m (RCBN 51), and 1 m at 12.5 g/t from 66 m (RCBN 52).
- Tunkillia (AngloGold Australasia Ltd Helix Resources NL) — RAB drilling of the gold-in-calcrete Smith anomaly adjacent to the Yarlbrinda Shear Zone returned intersections including 3 m at 4.2 g/t Au, 3 m at 1.5 g/t, 3 m at 1.05 g/t and 3 m at 1.04 g/t. Follow up RC drilling is planned.
- Weednanna (AngloGold Australasia Ltd Western Metals Resources Ltd.) — RC and diamond-drilling within the gold-in-calcrete anomaly, but west of



Fig. 1.2 Benagerie Ridge Magnetic Complex Cu–Au and base metal prospects (courtesy Pasminco – Werrie Gold JV).

previous drilling and a major north–south-trending magnetic anomaly, has returned intersections including 31 m at 1.6 g/t Au (including 24 m at 2.0 g/t) and 26 m at 1.9 g/t (including 16 m at 2.9 g/t). Further RAB drilling is planned.

In the Curnamona Province, the Pasminco Australia Ltd – Werrie Gold Ltd joint venture has continued exploration of several gold and base metal prospects within the Benagerie Ridge Magnetic Complex. At the Portia prospect, an inferred resource of 270 000 t at 7 g/t Au has been outlined for 'base of Tertiary' eluvial mineralisation; basement drill intersections include a bonanza grade of 3 m at 212.6 g/t Au. At the Shylock prospect, the potential for secondary mineralisation in Tertiary sand and clay has also been identified, with a best drill intersection of 3 m at 9.53 g/t Au from 65 m. Aircore drilling at Portia, to test for gold mineralisation in the basement, returned positive results with an intercept of 3 m at 7.39 g/t Au from 103 m within a broader 9 m zone averaging 3.94 g/t.

The Mount Isa Mines Ltd – Western Metals Resources Ltd – Normandy Minerals Ltd joint venture has outlined the Vertigo Au–Cu prospect 1.5 km southwest of its White Dam prospect. As with White Dam, mineralisation is contained within Willyama Supergroup banded, biotite-altered leucoratic gneiss. RC percussion drilling intersected a 150 m wide mineralised zone with intercepts of 10 m at 2.95 g/t Au and 0.6% Cu from 62 m (VG O9), and 30 m at 2.27 g/t Au and 0.2% Cu from 23 m including 10 m at 4 g/t Au from 32 m (VG O30).

LEAD-ZINC-SILVER

After completion of the four-year, \$33 million upgrade of the Port Pirie Smelter, Pasminco Ltd is on target in 2000 to at least equal the predicted output capacity of 250 000 t of lead, 450 t of silver, 40 000 t of zinc, 4000 t of copper and 600 kg of gold. The smelter is the world's largest integrated Pb–Zn producer and the third largest silver producer. Smelter feed is mainly sourced from Pasminco's Broken Hill Mine and BHP's Cannington Mine (Queensland).

The State's 1999 mine production of lead was nil; 4985 t of willemite zinc ore were produced from Pasminco's Aroona deposit, and 7697 kg of silver were produced from the Olympic Dam Mine. Mining operations at Aroona ceased during 2000 and the site is being rehabilitated; ~10 000 t of willemite zinc ore has been removed and stockpiled at Beltana.

Significant exploration prospects include:

• Gawler Craton where Menninnie Dam prospect has an inferred resource of 1.7 Mt at 5% Pb, 8% Zn and 100 g/t Ag within Palaeoproterozoic Hutchison Group marble and carbonate-facies BIF. Significant intersections associated with Palaeoproterozoic BIF elsewhere on the craton include 16 m at 0.15% Pb from 32 m and 16 m at 0.21% Zn from 44 m (MRC 009) at the Moola prospect,

Middleback Range, and 18 m at 659 ppm Pb, 0.39% Zn and 5 ppm Ag (including 2 m at 1.15% Zn) from 116 m (HKN 18) and 12 m at 0.49% Pb, 0.48% Zn, 0.65% Cu, 41 ppm Ag and 63 ppb Au from 68 m (HKN 38) at the Hawks Nest prospect south of Coober Pedy.

- Curnamona Province where the Minotaur Gold NL -Billiton joint venture has completed an RC and diamond-drilling program in the Mutooroo area where Broken Hill style pelitic metasediments occur with key alteration markers of garnet, gahnite, Mn-Fe oxide and sporadic Pb-Zn minerals. Rock chip samples have returned up to 15.8% Zn, 6.3% Pb and 31 g/t Ag, while drilling results at Dingo Ridge prospect returned a best intercept of 1 m at 7.3% Zn, 1.9% Pb and 16 g/t Ag within a broad mineralised zone of 18 m at 0.8% Zn, 0.5% Pb and 6 g/t Ag from 214 m. Other significant base and precious metal prospects include Ballara, Benagerie Ridge, Blue Dam - Meningie Well, Hunter's Dam, McBrides, Putt's Well and Ram Dam, all of which are at or near the boundary between the Upper and Lower Willyama Supergroup.
- Kanmantoo Trough where the Terramin Mining Inc. -Western Metals Resources Ltd joint venture has tested near-coincident 'Mise a la Masse' conductivity and transient electromagnetic (TEM) anomalies at the Angas prospect with two diamond-drillholes. Intersections include 1.41 m at 4.5% Zn, 0.5% Pb, 14 ppm Ag and 0.2 ppm Au from 80.84 m, and 7.29 m at 12.06% Zn, 6.07% Pb, 55 ppm Ag and 1.4 ppm Au from 95.48 m in DDAN 36, and 12.7 m at 12.22% Zn, 2.64% Pb, 24 ppm Ag and 0.41 ppm Au from 44.95 m including 4.16 m at 19.23% Zn, 5.09% Pb, 35.3 ppm Ag and 0.7 ppm Au in DDAN 37. Prior to drilling, an inferred resource of 1 Mt at 10% Zn, 4% Pb, 60 g/t Ag and 1 g/t Au had been outlined within guartz-mica-garnetandalusite-staurolite-gahnite schist of the Tapanappa Formation.

IRON ORE

Production for the 12 months to 30 June 2000 was 3 005 162 t of high-grade haematite ore mined by BHP from deposits in the Middleback Range. The ore is railed 50 km to the Whyalla Steelworks where most is processed into pellets and used as blast furnace feedstock. A significant proportion of pellets is shipped to the company's steelworks in Port Kembla, New South Wales.

Production is from three open-cut mines in the South Middleback Range, mainly from Iron Duke, but also Iron Duchess and Iron Knight which are neighbouring deposits to the north. Since 1915, more than 200 Mt of ore have been mined from these and other haematite deposits in the Middleback Range, with most coming from Iron Monarch, which closed in 1999. The remaining measured reserves of high-grade haematite ore are estimated at 26 Mt. The prospect for further discoveries of large haematite deposits in the Middleback Range is limited. Low-grade iron rocks (averaging ~30% total iron), predominantly banded iron formation (BIF), form the topographic expression to the Middleback Range. These rocks are currently not considered to be an economic resource as they require beneficiation to a higher-grade product and the present state of beneficiation technology precludes their economic development.

BHP announced on 25 February 2000 that it intended to give effect to the decision to divest its Long Products business in the second half of 2000. The new company is led by Bob Every as Managing Director and Chief Executive Officer, effective from 1 March, with the new company named OneSteel Ltd. BHP intends to spin-out the new entity through a pro-rata distribution to its shareholders, which will occur through a Scheme of Arrangement and Capital Reduction following shareholder and court approval. BHP shareholders will be given the option to retain the new shares or divest them prior to the shares being listed on the stock exchange, a move which is planned to be effected before the end of 2000. OneSteel will retain tenure of the ore deposits in the Middleback Range.

Whyalla Steelworks is OneSteel's major source of both Special Bar Quality (SBQ) and commercial-grade billet feed. It produces ~1.2 Mt/year of raw steel, with ~65% of that transferred to OneSteel's market mills in billet form for further value-added processing. The balance of the steel is converted to finished products at the Whyalla rolling mills. These products service the construction and rail transport industries, with Whyalla Steelworks being Australia's only manufacturer of rails. Given the highly competitive nature of the Australian and global iron and steel industry, Whyalla Steelworks is well prepared to proceed as the engine room of OneSteel's business.

During 1995–96, PIRSA, as a joint venture partner in the South Australian Steel and Energy (SASE) Project, identified significant resources of magnetite-rich rocks in the region of the Phillipson coal deposits. Exploration at Hawks Nest prospect identified seven neighbouring near-surface strike ridges of magnetite-rich Palaeoproterozoic BIF with a combined resource of ~600 Mt to 130 m depth, grading 35% Fe. Preliminary beneficiation test work by fine grinding and wet magnetic separation gave a high-grade magnetite concentrate.

In March 1999, the SASE Project vehicle was incorporated to SASE Pty Ltd with the ownership composition of 90% AuIron Energy Ltd, 5% Ausmelt Ltd and 5% PT Krakatoa Steel. The South Australian Government transferred title to iron ore and limestone resources previously held for the benefit of SASE to SASE Pty Ltd. AuIron Energy Ltd carried out a major drilling program in the period March–May 2000, and confirmed



SASE drilling in the Hawks Nest area (courtesy SASE Ltd). (Photo 47639)

inferred resources of 220 Mt at 36% total iron at Kestrel deposit and 7.2 Mt at 60% total iron at Buzzard deposit.

A demonstration pig iron plant has been built by SASE Pty Ltd in Whyalla as a forerunner to the construction of a full-scale facility. The Federal Government has granted a Research and Development 'Star Grant' on a dollar for dollar basis up to A\$6.5 million as assistance towards this test facility. Trial operations of the plant should commence by the end of 2000. Ausmelt's technology for pig iron manufacture has been established in small-scale pilot studies, and the demonstration plant will provide technical information for a 2.5 Mt/year commercial structure to be located near to the coal and iron deposits and the Tarcoola to Alice Springs railway.

The Warramboo iron prospect in central Eyre Peninsula is defined by a prominent, arcuate, east–west-striking magnetic anomaly. It has been the target of a reconnaissance exploration program by Adelaide Resources NL with assistance from the South Australian Government. Drillhole RCWMB 1 intersected Archaean magnetite-rich gneiss with an upper interval of 41 m at 24.2% Fe and a second interval of 53 m at 21.6% Fe. Test work is proceeding on the beneficiation characteristics of the magnetite-rich rocks, in particular their amenability to upgrade to a product suitable for use as feedstock to direct reduction smelters (i.e. magnetite concentrates with grades of >70% Fe).

Centrex Resources NL is an Adelaide-based, unlisted public company which holds tenure on the Lock coal and Wilgerup iron ore deposits in central Eyre Peninsula. Centrex is evaluating iron ore potential in the region with the aim of providing a resource base for use in a proposed iron ore smelter near the coal deposits.



Pilot SASE plant under construction at Whyalla (courtesy SASE Ltd). (Photo 47640)

PIRSA Mineral Resources Group has released a commodity review titled *Iron ore in South Australia*. The report recognises that the State's major iron ore resources appear to be magnetite-rich rocks, predominantly BIF and iron skarn which may provide a significant resource of low-grade iron which may be readily beneficiable to a preferred higher grade product.

The report identifies the northern Gawler Craton as containing potential for large resources of magnetite-rich rocks (additional to the proven resource at Hawks Nest). In this same region is the Peculiar Knob hydrothermal haematite deposit with inferred resources of 14 Mt at 63.2% Fe to 120 m depth, consisting of massive, coarse-grained specular haematite. There are indications of relatively near-surface magnetite-rich skarn at Agery, northern Yorke Peninsula, an area close to established infrastructure.

ENERGY MINERALS

COAL

Leigh Creek, the only operating coal mine in South Australia, is an open-cut operation with an annual production of \sim 3.0 Mt. Coal is supplied by a rail link to power stations at Port Augusta which supply \sim 25% of the State's electricity needs.

During the 1999 financial year, as part of the State Government's plan for reform and privatisation of the electricity supply industry in South Australia, the Leigh Creek Coalfield, Port Augusta power stations and the rail line linking them were combined to form Flinders Power Pty Ltd. On 2 August 2000, NRG Energy Inc. was announced as the successful bidder for the company, following legislation passed by the South Australian Parliament to allow the State's electricity assets to be leased to private investors. Now trading as NRG Flinders, the company is part of the portfolio of assets owned by



Terrace mining at Leigh Creek coal mine. (Photo 43810)

NRG Asia Pacific, a subsidiary of NRG Energy Inc., a leading global energy company with more than 100 power facilities around the world, and one of the world's leading independent power producers. Established in 1993, NRG Asia Pacific is the largest independent power producer in Australia. Other interests in Australia include Collinsville, Gladstone and Loy Yang A. Further information can be obtained from the ETSALE (www.treasury.sa.gov.au) and NRG Flinders (www.flinderspower.com.au) websites.

At the recent South Australian Chamber of Mines and Energy (SACOME) Environmental Excellence Awards held as part of the Resources Week 2000 conference, Flinders Power was awarded a commendation for its rehabilitation and stabilisation work completed at the Bowman's coal deposit trial pit site over the past several years.

During the year, assessment and reserve definition drilling continued at the Ingomar coal deposit (Phillipson Coalfield) as part of the SASE Project. The Ingomar resource is now well defined in readiness for a bulk coal sample for use in the SASE demonstration plant at Whyalla.

The provision for coal seam methane licences under the recently passed *Petroleum Act 2000* has created renewed interest in the potential of the State's coal resources for methane drainage. To date, tenure applications have been lodged over a number of known coal deposits (for further information refer to Section 2 of this publication).

URANIUM

WMC produced 4100 t of uranium oxide during 1999–00 from the Olympic Dam Mine; this was more than double that for the previous financial year as a result of the expansion to produce 200 000 t/year of copper. Uranium is a by-product of copper mining.

Heathgate Resources has completed the building of a commercial plant and related infrastructure on site at the Beverley deposit since the granting of a mineral lease in May 1999. Commercial production commenced in November 2000 after cold commissioning in October (using water circulation only) and subject to all necessary approvals using in situ leaching (ISL) techniques refined during the field leach trials which were carried out in 1998. Initial production is planned at 1000 t/year U₃O₈ equivalent from a total resource of 21 400 t of U₃O₈.

Southern Cross Resources submitted its Environmental Impact Statement (EIS) for the Honeymoon deposit in June 2000 for government and public scrutiny prior to the end of field leach trials which were carried out from March 1998 to September 2000. Subject to environmental approvals from both State and Commonwealth, a mining lease may be granted for ISL extraction and planned initial production of uranium peroxide at Honeymoon using the refurbished field leach trial plant. Commercial production could commence in 2001 after all necessary approvals, with production of ~5500 t U_3O_8 equivalent planned during the first six years of operation.

Current resources at Honeymoon and nearby East Kalkaroo total 7900 t of U_3O_8 equivalent. At Goulds Dam, 80 km northwest of Honeymoon, a significant resource of 17 600 t of U_3O_8 has been delineated.



Portion of the Honeymoon demonstration plant well field (courtesy Southern Cross Resources). (Photo 47625)

INDUSTRIAL MINERALS

BARITE

World production of barite is \sim 7 Mt/year, one-half of which comes from China. South Australia, which produced 13 403 t in 1999–00, is Australia's largest producer.

Over 160 barite deposits or occurrences have been documented in South Australia, with a total recorded production of ~700 000 t. All but a few are of the open-fracture infill type hosted by Adelaide Geosyncline rocks in the Mount Lofty and Flinders Ranges. The only South Australian mines in current production, Oraparinna and Dunbar in the Flinders Ranges, are associated with the Oraparinna Diapir. Both are operated by Unimin Corp.

Production commenced in 1940 at Oraparinna, 500 km north of Adelaide, and Normandy Industrial Minerals operated the deposit from 1984 to early 2000. The mine, comprising eight underground levels, works a system of 1–2 m wide veins which have developed in tensional fractures within Adelaidean Wilpena Group sediments. Ore is trucked 160 km to a treatment plant at Quorn where three industrial grades of barite are produced for use in surface coatings, plastics fillers, and mould coatings at Olympic Dam Mine. Some A and Standard grade material is trucked to Gillman in suburban Adelaide for fine milling.

The Dunbar deposit, 15 km southeast of the Oraparinna Mine, is worked by open cut on a 30 m wide subparallel vein system ~500 m in length. Individual veins up to 9 m wide have been exposed. Most Dunbar ore is used in producing oil-drilling grades of barite, but some is used to feed a magnetic separation plant at Quorn which produces a super-white AA industrial grade.

Production levels, largely determined by oil drilling activity, have recovered from the 1994 low of 4960 t and were \sim 20% above the 1998 output due to increased demand from drilling activity in Bass Strait. A reduction from the 1999 production is indicated for calendar year 2000.

DOLOMITE

South Australia, which produced 865 618 t in the 12 months to June 2000, is Australia's main producer of industrial grade dolomite. The largest producers are BHP at Ardrossan and Iron Prince, and ACI at Tantanoola in the State's South-East.

The largest dolomite mining operation in Australia is at Ardrossan on northern Yorke Peninsula, where BHP operates a quarry, crushing plant and ship-loading facility. Production was 700 213 t in 1999. Lump ore is used mainly as a flux in basic oxygen steelmaking at Whyalla and Port Kembla, and as a refractory material at Whyalla. It was also used at the Newcastle steelworks until its closure in September 1999. One quarter of production is exported to Japan. The quarry is located in dolomitic Kulpara Formation of the Early Cambrian Hawker Group.

At the Iron Prince Mine, Katunga Dolomite has been exposed beneath the Lower Middleback Jaspilite; the principal impurity is iron which may comprise up to 30% of the rock. In 1999, BHP mined 131 062 t for flux for pelleted iron ore at Whyalla.

ACI operates a quarry in an irregularly dolomitised zone within bryozoal limestone of the Oligo-Miocene Gambier Limestone near Tantanoola. Quarried rock is screened, crushed and blended to give a -3 mm product with an average grade of 42% MgCO₃. Glass-grade product is trucked to Pilkington (Aust.) Ltd's plants in Sydney and Melbourne for use as flux in the manufacture of plate glass. Agricultural dolomite is produced as by-product. The total 1999 production was 69 182 t.

A steady demand is anticipated for glass-grade dolomite, but the greatest influence on the overall production will be the level of iron and steel production.

GRAPHITE

Coarse flake graphite was produced in South Australia during 1990-93 after re-opening of the Uley Mine, 18 km west-southwest of Port Lincoln (Figs 1.3, 1.4). Uley was placed on care and maintenance in 1993 following a sharp decline in the world price for graphite during 1992, and there has been no recent commercial production. Recovery of prices over the past two years has encouraged mine owner, Eagle Bay Resources NL, to seek a joint venture partner to recommence mining and processing operations. Interest was expressed from German and Chinese producers and, in October 1999, Eagle Bay announced an agreement with Harbin Liumao Carbon Technical Development of China to undertake plant refurbishment and production trials. At September 2000, no action had taken place under this agreement following collapse of talks to resolve issues on the level of Chinese labour directly involved in the project and the cost of water supply required for the processing plant.



Fig. 1.3 Location of the Uley Mine and other prospects in the Mikkira Graphite Province, southern Eyre Peninsula.



Fig. 1.4 Geological cross-section showing graphite distribution in the Uley Mine area.

Indicated resources at Uley are 2.9 Mt grading 13% graphitic carbon, including 1.5 Mt at 15% graphite. Uley is part of a much larger resource contained within the Mikkira Graphite Province in which ~350 Mt at 6–7% graphite have been inferred from geophysical surveys and drilling of five prospects.

Annual world production of graphite is ~0.7 Mt, of which more than half comes from China; fluctuation in output from China has the potential to significantly influence world prices. Further exploration and development of the Mikkira resource is largely dependent on securing export markets. Expanded demand for natural flake graphite would positively impact on developments at Uley. For refractories, this is largely dependent on growth in the steel industry or reduction in the costs associated with manufacture and installation of carbon–magnesia refractories.

GYPSUM

Worldwide production exceeds 100 Mt/year. South Australia's output increased to 1.8 Mt for the 12 months to June 2000, accounting for about half of Australia's production, and supplies most of Australia's domestic plaster product requirements, whilst the growing Western Australian industry is largely directed towards South East Asian export markets.

Agricultural gypsum is being increasingly used to treat sodic soils, symptoms of which are waterlogging, increased runoff, poor water storage, surface crusting, and problems with cultivation and erosion. Production of agricultural gypsum has increased by over 400% during the last six years to 298 349 t in 1999.

Amended Regulations to the *Agricultural Chemical Act* 1955 became effective on 30 September 1999, so that

South Australian gypsum fertiliser products supplied either in bulk or in bags must now be labelled according to minimum gypsum, calcium and sulphur contents, size grading, and sodium content. Fertiliser gypsum has a 15% moisture content upper limit. Four grades of fertiliser gypsum (Premium, and Grades 1, 2 and 3) have now been specified.

Gypsum has been deposited in two distinct evaporitic environments in arid or semi-arid areas of the State:

- coastal salinas in interdunal corridors of Quaternary beach dune systems
- continental playas underlain by relatively impermeable sandy clay in enclosed inland depressions.

Coastal salinas contain the largest reserves, but continental playas and their associated lunette deposits provide most of the State's agricultural gypsum.

Lake MacDonnell, with a resource of ~500 Mt, is Australia's largest gypsum mine with production approaching 1.4 Mt in 1999. The deposit has been operated by Gypsum Resources of Australia Pty Ltd since 1984, when CSR Ltd and Boral Ltd combined their separate operations. The deposit comprises ~1 m of gypsarenite at 93% CaSO₄.2H₂O overlying ~5 m of selenite at 94–96% CaSO₄.2H₂O. Gypsum as mined has a salt content which is too high for plaster manufacture, so it is stockpiled on site for several years to allow leaching by rainwater. It is then railed 64 km to a 160 000 t stockpile at Thevenard for loading on ships by conveyor.

Waratah Gypsum Pty Ltd produced 35 381 t of plaster-grade gypsum in 1999 from a coastal deposit at Spider Lake on southern Yorke Peninsula, which contains a resource of 2.4 Mt.

David Linke Contractor Pty Ltd produced 140 454 t in 1999 from an indicated 9 Mt contained within a substantial undefined inland playa resource near Blanchetown. Various grades are produced at the Blanchetown and



Gypsum stockpile at Elephant Lake near Meningie (courtesy Meningie Gypsum Pty Ltd). (Photo 47669)

Nuriootpa screening plants and marketed for cement and plaster manufacture and for agricultural use.

Near Cooke Plains, variable tonnages (71 535 t in 1999) of gypsite and gypsarenite are produced for agricultural use in South Australia and the Eastern States. The indicated resource of 2 Mt is contained within a lunette adjacent to a samphire swamp.

Significant tonnages of agricultural gypsum (2.5–33 000 t) are also mined from inland playa deposits near Meningie, Lochiel, south of Burra, near Morgan and Renmark, and on Eyre Peninsula.

Demand for plaster and cement-grade gypsum is expected to remain steady, and a continued rise in consumption is predicted for agricultural uses.

HEAVY MINERAL SANDS

Heavy mineral sands exploration has seen a recent resurgence within the Murray Basin. Exploration expenditure increased to \$2.3 million and should continue to climb as resource drilling commences at several localities.

The Murray Basin is a major Tertiary depocentre for heavy minerals within the Parilla–Loxton Sands. The South Australian portion of the basin is currently almost covered by exploration licences, with Murray Basin Minerals NL holding significant acreage. Other companies with ground include Basin Minerals NL, Redfire Resources NL and Strand Minerals NL.

Previous exploration by Aberfoyle Resources Ltd intersected significant heavy mineral accumulations in the Mindarie–Mercunda area with an inferred resource of 56 Mt at 2% heavy minerals. Recent exploration by Murray

Basin Minerals NL has delineated eight discrete deposits within the Mindarie area. Current inferred and indicated resources, at 1.32% heavy mineral cutoff, total 65.6 Mt at an average 3.3% heavy minerals, with a total contained heavy mineral resource of 2.16 Mt.

The deposits are relatively shallow, to a depth of 20 m from surface, and are amenable to open-pit extraction (Fig. 1.5). Dry mining of both overburden and ore is considered the most cost-efficient method. Barren overburden will be stripped by bulldozer and conveyed 200–400 m to the rear of the pit, then mixed with dewatered tailings and fines from the wet processing plant and contoured by bulldozer. Stockpiled topsoil will be spread over the tailings prior to revegetation. Ore mined by bulldozer or backhoe will be pumped as a slurry to a nearby mobile wet plant for first-stage separation. This process will use water-feed spirals to gravity separate valuable heavy minerals from lighter trash minerals and sand. The small volume of recovered heavy minerals will be transported by rail or road to a fixed dry mill, where individual saleable minerals will be separated from each other by a combination of magnetic and electrostatic processes. The dry mill will require access to power and gas as well as transport infrastructure to an export port. Sites under consideration for the mill include Murray Bridge, Tailem Bend and Adelaide.

Testwork on a bulk sample from the Mercunda deposit indicates that three saleable products can be produced. Zircon is likely to be the highest single revenue component and represents $\sim 22\%$ of the total heavy mineral content. The rutile contains 97% TiO₂ and is therefore saleable into the pigment and welding rod markets. Rutile and anatase in total represent 8-10% of the heavy minerals. Ilmenite represents ~50% of the heavy minerals and, in the Mercunda area, is low in MgO and MnO compared to elsewhere in the Murray Basin. Murray Basin Minerals is confident that production of ilmenite, suitable as sulphate-route pigment feedstock, can be achieved. The company expects to be in a position to make a mine development decision by June 2001. If this is positive, a mine and processing operation could be commissioned by mid-2002. Capital cost of the model used in the feasibility study is \$35 million.

PIRSA recently acquired 200 m line spacing, 50 m elevation aeromagnetic data over the Chowilla area in the northern part of the Murray Basin as part of TEISA to



Fig. 1.5 Proposed mining and rehabilitation method, Mindarie–Mercunda project (courtesy Murray Basin Minerals NL).

encourage heavy mineral exploration. In the Eucla Basin, major coastal dune systems were delineated, including the Ooldea, Barton and Paling Ranges. Previous exploration by National Mineral Sands, Swan Reach NL and Peko Exploration Ltd outlined the Immarna prospect, which comprises two heavy mineral strandlines, with mineralisation in two distinct horizons. Exploration by BHP Minerals outlined anomalous zones within the Ooldea Range, with the mineral assemblage comprising predominantly ilmenite and zircon, with minor rutile. Prospective ground is currently available.

KAOLIN

Mixed kaolin–sillimanite ore is mined by Unimin Corp. near Williamstown in the Mount Lofty Ranges. This unique high-alumina kaolin is sold for manufacture of refractories and ceramic insulators. Reserves are limited and annual ore production averages 5000 t. High-grade kaolin is selectively mined at Birdwood by Adelaide Brighton Cement Ltd for manufacture of specialty white cement. Kaolin is also milled at the company's Gillman plant for filler grades for paint and rubber. Small tonnages of silty kaolin from Woodside and Birdwood are supplied to the Beverley plant of Thermal Ceramics Australia Pty Ltd for refractory clay blends.

Approximately 50 000 t of semi-plastic kaolin are mined annually, principally from pits at Golden Grove and One Tree Hill. The clay is used mostly as a plastic component in brick-clay blends, but small tonnages from One Tree Hill are also used as a refractory bond clay.

Company exploration on northwestern Eyre Peninsula has outlined large resources of high-grade kaolin to the southwest of Poochera and in the Calca–Chilba area; these are currently held under tenement by Unimin Corp. Limited access to high-quality water required for beneficiation of the kaolin may restrict the scale of any development.

LIMESTONE

Manufacture of Portland cement is one of the largest industrial uses of limestone, with the world now consuming ~1.5 billion tonnes per year. South Australian industrial and agricultural limestone production in 1999–00 totalled 2 580 444 t.

The 300 m thick Penrice marble deposit in the Barossa Valley, mined by Penrice Soda Products, is on the near-vertical eastern limb of a southerly plunging, partly overturned anticline. The high-grade central part of the marble formation is 95–98% CaCO₃, and is flanked by lower grade zones. The 1999 production was 767 235 t, of which ~0.5 Mt of the highest grade material were railed to the company's Osborne plant for soda ash production. The balance was used in Adelaide Brighton Cement Ltd's Angaston cement works, and for lime manufacture,

whiting and agricultural lime; 410 782 t of quarry products were also produced.

In 1925, Adelaide Cement Co. Ltd commenced quarrying at Klein Point, 6.5 km south of Stansbury on eastern Yorke Peninsula, to supply limestone to its Birkenhead plant. In 1971, this company amalgamated with the South Australian Portland Cement Co. to form Adelaide Brighton Cement Ltd, and the Klein Point deposit continued to be the new company's most important limestone source. Production in 1999 was 1 016 742 t of Port Willunga Formation fossiliferous limestone, with total carbonate content in the 85–92% range. The flat-lying 30 m thick limestone unit is mined by ripping and dozing, although some blasting of hard bands is required. The material is blended, hammer milled to -25 mm and shipped daily to Birkenhead in the purpose-built Accolade II bulk carrier.

ACI Resources Ltd has worked the Caroline limestone deposit, 25 km southeast of Mount Gambier, since 1979. The deposit, which is in the marine Oligo-Miocene Gambier Limestone, is exceptionally white, contains a significant silt-sized and finer carbonate fraction, and is low in deleterious non-carbonate materials such as sand, silt, clay, dolomite, flint, iron and manganese. The limestone is mined by elevating scrapers, and crushed and milled on site before dispatch by road to Australian Glass Manufacturers Co. in Melbourne; 34 723 t of glass-grade limestone were produced in 1999. Small quantities are also sold for agricultural uses.

At Parham, 65 km north of Adelaide, unconsolidated Holocene shellgrit beach deposits up to 3 m thick of St Kilda Formation are mined by scraper and screened, dried and crushed on site using a hammer mill and roll crusher. Product is trucked to Adelaide for glass manufacture at Australian Glass Manufacturer's Croydon plant; 39 784 t of glass-grade material were produced in 1999.

MAGNESITE

Small amounts of magnesite (<1500 t/year) are produced by Unimin Corp. from Proterozoic sedimentary magnesite at its Myrtle Springs Quarry, northwest of Leigh Creek, and by Fertico Pty Ltd from a residual deposit near Robertstown. Production is mainly for agricultural fertiliser and rockwool manufacture.

Worldwide interest in magnesium metal, encouraged by forecasts of increased demand by vehicle manufacturers, has seen several new Australian projects proposed for metal production using magnesite. Geological fieldwork by PIRSA Mineral Resources Group between 1996 and 1998 focused on detailed geological assessment of magnesite deposits between Screechowl Creek and the Leigh Creek area. This included field mapping, ore characterisation studies and leach testing. SAMAG Ltd was subsequently formed to progress a proposal for magnesium metal production based on South Australian Proterozoic sedimentary magnesite resources. Previous drilling and geological mapping have outlined over 500 Mt of cryptocrystalline magnesite as persistent thin magnesite conglomerate interbedded with dolomite at the Screechowl Creek, Pug Hut, Termination Hill, Witchelina and Mount Hutton prospects (Fig. 1.6).

During 1999–00, SAMAG Ltd completed geotechnical and trial mining studies at the Mount Hutton prospect, 25 km northwest of Leigh Creek. The company advised that SAMAG had amended its agreement with Dow Chemical Co. to include exclusive global rights for SAMAG to the grant of future licences of the 'Dow process' for magnesium metal production. SAMAG proposes to commence mining from the Mount Hutton magnesite deposit; ore would be crushed on site and trucked to Telford Siding for railing to the production plant (Fig. 1.6). The preferred site of the company's proposed 52 500 t/year magnesium metal plant is now near Weeroona, 8 km north of Port Pirie. In October 2000, Pima Mining raised a



Fig. 1.6 SAMAG Ltd magnesite tenements and proposed mine site in the Leigh Creek area, and proposed plant site near Port Pirie.

further \$10.1 million through the successful conversion of options at 20 cents each.

The transfer of leases held by BHP over the Balcanoona magnesite prospect in the Gammon Ranges was not approved on the basis that further development on the leases would have unacceptable environmental impacts.

SALT

The Australian annual salt production of ~8 Mt is dominated by Western Australia. South Australian production of 567 294 t in 1999 has declined from a record high of 946 063 t in 1989. All of the State's salt is produced by solar evaporation of sea water or saline lake water. The most important use of salt in South Australia is as feedstock for the manufacture of soda ash by Penrice Soda Products using the Solvay process.

ICI began salt production at Dry Creek in 1940 and, after almost 50 years, sold the operation to Penrice Soda Products in 1989. The saltfields cover ~4000 ha near the coast north of Adelaide. Salt water is pumped from the sea at two pumping stations 20 and 30 km north along the coast from the final crystallising area. Harvested salt is redissolved and pumped as brine to Osborne for manufacture of soda ash; 1999 production was 390 846 t.

Salt has been produced by solar evaporation of sea water at Price on eastern Yorke Peninsula since 1919. The operation, run by Cheetham Salt Ltd, comprises 1064 ha of evaporators and crystallisers, and a processing plant which produces bagged and packaged salt for industrial and household use. The 1999 production was 87 642 t. Bulk salt is sent to Cheetham's Geelong refinery (Victoria), or shipped to overseas markets in New Zealand and South East Asia from BHP's loading facilities at Ardrossan.

Salt has been produced since 1912 at Lochiel, where it is dissolved from saline mud by winter rains which then fill the 1500 ha inland Lake Bumbunga. The brine is pumped into three 25 ha crystallisers, from which Cheetham Salt Ltd produced 4312 t in 1999.

At Lake MacDonnell, salt is produced by solar evaporation of brine which seeps into a shallow lake through porous coastal dunes, or is pumped from the nearby gypsum operations. The 1999 production from 71 ha of crystallising pans was 35 225 t. Salt is either processed and bagged on site at Cheetham's plant, or railed in bulk 64 km to Thevenard for shipment to markets in South East Asia and New Zealand, or to the company's plant in Geelong.

BHP began salt production by solar evaporation of sea water at Whyalla in 1951. In 1979, Pacific Salt Pty Ltd built a processing plant on site and in 1988 took over production. In 1999, 46 554 t were produced from 240 ha of brine ponds and 20 ha of crystallisers.



Above right: SAMAG Ltd trial pit at the proposed Mount Hutton magnesite mine site, June 2000. The trial pit was located on the left side of the barren area in the centre of the photo above. (courtesy SAMAG Ltd) (Photos 47670 and 47614)

A small but consistent production is maintained from a groundwater-fed lake adjacent to the northern shore of Lake Alexandrina. Mulgundawa Salt produced 2715 t in 1999 for use in the processing of animal hides.

SILICA

Silica sand is mined by ACI at Glenshera near Mount Compass, 50 km south of Adelaide, to supply South Australia's only current glass manufacturing plant. Production of silica sand commenced at Glenshera in 1987, replacing ACI's dune sand mining operation at Normanville. The Mount Compass deposit contains Permian fluvioglacial sand, reworked during the Tertiary. About 10 m of yellow and orange sand, which is upgraded for amber glass and foundry sand, overlies pale cream sand which is processed for colourless container glass. In 1997, PIRSA Mineral Assessment Branch completed a drilling program of 64 RC holes to test for potentially mineable sand above the watertable. The results demonstrated considerable potential to prove up additional deposits of sand in the Mount Compass region, with a number of areas showing potential for a glass sand resource. These areas warrant further drilling and beneficiation studies. Competition for land within the area for a variety of purposes warrants continued monitoring; these deposits therefore need to be recognised within the local district council's structure plans. Annual production of silica sand from Glenshera to June 2000 was 96 280 t.

In August 2000, AMCOR announced plans to build a second South Australian glass manufacturing plant near Gawler for the production of wine bottles.

Lump silica from a massive quartz reef northwest of Whyalla has been quarried by BHP Ltd at the 23 Mile deposit since 1949 for use as blast furnace flux at the Whyalla Steelworks. Total production of silica during the 12 months to June 2000 was 114 752 t.

SILLIMANITE-KYANITE-ANDALUSITE

A small and irregular production of sillimanite and kyanite is reported from Unimin Corporation's Williamstown Mine. Sillimanite is present as remnant patches within kaolin orebodies. These are separated during mining and screening. Selection of ore for sale requires hand sorting of lump ore. All product is sold for refractories or ceramic manufacture.



Wine bottles exiting the annealing lehrs prior to automatic inspection at the ACI Glass Packaging Australia plant in West Croydon, a suburb of Adelaide. (courtesy ACI Glass Packaging Australia) (Photo 47384)

TALC

Australian talc production of ~120 000 t/year is dominated by Western Australia, with South Australian production averaging ~6000 t/year. Talc occurs in three main localities in South Australia — at Mount Fitton in the northern Flinders Ranges, in the Mount Lofty Ranges, and on Eyre Peninsula.

The Mount Fitton deposits, the largest and highest grade in the State, are 130 km northeast of Leigh Creek and have been mined continuously since 1945. Recorded production to 1999 totals 420 000 t. The leases are currently held by Unimin Corp. More than 40 individual deposits are known over an area of ~60 km². Talc is hosted by the Adelaidean Balcanoona Formation, a pale grey dolomite and dolomitic marble unit. The largest deposits are generally 10–15 m wide, >20 m thick and several hundred metres long. In 1997, Normandy Industrial Minerals temporarily ceased mining and embarked on a 10-year

program of re-screening and hand sorting ore from the large waste dumps which have accumulated over the 55-year mine life. Four grades are produced: QS, super white paint grade; J&J, pharmaceutical grade; medium-grade coloured talc; and low-grade impure talc. The 1999 production was 4400 t.

In the Mount Lofty Ranges, the Gumeracha deposits which have yielded ~180 000 t of mostly second and thirdgrade talc since 1901 now have only very small intermittent production. On Eyre Peninsula, the only production for 20 years has been small quantities of grey and green talc mined for carving and ornamental purposes by Gemstone Corp. of Australia from a deposit near Cowell.

DIMENSION STONE

GRANITE

South Australia is Australia's largest producer of granite, from quarries on northern Eyre Peninsula and a zone extending from the eastern Mount Lofty Ranges to the South-East. The State's production almost trebled during the 1990s, from 8329 t in 1991 to 22 650 t in 1999. The development of new varieties on Eyre Peninsula should see this trend continue in coming years.

The major granite dimension stone quarries on Eyre Peninsula are located in plutons of anorogenic Hiltaba Suite granite. These granites have distinctive red or pink colours due to abundant minute iron oxide inclusions within the plagioclase and K-feldspar. The



Ucontitchie Hill, 30 km southwest of Wudinna in central Eyre Peninsula, is one of many outcrops of Mesoproterozoic Hiltaba Suite granite. (Photo 44987)

best known is Calca Red granite which has been quarried since 1975 from near Streaky Bay. During the early 1990s, quarries were opened near Minnipa to produce varieties marketed as Desert Lilac and Desert Ruby, and a quarry in a coarser grained variety was opened near Wudinna to produce Desert Rose. Calca Red and Desert Rose, quarried by AustralAsian Granite Pty Ltd, accounted for almost all of Eyre Peninsula's 1999 production.

New varieties of red banded granite have been recognised in Palaeoproterozoic Minbrie Gneiss near Elbow Hill, 16 km southwest of Cowell. A quarry was opened in one of these in 1999, and the stone is being marketed as Royal Mahogany. Archaean Sleaford Complex granite gneiss is currently being quarried at Koongawa.

A variety of Delamerian (early Palaeozoic) granites crop out in the eastern Mount Lofty Ranges and in the South-East. Australia's largest 'granite' quarries are at Black Hill near Mannum, where three operators mine an igneous rock of gabbroic composition which, although not technically a granite, is marketed as Austral Black Granite or Imperial Black Granite, depending on the visibility of igneous layering in the final product. Production from the Black Hill quarries in 1999 accounted for ~40% of South Australia's total production. An unusual green granite marketed as Balmoral Green has been produced from Padthaway in the South-East since 1991.



Slab of Palaeoproterozoic Minbrie Gneiss, marketed as Royal Mahogany (courtesy The Stock Journal). (Photo 47671)

SLATE

The Mintaro Slate Quarries, opened in 1856 in Mintaro Shale, are among the oldest continuous quarrying operations in Australia, and currently produce ~5000 t/year. Slate deposits in Tapley Hill Formation at Willunga (Willunga Slate) produced almost 30 million roofing shingles and 60 000 t of paving and walling stone from four quarries until their closure in the 1930s. Two have been re-opened in recent years and now supply a range of tiles and veneers, sawn building blocks and paving material. Stone for paving and walling applications is produced from quarries in Tapley Hill Formation at Spalding (Broughton River Slate), Oladdie (Flinders Slate), and Jones Hill in the far northern Flinders Ranges (Parachillna Slate).

BLUESTONE

In South Australia, the term 'bluestone' describes a sedimentary rock, generally siltstone, used for walling. The earliest quarries to produce this type of material (Glen Osmond Bluestone) were opened in Belair Subgroup shale during the early years of the colony. Since the 1960s, a resurgence of interest in the use of bluestone has resulted in the opening of quarries in one particular horizon within the Cambrian Tapanappa Formation; Kanmantoo Bluestone and Wistow Bluestone are now used extensively for walling and paving stone, and are produced from quarries 30 km southeast of Adelaide.

SANDSTONE

Sandstone has been used extensively as a building material for both domestic and public buildings in Adelaide. The

largest sandstone quarries, producing Mount Lofty Sandstone, were opened in Aldgate Sandstone near Stirling in the 1880s, and supplied large quantities of stone for domestic construction, particularly during the 1920s and 30s. Sawn sandstone from Basket Range was popular in the 1950s but was gradually replaced by softer, more cheaply sawn stone from Kapunda, Brinkworth and Manoora during the early 1960s. The Finniss River Sandstone Quarry near Goolwa was recently re-opened and provides another source of quality stone.

LIMESTONE

The best known of the Tertiary fossiliferous limestones is Mount Gambier Stone, which is produced from two northwesterly trending lines of quarries in the Marte area, 10 km west of Mount Gambier. Over 1 Mt of ashlars (sawn building blocks) have been produced, with peak production being during the building boom of the 1950s when one-third of all houses built in metropolitan Adelaide by the SA Housing Trust were of Mount Gambier Stone. The stone is light, porous, even textured, and pale cream or white. Blocks of stone are cut from quarry floors by self-propelled circular saws with tungsten carbide tipped teeth. A variety of ashlar sizes, shapes and finishes are available.

MARBLE

South Australia does not currently produce marble for dimension stone but several areas are considered prospective. Cambrian red-brown, fossiliferous marble from near Leigh Creek is currently being assessed, with test work by Amdel reporting physical properties comparable or superior to currently available marble. The Katunga Dolomite is a banded, off-white and green marble which crops out on eastern Eyre Peninsula. Preliminary fieldwork located several sites of purer white marble, but these require further assessment. Marble from Sellicks Hill, south of Adelaide, is quarried for construction aggregate. The marble is predominantly black but with gold colouration throughout, and will be marketed as Austral Gold Marble; ~500 t have recently been exported to Italy for test production and marketing.

CONSTRUCTION MATERIALS

Large quantities of construction materials are required each year for domestic and commercial buildings, as well as in constructing and maintaining the State's infrastructure of road and rail networks and port facilities. In 1999–00, ~15 Mt of crushed rock products, 2.7 Mt of natural sand products, and 0.39 Mt of clay products were consumed in South Australia. The total ex-quarry value of these raw materials was conservatively estimated at \$100 million. Construction materials are relatively low-cost products, ranging in price from \$5 to \$18/t at the quarry gate. As transport costs are a major component of the final delivered price, sources are sought as near as possible to where materials are required. Most large country centres have quarries located nearby, and special purpose quarries are opened in remote areas to supply materials for projects such as construction of new roads and railways. Consequently, a wide range of materials with diverse geological origins are used throughout the State.

CRUSHED ROCK AGGREGATES

By blasting and subsequent crushing and screening, quarries produce a range of products including coarse screened rock for rail ballast, screenings for concrete, road sealing and hotmix aggregates, and crushed rock and rubble for road pavements. Large oversize 'spalls' of 1–8 t which are too large for the crushers to handle are often stockpiled for use in breakwater construction or beach protection works. In decreasing order, the main crushed rock aggregates and quarry products are rubble, crushed rock, screenings for concrete, filling and specification sand.

In the Mount Lofty and Flinders Ranges, sedimentary rocks, principally quartzite, dolomite and limestone of Neoproterozoic or Cambrian age, are the most important sources of aggregate, but shale and siltstone are widely used in the construction of unsealed roads. Port Lincoln derives most of its aggregate supplies from a quarry in Palaeoproterozoic Lincoln complex granite. Mesoproterozoic acid volcanic rocks of the Gawler Range Volcanics suite are important sources of rail ballast north of Tarcoola, and road sealing aggregate at Kingoonya and on northern Eyre Peninsula. Quaternary basalt deposits, principally at the Mount Schank and Mount McIntyre Quarries, supply the Lower South-East with aggregate used for road seal, rubble and screenings for concrete. One of the most widespread materials used for road building throughout the State is calcrete of Quaternary age. This material is particularly important on western Eyre Peninsula and in the Riverland where alternatives are not available

About half of the State's crushed rock aggregate, including all supplies for the Adelaide metropolitan area, comes from metasedimentary rocks of Adelaidean or Cambrian age. These comprise two rock types:

- carbonate, including dolomite, dolomitic limestone and limestone
- · quartzite, including sandstone and arkose.

Although a large range of products is made from both rock types, their uses are not fully interchangeable, with all of Adelaide's road sealing aggregate sourced from carbonate rocks which bond more readily with bitumen than does quartzite. Quartzite quarries produce a relatively higher proportion of rubble, filling and quarry sand products and a lower proportion of screenings than carbonate quarries. Because of the greater versatility of carbonate aggregates and the fact that they are less abrasive and therefore cheaper to crush, they have been steadily increasing their market share in Adelaide since the 1950s, when only 6% of metropolitan production was carbonate.

Stonyfell Quartzite is the source of all metropolitan quartzite aggregate, whereas carbonate aggregate is sourced from a variety of units including the Early Cambrian Fork Tree Limestone and Adelaidean Tapley Hill Formation from quarries south of Adelaide, and the Skillogalee Dolomite sourced from quarries immediately north of Adelaide.

The majority of carbonate aggregate resources are located in the southern metropolitan area. Recent exploration has been concentrated north of Adelaide in the Kapunda area for new sources in Adelaidean sedimentary rocks. Large resources of Early Cambrian Kulpara Formation, which crop out extensively on northern Yorke Peninsula, are a potential supply for Adelaide's long-term requirements for high-quality aggregate.

CONSTRUCTION SAND

Natural sand is used for a variety of purposes for which there is a range of specifications, where the sand is graded on size and silt and clay content. The most important use of natural sand is in concrete, which accounts for over half of all sand produced. Other significant uses include bricklaying, plastering, filling on building sites, concrete blocks, packing of water or gas pipeline trenches, and for gardening.

Most regional centres have small pits to cater for local requirements. Dry creek beds are a common source of concrete sand in country areas including northern Spencer Gulf, with Holocene dune sand being widely used for packing, filling and garden applications. Holocene beach



Concrete sand stockpile at Rocla Quarry Products Golden Grove pit. (Photo 47672)

ridge deposits of St Kilda Formation supply Port Lincoln, and Pleistocene Bridgewater Formation beach deposits are mined near Comaum in the South-East. Thick fluviolacustrine deposits from the Tertiary Loxton Sand are mined from exposures in the Murray River cliffs near Berri in the Riverland.

Almost all of metropolitan Adelaide's annual requirements of ~2 Mt of construction sand are sourced from fluviolacustrine deposits of Tertiary age located on the eastern flank of the St Vincent Basin. Because of the relatively high clay content of sand in these basins $(\sim 15\%)$, $\sim 70\%$ of production is treated by washing to meet specifications. Most of the remainder is dry screened. In the Maslin Beach - Pedlar Creek area, the Middle Eocene North Maslin Sand crops out along the northern margin of the Willunga Embayment. This is the only major source of construction sand south of the city. An equivalent unit in the northern part of the Golden Grove Embayment supplies just under half of metropolitan Adelaide's sand. Further north, remnants of Tertiary fluviolacustrine sediments which extend eastwards from Gawler to the Barossa Valley also supply the metropolitan area. During 1991, a Departmental mapping and drilling program between Bute and Ardrossan on northern Eyre Peninsula identified a 60 km long palaeochannel containing sand tentatively correlated with the North Maslin Sand. Pits in this deposit, along with others on southern Yorke Peninsula, now supply an increasing portion of the metropolitan market.

CLAY

Metropolitan Adelaide's supplies of industrial clay comes from two main sources:

- weathered shale deposits of Adelaidean Saddleworth Formation and Woolshed Flat Shale
- fluviolacustrine white plastic clay deposits in Tertiary sedimentary basins.

Golden Grove is the centre of the clay brick industry in South Australia and accounts for >80% of the State's clay brick manufacture. The bulk of clay used in brick blends is won from deposits of deeply weathered Adelaidean shale on the eastern flank of the Tertiary Golden Grove Embayment. The shale is blended with white plastic sedimentary clay, which occurs as interbeds within the Tertiary sand sequence, to increase green strength of brick clay blends, improve extrusion characteristics and reduce firing temperatures. During recent years, increasing use has been made of reclaimed fine tailings from sand washing operations.

Total clay consumption in the metropolitan brick industry in 1999–00 was 386 899 t, with an additional 233 121 t being used in cement manufacture.

PRECIOUS STONES

DIAMOND

Exploration in the Springfield Basin, which contains Permian-hosted alluvial diamonds, was carried out by Tiger International Resources Inc. which is now floating a new company, Flinders Diamonds Ltd, to raise capital for further exploration in the region. An additional 56 diamonds were found in 1998 during exploration trenching, bringing the total found to 184. Fresh indicator minerals suggest a close primary source but this has not yet been discovered. The company has also acquired tenements over the Echunga area, a gem-diamond-bearing Tertiary alluvial occurrence immediately south of Adelaide which produced 50 saleable diamonds in the late 1800s, the largest gem reported being 9¼ carat. Exploration has slowed pending a successful float and is then expected to intensify in late 2000 and 2001.

There has been no commercial production of diamonds in South Australia.

OPAL

The estimated production of opal for 1999 was \$37.5 million, down slightly on the previous year's \$38.6 million.

Production at Lambina has once again increased from the previous year, \$5 million up to \$7.5 million, an increase of 50%. This has been offset by a small decline in output from Coober Pedy and a larger fall at Mintabie.

Opalised 'sandstone' processing has now reached a high standard, and Andamooka Opalworld Australia Pty Ltd has set up an initial cutting and polishing facility in China and is negotiating with several overseas companies to provide this unique 'Andamooka Opal Stone'. The company is endeavouring to establish a full processing plant in Andamooka which, in addition to the mining, will include the enhancing, cutting and polishing. Future plans include sale of opal from all other South Australian opalfields through an outlet which would include a workshop for tourist viewing, a retail and wholesale venue, and accommodation for prospective buyers at a prominent locality in Adelaide. Andamooka is renowned for its exceptional quality of opal and the aim of the company is to promote 'Andamooka Opal Stone' worldwide.

JADE

Sale of nephrite jade from the Cowell Jade Province on Eyre Peninsula during 1999 was only 757 kg, as Gemstone Corp. is refinancing and intending to enter into a joint venture to further market its jade.

COMPANY MINERAL EXPLORATION ACTIVITY 1999

Expenditure by companies on mineral exploration licences in South Australia for calendar year 1999 was \$29.8 million, a 30% decrease on 1998. This is the second successive significant annual decline in expenditure since the record level of activity and expenditure of \$53 million in 1997 (Fig. 1.7, Tables 1.1, 1.2).

The continued decrease in exploration activity reflects an Australia-wide trend due to low commodity prices, inability of explorers to raise equity funds in the sharemarket, and the complex path that explorers have to negotiate to satisfy Native title requirements.

A comparison of national mineral exploration expenditure figures for calendar year 1999 indicates that South Australia accounted for 4.7% of the total Australian expenditure, exceeding only Tasmania with 1.6% and Victoria with 4.6% (Australian Bureau of Statistics Catalogue 8412).

As at 1 January 2000, 142 licensees held 372 exploration licences, with 282 070 km² (28%) of the State under licence (Fig. 1.8). These measures of activity are 5 15% lower than for the previous year. Mineral exploration drilling metreage was only marginally lower and did not reflect the significant decline in exploration expenditure due to the addition of a substantial amount of low cost, shallow exploration and evaluation drilling for heavy mineral sands in the Murray Basin.

As in previous years, exploration in South Australia was dominated by the search for Cu–Au and gold deposits in the Gawler Craton and Curnamona Province, although at substantially decreased levels (Figs 1.9, 1.10). Spending on gold continued to decline, dropping by 55% to \$6.5 million (21.6% of the total South Australian expenditure) while Cu–Au exploration declined by 36% to \$10.8 million



Fig. 1.7 Major South Australian mineral provinces.

(36.3%), reflecting significantly reduced exploration activity in both regions.

Going against the trend were Pb–Zn and nickel exploration, with Pb–Zn exploration expenditure increasing by 55% to \$3.3 million (10.9%) and nickel increasing from only \$700 000 in the past few years to nearly \$1 million in 1999. These trends are expected to continue into the year 2000. Pb–Zn exploration has substantially increased in the Olary – Broken Hill region of the Curnamona Province, and there was a slight increase in

YEAR	TOTAL		ME	TALS	ALS		COAL	URANIUM	HMS	OTHER
		Gold	Cu–Au	Pb–Zn	Other metals					
1990	10 949	755	1 340	2 355	1 875	2 657	252	350	1 229	136
1991	17 194	988	2 702	5 031	2 250	2 257	203	959	1 763	1 041
1992	18 153	1 408	2 934	5 363	2 977	1 884	129	2 646	394	418
1993	18 488	2 639	2 681	8 717	2 558	504	193	890	-	306
1994	20 240	3 894	6 797	4 312	1 261	2 550	447	20	-	959
1995	20 789	2 165	9 835	3 948	1 178	2 186	646	68	-	763
1996	26 011	11 300	5 934	4 018	1 870	1 665	520	93	-	611
1997	52 750	27 267	13 412	2 269	3 347	1 679	139	4 081	61	495
1998	42 461	14 375	17 028	2 104	1 685	1 684	241	3 854	622	868
1999	29 831	6 449	10 842	3 253	2 026	868	225	1 530	2 301	2 337

Table 1.1 Mineral exploration expenditure (\$'000), 10-year summary.

Note:

1. The above figures record expenditure (dollars of the day) reported to PIRSA for the calendar year. The figures are derived from reports submitted to PIRSA as a regulatory requirement for exploration licences, and for mineral claims and retention leases held within exploration licences.

2. 'Metals' includes 'major metals' (Cu, Pb, Zn, Sn, Al), 'precious metals' (Au, Ag, PGE) and 'steel industry metals' (Fe, Cr, Co, Mn, Mo, Ni, W, V, Nb).

3 'Other' includes 'industrial minerals', gemstones other than diamond, and 'specialty metals' (Mg, Ti, Be, REE, Zr, Hf, Hg, Se, Te, Ga, Ge, Ta, Rh, Cd, Sb, Li, Bi, In).

Table	1.2	Geological	province	expenditure,	exploration	drilling and	other measures	of	activity, .	5-year	summary.
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	1999	1998	1997	1996	1995
Geological province expenditure (\$'000)					
Gawler Craton	11 287	20 212	37 276	16 727	9 955
Curnamona Province (inc. Frome Embayment)	8 912	16 435	10 663	4 979	5 189
Adelaide Geosyncline (inc. Stuart Shelf)	5 239	3 736	2 992	2 718	4 278
Musgrave Block	1 409	663	326	220	330
Other	2 984	1 415	1 493	1 367	1 037
Exploration drilling (m)					
Cored	21 459	19 623	18 115	12 120	13 067
Non-cored RC	42 304	75 128	(breakdown int	o 'RC' and 'other	' not available)
other	173 170	163 369	616 435	288 383	124 512
Total	236 933	260 120	634 550	300 503	137 579
Other measures (as at 31 December 1999)					
Number of exploration licences	372	413	475	314	265
Area of exploration licences (km ²)	282 070	319 415	416 650	240 000	203 880
Number of licensees	142	152	167	130	105

Exploration licences current









Exploration expenditure











Fig. 1.8 South Australian mineral exploration statistics to 31 December 1999.

the Kanmantoo Trough of the Adelaide Geosyncline. Nickel activity was focused in the Musgrave Block and western Gawler Craton.

Uranium exploration declined in response to the completion of exploration and evaluation programs at the Beverley and Honeymoon ISL projects, while greenfields exploration elsewhere in the State remained subdued.

The 48% drop in diamond exploration expenditure to \$0.9 million (2.9%) was due to unsuccessful attempts by explorers to locate diamond source rocks in their initial phase of exploration. Exploration effort was focused in the Abminga region in the far north of the State and in the Quorn–Hawker area of the Flinders Ranges.

Exploration for coal and iron ore remained subdued during 1999, accounting for $\sim 1\%$ of the State's total expenditure, but substantial increases are expected in 2000 when deposit evaluation commences at the Phillipson coal



Fig. 1.9 Company mineral expenditure by commodity, 10-year summary.



Fig. 1.10 South Australian mineral exploration expenditure by commodity, 1999.

deposit and iron ore deposits south of Coober Pedy for the feasibility phase of the SASE Pty Ltd pig iron project.

Heavy mineral sands (HMS) exploration expenditure rose five-fold to \$2.3 million (7.7%), reflecting major exploration programs in the Murray Basin which have resulted in the discovery of several potentially commercial deposits southwest of Loxton.

Expenditure on magnesite (source rock for magnesium metal production) exploration and evaluation was ~\$2 million and resulted in the discovery and delineation of several deposits in the northern Flinders Ranges, northwest of Leigh Creek, which will provide feedstock for the proposed SAMAG Ltd magnesium metal project.

Exploration amounting to ~\$0.5 million was also conducted for other industrial minerals, mainly gypsum, salt, diatomite, limestone, coloured oxide and micaceous haematite, as well as for opal outside the Coober Pedy Proclaimed Precious Stones Field.

Exploration activity in both the Gawler Craton (\$11.3 million) and Curnamona Province (\$8.9 million) accounted for 68% of expenditure which was 45% less than in 1998, in line with the overall downturn in exploration. Going against the trend was increased activity in both the Adelaide Geosyncline (\$5.2 million) and Musgrave Block (\$1.4 million). Increased expenditure in the geosyncline was attributed primarily to substantial exploration for magnesite in the northern Flinders Ranges, and slightly increased exploration for Pb–Zn in the Kanmantoo Trough. Expenditure in the Musgrave Block in the far northwest of the State increased significantly due to accelerated exploration for base and precious metals in the Anangu Pitjantjatjara Lands.

MINERAL LEGISLATION HIGHLIGHTS

MINING (PRIVATE MINES) AMENDMENT ACT AND REGULATIONS

The *Mining (Private Mines) Amendment Act 1999* was passed by both Houses of Parliament in October 1999. This Act, which came into operation on 1 September 2000, provides for the proper management and control of mining operations on private mines, and introduces wider environmental controls than those afforded by the *Environment Protection Act 1993*.

NATIONAL COMPETITION POLICY LEGISLATION REVIEW

In accordance with clause 5 of the Competition Principles Agreement between the Commonwealth, State and Territory Governments dated April 1995, the following documents have been reviewed by a panel:

- *Mining Act 1971* and Mining Regulations 1998
- *Opal Mining Act 1995* and Opal Mining Regulations 1997
- *Mines and Works Inspection Act 1920* and Mines and Works Inspection Regulations 1998

The final draft document has been circulated to industry and other interested groups for comment. Any amendments considered necessary to any of the above Acts must be identified by the end of December 2000.

In addition, a desktop review of the *Roxby Downs* (*Indenture Ratification*) *Act 1982* has been completed by the Crown Solicitor's Office with input from PIRSA staff. The final report has been forwarded to the Minister for Minerals and Energy for approval, and the Economic Reform Branch of the Department of Premier and Cabinet has advised that the report satisfies the requirements of the Competition Principles Agreement.

As no anti-competitive issues were identified in the desktop review, no amendments to the Roxby Downs (Indenture Ratification) Act will be required.

MINING (ROYALTY) AMENDMENT ACT

The *Mining (Royalty) Amendment Act 2000* came into operation on 1 July 2000 and amended the Mining Act by changing the 'assessed value' of a commodity on which royalty is determined from the delivered value to the ex-mine value. This will disallow the inclusion of freight and handling costs downstream from the mine which unfairly inflate the assessed value for royalty purposes.

Other amendments include penalties for late or non-payment of royalties (as a percentage of royalty due), and allows the assessment of royalties to be determined other than according to weight or volume of minerals recovered.

EXPLORATION LICENCE PROCEDURES

The Resources Task Force indicated in its report that a greater turnover of exploration ground will facilitate new exploration and accelerate current activity within South Australia. In response, a number of changes to the management of exploration licences are proposed which include both legislative amendment and policy changes. These include a combination of reduced licence size, mandatory licence area reductions, and increases in both rental payments and expenditure commitments.

The proposal paper was forwarded to SACOME on 7 July 2000 for comment by 29 September 2000.



Mineral Registration enquiry counter. (Photo 47673)

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* came into operation on 16 July 2000 and gives the Commonwealth Environment Minister direct authority to regulate environmental impact assessment and approval of all activities or projects that any person may wish to undertake that will affect an area, matter or item for which Australia has international obligations and which are of national importance.

The Act is separate and distinct from South Australian legislation which regulates environmental impact assessment and approval of projects. The assessment and approval procedures under this Act will not replace or override the State's assessment and approval procedures; instead, they operate in parallel with State's systems.



The South Australian Government's amendments to State legislation to 'dovetail' processes with the Commonwealth's EPBC Act processes will be tabled in Parliament on 29^{th} November 2000.

For further information, PIRSA Earth Resources Information Sheet M17 (*A summary of the implications of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999*) can be downloaded from the Mineral Resources website, or contact Tracey Simmons (ph. 08 8463 3103) for a copy to be sent out.

OPAL LEGISLATION HIGHLIGHTS

REVIEW OF THE OPAL MINING ACT

The Opal Mining Act was assented to by the South Australian Parliament in November 1995, and proclaimed and brought into operation on 21 April 1997. The South Australian Opal Miners Association Inc. (SAOMAI) has requested the Office of Minerals and Energy Resources to undertake a review of the Act. The Office sent out invitations to all approved opal miner's associations to lodge submissions outlining any proposed amendments. The submissions have been received and a discussion paper has been prepared outlining those suggestions and incorporating proposals from PIRSA regional and head office staff. The discussion paper was circulated to the opal mining industry for comment by 29 September 2000.

For further information on any of the above mining legislation issues, contact Laura Johnston, Mining Registrar (ph. 08 8463 3099; e-mail johnston.laura@saugov.sa.gov.au).

EXTRACTIVE AREAS REHABILITATION FUND

Table 1.3 lists the EARF projects approved during 1999–00; the major projects are discussed below. Table 1.4 summarises the EARF by financial year from 1993–94.

Private Mine 94

Located 3 km east of the Sandy Creek Post Office. The proposal addressed the final rehabilitation of a worked out portion of the private mine approved for extraction of sand, shale and plastic clay. Approval for expenditure of \$148 999.40 was given in April 2000 for the battering down of the terminal faces, and formation of a permanent waterhole to ensure that all silt was kept on site during the construction phase, enabling return of the land to its pre-mining land use of grazing and cropping.

Private Mine 65

Located 5 km east of the Maslin Beach Post Office, within the Maslin Beach Extractive Zone. The private mine was originally granted for extraction of high-quality building sand. The proposal addressed the visual impacts of the operation from the surrounding environment, especially the users of Tatachilla Road. Approval for expenditure of \$92 005.62 was granted in April 2000 for the construction and vegetative covering of an earth embankment on the eastern boundary of the tenement.



Before and after restoration photographs of Private Mine 94 near Sandy Creek. Restoration was completed using monies provided by the Extractive Areas Rehabilitation Fund. (Photos 47674, 47675)

Private Mine 48

Located 10 km north of the Reynella Post Office, adjacent to the Field River and the newly developing residential area of Sheidow Estates. The proposal addressed the visual impacts of the private mine granted for extraction of dolomite on the eastern boundary of the operation on the newly developing residential areas surrounding Sheidow Park and Hallett Cove. Approval for expenditure of \$305 367 was granted in May 2000 for the construction and vegetative covering of an earth embankment on the northeastern boundary of the tenement as well as battering down of the top eastern terminal faces and reshaping of overburden dumps to blend these with the surrounding landscape.

Extractive Mineral Lease 3243

Located 15 km west of Kalangadoo in the South-East of the State. The proposal addressed the visual impacts on the surrounding rural environment, especially to users of Quarry Road, of the extractive mineral lease granted for extraction of dolomite aggregate. Approval for expenditure of \$85 007 was granted in March 2000 for the backfilling with waste materials of the older workings directly adjacent to the road. The area will be contoured into the existing landscape prior to grassing.

Private Mine 125

Located 5 km southwest of Mount Gambier Post Office within the limestone building block zone of Compton. The proposal addressed progressive rehabilitation of the worked portion of the private mine granted for extraction of limestone building blocks. Approval for expenditure of \$92 979 was granted in January 2000 for the formation of batter of approximately 1 in 3 of the 30 m high terminal face located on the eastern boundary of the tenement. On completion of earthworks, the area is to be grassed and returned to its pre-mining land use of grazing.

Private Mine 171

Located 4 km west of Balhannah. The proposal addressed progressive rehabilitation of the worked out portion of the private mine granted for extraction of quartzite and sandstone. Approval for expenditure of \$151 354.15 was granted for the battering down to a slope of 1 in 3 of the northern terminal faces which face the main road leading to Balhannah. On completion of earthworks, the area will be grassed and returned to its pre-mining land use of grazing.

Extractive Mineral Lease 5406

Located 5 km northeast of the Sandy Creek Post Office. The proposal addressed final rehabilitation of an exhausted deposit on the extractive mineral lease granted for extraction of brick shale. Approval for expenditure of \$84 124.80 was given in March 2000 for the battering down of the terminal faces, and formation of a permanent waterhole to ensure that all silt was kept on site during the construction phase, enabling return of the land to its pre-mining land use of grazing and cropping.

Extractive Mineral Lease 5603

Located 8 km northwest of the Ceduna. The proposal addressed progressive rehabilitation of an exhausted portion of the deposit on the extractive mineral lease granted for extraction of hard capping limestone. Approval for expenditure of \$99 335.50 was given in May 2000 for the battering down of the terminal faces, recontouring of the quarry floor and grassing, enabling return of the land to its pre-mining land use of grazing and cropping.

Application date	Applicant	Tenement	Eligibility	Amount (\$)	Approval date	Timeline	Comment
20/11/99	Clav & Mineral Sales	PM 94	а	148 999	19/4/00	20/3/00	Progressive rehabilitation
4/4/00	Christies Sands Ptv Ltd	PM 65	а	2 700	7/4/00	4/5/00	Design
4/4/00	Christies Sands Ptv Ltd	PM 65	а	92 005	27/4/00	4/6/00	Progressive rehabilitation
18/1/00	City of Onkaparinga	EML 2569-70) b	32 360	13/6/00	18/3/00	Design
6/11/99	Southern Quarries Ptv Ltd	PM 163	a	687	21/12/99	6/12/99	Progressive rehabilitation
21/5/99	Southern Quarries Pty Ltd	PM 163	b	4 460	2/9/99	21/6/99	Design progressive rehabilitation
Aug. '99	Southern Quarries Pty Ltd	PM 163	b	23 990	27/9/99	1/9/99	Progressive rehabilitation
26/1/99	Southern Quarries Pty Ltd	PM 163	а	32 990	19/1/00	26/3/99	Progressive rehabilitation
18/2/00	Southern Quarries Pty Ltd	PM 163	b	3 650	22/3/00	18/3/00	Design progressive rehabilitation
23/1/99	Rocla Quarry Products	PM 20	a, b	43 898	23/12/99	23/3/00	Progressive rehabilitation
22/3/00	Boral Resources (SA)	PM 1,6, 7	а	38 756	24/3/00	22/5/00	Progressive rehabilitation
22/3/00	Boral Resources (SA)	PM 1,6, 7	а	75 706	24/3/00	22/5/00	Progressive rehabilitation
28/1/99	CSR Readymix	PM 31	b	4 890	18/8/99	28/2/99	Design progressive rehabilitation
12/2/99	CSR Readymix	PM 35	b	45 350	14/12/99	12/4/99	Progressive rehabilitation
21/5/99	CSR Readymix	PM 31	b	3 130	2/9/99	21/6/99	Design progressive rehabilitation
26/11/99	CSR Readymix	PM 35	b	32 326	6/1/00	26/1/00	Design for screen mound
21/3/00	CSR Readymix	PM 35	b	4 700	26/4/00	21/4/00	Design progressive rehabilitation
31/10/99	Boral Resources (SA)	PM 48	a, b	2 839	21/12/99	30/11/99	Design progressive rehabilitation
6/12/99	Boral Resources (SA)	PM 48	а	305 357	4/5/00	6/3/00	Progressive rehabilitation
21/4/99	Boral Resources (SA)	PM 154	а	69 833	3/11/99	21/6/99	Progressive rehabilitation
6/1/99	Rocla Quarry Products	PM 204	а	6 386	21/12/99	6/2/99	Design progressive rehabilitation
1/4/98	South Eastern Auto Club	PM 134	а	59 683	23/12/99	1/6/98	Progressive rehabilitation
20/10/99	Boral Resources (SA)	EML 3243	а	85 007	24/3/00	20/12/99	Progressive rehabilitation
1/11/99	CSR Readymix	PM 197	а	3 870	14/12/99	1/12/99	Design progressive rehabilitation
16/2/00	CSR Readymix	PM 197	а	24 843	13/4/00	16/3/00	Progressive rehabilitation
28/5/00	CSR, Victor Harbor	PM 197	b	3 118	2/6/00	28/6/00	Design progressive rehabilitation
23/1/99	CSR Readymix	PM 197	а	3 570	30/9/99	23/2/99	Design progressive rehabilitation
24/2/99	CSR Readymix	PM 197	а	24 915	21/12/99	24/3/99	Progressive rehabilitation
10/1/00	J.L. Berrett	PM 274	а	38 453	3/5/00	10/3/00	Progressive rehabilitation
17/10/99	D. Pitt	EML 3394	а	3 775	21/12/99	17/11/99	Design progressive rehabilitation
16/5/00	D. Pitt, Naracoorte	EML 3395	а	32 967	26/6/00	16/7/00	Progressive rehabilitation
8/4/99	South Coast Sand & Metal	EML 4882	b	24 462	30/12/99	8/5/99	Final rehabilitation
29/11/99	J. Poulos	EML 5441	а	8 305	14/12/99	29/12/99	Progressive rehabilitation
20/4/99	Boral Resources (SA)	EML 3794	а	9 899	21/12/99	20/5/00	Design progressive rehabilitation
27/10/99	Boral Resources (SA)	EML 3794	а	44 198	23/12/99	27/12/99	Design progressive rehabilitation
6/5/99	Stafford and Earl	PM 125	а	92 979	6/1/00	6/7/99	Progressive rehabilitation
14/10/99	Cunningham Quarries	EML 3361	а	8 905	23/11/99	14/11/99	Progressive rehabilitation
28/5/99	H.E. Kruse	PM 301	b	1 975	2/9/99	28/6/99	Design progressive rehabilitation
28/11/99	H.E. Kruse	PM 301	b	1 020	21/12/99	28/12/99	Design progressive rehabilitation
30/11/99	H.E. Kruse	PM 301	b	30 662	6/1/00	30/1/00	Progressive rehabilitation
10/5/00	H.E. Kruse	PM 301	b	2 761	31/5/00	10/6/00	Design progressive rehabilitation
20/2/00	E.W. & M.D. Ross, One Tree Hill	EML 4493	b	56 682	18/5/00	20/4/00	Progressive rehabilitation
19/6/00	Wistow Stone Quarries	PM 194	b	22 957	21/6/00	19/7/00	Progressive rehabilitation
18/4/99	Clay & Mineral Sales	EML 5872	а	19 694	14/12/99	18/5/99	Progressive rehabilitation
1/10/98	CSR Readymix	PM 27	a, b	42 455	12/10/99	1/12/98	Progressive rehabilitation
7/6/00	Rudenti Nominees	EML 5419	а	22 812	13/6/00	7/7/00	Final rehabilitation
11/1/00	C. & M. Centofanti	PM 171	а	151 354	19/4/00	11/4/00	Progressive rehabilitation
25/8/99	K. & G. Constructions	PM 110	b	24 602	30/9/99	25/9/99	Progressive rehabilitation
31/12/99	CSA Earthmovers	EML 5843	а	68 772	18/5/00	28/2/00	Progressive rehabilitation

Table 1.3 Extractive Areas Rehabilitation Fund project approvals, 1 July 1999 to 30 June 2000.
Table 1.3 continued.

Application date	Applicant	Tenement E	Eligibility	Amount (\$)	Approval date	Timeline	Comment
31/3/99	Clay & Mineral Sales	EML 5997	а	15 279	27/9/99	31/4/99	Progressive rehabilitation
14/10/99	Adelaide Brighton Cement	EML 3601	а	5 621	23/11/99	14/11/99	Detailed rehabilitation program
20/12/99	Adelaide Brighton Cement	EML 3601	а	19 340	30/12/99	20/1/00	Final rehabilitation
20/3/00	Adelaide Brighton Cement	EML 3601	а	6 430	26/4/00	20/4/00	Final rehabilitation
Jan. '99	Rocla Quarry Products	EML 5320	а	23 535	27/9/99	1/2/99	Final rehabilitation
17/2/99	Rocla Quarry Products	EML 5321	а	4 800	2/9/99	17/3/99	Design final rehabilitation
Aug. '99	Rocla Quarry Products	EML 5321	а	19 252	27/9/99	1/9/99	Final rehabilitation
Aug. '99	Southern Quarries Pty Ltd	PM(A) 243	b	24 806	27/9/99	1/9/99	Progressive rehabilitation
17/9/99	Southern Quarries Pty Ltd	PM(A) 243	b	3 675	9/11/99	17/10/99	Design progressive rehabilitation
19/3/00	Salisbury Brick Pty Ltd	EML 5406	а	84 124	27/3/00	19/5/00	Progressive rehabilitation
1/6/98	Santos Readymix Pty Ltd	EML 3374/468	5 b, c	8 231	10/8/99	1/7/98	Design stage pilot research program
7/12/99	Santos Readymix Pty Ltd	EML 3374/468	5 b, c	26 650	21/12/99	1/2/00	Research
16/3/99	T. Pfeiffer	EML 5936	а	4 800	2/9/99	16/4/99	Progressive rehabilitation
29/3/99	Clay & Mineral Sales	EML 5786	а	35 146	14/12/99	29/5/99	Final rehabilitation
20/5/00	N. Mathews	EML 6014	а	10 695	3/8/99	20/6/00	Progressive rehabilitation
Aug. '99	West Wimmera Shire	EML 5698	а	4 765	27/9/99	1/9/99	Progressive rehabilitation
12/8/99	PIRSA	PIRSA	b	25 000	12/8/99		Project Approval Panel costs
27/8/99	G.D. Philips	PM 283	а	1 250	27/9/99	27/9/99	Final rehabilitation
25/8/99	P. Kelly	PM 148	а	13 691	9/11/99	25/9/99	Design final rehabilitation
22/9/99	T. Ryan	PM 119	а	17 890	3/11/99	22/10/99	Design progressive rehabilitation
2/3/00	G. Cundy	EML 5955	а	19 037	22/3/00	2/4/00	Final rehabilitation
16/5/00	R.N. East	EML 5593	а	16 974	2/6/00	16/6/00	Final rehabilitation
16/4/00	C.C. & S.A. Loechel	EML 5604	а	17 860	8/5/00	16/5/00	Final rehabilitation
13/4/00	SYP Blue Metal Pty Ltd	EML 4785	а	4 286	26/4/00	13/5/00	Progressive rehabilitation
4/5/00	W.L. Brealy	EML 4550	а	6 473	2/6/00	4/6/00	Design final rehabilitation
2/5/00	Boral Resources (SA)	EML 5630	а	99 335	3/5/00	2/7/00	Progressive rehabilitation
31/5/00	Boral Resources (SA)	EML 4778-478	31 b	50 521	6/6/00	31/7/00	Progressive rehabilitation screening mound
30/5/00	S. & M. Coleman, Rowland Flat	EML 57898	а	14 668	1/6/00	30/6/00	Design progressive rehabilitation
1/6/00 Total	A.H. & B.A. Traeger 78 approvals	EML 4658	a \$2	10 450 484 305	9/6/00	1/7/00	Progressive rehabilitation

Note: the amount granted (\$) has been rounded up to the nearest dollar; the total is the actual amount granted.

The Mining Act 1971 provides for the operation of the EARF and defines the following:

a) To rehabilitate land disturbed by mining operations for the recovery of extractive minerals: and

b) Implement measures designed to prevent, or limit, damage to or impairment of any aspect of the environment by mining operations for the recovery of extractive minerals; and

c) Promote research into methods of mining engineering and practice by which environmental damage or impairment resulting from mining operations for the recovery of extractive minerals may be reduced.

Table 1.4 Extractive Areas Rehabilitation Fund annual reports.

Year	Receipts	Expenditure	Number of	Approval	Balance
	(\$)	(\$)	projects	amounts	
1999–00	1 102 801	1 441 000	78	2 484 305	2 205 606
1998–99	887 000	885 000	43	922 574	3 700 000
1997–98	1 025 000	790 000	33	1 330 010	3 700 000
1996–97	810 000	750 000	47	510 154	4 100 000
1995–96	826 000	876 000	24	612 768	4 800 000
1994–95	950 000	623 000	38	1 108 000	4 900 000
1993–94	1 089 000	1 055 000	28	862 743	4 600 000

MINERAL RESOURCES GROUP, OFFICE OF MINERALS AND ENERGY RESOURCES

VISION

'South Australia — the preferred mineral investment destination'

- \$100 million/year mineral exploration investment by 2007
- \$4 billion/year mineral production and processing by 2020

Mineral Resources Group, a key Group for facilitating mineral exploration and development, is focused on increasing the prosperity of South Australians by ensuring responsible development of the State's mineral resources within a sustainable framework.

BUSINESS

The Mineral Resources Group's business is the responsible and accountable management of the mineral resource assets and related geoscientific data of South Australia. In undertaking our business, our focus is on influencing and, where required, ensuring that management and development decisions of key stakeholders take account of the needs of the community and future generations.

This involves working in partnership with the industry, government and the community to continually improve understanding of the mineral resources and geology of the State, promote its prospectivity nationally and internationally, regulate its responsible extraction, and provide high-quality advice and statistical analysis to government and the community.

ACHIEVEMENTS 1999-00

TARGETED EXPLORATION INITIATIVE SOUTH AUSTRALIA (TEISA)

The South Australian Government has signalled its continuing confidence in the ability of the mining sector to play a key role in the State's economic growth by committing \$23.2 million, to be spent over the years 1998–02, on TEISA, a phased, regional exploration strategy for minerals, petroleum and groundwater.

This strategy is providing comprehensive, accurate and relevant geoscientific data that will encourage private companies to focus their exploration efforts on prospective areas in South Australia in preference to the other States and offshore. The initiative comprises \$10 million over four years to fund large-scale geoscience data acquisition along with \$3.3 million/year to support ongoing research and geoscientific survey programs within PIRSA that are the basis of the TEISA program. The targeted areas are the Musgrave Block (a geological province in the AP Lands), southern Gawler Craton (including Eyre and Yorke Peninsulas), eastern Adelaide Geosyncline, Curnamona Province, and areas of South Australia's key sedimentary basins (including the Murray and Cooper Basins; Fig. 1.11).

Geophysical data releases

Since September 1999, over 200 000 line kilometres of new TEISA airborne geophysical data have been made available to industry free of charge. Data for each of the TEISA target regions are now available in a located ASCII data format which is complemented with ER Mapper grid files and hardcopy pixel imagery. Data are currently available for:

- WOODROFFE map area
- southern Gawler Craton
- Stuart Shelf Oodnadatta region
- Mannum–Kanmantoo region
- northern Murray Basin.

Nearly 500 CD data sets have been distributed, with the contained magnetic, radiometric and digital terrain data now being effectively used in exploration decision-making processes.

TEISA data will be merged with existing open file data to create a new high-resolution State total magnetic intensity (TMI) merge.



Fig. 1.11 TEISA geophysical programs.

Musgrave Program (AP Lands)

Flying of the WOODROFFE 1:250 000 map area in the northwest of the State, which has seen limited mineral exploration access in recent decades, was completed in late June 2000. This large survey, involving the flying of 96 000 line kilometres at 80 m above the ground and 200 m line spacing, was negotiated with indigenous stakeholders, who are keen to partner the Government in developing ways to increase job opportunities, develop infrastructure and generate prosperity in their lands.

Further funding from the Federal Government enabled PIRSA to continue data acquisition on the adjoining MANN and ALBERGA map areas (Fig. 1.12). Data acquisition commenced in early July and was completed in late August 2000.

Other TEISA projects planned for the Musgrave Program include regional bedrock drilling, acquisition of remotely sensed data and geological mapping. All projects will involve extensive consultation.

Exploration and subsequent mineral discoveries and developments in this part of the State, which is arguably the last major unexplored Australian mineral province, will increase job opportunities and prosperity for the people living in these areas.

Gawler Craton Program

Drilling programs

A bedrock drilling program has been completed in the western and southern Gawler Craton. Fifty-eight holes were drilled in the Ceduna area for a total of 2140 m, and a further 48 holes were drilled near Port Lincoln for a total of 2490 m. Three Aboriginal field assistants from the Wirangu Group were employed during the Ceduna program. Selected results include intrusive rocks with potential for nickel to the northeast of Ceduna, and altered Archaean volcanic rocks with potential for Cu–Zn to the north of Coffin Bay.

A stratigraphic drillhole was also completed west of Minlaton; 185 m of Permian and Cambrian cover rocks overlying deformed silica-poor Hiltaba Suite granite were intersected.

In collaboration with Adelaide Resources NL, ground magnetic and gravity surveys, six RC percussion drillholes totalling 945 m, and laboratory metallurgical studies were undertaken over extensive, coarse-grained Archaean banded iron formations in the Warramboo region of central Eyre Peninsula. Intersected iron ore grades (Fig. 1.13) are comparable to grades at a number of operating North American iron ore mines. Metallurgical testwork produced concentrates with consistent contents of 70% Fe or greater, with very low levels of contaminant elements.

Further extensive drilling programs are planned for the Gawler Craton in 2000–01.

Airborne electromagnetic (AEM) surveys

PIRSA and AGSO have undertaken a joint AEM orientation program over selected sites within the Gawler Craton. FUGRO Airborne Surveys successfully completed three test regions over Challenger, Tunkillia and Moonta using the TEMPEST system. The data are being processed and will be available in December 2000. Figure 1.14 shows a conductivity depth image (CDI) constructed from data acquired along a line over the Challenger test area.

Further orientation AEM surveys are planned over selected prospective regions of the State in early 2001.

Geoscientific databases

Improving access to geoscientific data is a key component of TEISA and several programs are being funded to help facilitate this.

MINDEP-SA, the mineral deposit database, is being upgraded and, after consulting various similar systems in Australia and around the world, many of the fields are undergoing design improvements. The database will provide readily accessible detailed information on mineral deposits, occurrences and exploration prospects ranging



Fig. 1.12 TMI merge of MANN, WOODROFFE and ALBERGA map areas.

from the smallest mineral show to world-class deposits such as Olympic Dam.

The database currently contains a limited number of 'first pass' entries and there is a major push to build up the number, detail and spread of mineral deposit entries. Consequently, several contract geologists are assisting the Mineral Potential team in systematically compiling data from the Gawler Craton, Curnamona Province and Adelaide Geosyncline. On completion, the database will provide comprehensive, accurate and relevant geoscientific data that will be the foundation for mineral potential maps, metallogenic studies and land-use planning, and will aid



Fig. 1.13 Iron ore grades, Warramboo region. (courtesy Adelaide Resources NL)

the private sector in developing exploration models and prospective area selection.

GeoServer is another major e-commerce initiative, which will migrate a critical component of the Government resource information business online. It will provide mineral exploration companies with the ability to access, interact with, and purchase from the vast pool of geospatial information held by PIRSA. It is due to come online mid-2001.

Opal Exploration Program

A program involving production of geoscientific databases and opal exploration drilling projects has been undertaken to promote opal mining activity. In April 2000 a CD was released for the Coober Pedy Precious Stones Field, which incorporated relevant geological, geophysical, satellite, elevation and cadastral data into a GIS system (Fig. 1.15). Similar packages will be prepared for Andamooka, Mintabie and other opal sites in South Australia.

Funds were also provided to the South Australian Opal Miners Association Inc (SAOMAI) and the Coober Pedy Miners Association Inc. (CPMAI) to conduct regional exploration drilling programs at Mintabie and Coober Pedy, respectively. At Mintabie, 360 drillholes totalling 3300 m were completed in March–April 2000, while at Coober Pedy, 451 drillholes totalling 5176 m were undertaken in May–June. Areas of good 'sandstone' and some potch (common opal) found at both fields will encourage intensive follow up in these areas.

GEOLOGICAL SURVEY

General

Agreement was reached with the Australian Geological Survey Organisation (AGSO) regarding a South Australian

> contribution to a new national geological mapping digital data set, including the recently completed State outcrop geology coverage and new interpretive tectonic and basin coverages. Briefings, core displays and field visits on prospectivity of aspects of South Australian geology were provided to planning teams from several major exploration companies. A report and MESA Journal article on the Pb–Zn potential of the Officer Basin were published.

Areas of current geological mapping, geoscientific projects and status of geological mapping in South Australia are shown on Figure 1.16.



Fig. 1.14 Conductivity depth image, Challenger test area.

GIS and SA_Geodata

Various issues were resolved with database confidentiality and standardisation. Development of the field palm-top data logging system continued; all data were successfully transferred to the new geodetic data system (GDA 94). Progress was made with design requirements for digital submission of company reports to be implemented during 2000–01. Input of information to the drillhole database from open file company information continued.

Geophysics

The State magnetic image is being regridded at finer resolution, with completion expected in 2000–01. Radiometric data over OLARY was verified with ground traverses; 256 channel radiometrics were successfully



Fig. 1.15 Coober Pedy Precious Stones Field radiometric image, with opal diggings, palaeochannels and roads superimposed.

regridded over CURNAMONA. A new merge of aeromagnetic data over the southern Gawler Craton was undertaken. The gravity database for the Moonta–Wallaroo region was examined in detail for discrepancies and several major problems were resolved. Data requests continue to be serviced.

Remote sensing

Orthophotography and a digital elevation model were purchased for the Curnamona Province as an aid to detailed geological mapping. Cooperation continued with CSIRO in the field of hyperspectral remote sensing, including the ASTER and OARS research and evaluation programs, Brukunga acid mine drainage monitoring, and regolith studies. CSIRO provided software for the analysis of HyMap data. A contract has been negotiated for flying a hyperspectral survey in the Musgrave Ranges as part of TEISA.

Web and information technology

Mineral Resource Group's Web presence underwent a significant upgrade during 2000, with more changes anticipated for 2001. As active partners in the GeoServer project, it is planned to have web access to GIS coverages by the latter half of 2000. In addition, Image Web Server software has been purchased with the object of providing compressed images over the web to potential clients.

Curnamona Province

The Curnamona Province program incorporates the Broken Hill Exploration Initiative (BHEI) and



aims to provide a new generation of geoscientific data for the Olary – Broken Hill region as a basis for more effective mineral exploration by industry, and to help secure the future of Port Pirie and Broken Hill. The BHEI is a joint program involving PIRSA, New South Wales Department of Mineral Resources and AGSO.

Collaborative research on geochronology, regional lithostratigraphy including a better correlation of the Broken Hill host rocks with those at Olary, geochemistry, and Cu–Au mineralisation and associated alteration halos has resulted in major advances in geological understanding. Conferences, including the recent BHEI–Exploration 2000 at Broken Hill, combined with field workshops and drill core displays are allowing the quick transfer of these recent developments to the exploration industry.

Detailed geological mapping has demonstrated close correlation with new generation geophysical data, particularly radiometrics, with the potential for this mapping tool to be applied widely across the province. Detailed mapping has also resulted in a new interpretation of the Broken Hill – Olary Domain boundary with the potential to influence metallogenic modelling.



Fig. 1.16 Current PIRSA mapping and geoscientific projects in South Australia.

KERSAIN

Mapping complete

digital data available

Mapping in progress

digital data available for some areas

Gawler Craton

Coloured manuscripts of the LINCOLN and MAITLAND 1:250 000 maps and accompanying explanatory notes have been prepared for publication. Geological mapping of areas with difficult access in western CHILDARA has been undertaken using a helicopter. Permission for access to the region was sought from the local Native title joint claimants, the Wirangu Group, who were supportive of the survey.

Collaborative research (funded by an Australian Research Council Grant) on the physical volcanology of the Gawler Range Volcanics was undertaken with the Centre for Ore Deposit Studies (CODES), University of Tasmania. The purpose of the study is to locate new, possibly mineralised, extrusion centres.

PIRSA and AGSO have begun a new three-year collaborative program in the Gawler Craton. Specific projects include study of the regional geology adjacent to the Olympic Dam deposit, structural history of the gold-bearing Archaean Mulgathing Complex in the region adjacent to the Challenger gold prospect, and Cu–Au mineralisation associated with Hiltaba Suite granites and major shear zones in the central Gawler Craton. A joint gravity survey within the central Gawler Craton will also be undertaken.

Sedimentary Basins

Compilation of the OOLDEA 1:250 000 geological map has been completed, and geological mapping of WINTINNA is in progress. Progress in the Gawler Craton palaeochannels project includes refinement of the location of the palaeochannels and development of preliminary models identifying economic mineral targets. Several reports have been produced as part of an integrated sequence stratigraphic study of the Gambier Basin. The Biostratigraphic Database is being upgraded and integrated into SA_Geodata (the main Oracle geoscience database). Contributions to the Petroleum Geology of South Australia Volume 5 (Bight and Duntroon Basins) and revision of the Otway Basin (Volume 1) are being prepared.

Biostratigraphic and general sedimentary studies for other agencies have included palynological analysis of the Lochiel coal pit and Honeymoon uranium deposit, provision of advice on the occurrence of glauconite in South Australia, and comments on consultants reports on the Coonawarra wine region. In collaboration with the Sustainable Resources and Information Management Groups, a brochure on the Geology of the McLaren Vale Wine Region, mostly written by an external author, was published promoting awareness of the underlying geology, soils and groundwater.

Adelaide Geosyncline

A major paper on the Adelaide Geosyncline and its significance in Neoproterozoic continental reconstruction was published in the international journal *Precambrian* *Research.* A paper on the geology, geochemistry and age of the Teal Flat and Marne River Volcanics was published in the *MESA Journal*.

Geological mapping in the Mid North region is in its final phase, with field work on the BURRA 1:250 000 map area over 90% complete and 19 of the twenty-four 1:50 000 maps now being available in digital form. Stratigraphic and tectonic interpretation is continuing. Mapping on MARREE and KINGSCOTE is complete and the 1:250 000 maps are being finalised for publication.

Mapping on the ADELAIDE and BARKER 1:250 000 map areas continues to focus on the Kanmantoo Group and Delamerian igneous activity. The timing of the Delamerian Orogeny and associated mineralisation is being investigated by collaborative geochronology projects with ANU (timing of deformation and igneous events) and Adelaide University (dating of metamorphic minerals).

An AMIRA project at CODES on comparisons of synsedimentary mineralisation in the Zambian Copper Belt, Mount Isa and the Adelaide Geosyncline and Stuart Shelf is being supported.

Regolith

Regolith studies to assist exploration in the Gawler Craton continued in collaboration with the CRC on Landscape Evolution and Mineral Exploration (CRC LEME). An article on regolith geochemistry of the Challenger gold deposit was published. University collaborative projects on Challenger, Windabout Cu–Co prospect, Moonta copper mines and the Mount Lofty Ranges were completed. A workshop on 'Exploring Ancient Landscapes' was held in December 1999. Advice was given to industry on many aspects of regolith exploration.

A new collaborative project has commenced with CRC LEME, centred on the ET prospect and researching the effect of regolith on exploration, following a pilot study of five sites in the Gawler Craton. A preliminary regolith geochemistry and mapping study of part of the Olary (Curnamona Province) area will commence soon, also with CRC LEME.

Sutton Earthquake Centre

The largest earthquake for the year was on 18 August 1999 at Gladstone (MI 4.1). An isoseismal questionnaire was distributed for this event and a map is being produced. The number of earthquakes located (123 for June 1999 – May 2000) is again well below the average of the 1980s and early 1990s (300), but the number of magnitude 3 or greater events is about average at 14. The reason for this change in activity is not known. There were 26 events reported felt which is about average.

Partacoona Station seismograph has closed after 30-years operation. The seismograph has had a number of problems recently and the station manager has insufficient time to continue to operate it. This station has probably recorded more earthquakes than any other station in the State and it is likely that monthly numbers will drop a small amount until a suitable replacement is installed.

The Office of Minerals and Energy Resources is assisting in formulating the Australian and New Zealand Earthquake Loading Code, to become part of the next set of building standards for Australia and New Zealand. The Office also supported an Adelaide and Monash University project deploying an array of 40 seismographs across the Adelaide Geosyncline and Murray Basin. This is the last part of a three-year project modelling the crust and mantle from western Victoria into South Australia. The results will also be useful for locating local earthquakes more accurately.

MINERAL ASSESSMENT

Aboriginal liaison

Activities included Aboriginal heritage site clearances for TEISA drilling programs at Abminga and on the Gawler Craton, consultation regarding opal mining and maintenance of the access road at Lambina, facilitation of a land usage agreement at Oolgelima Creek northeast of Coober Pedy, consultation with traditional owners regarding exploration in Yumbarra Conservation Park, and assistance to exploration companies on Aboriginal heritage and Native title issues.

In the AP Lands, liaison included initiation of negotiations regarding the Mintabie town lease and a possible new opal mining area, gaining approvals for TEISA airborne geophysical and hyperspectral surveys, ongoing consultation to effect mineral exploration and mining access to AP Lands, and support to AP to help process outstanding mineral exploration licence applications and develop mining policy. John Keeling, Principal Geologist Industrial Minerals, was seconded to the Attorney General's Department as the PIRSA representative for negotiation of Indigenous Land Use Agreements (ILUA).

Company exploration

Assistance was provided to the exploration industry via information sheets, guidelines and verbal advice to facilitate mineral exploration. All guidelines and regulatory forms for exploration on mineral exploration licences are now available on the PIRSA Minerals website.

During 1999–00, 125 exploration licence applications were assessed and 258 renewals processed within an acceptable timeframe. Technical reports (geoscientific data) for over 300 exploration licences were processed for archiving or public release. Guidelines for submission of mineral exploration data in digital form were finalised for proposed official release in late 2000. These guidelines will facilitate industry submissions and access to exploration data. Procedures and systems will be put in place during 2000–01 for verification and storage of digital company reports and data.

A total of 105 exploration licence work approvals were processed, 85% within targeted time. Inspections and audits of selected exploration activities were undertaken to ensure that these were carried out to standards specified in guidelines and work approval conditions. During 1999–00, 71% of the mineral exploration sites inspected were in compliance and all non-compliance cases requiring corrective action were resolved.

Environmental monitoring —Yumbarra Conservation Park

The central portion of Yumbarra Conservation Park, ~30 km northwest of Ceduna, was reproclaimed in September 1999 to allow for exploration and mining activities. On 5 January 2000, Exploration Licence 2685 was granted to the Gawler Joint Venture (Resolute Resources Ltd and



Pantju Thompson (right), Director, and Tony Adamson, Executive Member, Anangu Pitjantjatjara, examining aeromagnetic data for the MANN map area. (Photo 47676)



Portion of Yumbarra Conservation Park. (Photo 47409)

Dominion Gold Operations Ltd). Exploration activities will be required to achieve stringent environmental outcomes set out as licence conditions (including those specified in the park proclamation) agreed to, and enforced by, appropriate officers of the Office of Minerals and Energy Resources and the Department for Environment and Heritage (DEH).

Government and company staff will be involved throughout the program to ensure that appropriate operational and rehabilitation methods are applied. Monitoring programs employed by the environmental consultant as required in the exploration licence conditions will be undertaken for the duration of exploration activity and, should the licence be relinquished, these will be maintained by PIRSA and DEH staff.

In February 2000, the Gawler Joint Venture carried out a detailed low-level aerial geophysical survey, flying at 40 m intervals 20 m above the ground. This was followed by an airborne electromagnetic survey in mid-July and a calcrete survey in early September after obtaining approval through a Declaration of Environmental Factors (DEF).

Yellabinna Regional Reserve rehabilitation project

The second and final phase of the Yellabinna Regional Reserve rehabilitation project was completed in June 2000. Restoration works included rehabilitation of old exploration sites which did not meet current rehabilitation standards. The project was carried out in response to a 1995 Department of Mines and Energy commissioned audit of mineral exploration impacts in the reserve area since proclamation in 1990.

This program was undertaken by private contractors and involved the use of ripping and scarification equipment. Work included removal of hard rubbish, filling in of sumps and excavations, removal of drill casings and closure of open drillholes, ripping and scarification of compacted areas associated with old camp and drill sites, and closure of access track entrances by ripping, signposting or disguising. Photopoints have been set up at a number of locations to monitor regeneration. In general, the tracks closed off were already in various stages of regeneration and it was not considered necessary to rip for long distances. Exploration companies can apply to re-open tracks for specific projects (through the DEF process) with the provision that these be reinstated on completion of the project to a condition which will facilitate regeneration. Some tracks earmarked for future closure are still in use by exploration companies and these will remain open.

Low impact exploration poster

A poster was prepared as an educational tool to assist stakeholders understand the exploration process and various types of low-impact exploration activity. The poster has been favourably received by industry and community groups; copies can be obtained from PIRSA Customer Services or as a downloadable file on the Minerals website (www.minerals.pir.sa.gov.au). Further posters relating to exploration drilling techniques and environmental management in mineral exploration are planned.

Mineral exploration rehabilitation implement

As a result of compliance monitoring activities and subsequent discussions with officers from DEH and industry representatives, an opportunity was identified where the Office of Minerals and Energy Resources could assist the mineral exploration industry by developing a ripping and/or scarification tool which could be towed behind a standard 4WD vehicle. This implement was successfully developed in 1998 and has been used by contractors and exploration companies throughout 1999–00 with encouraging results.

It is envisaged that the tool could reduce the need and cost of using heavy equipment in many cases, and enable rehabilitation to be done in a more progressive manner. Ongoing monitoring of site regeneration rates will be continued by the Office, and further trials and use by companies are encouraged. Two units are currently available from the Office for companies to trial (first time use is free for a maximum of one to two weeks) or hire at reasonable rates. For further information contact Neil Gray (ph. 08 8463 3118).

Commodity and deposit assessment

A major commodity review on iron ore in South Australia was published, and comprehensive reports on kaolin, the Uley graphite deposit and on porphyry occurrence in the Gawler Craton were also released. There was a major input into the publication of *Minerals South Australia 2000*.

Field investigations were undertaken in the Cowell jade province and Mintaro slate deposit to re-evaluate the respective resources. A comprehensive sampling program of stockpiles from all agricultural gypsum producers in South Australia was undertaken to assist in establishing standard product grading for the industry.

Gemstones

In 1999, Departmental geoscientists attended the first national Opal Symposium at Lightning Ridge, New South Wales, and gave a presentation on opal formation and exploration in South Australia. Outcomes from the symposium led to development of the first GIS database on opal for Coober Pedy and the production of a CD (May 2000) to assist opal miners and explorers. The CD has proven to be popular with miners and was used in locating exploration targets at Coober Pedy in June 2000 as part of the TEISA drilling at both Coober Pedy and Mintabie. The national Opal Symposium will be run every two years;



South Australia will host the second during 10–12 April 2001 at Coober Pedy. Further information can be found at www.opalsymposium.com.

GIS systems are currently being prepared for Mintabie and Andamooka to assist miners in exploration, and a fourth data package is planned for other opal areas in South Australia.

In August 2000, Senior Geologist Jack Townsend attended the 31st International Geological Conference in Rio de Janeiro, Brazil, and spoke at the Special Symposium on Gemstones on the geology and formation of Australian opal. This was followed by a field trip in the state of Minas Gerais visiting many gem-bearing pegmatites. The mines and gem localities included emerald, aquamarine, heliodor, quartz, alexandrite, tourmaline, amazonite and imperial topaz. Extended abstracts of the seven gemstone papers from the symposium are being printed in the *Australian Gemmologist* (Vol. 24).

Multiple land-use planning

Review and comment on various land planning and local council planning issues was undertaken; this included

compilation of significant reports on mineral potential of the proposed Gawler Ranges National Park on northern Eyre Peninsula and on gold potential of the Lady Alice and Lady Edith gold mines within proposed additions to the Para Wirra Recreation Park.

Contributions were provided for a consultant report for Planning SA on extractive industries and land-use planning, and significant resource planning input was provided on the proposed Mount Lofty Ranges Parkland Strategy.

Mineral potential mapping

Progress on MINDEP-SA, the mineral deposit database, has been reported under the TEISA program. Preliminary data sets are being collated as the first stage in development of a mineral potential map of South Australia.

MINERAL POLICY AND REGISTRATION

Administration

During the 1999–00 financial year, the PIRSA Minerals Policy and Registration Branch granted 144 exploration licences covering a total area of 98 593 km², 30 mining leases covering 495.84 ha and 105 mineral claims covering 5777.23 ha. In addition, applications for the renewal, transfer and surrender of tenements were processed, together with all precious stones tenement applications from the opalfield offices.

Three mining Native title agreements were registered pursuant to Part 9B of the *Mining Act 1971*, and one Environment Resources and Development Court determination authorising the grant of an extractive minerals lease was also registered. Twelve notices initiating negotiations with Native title parties pursuant to the Act were also served by various companies during this time.

Legislation

The *Mining (Royalty) Amendment Act 2000* came into operation on 1 July 2000 and amended the Mining Act by changing the 'assessed value' of a commodity on which royalty is determined from the delivered value to the ex-mine value.

The National Competition Policy Review of legislation, which commenced in 1999 to look at the provisions of all State mining legislation in terms of the Competition Principles Agreement between the State and Federal Governments, has resulted in a review paper being circulated to industry and relevant stakeholders for comment. Cabinet will be advised of any legislative amendments required as a result of this review process by the due date of 31 December 2000. The *Mining (Private Mines) Amendment Act 2000* came into operation on 1 September 2000, with the exception of section 73G which deals with the lodgement of mines operations plans which will come into effect on 1 March 2001.

The review of the *Opal Mining Act 1995* and Regulations thereunder is continuing, with comments on the Discussion Paper released in July 2000 being received.

Website

Further information sheets and a list of frequently asked questions have been uploaded onto the Web to provide a more comprehensive picture of South Australia's legislative regime and the rights of landowners, explorers and miners.

Electronic lodgement of applications

Funding has been given and tenders have been called for the introduction of electronic lodgement of exploration licence applications. Clients will be able to make application for licences and use online mapping tools to define the geographic location and extent of their tenement application. If this project is successful, the possibility of extending the electronic lodgement of applications to all other mining tenements will be investigated.

ANZMEC

Management of ANZMEC (Australian and New Zealand Minerals and Energy Council) business, including briefings for Ministerial Council and SCO meetings and preparation of submission, has continued.

MINING OPERATIONS

Compliance services

Mining operations must comply with the Regulations under the Mining Act and the Mines and Works Inspection Act to ensure that mining activities are carried out to acceptable standards. In addition, special conditions on mining tenements are designed to protect the environment from any adverse impacts of mining. All mines must be operated in accordance with an Approved Mining Program which includes mine plans, measures to ameliorate the environmental impacts created by mining, progressive and final rehabilitation, and mine closure.

Mining operations are inspected for compliance at regular intervals and prior to renewal, transfer, expiry or cancellation. The holders of mining tenements (except extractive mineral leases) are required to enter into a bond prior to commencing to ensure that the obligation to rehabilitate land disturbed by mining is satisfied. During the year, 58 mining programs were approved, 954 mining tenement inspections were undertaken, and 11 bonds totalling \$63 500 were lodged. Of the 954 operating mine and quarry sites inspected, 89% complied; 53% of the 107 which did not comply have been rectified.

Tenement assessments

Mining tenements are issued subject to a term and conditions designed to minimise nuisance and adverse environmental impacts and to ensure that land disturbed by mining operations is rehabilitated to an acceptable after-use.

The holder of a Miner's Right may, after serving appropriate Notice of Entry to the landowner, peg and register a Mineral Claim. The registration of a claim gives the holder an exclusive right for a period of 12 months to prospect and to make an application for a Mining Lease if an economic mineral deposit is found.

The PIRSA Tenement Assessment Section is responsible for ensuring that mining tenement applications are adequately assessed in accordance with requirements of the Mining Act. This includes determining the appropriateness of mining and rehabilitation proposals to describe the proposed operation, its feasibility, and appropriate after-use, any significant environmental concerns, and appropriate terms and conditions for the lease.

Pursuant to the Mining Act, the Minister in determining the granting of a tenement shall give proper consideration to the natural beauty and amenity of the area, flora and fauna, historical or Aboriginal items, or any other factor considered appropriate in the particular case. The Minister is required to invite comment from members of the public and to circulate the proposal to the landowner and council in the area. The proposal is also circulated to various Government departments for specialised advice.

In some instances, applications are referred to the Development Assessment Commission for consideration with reference to consistency with the planning objectives and principles of the relevant planning zone in which the application is located.

In the year ended 30 June 2000, of the 33 mineral tenement applications received, 32 were processed and one was refused. Included in the tenements were seven mineral leases, 19 extractive mineral leases, two miscellaneous purposes licences, 13 special approvals and three were withdrawn.

EARF Project Assessment Panel

Following Ministerial approval of the Extractive Areas Rehabilitation Fund (EARF) Guidelines in February 1998, a Project Assessment Panel was established, comprising membership from Government, SACOME and the South Australian Employers' Chamber of Commerce and Industry to assess large projects over \$100 000. The panel has assessed six major rehabilitation projects to date.



Revegetation at Brukunga Mine, 2000. (Photo 47556)

Brukunga Mine site

The Office of Minerals and Energy Resources is responsible for management of remedial operations at Brukunga, which include the ongoing operation of the water treatment plant to neutralise acid seepage intercepted before it reaches Dawesley Creek. Another 5000 trees were planted on the mine site during the year to continue the establishment of a vegetative cover over barren areas. In May 2000, the Geological Survey Branch completed a detailed study of metal levels in soil in the Dawesley–Bremer catchment. A further 6200 m² of sludge ponds, located on the historic tailings dam, were backfilled with rubble and top-dressed in preparation for vegetation. Trees will be established on the surface to complete the evapo-transpiration layer on the dam surface, which began with the construction of the treatment plant in 1980 and planting of the first trees in 1989.

The Brukunga Mine Site Remediation Board met on a monthly basis and provided time for public consultation and comment. A preliminary feasibility study into the practicality of diverting Dawesley Creek past the mine site was completed in August 2000. An assessment of options and a cost-benefit analysis are being examined to provide information for future directions.

SASE Project

On 10 February 2000, the South Australian Government paid the remaining \$750 000 to the SASE Project. This was an important milestone for the project enabling SASE Pty Ltd to finalise funding for the demonstration Ausmelt plant at Whyalla. Construction of the plant was completed in October 2000 and commissioning commenced in November. Data collected from the plant operations will be used to establish engineering and commercial parameters in the design of a commercial facility. The SASE Project proposes to use iron ore and coal resources located south of Coober Pedy to produce pig iron for export.

Beverley Mine

Considerable resources were expended in securing appropriate approvals for the Beverley uranium mine. Following the granting of the mining lease in April 1999, a mining and rehabilitation program comprising seven supplementary mining plans was approved in October 2000. In addition, approval under the Code of Practice of the Management of Radioactive Waste for the Mining and Milling of Radioactive Ores was approved on 6 October.

Negotiations are continuing for finalising the environmental management and monitoring program, establishing an environmental monitoring committee, and establishing an appropriate surety for the project.

Olympic Dam operations

The \$1.94 billion dollar expansion of the Olympic Dam mining and processing operations was completed during the financial year. The expansion incorporated key features such as a third haulage shaft, a new smelter complex and acid plant, expansion of the copper refinery facility and new hydrometallurgical plant. The expansion also required an extension to the tailings retention system. Mining Operations Branch was required to inspect and give approvals for construction and operation of the facilities.

Mining Operations personnel were informed of the fire in the SX plant in December 1999, and approved a new development plan for quarry operations on the special mining lease.

Several meetings of the Olympic Dam Environment Consultative Committee, comprising State, Commonwealth and company representatives, were convened during the year.

Port Pirie tailings dam

Mining Operations Branch, with assistance from Crown Law, has commenced negotiations with Pasminco for a lease over the Port Pirie tailings dam site and to complete a long-term rehabilitation plan.

Penrice

Mining Operations Branch held two meetings of the Penrice Consultative Committee in accordance with regulatory requirements under the Penrice Crown Agreement.

Leigh Creek

Mining Operations Branch approved revised mine rehabilitation plans for the old mined out areas at Lobes C and D to assist consultants acting for the State Government to quantify the cost and future rehabilitation risk for potential buyers of the Leigh Creek Mine. Mine and rehabilitation plans were also revised, submitted and approved for Lobe B.

Opalfields

The principal roles of Mining Operations Branch opalfields staff are to administer and regulate opal mining in the State, and provide professional advice to Government, industry and the community on matters relating to opal mining. The staff also assist in maintaining law and good order in the fields by ensuring that tenement holders work in accordance with legislative requirements. This is achieved by conducting tenement inspections for compliance with the provisions of the Opal Mining Act to ensure that lease posts are in place and maintained and that the registered tenements are being worked for 20 hours/week.

During the financial year ended 30 June 2000, 5371 inspections made in the four opalfields found that 324 tenements were improperly pegged and/or pegs did not contain registration data as required by opal mining legislation. Required labour conditions were not adhered to on 223 tenements and were therefore not in compliance with opal mining legislation.

Letters requesting compliance in 28 days were sent to the tenement holders and a series of second inspections revealed that compliance was achieved on 362 tenements. Tenement pegs were confiscated where compliance requests were ignored.

At the Lambina opal diggings, 209 rehabilitation inspections were conducted to ensure compliance with Article 8 of the Native Title Mining Agreement. Interest in the new diggings remains relatively high and at 30 June 2000 there were 289 registered tenements, comprising 22 at Broken Leg diggings, 266 at Seven Water Holes and one at Stutley's Ridge.

During the 1999–00 financial year, the opalfield offices issued 1229 precious stones prospecting permits (PSPP), and registered 13 opal development leases ($200 \times 200 \text{ m}$), 160 extra large opal mining claims ($200 \times 100 \text{ m}$), 1437 large claims ($100 \times 100 \text{ m}$) and 390 small claims ($50 \times 50 \text{ m}$). The offices processed 985 registration renewals and 730 cancellations of unwanted registered claims, together with 126 permits to miners for the purchase of explosives.

2000-01 PROGRAMS

MINERAL RESOURCES GROUP AGREED MILESTONES

Outcome 1: more accessible land

Strategy 1: Take an active role in the negotiations for ILUA.

• continue to participate in the ILUA Negotiating Team.

Strategy 2: Take an active role in facilitating resolution of Aboriginal heritage issues affecting the exploration and mining industry.

- commence development of a register of sites of significance to Aboriginal culture
- ensure accreditation of South Australia's Aboriginal heritage legislation by the Commonwealth
- actively participate with the Division of State Aboriginal Affairs in developing Aboriginal heritage legislation as well as the processes and procedures for Aboriginal site avoidance.

Strategy 3: Actively liaise with Aboriginal landowner groups in South Australia on the mineral industry, to advance and maintain access to Aboriginal-owned lands for mineral exploration and development.

- formation of the AP Mining Committee
- complete Exploration Guidelines in AP Lands manual
- update 5-year strategic plan for exploration and development in AP Lands
- presentation of TEISA aerial geophysical data to AP
- commence negotiations with AP on TEISA Year 4 programs
- complete new agreement on Mintabie town lease
- complete negotiations on a new opal mining area west of Mintabie.

Strategy 4: Review and improve processes for exploration and mining approvals and procedures to gain stakeholder acceptance of processes.

- formalise PIRSA–DEH arrangements for approval and compliance for low-impact exploration activity in parks and reserves, including a Memorandum of Understanding (MoU)
- establish criteria to determine 'low', 'medium' and 'high'-impact exploration and mining, and consequent procedures and levels of assessment
- establish a database for Environment Protection and Biodiversity Conservation (EPBC) Act referrals and determinations
- finalise guidelines for minimising environmental impacts of mining and quarrying.

Strategy 5: Maintain the framework for Government multiple land-use policy.

- establish key links with planning agencies and key interest groups
- revise the consultative and response process on planning issues
- review resources and future demands for metropolitan construction materials
- complete a 'planning bulletin' for extractive industries
- complete a MoU with Planning SA about impact assessment for mining
- keep under review land access and land availability issues
- develop guidelines for assessment of new parks and reserves proposals to provide for mineral exploration and development where appropriate
- establish a multiple land-use database.

Strategy 6: Provide accurate and timely advice on land access issues to all our customers and stakeholders.

• answer all enquiries accurately and within agreed timeframes.

Outcome 2: effective and efficient regulation

Strategy 1: Ensure that legislation is relevant, transparent, and provides for accountability and certainty within the principles of Ecologically Sustainable Development (ESD).

- commence a review of the entire Mining Act, including consultation with relevant parties
- complete National Competition Policy (NCP) review of the Mining Act
- passage through Parliament of updated Native title legislation
- active participation in improving Aboriginal land rights legislation
- complete the review of the Opal Mining Act.

Strategy 2: Ensure that administrative processes and procedures are accessible, effective and easily understood for implementation of the legislation.

- ensure that facilities for electronic lodgement of exploration licence applications are in place
- · review and update all processes and procedures
- process all new, renewed, transferred and surrendered mining tenements within agreed timeframes
- process all joint venture and other agreements within agreed timeframes
- · maintain the Mining Register and associated databases
- · collect royalties.

Strategy 3: Ensure compliance and enforcement of legislation.

- inspect precious stones and mineral tenements on a regular basis to ensure compliance
- inspect all tenements at least six months prior to expiry date
- ensure that every operating mine and quarry has a current approved development plan, mine operation plan, or mining and rehabilitation program
- develop and maintain a database to monitor compliance with tenement conditions
- establish a database of approvals, authorisations and notifications for each uranium mine
- establish a policy and procedure for requiring and setting bonds.

Strategy 4: Provide accurate and timely advice on mining legislation issues to all our customers and stakeholders.

• Answer all enquiries accurately and within agreed timeframes.



Ore face, Iron Prince open pit, Middleback Range. (Photo 47677)

Outcome 3: enhanced understanding of the State's geological framework and mineral resource potential

Strategy 1: Acquire and add value to geoscientific data in targeted areas.

- complete the TEISA pilot stratigraphic drilling in the northern Murray Basin
- complete the data packages on Callabonna Sub-Basin, northern Murray Basin and area covered by the Lindsay Palaeochannel which drains the Musgrave Block
- complete the airborne hyperspectral survey of the WOODROFFE map area, Musgrave Block
- complete the airborne magnetic-radiometric survey of MANN and ALBERGA, Musgrave Block

- complete the airborne EM survey over the Gawler Craton
- complete the new release of the State gravity database
- complete the new release of the State magnetic image
- complete the new release of the State radiometric image
- complete the TEISA Gawler Regolith Project, including detailed geochemical study of ET prospect and appraisals of Golf Bore, Monsoon, Jumbuck and South Hilga prospects
- complete gravity and ground magnetic surveys, and drilling program for Black Hill Norite
- progress the Padthaway Ridge and Murray Basin basement solid geology interpretation
- complete the geological mapping of the following 1:25 000 map areas in the Olary Domain (mapping at or better than 1:25 000 scale) — Radium Hill South, Radium Hill North, Outalpa North, Outalpa South and part Bulloo South
- complete the Curnamona Province 1:500 000 geological map in conjunction with New South Wales Department of Mineral Resources
- publish 12 articles on selected results of the BHEI in the MESA Journal
- formalise Willyama Supergroup lithostratigraphy for the Olary Domain, including characterisation of the 'Bimba formation'
- develop the use of digital ortho-imagery in conjunction with airborne radiometric and magnetic data sets to become a standard tool for geological mapping in the Olary Domain and in other highly metamorphosed terrains
- compile and interpret recently acquired geochronology for the Olary Domain
- undertake detailed gravity surveys on selected key areas of the Gawler Craton in collaboration with AGSO
- complete greenstone drilling program in the Gawler Craton and submit samples for analysis
- complete an interim GIS data set for the Andamooka area of the Olympic Subdomain, including reinterpretation of basement geology (AGSO)
- complete a GIS data set for selected prospects within the central Gawler Craton, including reinterpretation (AGSO)
- complete interpreted solid geology map for key 1:100 000 map areas in the Mulgathing Complex (AGSO).

Strategy 2: Develop new and improved exploration models and techniques.

• complete the final report on models for mineral exploration in Tertiary palaeochannels draining the northwestern Gawler Craton

- progress sequence stratigraphic modelling of the Gambier Basin
- complete data entry in MINDEP and preliminary prospectivity modelling report for the Kanmantoo Trough.

Strategy 3: Assess the prospectivity of targeted commodities in targeted areas.

- complete a report on agricultural gypsum sampling and standards to assist gypsum producers position their products in line with the new regulations
- complete reports on Mintabie opalfield drilling and Abminga bedrock drilling.

Strategy 4: Maintain a framework of geoscientific information and knowledge to provide quality and timely advice to our stakeholders on all aspects of the State's geology.

- complete the following 1:250 000 geological maps to digital plot for release to customers — OOLDEA, MARREE, CALLABONNA, MAITLAND, CHILDARA and LINCOLN (mapping at better than 1:100 000 scale)
- progress geological mapping of WINTINNA
- complete the digital lithostratigraphic maps of Clare, Apoinga and Spalding 1:50 000 geological map areas (all on BURRA; mapping at 1:40 000 scale)
- complete the LINCOLN, MAITLAND and CHILDARA manuscripts for publication — explanatory notes and GIS packages
- complete the third edition of the Tertiary palaeochannel map of South Australia
- complete a geological information brochure on the Oodnadatta Track
- complete a review of uranium in South Australia
- complete an update of brochures on magnesite, gypsum, gold, copper, and coal in South Australia
- complete a report on Cowell jade, including revised resource data
- achieve 80% completion of compilation of South Australia's mineral occurrences into MINDEP-SA
- bi-annual updates of a CD of the State GIS package
- 2000 drillholes entered onto the SA_Geodata database
- 4000 petrographic slides entered onto the SA_Geodata database
- new Special Region GIS package prepared for the Musgrave Block and Adelaide Geosyncline
- complete field observations support infrastructure for field portable data recorders
- complete the infrastructure for digital submission of company reports

- complete draft versions of the new State tectonics (including solid geology) and basins maps
- maintain and extend the seismic events database to fulfil government, industry and community requirements
- complete the input into a proposed Australian and New Zealand Earthquake Loading Code (to be part of the Building Code of Australia)
- complete a report and paper on the Rathjen Gneiss (Angaston 1:50 000)
- complete an interim tectonic map (1:1 000 000) for the Gawler Craton (AGSO)
- answer all enquiries within agreed timeframes.

Strategy 5: Improve access to, and delivery of, geoscientific information.

- incorporate the Biostratigraphy Database into SA_Geodata
- progress the MINDEP database by testing the screen online, compiling a user guide, and ensuring compliance with national geological attribute data standards
- complete GeoServer pilot projects prototyping ArcIMS and Image Web Server
- complete the Minerals Exploration Tenement Application module of GeoServer
- scope and design the Mining Industries GeoServer
- complete the database documentation of SA_Geodata
- complete the Landsat TM meta-database



Field checking the War Loan copper deposit in the Peake and Denison Ranges for the MINDEP database. (Photo 47679)

- prepare a confidential database for company geophysical data sets (gravity, magnetics, radiometrics)
- update the meta-database of company geophysical surveys on open file
- continue to provide high-quality data at minimal or no cost to industry.

Outcome 4: accelerated development of the State's mineral resources

Strategy 1: Ensure that the Mineral Resources Group operates as One Window into Government (OWIG) for mineral resource development.

- develop a Cabinet submission for endorsement of the OWIG approach
- identify areas of Government in which the Group can provide OWIG to industry
- negotiate agreements with appropriate agencies
- develop and implement procedures.

Strategy 2: Ensure efficient facilitation of mineral projects.

- identify and broker early stage collaborative arrangements for mineral resource development projects
- enhance the probability of project success by facilitating public sector support of Yumbarra, Honeymoon, Murray Basin mineral sands, Uley graphite, SASE and SAMAG
- establish a benchmarking system to ensure that project facilitators have sufficient training and knowledgeparticipate in implementing recommendations of the Murray Basin Infrastructure Report.

Strategy 3: Identify and enhance the competitive advantages of South Australia for mineral investment.

- continue to compare South Australia's business environment for mineral development with that of our competitors
- upgrade the Mineral Resources Group laboratory to improve safety standards and increase sample output
- facilitate formation of the Resources Industry Development Board
- provide active support of, and interaction with, the Resources Industry Development Board.

Strategy 4: Promote community understanding and support for the mineral resource industry

• develop a Public Awareness Plan and implement milestones agreed for June 2001.

Strategy 5: Provide advice on mineral development issues to all our customers and stakeholders.

• respond to all enquiries accurately and within agreed timeframes.

Outcome 5: improved perception of the State's prospectivity

Strategy 1: Develop, implement and continually review a marketing plan to promote South Australia's mineral prospectivity and competitive advantage.

• develop a Minerals Marketing Plan and implement milestones agreed for June 2001.

Outcome 6: effective and efficient use of public funds

Strategy 1: Improve Government efficiency by providing authoritative strategic and policy advice to the Government on 'Whole of Government' issues relating to mineral resource exploration and development issues.

- identify significant market failures and advise the Government on response options
- answer all enquiries accurately and within agreed timeframes.

Strategy 2: Increase the State's competitive edge in Commonwealth–State negotiations by promoting better understanding by State and Federal Governments of South Australia's mineral prospectivity and related development potential.

- advise the Government on all relevant mineral resource and related issues affecting South Australia
- answer all enquiries accurately and within agreed timeframes.

Strategy 3: Maximise benefit to our customers and stakeholders by promoting Mineral Resources Group services and expertise.

• develop a Mineral Resources Group promotions plan and implement milestones agreed for June 2001.

Strategy 4: Maximise the use of available expertise and funds through collaborative arrangements.

- take advantage of public sector opportunities and initiatives that may benefit mineral resource development
- identify, participate in and/or communicate opportunities and initiatives for collaborative activities within the public sector and between public and private sectors relating to mineral exploration and development.

Strategy 5: Ensure a highly skilled, motivated, customer-focused workforce that operates safely and efficiently within the human, physical and financial resource allocation.

- develop a formalised induction process, and implement for all new and transferring staff
- develop a training plan that provides staff opportunity for further development
- complete performance reviews of all Mineral Resources Group staff, and implement action items within agreed timeframes
- complete an annual self-assessment process and implement action items within agreed timeframes
- undertake annual customer surveys on Group performance
 - provide an on-line facility for continuous feedback from our customers
 - actively maintain open communication with our customers
 - implement action items contained in the Group PIRSAFE and Injury Management Action Plan by the agreed target completion dates
 - revise the Group strategic plan, incorporating performance measures
 - align individual, team and Branch work plans with Group strategies (as per the strategic plan)
 - develop a budget to reflect the work plans and Group strategies that can be achieved within the annual financial resource allocation
 - minimise variance between budgeted and actual expenditure for the Group.



Drill site at Barns gold prospect looking north towards the proposed Gawler Ranges National Park, northern Eyre Peninsula (Photo 47678)



Ocean Epoch offshore rig drilling Sophie Jane 1, Otway Basin, 1995. (Photo 44145)

SECTION 2: SOUTH AUSTRALIA'S PETROLEUM INDUSTRY

COMMODITIES

GAS

Gas was discovered in the Cooper Basin in the Permian section in Gidgealpa 2 in 1963 and three years later the giant Moomba gasfield was discovered. The decision to generate the bulk of South Australia's electricity from natural gas ensured the economic viability of constructing and operating the Moomba–Adelaide Pipeline, and gas was first supplied to Adelaide in 1969 and to Sydney in 1976. Over one million residential, commercial and industrial customers in South Australia, New South Wales, Australian Capital Territory and recently Victoria are supplied from South Australia (Fig. 2.1). A total of 153 gas fields had been discovered in the South Australian portion of the Cooper Basin at 1 January 2000; Santos estimate remaining reserves as 2280 petajoules (PJ) of sales gas and 284 PJ of ethane.

Gas from individual wells passes via field gathering systems to field satellite stations which separate gas, free water and condensate. This gas passes through trunklines to the central Moomba Plant where it is processed. Gas is also supplied into South Australia from the South-West Queensland portion of the Cooper Basin and processed at Moomba. The Moomba Plant has been designed to process 25.4×10^6 m³ (902 mmcf) of raw gas per day. The plant operates at close to maximum capacity during the year, with processed sales gas being stored underground in the Lower Daralingie Beds in times of low demand. This gas is removed from storage and produced during times of peak demand.

Ex-field natural gas prices in South Australia are freely negotiated between buyer and seller. Ex-Moomba plant natural gas prices from the Cooper Basin are currently in the order of \$2.50/gigajoule (Fig. 2.2).

In the Otway Basin in the South-East of the State, five gasfields have been discovered and total resources are estimated at 100 PJ. Gas from Katnook has been supplying local domestic and industrial users since early 1991 and the current annual sales gas production rate is 2.5 PJ (Fig. 2.3). A pipeline network and processing plant gathers and treats the raw gas. Minimum processing occurs and sales gas is sold out at the pipeline outlet from the Katnook Plant. Additional quantities of low quality Ladbroke Grove gas are used to power two 40-megawatt (MW) gas turbines installed in early to mid-2000.

As a consequence of the gas reform process in Australia, regulatory policy impediments to the free trade in gas are being removed, rights of access to gas transmission and reticulation pipelines have been provided, and direct negotiations between consumers and producers have been facilitated.



Fig. 2.1 Gas and liquids pipelines in Australia.

Existing contracts with the South Australian and **Oueensland** Cooper Basin Producers supply the State's needs in full until 2004, and partial needs to 2013, and declining quantities to New South Wales until 2006. Demand in New South Wales is forecast to exceed current contracted quantities after 2001. The Australian Gas Association predict that gas will be the fastest growing energy source in Australia to 2030, with an annual growth of 3% predicted. Natural gas currently supplies around 18% of Australia's primary energy needs, and the Australian Gas Association predict this will increase to 28% by 2030. Their study of future Australian gas supplies and demand forecasts that gas reserves in southern and eastern Australia will be insufficient to supply market demand within the decade.



Fig. 2.2 Average gas price at Moomba gate.



Fig. 2.3 Gas sales.

OIL AND GAS LIQUIDS

The first Cooper Basin oil was discovered in Tirrawarra 1 in 1970. Eromanga Basin oil was discovered in 1977 with an uneconomic flow from Poolowanna 1 (Poolowanna Trough) and the first economic oil flow was recorded from Strzelecki 3 in the following year. In order to market newly discovered oil and existing gas liquids, the Cooper Basin Liquids Project was initiated in 1980 and completed in stages from 1982 to 1984 at a cost of \$1.4 billion. The project involved the construction of a high vapour pressure liquids pipeline from Moomba to a processing plant and storage and loading facilities at Port Bonython, as well as field development, oil collection and crude stabilisation facilities at Moomba.

Shipments of crude oil and condensate commenced in 1983 and liquefied petroleum gas (LPG) handling facilities were commissioned in July 1984. The establishment of these facilities enabled the Cooper Basin Producers to bring the 'wet' gas reservoirs into production, which further enhanced production flexibility. Due to the added value of LPG and condensate to the sales gas price production priority is given



Tirrawarra oilfield satellite, Cooper Basin, 1993. (Photo 43356)

to the fields richer in these components. A typical Cooper Basin wet gasfield contains 100 t of LPG and 200 kL of condensate/ 10^6 m³ (34 and 32 bbl/mmcf respectively). A typical 'dry' gasfield contains 2.0 t of LPG and 22 kL of condensate/ 10^6 m³ (7 and 4 bbl/mmcf respectively). In 1991 condensate production from Port Bonython was replaced by a full range naphtha, which has a greater market value. Annual sales are shown in Figures 2.4–2.6.

A free market was introduced in 1988 for all oil and condensate produced in Australia. There is no restriction on imports or exports of crude oil or refined petroleum products. A similar regime has applied since 1991 for LPG. Markets for crude oil and condensate exist in South Australia and Australia and low sulphur light crude oils find a ready domestic and overseas market.

ETHANE

Approximately 7% of the total ethane entering the Moomba plant is consumed as fuel at Moomba or Port Bonython. Approximately 25% of the ethane remains in the sales gas stream after liquids extraction processing and the bulk of the remainder is used to supply ICI via a pipeline to Sydney.



Fig. 2.4 Crude oil sales.



Fig. 2.5 LPG sales.



Fig. 2.6 Condensate sales.

CARBON DIOXIDE

Commercial amounts of carbon dioxide were discovered in the Otway Basin in the Caroline 1 petroleum exploration well in 1967, which has been on production since 1968. Isotopic studies indicate that the carbon dioxide originates from a volcanic source. Caroline 1 ranks as the most productive well in South Australia (in terms of value of product) with approximately \$217 million of liquid carbon dioxide being produced since 1968 (Fig. 2.7). It is transported by road tanker to supply soft drink, firefighting, medical and other industry markets in Melbourne and Adelaide.

GEOTHERMAL ENERGY

The *Petroleum Act 2000* which came into effect in September 2000 allows the offering of exploration and production licences for exploitation of geothermal energy from hot dry rock — a first for South Australia. Although the technology to exploit this greenhouse-friendly resource has not yet proven commercial, areas underneath the Cooper Basin in the northeast of the State have been identified as the most suitable in Australia for hot dry rock geothermal energy and the Government has offered three areas for geothermal exploration (Fig. 2.8).



Fig. 2.7 Carbon dioxide sales, Caroline 1.



Fig. 2.8 Cooper Basin acreage release blocks.

COAL SEAM METHANE

Following on success achieved in the United States in producing methane from low rank coal, interest has been shown by a number of companies in applying this technology to South Australian coal basins, particularly the Tertiary coal deposits north and east of Adelaide, the Permian Arckaringa Basin coal deposits, the Kingston coal deposit in the South-East and in the southern Cooper Basin (Fig. 2.10).

COMPANY EXPLORATION AND DEVELOPMENT ACTIVITY

ONSHORE

The number of petroleum exploration licences (PELs) and licence applications is at an all time high (Fig. 2.9), with over 75% of the State's prospective areas covered (Figs 2.10, 2.11).

Seven applications totalling 42 800 km² are being held pending resolution of Native title issues in the western Eromanga Basin. PEL 49 is subject to its final renewal and expires in mid-2001, and adjacent PEL 50 will be subject to a 50% relinquishment in mid-2001.

The Officer Basin has one area under application within freehold Aboriginal land. An access agreement is being negotiated in order for the licence to be granted. An Officer Basin land access and petroleum acreage promotional policy will be developed by Petroleum Group over the next year.

Two areas are being held under application in the Arrowie Basin over Lakes Torrens and Frome following the expiry of PELs 45 and 51, subject to resolution of Native title issues. PEL 41, which lay between these two areas over the Flinders Ranges, expired on the 18 February 2000.



Fig. 2.9 Petroleum exploration licences, including applications.

PEL 73 covering an area of 613 km² in the onshore Stansbury Basin was granted in June 2000, and applications for surrender of PELs 53 and 59 covering the offshore and southern parts of the basin are being processed.

In the Otway Basin, two tenements have been renewed this year — PEL 32 (area is now 530 km² following compulsory relinquishment of 50% of the licence in February 2000) and PEL 27 (area is now 240 km² following compulsory relinquishment of 50% of the licence also in February 2000). PEL 76 was cancelled for non-performance of the work program and PEL 62 expired on 2 November. Vacant Otway acreage resulting from the relinquishments, previous licence expiries and cancellations were offered in the OT2000 acreage release and three new licences will be offered as a result.



Drillstem testing Redman 1, with gas flare in the background, Otway Basin, 1998. (Photo 45902)

There are 163 petroleum production licences in place and a number being processed with all but three in the Cooper and Eromanga Basins. The three are in the Otway Basin over Katnook – Ladbroke Grove – Haselgrove gasfields, the Redman gasfield and the Caroline carbon dioxide field. The area under production licence in South Australia is 8899 km^{2,} and a further 1252 km² is under application.

A 14 km natural gas pipeline (Pipeline Licence (PL) 12) was commissioned in July 2000 to supply the Beverley uranium mine with gas from the Moomba–Adelaide Pipeline (PL 1). It is owned and operated by Heathgate Resources. The Moomba–Adelaide Pipeline was duplicated at three sections by Epic Energy and the Riverland Pipeline was extended by Envestra Energy from Berri to service towns in Victoria, including Mildura (PL 11).

Onshore exploration in South Australia has comprised $\sim 40\%$ of the total Australian onshore exploration over the



Fig. 2.10 Pre-Tertiary sedimentary basins of South Australia.



Fig. 2.11 Petroleum tenements in South Australia, November 2000.

last few years, but this dropped to ~24% in 1999 largely as a result of the expiry of PELs 5 and 6. South Australian exploration and appraisal drilling activity levels are expected to increase in 2001 once Native title issues are resolved and new licences can be issued (Fig. 2.12). Since 1964, the total petroleum industry investment in this State in today's dollars is \$10.4 billion, comprising \$4.2 billion operating expenditure, \$4.3 billion capital expenditure and \$1.9 billion exploration expenditure, concentrated largely in the Cooper Basin (Fig. 2.13).

Petroleum royalty payments to the State were \$43.2 million dollars from total sales of \$677 million in 1999 (Fig. 2.14), bringing the cumulative royalty paid to \$929 million and cumulative sales to \$16 750 million in today's dollars. Royalties in 2000 are forecast to exceed \$58 million. The first petroleum royalty payment (for carbon dioxide) was made in 1968 and the first royalty for natural gas was paid in 1970. It is anticipated that the billionth petroleum royalty dollar will be paid in late 2000. Since



Fig. 2.12 Exploration and appraisal drilling in Australia and South Australia.



Fig. 2.13 Exploration, operating and capital expenditure.

1991, the average royalty paid equals 6.9% of the sales value of the petroleum.

South Australian exploration and appraisal drilling fell from 45 wells in 1998 to 12 in 1999 (Fig. 2.15). Santos expected to drill seven exploration wells in 2000 in the Cooper Basin and had drilled four at 31 November (Fig. 2.16). One exploration well was drilled in 2000 in the Otway Basin and up to three wells are possible in 2001. The amount of seismic lines recorded in South Australia also declined in 2000, again largely as a result of the expiry of PELs 5 and 6 (Fig. 2.17). A total of 22 line kilometres of two-dimensional (2D) seismic and 214 km² of three-dimensional (3D) seismic have been acquired in the Otway in 2000.

Development drilling in the Santos Joint Venture production licences in the Cooper Basin increased in 2000 and nearly \$400 million was budgeted for Joint Venture development expenditure, up from \$330 million in 1999.



Fig. 2.14 Petroleum sales and royalty payments.



Fig. 2.15 Exploration, development and appraisal drilling statistics.



Fig. 2.16 Petroleum tenements and drilling activities in the Cooper Basin, November 2000.

Twenty-six wells were proposed for 2000 compared to 12 in 1999, however, at 31 November 2000, 37 development and two appraisal wells had been drilled. A total of 644 km² of 3D seismic has been acquired by the Santos Joint Venture in 2000, with 167 line kilometres of 2D seismic.

A reserve summary for the Cooper Basin is shown in Table 2.1. Looking at the future, the petroleum potential of the State is considered to be at least as significant as discoveries made to date. The State's total recoverable reserves of raw gas were $235.0 \times 10^9 \text{ m}^3$ (8.3 tcf), of which $135.9 \times 10^9 \text{ m}^3$ (4.8 tcf) has been produced; and total recoverable reserves of oil totalling 20.7 x 10^6 kL (130 mmbbl), of which 17.0 x 10^{6} kL (107 mmbbl) has been produced. Estimates are that there is an even chance that a further 1520 PJ (40.6 x 10^{9} m³ (1.4 tcf)) will be discovered in conventional structures in the Cooper Basin (i.e. equivalent to over nine-years supply at current production rates). The Otway and Bight Basins in particular are also considered to have significant potential, as do the extensive Cambrian and older sequences.

In the longer term, huge reserves of gas in low permeability rocks exist (e.g. in the Nappamerri Trough area of the Cooper Basin) and Santos have committed significant funds to investigating this potential. Expenditure in the Nappamerri Trough (Petroleum Production Licences 101–117) was reported by Santos as \$10.2 million for the first two years of an initial six-year term commencing in November 1997. The committed amount is \$50 million over the initial six-year term of the licences.

Cooper Basin

Opening up Australia's largest onshore oil and gas province, the Cooper Basin has attracted national and international interest. A phased acreage release program commenced around the expiry of Santos' exploration licences in the region in February 1999 (Fig. 2.8).

The first Cooper Basin bidding round commenced in October 1998 when 11 blocks flanking the Cooper Basin were released. Applications closed in March 1999 and 41 bids were received. This keen bidding resulted in six

Table 2.1	Cooper	Basin	remaining	reserve	summary,	1	January
2000 (cou	rtesy Sa	ntos).					

Commodity	Reserves
Sales gas	2282.2 PJ
Ethane	284.5 PJ
LPG	8.0 x 10 ⁶ kL (50.4 mmbbl)
Condensate	5.3 x 10 ⁶ kL (33.3 mmbbl)
Oil	3.8 x 10 ⁶ kL (24.1 mmbbl)



Fig. 2.17 Seismic statistics (includes 3D source kilometres).

consortia proposing to invest a total of \$45 million during the first five years.

The second round of eight core Cooper Basin blocks was released in April 1999. Applications closed in November 1999 and 47 bids were received resulting in seven consortia investing a total of \$110 million during the first five years.

Bidding for the first batch of five third round blocks (CO2000-A to E) closed on 29 June 2000 and 11 bids were received from a total of five applicants. The winning bids contain work program commitments of \$10 million. The second batch of blocks (CO2000 F–H) closed on 28 September and twenty-one bids were received. The winning bids contained work program commitments of \$58 million. Bidding results are summarised in Table 2.2.

This brings to 27 the number of new petroleum exploration licences which will be offered in the Cooper Basin. The winning bids in the three rounds contain guaranteed commitments of more than \$244 million of investment in the region over the next five years (Table 2.3). A total of 120 bids were lodged by 27 different consortia during the three-year acreage release program. Of the different applicant consortia, only 12 had previously explored for petroleum in South Australia. This broad mix of local, interstate and international companies will bring new ideas and exploration concepts to Australia's premier onshore petroleum province.

Otway Basin

The Katnook gasfield, south of Penola, was discovered in 1987 by Ultramar and was the first commercial gas discovery in the South Australian part of the Otway Basin. Follow-up drilling confirmed sufficient reserves to justify construction of a pipeline by the Natural Gas Pipelines Authority of South Australia (now EPIC Energy) to local markets in 1990. Commercial development of the field by Sagasco (now Origin Energy) who acquired Ultramar's



Vibroseis geophysical survey in an Otway Basin pine forest, 1999. (Photo 47562)

Bidding round	Number of bids	Total \$m guaranteed	Total \$m bid	Total wells guaranteed	Total wells bid
Round 1	41				
Total bid		38	139	29	130
Total winning bids		22	45	20	58
Round 2	47				
Total bid		239	369	147	259
Total winning bids		84	110	44	75
Round 3	32				
Total bid		251	294	228	262
Total winning bids		69	79	53	61

Table 2.2 Summary of Cooper Basin bidding round results.

Company/consortia	Number of blocks won	Blocks won	Expenditure (\$m)	e bid	Wells bid	
			Guaranteed	Total	Guaranteed	Total
Amity Oil, Dan A Hughes, Tri-C Resources	1	CO99-F	7	14	4	8
Australia Crude Oil Co.	4	CO98-A, CO98-B, CO98-D, CO2000-D	3	12	2	8
Australian Canadian Oil Royalties, Ely Sakh	ai 3	СО2000-А, СО2000-В, СО2000-Е	4	7	3	7
Beach Petroleum	2	CO98-G, CO2000-D	7	11	4	7
Beach Petroleum, Magellan Petroleum (NT)) 2	CO98-I, CO98-J	7	10	6	9
Boral Energy Resources	1	СО99-Е,	17	25	8	12
Liberty	2	CO98-C, CO99-A,	4	6	5	7
Santos	3	CO99-G, CO2000-G, CO2000-H	66	66	42	42
Strike Oil, Australian Gasfields	1	CO98-K,	1	5	3	6
Stuart Petroleum	4	CO98-E, CO98-H, CO99-C, CO2000F	31	35	27	51
Tyers Investments	2	CO98-F, CO99-H,	7	21	6	15
Vernon E Faulconer Australia	2	CO99-B, CO99-D,	12	32	7	22
TOTAL			166	244	117	194

Table 2.3	Winning	hidders	and	summarv	ot	their	hids
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interests progressed with the construction of the Katnook Gas Plant, which commenced production in 1991.

Since the original discovery at Katnook, commercial quantities of gas have been discovered in the neighbouring Haselgrove and Redman Fields. This gas is also processed through the Katnook Plant and requires minimal processing to yield sales gas. Condensate produced is stored on site before being trucked to the Port Stanvac refinery.

Low quality gas has also been discovered in the Ladbroke Grove gasfield, and has found a commercial use in electricity generation at the Ladbroke Grove Power Station. Opportunities created for small power stations in the more competitive electricity market, and the strategic location of the field adjacent to the main electricity link between Adelaide and Victoria, led to Origin Energy seeing an opportunity to make the Ladbroke Grove Field commercial by using the gas to fire a 40 MW power station which began supplying power into the national electricity grid in January 2000.

The power station utilises an advanced turbine design capable of burning the low quality gas. A second turbine was added in May 2000 boosting generating capacity to 80 MW. With both turbines operating, annual production is estimated to exceed 4 PJ of gas per year. The total investment in the electricity development project by Origin is about \$65 million.

The local South-East gas market has grown significantly since 1991, from 1.5 PJ/year to over 2.5 PJ/year in 1999, compared to 154 PJ of South Australian Cooper Basin gas sold in 1999. The main gas customers are Kimberly Clark near Millicent, where gas replaced the use of LPG and

brown coal briquettes, the Safries potato chip factory near Penola, which was attracted to the area by the natural gas supply, and domestic and industrial customers in Mount Gambier, which were previously supplied tempered LPG via a reticulation network.

The oil and gas industry in the South-East makes a significant contribution to the State's economy, with more than \$1 million of royalty payments expected to be made to the State from existing gas production in the South-East in 2000–01.



Ladbroke Grove Power Station during construction, Otway Basin, 1999. (Photo 47561)

The recent Government announcement of facilitation of competitive gas supplies into South Australia is also of potential benefit to the South-East as the area lies on the route of one possible transmission pipeline route. Such a pipeline would both increase competition in the South-East gas market and encourage more exploration in the region.

Seven areas were released in 2000 for petroleum exploration licences in the Otway Basin (Blocks OT2000-A to G; Fig. 2.11). This release included some of the most prospective area of the basin to be offered for more than 15 years with some blocks adjacent to Origin's producing fields. Bidding closed on 26 October and as a result, three new petroleum exploration licences will be offered to the successful applicants for blocks OT2000 A, B and D.

OFFSHORE

At 31 December 2000 there were five exploration petroleum permits (EPPs) in federal waters adjacent to South Australian waters. These licences are located in the Otway Basin in the South-East (EPPs 24 and 27) and the Bight Basin in the Great Australian Bight (EPPs 28, 29 and 30). Total licence commitments and expenditure are outlined in Table 2.4. Over the next six years approximately \$100 million will be spent exploring these basins including the drilling of at least two deepwater wells.

Otway Basin

EPP 24 is held by a consortium, operated by Origin Energy, who have held the licence since July 1996. This licence is due to expire in July 2001. Licence activity has concentrated on geological, geophysical and marketing studies. Year 5 activity is likely to concentrate on acquisition of 140 km² of 3D seismic over the Troas discovery.

EPP 27 was granted to Tyers Investments in August 1999. First-year licence commitments comprised data acquisition and review. Year 2 includes seismic reprocessing and 4000 km of airborne laser fluorescence survey.

Bight Basin

EPPs 28, 29 and 30 were awarded to Woodside Energy (in consortium with Anadarko Australia and PanCanadian Petroleum) in July 2000. Total Year 1 commitments for these three licences amount to \$14.3 million (Table 2.4). The bulk of this expenditure will be spent on a 15 600 line kilometres 2D seismic survey which will commence in December 2000 and extend until May 2001.



AGSO research vessel Rig Seismic operating in the Bight Basin. (Photo 42489)

LEGISLATION HIGHLIGHTS

PETROLEUM ACT

The legislation governing onshore petroleum exploration and production in South Australia was reviewed through an extensive process of industry and public stakeholder consultation commencing in 1996 which led to the proclamation of the new Petroleum Act and the promulgation of the Petroleum Regulation 2000 on the 25 September 2000.

The main drivers behind the need for this new Act were:

• Changing attitudes and expectations of the community at large in particular to environmental issues. These changing expectations called for legislation which can adequately address environmental and heritage issues more openly and transparently than the previous Act.

Table 2.4 Off	shore licence	commitments	2000-2006
---------------	---------------	-------------	-----------

Year	2000-01	2001-02	2002-03	2003–04	2004–05	2005-06
Guaranteed (\$m)	14.5	2.5	22.5	0	0	0
Non-guaranteed (\$m)	4		9	26	1.5	22.5
Wells	0	0	1	0	0	1
Seismic 2D (km)	15 000	400	0	0	0	0
Seismic 3D (km ²)	140	0	0	2 600	0	0

- Competition policy reform facing the industry required exposing the industry to greater competition, e.g. smaller blocks, shorter licence terms and access to prospective areas to more licensees.
- A need for regulations to be more receptive to changing and improving technology by focusing on the achievement of objectives rather than prescribing what needs to be done.

To address these issues the new Petroleum Act was developed through embracing six key principles of certainty, openness, transparency, flexibility, practicality and efficiency. In summary, these principles were applied by:

1 Certainty

The rights conferred by licences are certain and will not be subject to unreasonable change or challenge. Also the regulatory objectives and obligations under the regulatory regime are uniform, clear and predictable to all licensees.

2 Openness

Decision-making processes are not exclusive and the legal rights of all stakeholders are not unfairly compromised. This entails the need for fair and equitable processes for the:

- allocation of title rights
- managing of rights of other land owners with overlapping land rights
- managing of rights of title holders to access land for the exploration and development of regulated resources
- provision of access to natural resources governed by this legislation where surface access within the licence area may be restricted by the sensitivity of the natural environment or other previously established rights
- stakeholder consultation on the establishment of the environmental protection objectives
- appeal rights to those affected by decisions made under the legislation.

3 Transparency

The objects and intent of the regulatory regime are clearly communicated and understood by all stakeholders. Also, stakeholders are provided with the opportunity to input into the development of these objects and intent.

The decision-making processes are visible and comprehensible to all stakeholders and that industry performance in terms of compliance with the regulatory objectives is apparent to all stakeholders.

4 Flexibility

There is sufficient flexibility in the types of licences that can be granted so as to more adequately reflect the purpose of the activities to be undertaken and the stage of development of the resource under the licence. The level of intervention (including enforcement) needed to ensure compliance is determined on the basis of the individual company being regulated and the outcomes needed to be achieved.

5 Practicality

The regulatory objectives are achievable and measurable.

6 Efficiency

The compliance costs imposed on both Government and the company by the regulatory requirements are minimised and justified. Distributional effects across society of company negative externalities is minimised and companies remain liable for the costs of such externalities. An appropriate rent is paid to the community of South Australia from the value realised from the exploitation of its natural resources.

The new Act also extends the resources administered by this legislation through the inclusion of geothermal energy, coal seam methane and underground gas storage.

Main features

In applying the above principles the Act achieves:

- a more effective means for allocating and managing the rights to explore for and develop petroleum and other natural resources so as to facilitate competition
- greater security of title of petroleum rights through improved registration procedures and greater flexibility in the types of licences that can be granted
- a regulatory regime designed to more effectively and efficiently set and achieve environment and public safety protection objectives
- effective public consultation processes for the establishment of environmental objectives
- a more effective means for ensuring that security of production and supply of natural gas is maintained at a prudent level
- effective public reporting to provide all stakeholders with sufficient information on industry performance and government decision-making
- a flexible regulatory approach which allows the selection of the most appropriate level of regulatory intervention and enforcement in order to ensure compliance with the regulatory objectives.

COMPLIANCE MONITORING

To ensure that activities are carried out to appropriate standards, industry must comply with the Petroleum Act and Regulations. Petroleum Group carries out a program of checking of both achievement of regulated outcomes and of management processes in place to verify that the reports, received from each operator demonstrating their compliance with the regulatory regime, have a sufficient degree of integrity.

Work program compliance

During 2000, 14 petroleum exploration licences required work to be performed in the previous licence year. Of these, five licensees were in breach of work program commitments, two licences expired without renewal and one licensee failed to submit an annual report by the licence anniversary date. The Petroleum Group is following up on these noncompliances.

Seismic compliance

Petroleum Geophysics Branch is responsible for monitoring compliance of petroleum geophysical exploration activities with relevant legislation. This includes offshore activities under the *Petroleum (Submerged Lands) Act 1967* (Cwlth) for federal waters and *Petroleum (Submerged Lands) Act 1982* for State waters. Onshore, the relevant legislation was the *Petroleum Act 1940* until 25 September 2000, and the new Petroleum Act thereafter.

In May 1998 the Petroleum Group prepared a *Statement* of environmental objectives for seismic operations in the *Cooper and Eromanga Basins, South Australia* to encapsulate the key points of objective regulation which were being developed at the time, and which have been included in the new Act. These concepts have been accepted by industry and in use for some time. Petroleum Group subsequently prepared a similar document for drilling operations in the Cooper Basin, and another seismic 'Statement' has been prepared for the Otway Basins for generic use.

Petroleum Group has also been using the assessment criteria contained in these statements in the monitoring of environmental compliance by operators, as well as using checks against prescriptive requirements contained in the 1940 Act. There has been a high level of environmental compliance with few instances requiring remedial action in recent years.

Long-term environmental monitoring of seismic lines is also undertaken to identify any area requiring rehabilitation, and to validate assessment criteria. With the expiry of PELs 5 and 6 there was a major program to monitor the status of the 100 000 km of seismic access tracks that had previously been utilised in the Cooper and Eromanga Basins. An aerial inspection of over 6000 km of historical and recent seismic lines within these licences resulted in the recording of over 5000 assessment scores. A total of 1537 instances of noncompliance were noted, including 409 which were significant and warranted rehabilitation or address. Virtually all these instances related to seismic lines recorded in the 1970s and early 1980s and rehabilitation plans have been developed or are being developed in conjunction with the licensee to address these.

Well drilling and well site compliance

During 1999–00 the following breaches of the Petroleum Act and Regulations occurred. Two (6%) wells commenced drilling prior to gaining approval (regulation 121), compared to six (15%) in 1998–99. A total of 22 well completion reports were due for submission from industry over the period, but only seven (32%) were submitted by the due date (regulation 133); outstanding data are being sought. Operations on two wells were completed without approval, and the Petroleum Group is currently resolving the issue with the relevant licensee.

Over 250 inspections of wellsites, water disposal ponds and pipelines were carried out with various objectives; the number was higher than normal to ensure that unacceptable sites were not included in acreage to be relinquished. In addition, 20 reports required by regulation, including declarations of environmental factors, research



Interpreting a seismic section. (Photo 43596)



Preparing an ant trap in the Cooper Basin as part of research into the impact of seismic operations on fauna. (Photo 47680)



Petroleum production facility in the Cooper Basin, 1996. (Photo 43793)

studies and incident reports, were reviewed for sufficient standard to achieve compliance with regulations.

All 42 oil spills reported during 1999–00 were relatively minor in both volume spilt and area affected and in every instance appropriate corrective action was undertaken by the operator. The increased number of spills is directly attributed to improved spill monitoring and reporting mechanisms put in place, and not a result of poorer performance.

Data submission

The Petroleum Act requires that geotechnical data be submitted to the Government and compliance with this requirement is an ongoing role of the Petroleum Group. Guidelines have been prepared to assist operators in submitting the data in an appropriate form. There has been a clearer definition of data types required for submission in the new Act which when coupled with the supporting guidelines, aims to assist industry as well as regulators in



Drilling rig on-site in the Cooper Basin. (Photo 43785)

complying with data submission requirements. There has been a major improvement in the manner and form that geological and geophysical data have been submitted in recent years and this is expected to further improve as guidelines under the new Act are utilised. Input into developing data submission standards with other State and federal agencies is facilitated by Petroleum Group representation on national industry and regulator bodies.

Royalty compliance monitoring

There were no significant royalty reporting non-conformances or licence fee payment non-conformances during 1999–00.

PETROLEUM GROUP PUBLIC REGISTERS

The Petroleum Group Public Registers provide public access to licence material and to environmental documentation as required under the new Petroleum Act and associated Regulations. Both registers can be accessed via the PIRSA Petroleum Group web site.

Petroleum Licence Register

Provision of the Petroleum Licence Public Register is a strategy to ensure that Government is transparent and accountable in its decision making processes. In addition, sections 115 and 116 of the Petroleum Act require that a Public Register be established for public inspection. These sections are intended to provide the means of determining the legal status of a licence and its history.

- The register contains the following information:
- the terms and conditions of each licence
- the name of the licensees
- a description of the licence area or pipeline route
- a memorandum advising of all registrable dealings affecting the licence.

The Minister has discretion to include any other information considered appropriate (other than commercially sensitive information).

Environmental Register

Provision of this public register is part of a strategy to demonstrate that there is transparency and accountability in the decision-making processes.

Sections 106 and 107 of the Petroleum Act requires that an Environmental Register be established for public inspection. These sections are intended to provide the means that will aid stakeholders in determining whether the regulatory objectives of the Act have been met.

The register contains information on the four areas of petroleum industry activity, which includes seismic surveying, drilling, pipelines and facilities, as administered by the Petroleum Group. The Act specifies that the following data will be contained in the register:

- environmental impact reports
- the current criteria for the classification of regulated activities
- the classifications of regulated activities made by the Minister
- statement of environmental objectives that have been approved under this Act
- reports provided under reporting obligations imposed by statements of environmental objectives
- environmental impact assessments that affect regulated activities under the *Development Act 1993*
- annual reports submitted as a requirement of the Petroleum Act.

The Minister has the discretion to include other data as deemed appropriate such as:

- fitness for purpose reports
- emergency response drill reports subsequent to consultation with licensees
- Petroleum Group inspection and audit reports.

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* came into operation on 16 July 2000. Under the Act, applications made under other legislation such as the Petroleum Act may involve actions which need to be referred to the Federal Government for a determination as to whether or not National Environmental Significance triggers have been tripped (i.e. that the action will, or may, have a significant impact on them). The onus is on the proponent to make the referral if they think the action might trigger the Environment Protection and Biodiversity Conservation Act.

The six current triggers for National Environmental Significance are:

- World Heritage properties
- Ramsar wetlands of international importance
- listed threatened species and ecological communities
- · listed migratory species
- nuclear actions

• marine environment — federal waters. A seventh trigger, greenhouse, is currently under consideration.

Any action that would be likely to have a significant impact on any National Environmental Significance trigger is caught by the Act. A proponent must have the application for such an action assessed and approved by the Federal Minister for Environment. The assessment and approvals processes under the Act will run in addition to any other assessment and approvals process (e.g. State approvals) which may apply to the whole project.

NATIVE TITLE

Following the High Court Wik decision, no new petroleum exploration licences have been issued in South Australia over crown land or pastoral leasehold land. Issue of production licences to the Santos Joint Venture has continued under Indenture and Petroleum Act rights.

The South Australian Government is also resourcing an initiative to achieve Indigenous Land Use Agreements to codify Aboriginal rights over pastoral leases and other crown land and establish compensation principles for new petroleum and mineral tenements etc. Negotiations have commenced between Government, Aboriginal, pastoralist, mining and petroleum stakeholders. The agreements can provide processes and principles which substitute for those in the *Native Title Act 1993* (Cwlth) and therefore have the potential to greatly simplify and speed resolution of Native title issues.

The Government has also initiated the right to negotiate process under the Native Title Act with the Native title claimants and licence applicants in the Cooper Basin and is assisting through funding of some negotiation costs.

For Cooper Basin Round 1 applicants this process started in 1999 with the South Australian Chamber of Mines and Energy facilitating the applicants to negotiate as a group. Four Native title claimants are eligible to be part of the negotiation process for Round 1 (in contrast to eight claimants prior to the re-registration test determinations). Negotiations are in progress.

For Round 2, the negotiation process commenced officially on 15 March 2000 and two registered Native title claimants (also involved in the Round 1 process) are to participating in the right to negotiate process.



Sand dunes in the Cooper Basin. (Photo 43782)

PETROLEUM GROUP, OFFICE OF MINERALS AND ENERGY RESOURCES

VISION

For South Australia's petroleum and geothermal potential to be efficiently realised with the community's support.

ROLE AND FUNCTIONS

The Petroleum Group achieves its mission, outcomes and objectives through three key interrelated roles:

Attract private sector exploration investment that will lead to new commercial petroleum resource discoveries

- Ensure ready availability of comprehensive and user friendly data and databases which are valid, accurate and relevant to upstream petroleum and geothermal industries.
- Maintain and disseminate expertise, data and information on technical and business environment aspects of the petroleum industry in the State.
- · Research new exploration opportunities.
- Promote South Australian exploration opportunities to the worldwide petroleum industry.

Regulate petroleum exploration and development activities in a manner acceptable to both the community and industry

- Issue and administer licences as required in accordance with legislative and policy requirements.
- Maintain clear and comprehensive administrative guidelines and ensure their transparent implementation.
- Monitor petroleum industry activities to ensure compliance with the relevant legislation.
- Ensure royalties and fees are collected in accordance with legislative requirements.
- Ensure data from industry activities are collected in accordance with legislative requirements.

Provide policy advice to Government on all aspects of managing the petroleum resources of South Australia

- Respond in a timely and authoritative manner to any ad hoc policy issues relating to the petroleum industry in South Australia.
- Identify and remove unwarranted impediments to upstream petroleum industry investment in the State.
- Establish consultative processes and implement policy changes to ensure the petroleum industry's activities achieve continued or enhanced community acceptance.
- Facilitate existing and development of new petroleum resource projects by acting as the 'lead agency'.

ACHIEVEMENTS 2000

POLICY ACHIEVEMENTS

The Government has implemented a number of initiatives to boost petroleum exploration investment and facilitate competition in gas supply while ensuring the protection of the environment, Aboriginal heritage and the rights of Native title claimants. These include:

- opening up the Cooper Basin in South Australia to new exploration companies after expiry of the Santos Joint Venture exploration licences
- initiating the right to negotiate process under the Native Title Act between the successful new licence applicants and the Native title claimants and assisting through funding of some negotiation costs
- new Petroleum Act and Regulations
- development of memorandums of understanding with Planning SA and the Department of Environment and Heritage in regard to administration of new Act
- gas supply and demand study
- major involvement in a study of new competitive supplies of gas for South Australia
- initiating a public process to help determine the future of petroleum exploration and development in the Coongie Lakes area
- facilitation of exploration and development in the Otway Basin
- promoting geothermal energy opportunities.

TEISA

There are three major Targeted Exploration Initiative South Australia (TEISA) petroleum programs that aim to address shortfalls in knowledge of prospective sedimentary basins in South Australia. Each are designed to assist industry in targeting exploration activities in existing and new licence areas. In addition to these programs, the Chair of Petrophysics at the National Centre for Petroleum Geology and Geophysics was funded by TEISA. Key achievements during 2000 are discussed below.

Cooper Basin Program

The following projects were completed:

- thermal history study
- Warburton Basin and lower Cooper Basin regional seals
- Cooper Basin Triassic seals
- algal matter in Cooper Basin source rocks
- electrofacies analysis of the Cooper Basin
- undiscovered hydrocarbon reserve assessment.

Thermal history study

Sampling of cuttings and core for zircon and apatite fission-track analysis has provided greater control on early

heatflow events in the Cooper and Warburton Basins and led to a better understanding of the timing of expulsion and migration of hydrocarbons.

Warburton Basin and lower Cooper Basin regional seals

A unique alteration profile was recognised several years ago at the base Cooper Basin unconformity. Recognition of this zone has provided a simple understanding of basement (Warburton Basin) reservoirs sealed by the altered zone and has profound implications on drilling depths and costs. The study attempted to identify the origins of the seal by a systematic mapping of wireline log signatures from every well in the Cooper Basin area, in addition to petrological and various chemical analysis. The nature of the alteration remains enigmatic and it is uncertain if it is a palaeosol or a result of hydrothermal alteration. The study also highlighted a high success ratio for exploration wells that fully penetrated the altered zone.

Cooper Basin Triassic seals

This project determined the extent and integrity of Triassic (Nappamerri Group) sediments, commonly regarded as a regional seal to Permian oil and gas reservoirs. The Birkhead Formation seal in the overlying Eromanga Basin has been extensively studied, but this is the first detailed examination of the seal capacity of the Nappamerri Group. The project is a collaborative study between PIRSA and the National Centre for Petroleum Geology and Geophysics.

Algal matter in Cooper Basin source rocks

An evaluation of potential alginite sources in Cooper Basin coal and siltstone has been undertaken. Qualitative data on the occurrence of algae from palynological reports has been captured, and the presence of six genera recorded. Regional distribution maps of algal occurrences indicate that the relative abundance of the different genera vary considerably but, in general, have been found to occur most commonly in areas marginal to maximum coal development. Algal abundances decline rapidly basinwards, as mud content increases. Overall the data imply that algal accumulations are environmentally constrained and that algal-rich source rocks may occur in relatively localised, well-defined facies associations. Results of the project were presented at the Sprigg Symposium held in Adelaide in June 2000.

Electrofacies analysis of the Cooper Basin

This project complements a pilot study conducted in 1998 and involved routine electrofacies analysis of approximately 1000 wells in the Cooper Basin. It provides industry with an indication of the fluvial fairways, regional seals and source kitchens of selected Permo-Triassic units.

Undiscovered hydrocarbon reserve assessment

An independent assessment of the hydrocarbon potential of the Cooper Basin has been undertaken by Professor Cedric Griffiths, formerly of the National Centre for Petroleum Geology and Geophysics, and the final report is now being promoted to industry.

National Geoscience Mapping Accord Cooper and Eromanga Basins Project

Under the National Geoscience Mapping Accord,

consolidated C, P and Z time and depth seismic horizon maps covering South Australia, Queensland, Northern Territory and New South Wales were completed (Fig. 2.18). This is the first



Fig. 2.18 Final image of the C horizon depth structure, Eromanga Basin.

time such detailed data sets have been produced and they have been favourably received by industry.

Cambrian Basins Program

A study investigating reservoir potential and distribution, and structural geology of fractured early Palaeozoic Warburton Basin units underlying the Cooper Basin, was completed.

A study investigating the porosity and permeability properties of the Kulpara Formation of the Stansbury Basin is due for completion in early 2001.

The results of joint study, between Petroleum Group and the Paleontological Institute of the Russian Academy of Sciences investigating small shelly fossils from the Stansbury and Arrowie Basins and developing a biostratigraphic framework and correlations with other Cambrian basins has been completed. A monograph entitled *The Cambrian biostratigraphy of the Stansbury Basin, South Australia* is in preparation and it is planned to be published in 2001. The monograph will be dedicated to the late Dr Dave Gravestock of Petroleum Group and is aimed at assisting petroleum explorers in this frontier basin.

Data Capture, Archiving and Online Access Program

A four-year Data Capture, Archiving and Online Access Program is the single largest petroleum program funded by TEISA and involves the digital capture (primarily scanning) of all appropriate petroleum data into a suitable format for fast and efficient retrieval by industry. Progress to date is outlined below.

Well completion reports and geological reports

Work is well advanced in the scanning of geological studies, company reports including well completion reports and the Petroleum Register; all are being made progressively available on CD. Over 650 open file well completion reports, 340 geological reports and documentation relating to all current tenements have been scanned, totalling over 16 gigabytes. Data in and adjacent to recent and future acreage releases in the Cooper, Otway, Bight and Duntroon Basins have been targeted to assist industry in acreage assessment. Examples of digital scanned well completion reports can be found on recent acreage release CDs.

Migration of the digital open hole well log database

All digital wireline logs are being migrated into Schlumberger's Geoframe software. Over 60% of files have been loaded and will be verified once loading is complete. This database will enable provision of wireline logs in selected formats and media; the Petroleum Group will continue to archive basic log data to CD.

Geophysical data capture

A tender for scanning seismic survey reports, seismic record sections and field survey data was awarded in September 1999. To date, 9000 seismic sections have been scanned out of a total of 32 000 (28%). It is expected that this project will be completed by June 2002.

Seismic ancillary data scanning sub-project

A tender has been awarded for the scanning of 250 000 ancillary seismic field documents. This project is also expected to be completed by June 2002.

Seismic reports and uphole database collation

Personnel have been contracted to collate reports for scanning and data for consolidation into a database.

2001 PROGRAMS

Policy initiatives

Policy initiatives planned for 2000-01 include:

- implementation of the new Petroleum Act and Regulations and development of associated guidelines and policies (e.g. security of supply, land owner liaison guidelines)
- working with stakeholders in developing relevant requirements under the Act including statements of environmental objectives
- researching measures for assessing company regulatory compliance performance
- researching and developing regulatory enforcement policy
- developing Officer Basin land access and petroleum acreage promotional policy
- progressing environmental impact studies (ant study and South-East faunal study)
- · ongoing promotion of the State's petroleum potential
- finalisation of the Coongie Lakes Management Plan.

TEISA and other geoscience initiatives

TEISA and other geoscience initiatives planned for 2000–01 include:

- working with other jurisdictions to minimise duplication of petroleum prospectivity assessments
- reviewing market failures and initiating applied petroleum prospectivity research of South Australian basins
- targeted promotion of products resulting from TEISA research and data management projects
- ongoing promotion of any new Cooper Basin acreage releases and facilitation of company farmin activity
- major upgrading of petroleum web site.
SECTION 3: OFFICE OF MINERALS AND ENERGY RESOURCES CONTACTS

PIRSA ORGANISATION CHART



OFFICE OF MINERALS AND ENERGY RESOURCES DIRECTORATE

Role

- Provide leadership, strategic planning, human resource and financial support for the Office of Minerals and Energy Resources, and high-level, timely advice to PIRSA and the Government of South Australia on the minerals and petroleum industries.
- Coordinate implementation of the Government's response to the Resources Task Force Mineral Resources Plan.

Executive Director, Office of Minerals and Energy Resources — David Blight

- manage the Office of Minerals and Energy Resources at Executive level
- provide leadership, strategic planning and policy direction
- provide advice to the Chief Executive
- provide advice to the Minister and Government (State and Federal)
- coordinate the Government's response to the Resources Task Force Mineral Resources Plan
- liaise with the Industry Development Board in addressing minerals and petroleum issues
- liaise with the community (including Aboriginal).

Director, Mineral Resources — Neville Alley

- manage the Minerals Resources Group
- provide leadership, strategic planning and policy direction
- provide advice to the Executive Director
- provide advice to the Minister and Government (State and Federal)
- liaise with industry and research organisations
- liaise with the community (including Aboriginal).

Director, Petroleum Group — Bob Laws

- Provide leadership, management and strategic policy direction:
 - to achieve the Petroleum Group's mission to maximise the community's net benefit for the State's ownership of the rights to petroleum (i.e. maximise economic benefits and minimise environmental costs)
 - to administer the Petroleum Act in an effective and efficient manner
 - to ensure that exploration and development opportunities are developed and promoted
 - to ensure that the Petroleum Group workforce is motivated and skilled and works in a safe and satisfying environment.

Executive Assistants — Marion Reedman and Rosa Marafiote

- provide administrative support to the Executive Director and Directors.
- Finance Manager Alan Finch
 - provide budgetary, finance and accounting support
 - provide administrative and strategic planning.
- Human Resources Coordinator Julie McCowat
 - provide human resource management support
 - provide administrative and policy planning
 - coordinate the Office's records management.
- OHS&W and Administrative Officer Joe Cappella
 - provide OHS&W planning and administration
 - coordinate the Office's performance management
 - provide administrative and strategic planning support to the Office.
- Administrative Support Officers Jeanette Bell and Melanie Lenuzzi
 - provide administrative support.
- Records Management Officers Jason Tugwell and Trish McGuire
 - provide company records management support
 - provide administrative support.

Contacts

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Dr Neville Alley

Bob Laws

MINERAL RESOURCES GROUP

GEOLOGICAL SURVEY

Role

- The Geological Survey Branch collects, manages and interprets geoscientific information and provides geoscientific advice and data to government, industry and the community to assist exploration, responsible development and sound land-use planning.
- Branch activities include regional geological mapping, geophysics, remote sensing, seismology, biostratigraphy, regolith studies and geoscientific information services. Current programs and a selection of current projects are listed below.

State-wide geology and administration — Stuart Robertson

- State-wide geological investigations, maps and databases
- promotion of State mineral prospectivity
- advice to government and Branch administration.

Adelaide Geosyncline and Kanmantoo Trough - Wolfgang Preiss

- regional geological mapping, data assembly and interpretation
- solid geology interpretation and GIS modelling of the Kanmantoo Trough and concealed basement to the Murray Basin
- regional stratigraphic, tectonic and metallogenic studies.
- Curnamona Province Colin Conor
 - regional geological mapping and data assembly
 - geological interpretation, history and metallogenesis of the Curnamona Province in conjunction with NSW Department of Mineral Resources and AGSO (Broken Hill Exploration Initiative).
- Gawler Craton Sue Daly
 - regional geological mapping, data assembly and interpretation
 - regional bedrock drilling
 - regional studies including tectonic and magmatic history, geochronology and metallogenesis.

Regolith (in cooperation with CRC-LEME) — Malcolm Sheard

- regolith geochemical and mineralogical characterisation, regolith mapping of the Gawler Craton
 - development of new procedures for mineral exploration through understanding of regolith and effects on the surface expression of concealed mineralisation.
- Sedimentary terranes Marigold White
 - regional geological mapping and interpretation in sedimentary terranes
 - microfossil dating to correlate sedimentary rocks, supporting Departmental mapping and industry exploration programs
 - · laboratory services (including palaeontological laboratory services), palaeontological computer database
 - basin and palaeochannel studies.

Geoscientific information systems and services — Alan Mauger

- maintenance and development of digital (SA_Geodata, SA_Geology) GIS and Oracle geoscientific databases in cooperation with other PIRSA Groups
- management and provision of geophysical data for the State
- management and development of remote sensing data for use in exploration in South Australia.
- Seismology David Love
 - maintain and monitor a network of seismograph stations
 - compute epicentres and magnitudes of South Australian earthquakes
 - maintain an earthquake database and provide information on earthquake hazards.

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Geoscientists	Pho	ne	Title	Projects and/or expertise
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Andrew Burtt burtt.andy@saugov.sa.gov.au	8463 3072	Senior Geologist	Geological mapping, Kanmanto	o Trough, GISmodelling, image processing
Domenic Calandro calandro.domenic@saugov.sa.gov.au	8463 3051 mob 0417 816	Senior Geophysicist 462	Coordinator airborne geophysics	s, TEISA airborne geophysics

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Sue Daly daly sue@saugoy sa goy au	8463 3066	Senior Geologist	geology; Convenor State Stratigraphic Nomenclature Subcommittee Geological mapping, geochronology,geochemistry and tectonics of the Gawler Craton Precambrian ore genesis
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Collaborative researchers base	ed with Geol	ogical Survey	
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Research Geologist PIRSA-AGSO Gawler Craton Program – Olympic Subdomain Project

MINERAL ASSESSMENT

Role

- Encourage and promote mineral exploration and development in South Australia.
- Administer and regulate mineral exploration in South Australia.
- Increase public awareness of mineral exploration and mining practice and its benefits to the community. *Minerals (general) Warwick Newton*
 - management, administration and personnel
 - advice to government
 - public enquiries, preparation of information brochures
 - project evaluation
 - community (including Aboriginal) liaison
 - land access
 - identification of new mineral development opportunities
 - identification of mineral exploration opportunities.

Resource assessment — Max Pain

- extractive industry and land-use planning
- resource evaluation
- commodity reviews
- commodity and product research.

Company exploration — George Kwitko

- regulation, assessment and monitoring of mineral exploration
- environmental compliance monitoring
- facilitation of mineral exploration work approvals.

Mineral potential — Brian Morris

- development of mineral deposit database
- mineral potential mapping
- development of exploration concepts, models and techniques.

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MINING OPERATIONS

Role

The principal role of the Mining Operations Branch is to regulate the South Australian mining industry in accordance with legislative requirements, and in a manner which minimises impact on the community. This includes:

- regularly inspecting mining operations
- administering and regulating opal mining in the State
- · providing professional advice to government, industry and the community on matters relating to mining
- administering the Extractive Areas Rehabilitation Fund
- coordinating the rehabilitation of disused mine sites.

Mining operations (general) - Roger Mathews

- management and Branch coordination
- advise the Minister on matters relating to mining
- statutory approval of mine operation plans and development programs
- compliance with the State's mining legislation.

Mining operations and special projects — Serge Caplygin

- Olympic Dam Mine
- compliance major mines and quarries, central, northern and northeastern regions
- evaluation of mine operation plans for major operations
- security deposits (bonds) for operating sites
- administration of the SASE Project
- coal development advice
- Penrice Crown Agreement and Consultative Committee

Mining operations — Olando Puccini

- opal fields
- iron ore and coal mines
- compliance major mines and quarries, southern and western regions
- evaluation of mine operation plans for major operations
- security deposits (bonds) for operating sites
- special projects.

Brukunga — Ray Cox

- Brukunga Mine treatment plant
- Brukunga Task Force

Mining lease assessments — Garry Wardle

- assessment of mining proposals
- assessment of tenement applications and renewals
- assessment of security deposits (bonds) for proposed operations.

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Geoff Price price.geoff@saugov.sa.gov.au	8670 5042 8672 7017	Clerk, Mintabie, Marla	Opal field administration, issuing permits, registering and renewing claims

MINERAL POLICY AND REGISTRATION

Role

• To provide an exploration and mining legislative and policy framework to ensure security of tenure, facilitate access to land, and deliver assessments and advice on these issues to Government, industry and the community.

Policy and registration (general) - Pru Freeman

- management, administration and personnel
- advice to Government on land access issues.
- Policy and economics Fred Cook
 - mineral production statistics
 - royalty assessment
 - policy development and advice
 - mineral economics
 - mining industry review, promotion and assessment.

Administration and liaison — Ken Wigglesworth

- ANZMEC administration
- Australian Bureau of Statistics liaison
- project investigation.
- Facilitation Sam Walker
 - new project facilitation
 - administration of major projects.

Mineral registration and Mining Registrar - Laura Johnston

- administration of the Mining Act and Opal Mining Act
- processing of tenement applications mineral and opal
- provide advice on the provisions of the mining legislation
- represent the Director of Mines in the Warden's Court
- · production statistics and collection of royalties
- Native title and other land access matters
- review of mining legislation.

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PETROLEUM GROUP

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- Otway and Officer Basins John Morton (Petroleum Geology Branch)

Data

- Geological and well data *Alan Sansome (Petroleum Geology Branch)*
- Seismic geophysical data Peter Hough (Petroleum Geophysics Branch)

Regulation

- Seismic activity approvals Dave Cockshell (Petroleum Geophysics Branch)
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PETROLEUM GEOLOGY

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PETROLEUM ADMINISTRATION

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SECTION 4: ABOUT SOUTH AUSTRALIA

Australia is an island continent having an area of 7 682 000 km^2 (2 966 000 sq. miles) and surrounded by the Indian, Pacific and Southern Oceans. It comprises six States and two Territories. South Australia, which is in the central southern region, occupies about one eighth of the continent.

South Australia

Area	984 377 km ² (380 100 sq. miles)
Capital city	Adelaide
Population	1.5 million
Main language	English
State founded	1836

South Australia combines competitive cost, skill and infrastructure advantages with an exceptional quality of life. It is strategically located at the convergence of the nation's road, rail and air transport linkages. South Australia is an ideal location for national and international investment and business ventures. Major South Australian infrastructure is shown in Figure 4.1.

Major strengths:

- strategic location on the Asia-Pacific rim
- well-developed modern industry
- competitive business costs
- advanced research and development base
- highly skilled and productive workforce
- successful collaboration between industry, government and universities
- high quality living.

Climate

Australia's seasons are opposite to those of the northern hemisphere. The southern settled districts have a Mediterranean climate with mild wet winters and hot dry summers. The hottest months are January–February with a mean maximum temperature of 29°C (84°F); the coldest month is July with a mean maximum of 15°C (59°F). At Moomba, in the northeast of the State, temperatures can range as high as 48°C (118°F) in summer while overnight temperatures can drop to 2°C (36°F).

The average annual rainfall for Adelaide is 585 mm (23 in). In far northern South Australia, average annual rainfall is 176 mm (7 in), the heaviest rainfall months are December–February. In South Australia's South-East, average annual rainfall is 712 mm (28 in) and the driest months (during which drilling and seismic operations are typically scheduled) are December–March.

Economy

South Australia is closely integrated into the Australian economy. In the past decade its growth has parallelled that of Australia as a whole and all indicators show this trend continuing. Traditionally strong in agriculture, raw materials and automobile production, it has diversified into a wide range of manufacturing industries of international standard. High technology has become one of the State's growth industries, in particular microelectronics and biotechnology.

The State produces virtually all the natural gas, coal and oil needed to meet its own energy requirements. The development of Olympic Dam, the world's largest copper–uranium mine, in the 1980s helped stimulate South Australia's economy. Significant mineral and petroleum occurrences are shown in Figure 1. Foreign investment is encouraged, and government policy is directed towards the development of companies and industries with export potential. South Australia is a net exporter of goods, including energy.

Major exports include wine, seafood, live sheep and meat, communications equipment, machinery, optical lenses and gemstones.

Government

Australia was founded as an independent sovereign nation within the British Commonwealth in 1901. It comprises a political federation with a central Commonwealth (Federal) Government based in the capital city Canberra, six States each with its own government, two internal Territories and several external Territories. Australia retains the British monarch as Head of State, represented by the Governor-General who resides in Canberra, and by a Governor in each of the States.

Major Federal Government responsibilities include defence, foreign affairs, immigration, customs and excise, public finance and taxation. State Governments are responsible for justice, onshore mineral and petroleum rights, education, child welfare, transport and similar matters directly affecting the State. There are also local governments comprising city, country town or shire councils.

Federal Parliament is democratic and based on the British system. It comprises an upper house (the Senate) and a lower house (the House of Representatives) both of which are directly elected by the public. Voting is compulsory. Lower house members represent electorates or seats and function to serve the people and to introduce new legislation (which must then be passed by the Senate). The political party with the majority of votes at a general election forms the Government, its leader becoming Prime Minister. Ministers are selected from government members and given a portfolio to administer one or more government departments. Cabinet is the policy forming committee of the Government and is selected from the ministry. State Governments are modelled on the Federal Government. The leader of the elected State Government is called the Premier.



Fig. 4.1 Locality map of South Australia showing major infrastructure.

The main political parties are the Australian Labor Party and the Liberal Party. Other political parties of significance are the National Party (normally in coalition with the Liberals) and the Australian Democrats.

Time zones

There are three time zones in Australia: Eastern Standard Time (EST), which operates in New South Wales, Victoria, Tasmania, and Queensland; Central Standard Time (CST), which operates in South Australia and the Northern Territory and is 30 minutes behind EST; Western Standard Time (WST), which operates in Western Australia and is two hours behind EST. London is 9.5 hours behind and Houston is 15.5 hours behind Adelaide.

Land access

The total area of protected land (i.e. land proclaimed or reserved for conservation purposes) onshore South Australia is 212 429 km² (82 019 sq. miles), nearly 21.6% of the State (Fig. 4.2). Approximately 78% of onshore protected areas allow access for mineral and petroleum exploration and development. The areas are administered under the *National Parks and Wildlife Act 1972, Crown Lands Act 1929* and *Wilderness Protection Act 1992*. There are seven categories of reserve (Table 4.1).

Table 4.1 Summary of protected areas onshore South Australia (after data from the Reserve Planning Unit, Department for Environment, Heritage and Aboriginal Affairs, 1999.)

Reserve type	No. of reserves	Total area (ha)	Area available for mining (%)
Conservation park	216	5 787 402	31
Conservation reserve	48	274 523	100
Game reserve	10	25 213	3
National park	19	4 457 231	86
Recreation park	12	2 994	10
Regional reserve	7	10 625 466	100
Wilderness protection area	a 5	70 074	0
Total	317	21 242 902	78

Protected areas also occur offshore (e.g. the Great Australian Bight Marine Park) and are administered under the National Parks and Wildlife Act and *Fisheries Act* 1982.

Basically, the legislation is designed for conservation purposes, but there are provisions for joint proclamations and Regional Reserves both of which allow access for mineral and petroleum exploration and development.

Proclamation allowing mining rights is a mechanism under section 43(2) of the National Parks and Wildlife Act which provides for the Governor to proclaim conditions whereby rights of entry, prospecting, exploration and mining may be acquired for newly created national parks and conservation parks. This is qualified by section 43(5) which states that such a proclamation cannot be made unless:

- (a) it allows for continuing rights vested in a person immediately before commencement of the Act
- (b) the proclamation is made simultaneously with the proclamation constituting a reserve.

Mineral exploration and mining activity are possible only with approval of the Minister for Environment and Heritage and in accordance with the management plan for the park. This is also the case for petroleum exploration and production, except where a petroleum exploration licence was in force immediately prior to proclamation of the park. In this case, the proclamation may allow application for a production licence without approval of the Minister.

Recent large conservation and national park additions to the reserve system have all been made under joint proclamations which allow existing rights to continue and future rights to be acquired.

Business

South Australia offers exceptional value and advantages to businesses setting up operations in the State. In 1998 the State Government commissioned a major competitive study. It assessed South Australia and its capital city, Adelaide, with comparable locations in the United States, Asia and the United Kingdom. The results are summarised below.

Business climate:

- · lower taxes and charges
- industrial harmony
- Government assistance to potential investors
- fast-tracking of projects.

Management and labour costs:

- highly educated multi-lingual and skilled workforce
- competitive labour and management costs
- low on-costs
- enterprise agreements in place
- cost-competitive on professional service providers, e.g. legal, insurance.

Construction advantages:

- well located
- inexpensive flat land (highly cost-competitive within Australia)
- easy access to all transport links
- average three months planning and building approval time
- building completion costs are amongst the most competitive in all advanced industrial countries.



Fig. 4.2 Areas in South Australia subject to access restrictions. November 2000.

Factory and office rental:

- some of the lowest commercial rents in Australia
- further regional advantages.

Lower energy costs:

• competitive electricity and gas prices.

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