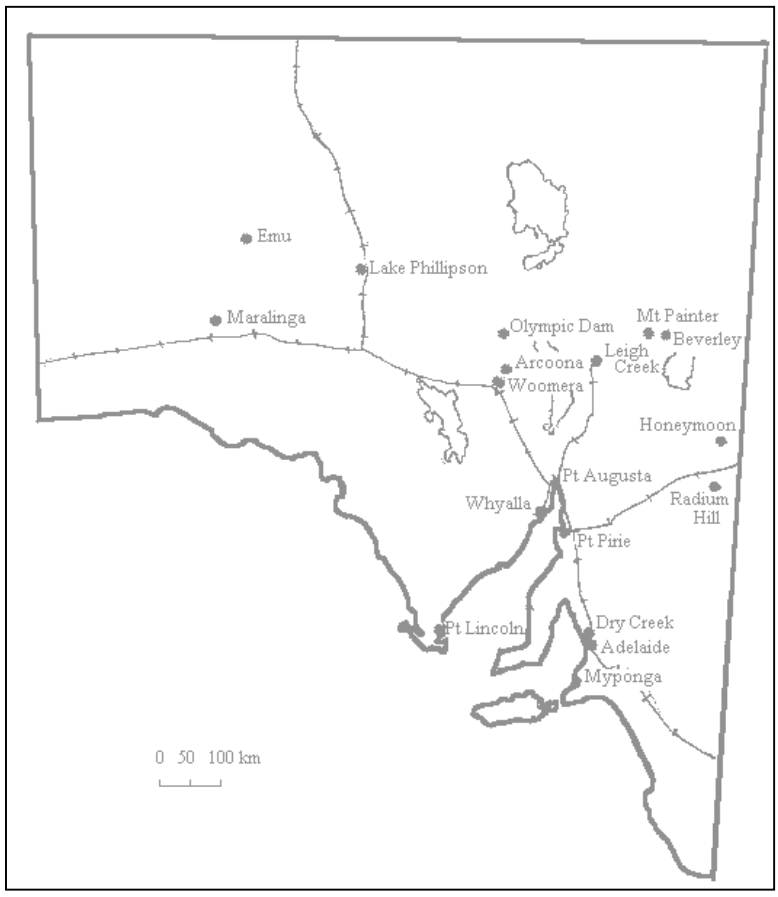
Uranium in South Australia – Politics and Reality

By R. KEITH JOHNS

South Australia has been in the forefront of developments in the Australian uranium industry since the earliest discoveries were made almost a century ago by prospectors A.J. Smith at Radium Hill in 1906[1] and W.B. Greenwood at Mount Painter in 1910[2]. The black, heavy refractory mineral, davidite, at the former and rather more spectacular yellow and green torbernite and autunite (which were derived from uraninite) at the latter, were mined for shipment overseas and for processing at Woolwich (N.S.W.), Bairnsdale (Vic.) and on the northern outskirts of Adelaide.[3]

Figure 1: Showing u*ranium location sites, South Australia*



To this time uranium was used as a pigment in glass and ceramics or dumped as a waste product after its minute content of radium had been recovered. Radium, which results from the natural decay of uranium, was used in medicine, cancer therapy and for experimentation with radioactivity, following the pioneer work of Henri and Marie

Curie in Paris. Thus, ores from Radium Hill and Mount Painter were worked intermittently for the recovery of radium (as radium dibromide) by the Radium and Rare Earths Treatment Company at Dry Creek; a plant was erected in 1923 and ceased operations in 1932.[4]

Photograph 1: *Bentley and 'Smiler' Greenwood at Radium Creek, 1919*

Source: PIRSA, Division of Minerals and Energy, South Australia

Photograph 2: *Radium and Rare Earths Co. Mine, Radium Hill, 1925*

Source: PIRSA, Division of Minerals and Energy, South Australia

Uranium as a strategic military commodity

Unravelling the nature of the atom (of electrons, protons and neutrons) would lead to development of the new science of nuclear physics during the period 1911 – 1939, which culminated in the splitting of the uranium (U_{235}) atom. Demonstration of a controlled chain reaction through nuclear fission and the release of energy to generate heat would lead to utilisation of a major new energy resource.[5]

The onset of World War II ensured that research, cloaked in secrecy, would be directed to military purposes and the development of atomic weapons. In 1942 a controlled nuclear chain reaction was achieved at the University of Chicago. The Manhattan Project delivered the first nuclear explosion in the desert of Alamogordo (New Mexico) in July 1945[6]. The world would become aware of the awesome destructive power of nuclear weapons when an atomic bomb was dropped on Hiroshima on 6 August 1945 and, three days later, over Nagasaki.

The demand for uranium ore for munition purposes led to exploration by the South Australian Government, for the UK and US defence programmes in 1944. The work was undertaken by the SA Department of Mines. Initially, attention was paid to the Mount Painter area where the deposits were tested by diamond drilling and through excavation of exploratory adits. Camels were again used for transport of ore, westerly over Radium Ridge and along a camel pad that terminated at Blue Mine Creek to connect with the road to Copley, until construction of a track along East Painter Gorge provided vehicular access.[7]

Exploration and development by the South Australian government, 1945-1962

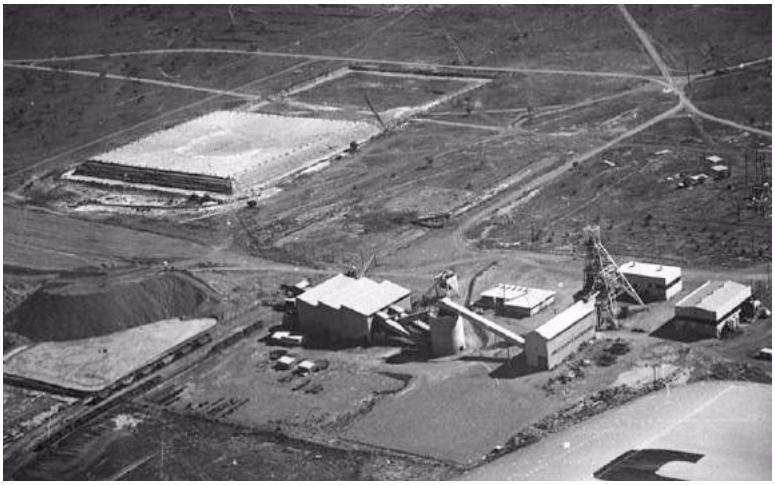
As World War II came to an end SA Premier Tom Playford saw an opportunity to take advantage of requirements for development of a new source of electrical energy that might be generated in nuclear power plants overseas and, perhaps, locally.

Amendments were made to the SA Mining Act in 1945 to provide for the control of mining, treatment and use of the ores of uranium and thorium and the vesting of those minerals in the Crown. The SA Department of Mines directed attention to assessment of mineralisation at Radium Hill in 1947 and laboratories were established in Adelaide to provide supportive chemical, mineralogical, radiometric and metallurgical requirements.[8]

In 1952 the Commonwealth and SA Governments signed a seven-year (cost-plus) contract with the UK Atomic Energy Authority and the joint UK/USA Combined

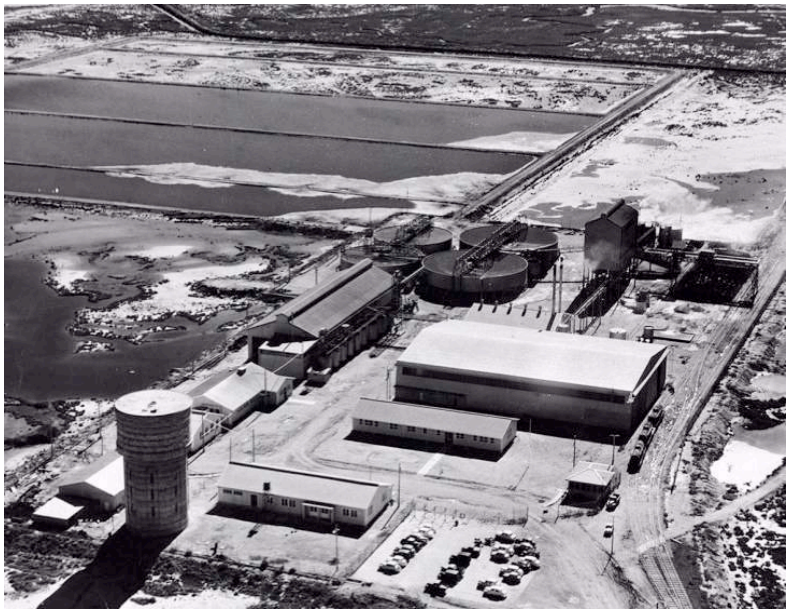
Development Agency. During the period 1954-1961 the SA Government operated the Radium Hill mine; it produced 1 million tonnes of ore concentrate for chemical treatment at Port Pirie (1955-1962) to yield 852 tonnes of uranium oxide (U_3O_8 – yellow cake) valued at $36 million.[9]

Photograph 3*: Radium Hill Mine, 1960*



Source: PIRSA, Division of Minerals and Energy, South Australia

Photograph 4: *Uranium processing plant, Port Pirie, 1958*



Source: PIRSA, Division of Minerals and Energy, South Australia

Meanwhile, prospectors and exploration teams were engaged in exploration throughout Australia. The SA Government extended its search through conduct of air-borne scintillation and ground surveys; sub-economic mineralisation was disclosed at

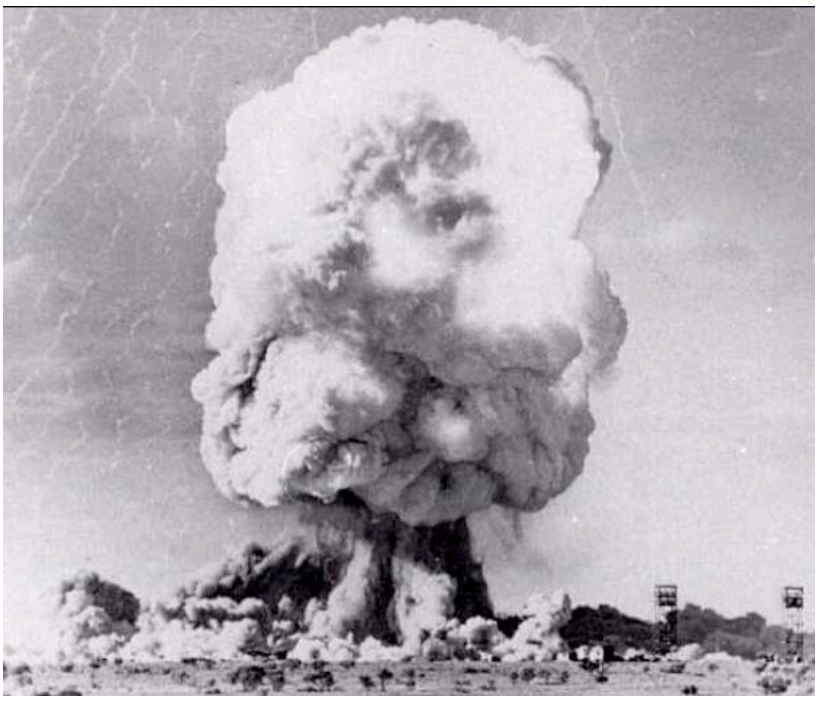
Crocker's Well, Mount Victoria, Houghton, Myponga and Port Lincoln. As contracts were satisfied there was little prospect for further sales and exploration interest dwindled. Work in this sector had virtually ceased by 1958 and the Uranium Section of the SA Department of Mines was disbanded in 1961.

The Commonwealth Government had established the Australian Atomic Energy Commission in 1953 to conduct research into a nuclear power reactor, nuclear technology and application. A research reactor (HIFAR) has been operated at Lucas Heights (NSW) since 1958 for research and production of radioactive pharmaceuticals and isotopes for medical use and industry.

Nuclear tests at Maralinga

The British Government, with the agreement and support of the Australian Government carried out nuclear tests at Emu Field and Maralinga during the period 1952-1963. Maralinga was developed as a jointly funded facility to become the principal proving ground site for conduct of experiments in Australia.

Photograph 5: *Nuclear weapons trial, One Tree, Maralinga, 1957*



Source: *'British Nuclear Testing',* http://comfuture.com/hew/Uk/UKTesting.html, *January 2005.*

Following the two major trials (Operation Buffalo in 1956 and Operation Antler in1957) a number of minor trials, assessment tests and experimental programmes

(variously code-named Totem, One Tree, Marcoo, Kite, Breakaway, Tadje, Biak and Taranaki), dating from 1959, were held at the range until 1963.[10]

The SA Department of Mines was involved with the establishment of underground water supplies, the drilling of bores and maintenance of pumps; geological surveys were undertaken, in the late 50's and early 60's, of construction aggregate and clay in connection with the trials.

Uranium conversion and enrichment

Uranium in nature consists of two isotopes (U_{238} and U_{235}) of which the U_{235} is more important since this is the fissile isotope on which the chain reaction in a nuclear reactor depends. By increasing the U_{235} content in the fuel (from naturally occurring 0.7 per cent to approximately 3 per cent) it becomes more effective and economic; thus enabling reactors to operate at higher temperatures and increased power – and to be built in smaller more compact modules.

The enrichment process is based on the use of uranium hexafluoride (UF_6) – readily produced from U_3O_8, in its gas phase, and carried out commercially by physical separation of the U_{235} isotope by the gaseous diffusion or the gas centrifuge processes.[11] Proposals for construction of a uranium enrichment plant in Australia were first mooted early in 1972 when a joint Australian /French (Government to Government) study was undertaken, based on the French diffusion process. The preferred site was identified in June 1972 on the shores of Spencer Gulf, South of Whyalla. A seawater desalination plant to be built in conjunction with the enrichment facility was seen to convey a significant benefit to the State. Initially, it was considered that energy requirements would be supplied by gas from Palm Valley (NT). But by mid 1974, speculation switched to favouring the use of Lake Phillipson coal deposits that had been identified by Utah Development Co. as having large resources; a revised estimate of economics based on that fuel was made.

The Whitlam Labour Government which came into office in late 1972 saw that development of energy resources, including the further processing of its minerals, held the key to Australia's future prosperity. Their policy called for full Australian ownership in uranium mining projects; foreign companies were denied opportunity to participate in exploration and subsequent development; controls were placed on export of strategic minerals and mineral products. The Government would explore for, develop, process and market uranium through its agencies, viz. the Australian Atomic

Energy Commission and a new enterprise, the Petroleum and Minerals Authority (PMA).

The Commonwealth Minister for Minerals and Energy (Rex Connor) predicted that the value of uranium would rise from $6/lb in early 1973, to $40/lb in 1977, and to $100/lb in 1980. And he looked toward enrichment of uranium to quadruple the value of Australian uranium resources, claiming in May 1974 'that it would be very close to $30 billion - the biggest deal in Australia's history'.[12] Such plans took advantage of studies being undertaken under the auspices of the Dunstan Government in South Australia. In May 1974 an AMDEL report proposed that a centralised uranium processing plant be sited on the shores of Northern Spencer Gulf, to be Australian owned and operated, for the conversion of all yellowcake produced in Australian mines to uranium hexafluoride. In February 1976, Premier Don Dunstan released a report prepared by the SA Uranium Enrichment Committee, on uranium enrichment in South Australia – to be established at Redcliffs by the Commonwealth Government but with full State Government support and participation; it would utilise Urenco gas centrifuge technology. Export sales of uranium from Australian mines were to be conditional on enrichment of such sales in this plant; thus trebling the nominal value of the product, put at $750 million per year. The proposed development was seen to be comparable with the Snowy Mountains Hydro Electric Scheme in magnitude and long-term benefit to Australia. Service industries to benefit included the conversion of yellowcake to uranium hexafluoride and the manufacture of centrifuges (as an adjunct to the car manufacturing industry). Permanent employment would have been provided to 1500 workers. Further site development in the future was seen to include nuclear power generation and the desalination of seawater. The cost of the processing centre was put at $1400 million. When the Minister of Mines, Hugh Hudson, travelled overseas in mid 1976 copies of this report were freely distributed in the UK, in Oslo, Vienna, Paris, Rome, Ottawa and Washington.[13]

In July 1975 the Whitlam Government set up the Ranger Uranium Environmental Enquiry (under Chairman, Justice Fox); its report of October 1976 gave the green light to uranium mining, with appropriate safeguards. Minister Connor came undone through the so called "loans affair", when he sought to borrow development funds from one Khemlani to circumvent the Loans Council – and he was dismissed from office in October 1975. The High Court of Australia was to find (in June 1975) that the formation of the Petroleum and Minerals Authority was invalid.

With the return of a Liberal Government to office, the Federal Minister for National Resources (Doug Anthony) in December 1975 established that their policy on uranium was as for other minerals – it was a matter for private rather than for Government development. The PMA was disbanded.

On 30 March 1977 the South Australian House of Assembly passed a motion that 'it has not yet been demonstrated to its satisfaction that it is safe to provide uranium to a customer country, and unless and until it is so demonstrated, no mining or treatment of uranium should occur in South Australia'. This SA Government Moratorium on Mining legislation was passed by Parliament for the second time on 13 July 1978 when it was discovered that the previous Bill was 'flawed'.

A report of the SA Uranium Enrichment Committee in 1978 established that an Urenco-Centec plant could be built by 1988 to take advantage of the predicted expanded requirements of the industry at that time. When fully operational, the income from sales of enriched uranium was put at $570 million per year (1978 dollars). But, following a visit overseas to fully assess safety aspects of nuclear power generation for himself, Premier Don Dunstan reaffirmed his 'leave it in the ground' policy in February 1979. He affirmed, however, that studies on an enrichment plant would continue.

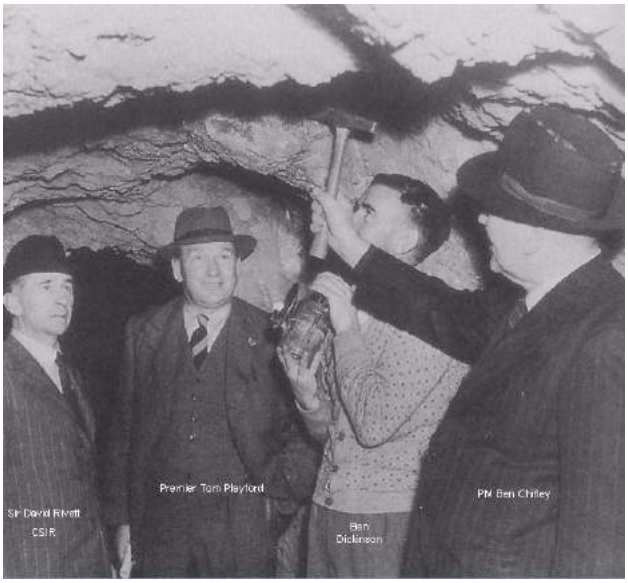
Sedimentary uranium and *in-situ* leach recovery

Driven by the prospect of an increased international demand for uranium, a new phase of exploration, dating from 1965, resulted in the discovery of sedimentary uranium deposits – notably at Beverley (adjacent to Four Mile Creek, by Petromin NL, in 1969) and near Honeymoon Hut (by Mt Isa Mines Ltd and Minad – Teton Australia, in 1971). The uranium has been derived from the erosion of deposits (such as are exposed in crystalline basement rocks at Mount Painter and in the Olary region), transported along palaeochannels, and concentrated as finely divided coffinite and uraninite in Tertiary sands. The ore-bodies are buried at depths ranging from 85m-145m and have no surface expression in terms of landform, vegetation or surface radiometrics.[14]

Resources at Beverley amount to 21,000 t U_3O_8 and, at Honeymoon, in excess of 6,800 t; such deposits were seen to be of world class in terms of recoverability and associated costs; their development would entail minimal environmental impact since they are amenable to *in-situ* leaching. In this process, dilute acid is injected underground through cased boreholes into the mineralised formation; the pregnant liquor is withdrawn from recovery wells and pumped to a treatment plant for stripping

of the uranium content in ion-exchange columns; the barren liquor, containing radon and radioactive daughter products, is returned underground. Thus, the mining of rock is dispensed with and the accumulation of waste piles and tailings dams, which are features of conventional mining operations, are eliminated. The simple chemical processing obviates the breaking of rock, crushing, grinding, and flotation – and has minimal impact on the underground water regime beyond the ore body.[15]

Photograph 6: *Sir David Rivett, Thomas Playford, Ben Dickinson, Ben Chifley at Mount Painter mine, 1947.*



Source: PIRSA, Division of Minerals and Energy, South Australia

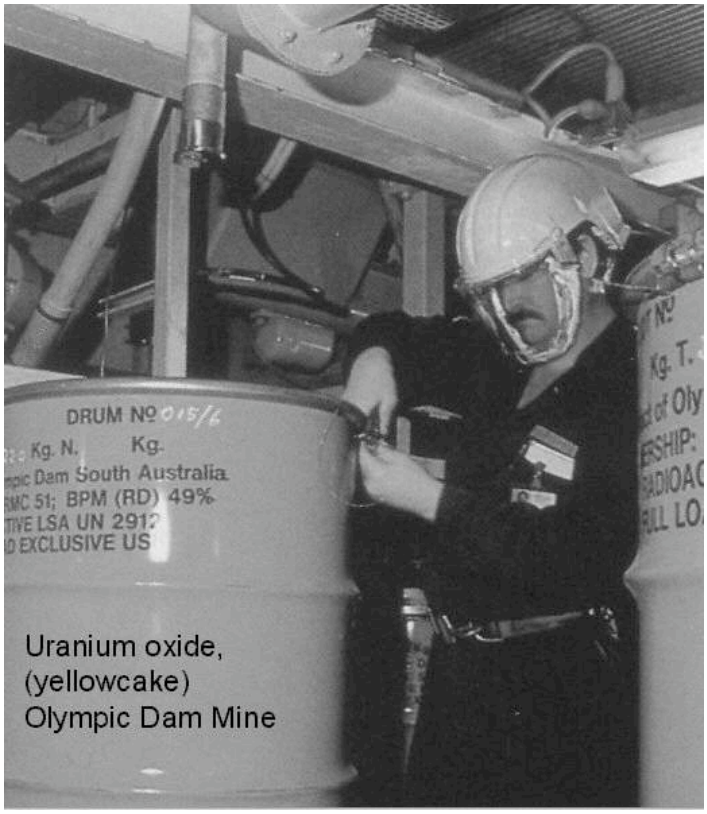
Photograph 7: *Beverley uranium mine,* in-situ *leach recovery, 2004*

Source: PIRSA, Division of Minerals and Energy, South Australia

Olympic Dam – a champion mine shapes a '3-mines policy'

The Olympic Dam ore body, discovered by Western Mining Corporation in 1975, lies hidden beneath 300m of sedimentary cover rocks. It has proven to be the world's largest known concentration of copper, uranium, gold and silver mineralisation – it contains 1.2 million tonnes of uranium oxide (40% of the world's known uranium resources) and it ranks among the world's largest producers. Mining and processing operations commenced in 1988. Such a bonanza might have been expected to enjoy bi-partisan support in its development from the outset, but that was not to be the case.[16]

Photograph 8: *Uranium oxide product, Olympic Dam Mine, 1988.*



Source: PIRSA, Division of Minerals and Energy, South Australia

When the Tonkin Liberal Government came to office in South Australia in September 1979, the Minister of Mines and Energy (Roger Goldsworthy) was quick to establish that mineral development was to be the top priority. Their policy on uranium development which was enunciated in Parliament in February 1980 extended to conversion and enrichment in South Australia, including SA Government equity in such projects, utilising Urenco-Centec technology; thus, to generate major new manufacturing activity and enhancement of the export value of the product in helping to

satisfy the increasing nuclear power demand from overseas. Sales of enriched uranium were expected to earn $600 million per year at that time. The cost of a conversion plant at Port Pirie was put at $80 million; an $800 million enrichment plant could be expected to start operations in the late 1980's.[17]

Photograph 9*: Honeymoon uranium recovery pilot plant, 1983.*

Source: PIRSA, Division of Minerals and Energy, South Australia

Meanwhile, the policy adopted by the ALP provided for closure of all uranium mines and to repudiate, without compensation, any existing contracts. John Bannon, as Leader of the Opposition in SA scorned the Olympic Dam Project, describing it as 'pie in the sky' in November 1981 – it was seen to be a mirage in the desert[18]. An Indenture to provide for mine development was enacted only when one of the Opposition crossed the floor in the Legislative Council and voted with the Government in June 1982. As proposals to mine at Olympic Dam loomed as a major issue in the forthcoming State elections, the ALP uranium policy was modified.

Denial of a production tenement to develop the Honeymoon deposit, despite successful pilot tests and the construction of a processing plant, was made by the ensuing Bannon Government in March 1983. The Beverley joint-venturers were, likewise, stalled. Ostensibly, the decision was based on concerns that there were unresolved problems associated with the nuclear industry; further, that there should be

no impediment to Olympic Dam becoming economically viable; and, disquiet about *in-situ* leaching as an experimental process. The 'reasoning' was fatuous and hypocritical in the extreme with regard to the distinction drawn between them and Olympic Dam; the one was 'safe' to mine and sell because uranium occurred together with other minerals – the other not.

Ideology gave way to expediency as 'the three mines' uranium policy was adopted by the ALP in November 1983 to accommodate Olympic Dam (together with existing mines in the Northern Territory –Nabarlek and Ranger). Part of the *quid pro quo* was the prohibition of the establishment of nuclear power plants and other stages of the nuclear fuel cycle.

The newly elected Hawke Federal Government, at the same time, withdrew support for UEGA (the Uranium Enrichment Group of Australia) by denying access to classified technology exchange and Government support on International Atomic Energy Agency commitments. UEGA had been established in early 1980 and comprised representatives of BHP, CSR, Peko-Wallsend and WMC. The enrichment opportunity which was destined to have more than trebled the value of Australian uranium exports was finally lost to construction of a similar plant in Louisiana (USA).[19]

A national low-level radioactive waste repository

A study was initiated in September 1991 for identification of a central site to provide a repository for the nation's low-level radioactive waste – geological integrity was seen to be a key requirement; a discussion paper was released to the State Governments by the Commonwealth Minister for Primary Industry and Energy (Simon Crean). Low-level waste consisting of contaminated soil, clothing, laboratory equipment, radiation sources and other items arising from research, medical and industrial use of radionuclides and amounting to 3,700m^3 have accumulated during the past 55 years; a further 40m^3 are being generated annually. In South Australia alone, there are 19 locations in metropolitan Adelaide and seven in country towns where such radioactive waste is held – additional to 2,500 tonnes that were consigned to Woomera for storage by the Keating Government.[20]

The issue was taken up by the Federal Howard Government in 2000 when the preferred site for such a facility was identified as being on Arcoona, near Woomera – but their proposals have been thwarted by the South Australian Rann Government,

which has chosen to ignore the advantages and political leverage that might have been extracted by way of compensation, infrastructure requirements and levies for usage.

The 2000 position – and outlook

No element has had such an impact on civilisation as has uranium. In the space of 100 years it has emerged from obscurity to become universally recognised as of wide medical and industrial benefit, dreaded as a weapon of potential mass destruction, and is utilised as a source of electrical energy.

The first nuclear power station to be connected to a public electricity grid was a 50 MW reactor at Calder Hall (England) in 1956. Fifty years later there are 440 commercial nuclear reactors operating in 31 countries (with over 360,000 MW of total capacity), supplying 16 per cent of the world's electricity as base-load power; a further 30 reactors are under construction in 11 countries, while 284 research reactors operate in 56 countries (including Australia)[21]. To meet their fuel requirements, about 70,000 tonnes of uranium are consumed annually. The demand is likely to increase in the future, it being argued by some that this is the most significant means of limiting anthropogenic 'greenhouse' gas emissions that are seen to influence global climate change.

South Australia is recognised, geologically, as a uranium province; it has a 100 years' history of uranium mining and processing. Despite turning down opportunities presented for involvement in other phases of the nuclear fuel cycle, the Government is supportive of proposals under consideration for expansion of output from Olympic Dam. *In-situ* leach recovery of uranium was initiated at Beverley in 2001. Despite the fact that the ALP's '3 mine policy' still pertains, this State is obviously well placed to take advantage of perceived future international growth of the nuclear power industry.

Endnotes

[1] D. Mawson, 'On certain mineral species associated with carnotite in the radioactive ore body near Olary', *Transactions of the Royal Society of South Australia,* 30, 1906, pp. 188-193

[2] L.C.E. Gee, *The occurrence of uranium (radioactive) ores and other rare metals and minerals, South Australia*, Government Printer, Adelaide, 1911.

[3] B. Campana and D. King, 'Regional geology and mineral resources of the Olary Province', *Bulletin of the Geological Survey of South Australia*, 34, 1958.

[4] R.P. Coats and A.H. Blissett, *Regional and Economic Geology of the Mount Painter Province*, 1971, Bulletin of the Geological Survey of South Australia, 43, 1971.

[5] *Uranium: the energy mineral, 1789 – 1989*, pamphlet published by The Uranium Institute, London, 1990.
[6] S. Cockburn and D. Ellyard, *Oliphant: the life and times of Sir Mark Oliphant*, Axiom, 1981.
[7] S.B. Dickinson, 'South Australian interests in uranium and atomic energy', *Symposium – Atomic Energy in South Australia*, N.S.W. University of Technology, 1954.
[8] *Radium Hill*, reprinted from Atomic Energy (Australian Atomic Energy Commission), January 1962.
[9] R. K. Johns, 'Uranium exploration in South Australia', in *AustIMM Monograph Series,* no. 17, 1990, pp 495–498.
[10] 'British Nuclear Testing', *http://comfuture.com/hew/Uk/UKTesting.html*, January 2005.
[11] Gaseous diffusion process: relying on the difference in the rate at which the hexafluoride's of U238 and U235 diffuse through a porous membrane – U235 molecules being smaller are able to pass through fine openings more readily. The operation is repeated in over 1000 diffusion stages under high compression to effect appropriate concentration. Such plants are physically large and have high electricity consumption; this technology may be regarded as obsolete.
Gas centrifuge process: pioneered by a British/Dutch/German consortium (Urenco), is also based on uranium hexafluoride gas which is fed into rapidly rotating centrifuges which spin the gas at high speed, causing the heavier U238 to settle near the walls of the machines and the lighter U235 near the centre. By counter-current repetition, through an interconnected series of centrifuges, a cascade affects the required degree of enrichment.
[12] A. Cawte, *Atomic Australia, 1944 – 1990*, NSW University Press, 1992.
[13] South Australia: Uranium Enrichment, Second interim report of the Uranium Enrichment Committee, Premier's Department, Adelaide, February, 1976.
[14] J.L. Curtis, D.A. Brunt and P.J. Binks, 'Tertiary palaeochannel uranium deposits of South Australia', in *AustIMM Monograph Series,* no. 14, vol. 2*,* 1990*,* pp. 1631–36.
[15] S.R. Howles, 'Beverley uranium project – groundwater resources, management and monitoring', *MESA Journal 17*, April 2000, pp. 4–6.
[16] N.C. Shierlaw, 'Roxby Downs and uranium – the key to South Australia's future', *Adelaide Advertiser,* 17 January 1979.
[17] 'Go ahead for nuclear enrichment industry', *The Australian*, 1 December 1981.
[18] Mike Rann, *'Uranium: Play it safe',* for the ALP (SA) Nuclear Hazard Committee, *Labor Forum*, vol. 4, no.1, March 1982.
[19] *Mineral Industry Quarterly*, no. 32, December 1983, SA Department of Mines and Energy.
[20] *Adelaide Advertiser*, 11 February 2003.
[21] '*Nuclear Power in the World Today*', *Nuclear Issues Briefing Paper no.7*, World Nuclear Association, London, October 2003.