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- Nuclear Power Plant Construction, Operation and Development -

AUSTRALIAN URANIUM RESOURCES, DEVELOPMENT AND SUPPLY

by

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ABSTRACT

The geologically favourable areas for the occurrence of uranium in Australia and the geology of the major deposits are discussed as well as exploration programs and expenditures. Australia has no short-term requirement for nuclear power generation and its reserves of 289,000 tonnes uranium, together with the prospects for further discoveries indicate that the country is destined to become a major exporter of uranium.

The Government's decisions on the development of the uranium mining and milling industry are outlined and information is given on the plans to bring new projects into operation.

1. INTRODUCTION

Australia possesses 17.5% of the Western World's uranium reserves (i.e. reasonably assured resources recoverable at a cost below US$80/kgU.(1) There is no doubt that further substantial additions to the country's uranium resources will occur if exploration continues, particularly in the Alligator Rivers Province in the Northern Territory. Nuclear power generation is unlikely to be adopted in Australia before the 1990's at the earliest, and hence domestic requirements for uranium are expected to be relatively small up to the turn of the century. Australia, therefore, is destined to become a major exporter of uranium.

This paper deals with the exploration for and the resources of uranium in Australia, the Government's decisions relating to development of the uranium industry, and the plans for the production of uranium concentrate.

2. URANIUM EXPLORATION

2.1 Geologically Favourable Areas (Figure 1)

The Alligator Rivers Uranium Province in the Northern Territory covers an area of about 25,000 km^2 and contains about 83% of Australia's uranium reserves. The region comprises complexes of granitoid rocks, gneisses and migmatite mantled and surrounded by a sequence of Lower Proterozoic sediments which are overlain by Middle Proterozoic sandstone and interbedded volcanics to the east and south. Mesozoic sandstone and Cainozoic sand and alluvium cover much of the central and northern parts of the region. The uranium deposits occur in the metamorphosed Lower Proterozoic sediments. Because a large percentage of the potential host rocks is covered by younger sandstones or by sand and alluvium, exploration to date is considered to have located only a portion of the uranium resources in this region.

Carnotite mineralisation is widespread in calcrete which occurs associated with valley-fill sediments in broad fossil valleys and existing trunk systems in semi-arid regions particularly in Western Australia. Carnotite mineralisation also occurs on the margins of several playa lakes. In addition to the Yeelirrie deposit several smaller occurrences are known. These deposits are all at shallow depth.

Several sedimentary deposits have been found in the Frome Embayment of the Great Artesian Basin in South Australia and western New South Wales. The Beverley deposit is a subsurface deposit in Tertiary sediments east of the Flinders Ranges where uranium rich granite basement crops out. Additional sedimentary uranium deposits occur in the southern part of the Frome Embayment in Pleistocene river channels cut into basement rocks of Precambrian to Tertiary age. Small roll front type deposits have been outlined at Gould's Dam, Honeymoon and East Kalkaroo.

The Mary Kathleen deposit in northwest Queensland occurs in a metamorphosed sedimentary sequence of Middle Proterozoic

age. Other occurrences have been found in this succession but exploration to date has not delineated further significant resources. To the west numerous uranium occurrences including a few small deposits occur within a predominantly volcanic sequence but the refractory nature of the mineralisation together with high acid consumption gangue materials have inhibited development.

In Central Australia uranium prospects have been found in Carboniferous sandstones of the Ngalia Basin at Bigrlyi and albiri and in Devonian-Carboniferous sandstones of the Amadeus Basin at Angela. There are also prospects for mineralisation of this type in the Eucla Basin in South Australia and in other sedimentary basins in the vicinity of Precambrian orogenic blocks.

Mineralisation has been found in several places in the Georgetown area of northern Queensland in sediments within an acid volcanic sequence of Carboniferous-Permian age. At the Maureen deposit, uranium mineralisation associated with fluorite and molybdenite occurs in a basal arkosic unit unconformably overlying high grade metamorphics of probable Archean age. There has been insufficient exploration to date to assess this area which has only recently been recognised as a potential new uranium province.

In the Westmoreland area on the Northern Territory-Queensland border there are several uranium prospects in a Middle Proterozoic sandstone. The deposits are essentially vein-type and mineralisation is concentrated along dykes, faults and disconformities and in places is bedding controlled.

Significant intersections of uranium have been encountered recently in drilling at the Olympic Dam prospect in South Australia. The uranium is associated with copper mineralisation and occurs in a hematitic granite breccia on a basement high overlain by some 350 metres of sediments. Further drilling is in progress to assess this prospect.

Uranium mineralisation has been located in several locations in Lower Proterozoic rocks of the Gascoyne Block in Western Australia. The uranium is associated with faults and pegmatites. No significant resource has been delineated to date but exploration is continuing.

2.2 Programs and Expenditures

Exploration for uranium in Australia can be divided into two distinct periods - 1947 to 1961 and post-1966. Several of the deposits discovered during the first period produced uranium - the two largest producers being the Rum Jungle field in the Northern Territory and Mary Kathleen in Queensland. Total production during the period 1954-1971 amounted to some 7,800 tonnes U.

In the second period of uranium exploration most of the work was undertaken by companies with substantial exploration budgets utilising the more advanced geological and geophysical techniques now available. Several major discoveries were made

steep dipping Lower Proterozoic sediments. In the unweathered parts of these orebodies the principal uranium mineral is pitchblende. The average grades range from 0.2 to 0.3% U_3O_8 at Ranger to 2.37% U_3O_8 at Nabarlek.

The Yeelirrie uranium deposit is situated in a drainage channel that cuts a granitoid-gneiss terrain in the northeast portion of the Archaean Yilgarn Block which is a shield area in Western Australia. Fill material in the Yeelirrie Channel which lies between erosion scarps of an old plateau surface is in excess of 85 m in depth in places, but it is seldom more than 30 m in the vininity of the orebody. The principal component of the fill material is fluvial clay with varying proportions of detrital quartz and feldspar, though aeolian sands form widespread plains together with sparse dune systems. Calcrete has developed extensively along the trunk valleys as a result of the calcification of valley fill sediments. This calcrete occurs in forms ranging from small discontinuous pods to large, irregular lenticular sheets up to 6.5 km in width and 20 m in thickness. Carnotite, the only uranium mineral identified, has been deposited as thin films on cavity walls in porcelaneous calcrete; it is dispersed through the earthy calcrete and it also occurs as grain coatings and disseminations in the clay-quartz unit and on fractures and fault planes in any lithology. The main zone of mineralisation extends over an area of approximately 6,000 m by 500 m and has an average depth of 8 m. The average grade of this orebody is 0.15 per cent U_3O_8.

The Mary Kathleen orebody is within Middle Proterozoic sediments which have been subjected to a high grade of metamorphism and intense structural deformation. These sediments consist of thinly bedded calcareous, siliceous and arenaceous material and near the top of the sedimentary sequence in the vicinity of the orebody there is a lenticular polymict cobble conglomerate containing mostly acid volcanic fragments. Granites and acid and basic dykes have intruded the sequence. Folding has produced a north plunging syncline, but subsequent faulting along a shear has "removed" a large part of the western limb of the fold. Metamorphism has altered the sedimentary sequence to impure marbles, schists, slates, feldspar diopside granofels, quartzites and amphibolites. The orebody is considered to occupy an altered part of the cobble conglomerate unit and the host to the uranium mineralisation is a zone of massive structureless garnet with lesser amounts of diopside, scapolite and feldspar. This orebody which cropped out at the surface is made up of lensoid shoots which parallel the margins of a broader garnetite mineralised zone. In plan the orebody is oval in shape with the long axis roughly parallel to the north-south strike of the country rock. In section the lenses dip to the west with the country rock. The dip is about 35° in the eastern portion and near vertical in the western margin. Within the shoots, uraninite is disseminated throughout allanite. Metal sulphides occur in minor quantities in places in the ore zone and rare earths are present in quantities that could possibly be exploited commercially. The average ore grade is 0.12% U_3O_8.

The Beverley deposit occurs in flat-lying Miocene sand

lenses within fine unconsolidated argillaceous sediments on an arid plain approximately 16 km east of the piedmonts of the Flinders Ranges. These ranges contain relatively small uranium vein deposits within Precambrian crystalline basement rocks. The sediments containing the ore lenses at Beverley occur between overlying non-carbonaceous clays and underlying carbonaceous clays which lie unconformably on Cretaceous shales and sandstones. The Cretaceous rocks in turn lie unconformably on a Precambrian crystalline basement at a depth of about 400 m. Pleistocene (?) argillaceous and clastic sediments, with some boulder beds, overlie the non-carbonaceous sediments. The uranium-bearing sands, which vary in thickness from one metre to over 20 m, are at an average depth of 107 m below the surface. Major variations in the thickness of the sands occur over very small horizontal distances. Within a 50 km^2 subsurface cell of anomalous radioactivity, one set of contiguous sands contain deposits of uranium that are collectively known as the Beverley Deposit. Uranium-bearing sand lenticles have been traced over a north-south distance of 3 km and with a width varying between 900 m at the north end and 100 m at the south end; interconnecting channels may be only a few metres in width. Uranium occurs as finely divided uraninite that probably is absorbed on clay and it is most frequently found in the lower sections of a sand lens. The average grade is 0.26% U_3O_8.

3.2 Resource Estimates

At June 30, 1977 the official estimates, prepared by the AAEC, of Australia's uranium resources are as shown in Table 2.

TABLE 2

ESTIMATED AUSTRALIAN URANIUM RESOURCES

(tonnes U; at 30 June, 1977)

Resources	Cost Range	
	Up to US$80/kg U	US$80-130/kg U
Reasonably Assured (1)	289,000	7,000
Estimated Additional (2)	44,000	5,000

Notes: (1) "Reasonably Assured Resources" refers to uranium that occurs in known mineral deposits of such size, grade and configuration that it could be recovered within the given production cost ranges, with currently proven mining and processing technology. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics. Reasonably Assured Resources have a high assurance of existence and in the cost category below $80/kg U ($30/lb U_3O_8) are considered as reserves.

(2) "Estimated Additional Resources" are confined to those known uranium deposits where there are insufficient data to classify the resources as "Reasonably Assured", and to extensions of known deposits beyond the limits of "Reasonably Assured Resources" in those deposits. (This definition is therefore more restrictive than that adopted by OECD-NEA and IAEA (1).

The data in Table 2 are for recoverable uranium, after taking account of mining and milling losses, and do not include potential or speculative ore at or in uranium districts away from the known deposits. The seven major deposits discussed in this paper account for about 98% of Australia's known reserves; most of the balance occurs within the Maureen deposit in Northern Queensland, the Westmoreland district in northwest Queensland, the Mount Isa district to the west of Mary Kathleen, and the Flinders Ranges deposits in South Australia.

Australia's uranium reserves in 1967 amounted to 6,200 tonnes U; after a decade of exploration the reserves have been increased to 289,000 tonnes U. Overall uranium exploration expenditure during this period amounted to approximately A$135 million (1977 values), indicating that the reserves delineated since 1967 have been established at a cost of A48 cents/kg U (1977 values). Table 3 gives a comparison of exploration costs (actual values) and the resultant increases in reserves for Australia and U.S.A.

TABLE 3

URANIUM RESERVES AND EXPLORATION EXPENDITURE - AUSTRALIA AND U.S.A.

Country	Uranium Reserves tonnes U		Exploration Expenditure 1966-1976 (inclusive)
	1966	mid-1977	
Australia	6,400	289,000	US$99,000,000
U.S.A.	123,000	523,000	US$693,000,000

The areas of the two countries are comparable; the data in Table 3 indicate the much larger exploration effort in the U.S.A. and emphasise the relatively low discovery cost of the Australian reserves.

Many of the Australian deposits at this stage are not fully delineated. Therefore, substantial increases in reserves at relatively low cost could be expected from drilling programs on extensions of known deposits, on anomalies where mineralisation has been indicated, and generally in the vicinity of known deposits. The cost of discovery of new deposits in areas

removed from the known deposits could be expected to be considerably greater since exploration to date would have found the more accessible resources in the known geologically favourable areas of the country.

It is considered that the potential for the discovery of further resources in Australia is of the order of five to ten times the known reserves.

4. THE GOVERNMENT'S URANIUM DECISIONS

A program of large scale development of uranium resources in the Northern Territory was announced by the Whitlam Government in October 1974, commencing with exploitation of the Ranger deposit followed by development of the other deposits in the Alligator Rivers Province. At that time an agreement was entered into by the Government, Peko Mines Ltd. and Electrolytic Zinc Company of Australasia Ltd. (Peko/EZ) for the joint development of the Ranger deposit by the Commonwealth Government and those companies. This agreement was elaborated subsequently in a Memorandum of Understanding concluded between the Whitlam Government and Peko/EZ. The Memorandum of Understanding provides for the Commonwealth, through the Australian Atomic Energy Commission, to engage in a Joint Venture with Peko/EZ for the mining of uranium at Ranger beginning with the establishment of a mine of 2,500 tonnes uranium capacity. The capital is to be provided in the proportions 72½% by the Commonwealth and 27½% by Peko/EZ, with Peko/EZ receiving the net proceeds of sale of 50% of the uranium produced.

In July 1975 the Whitlam Government directed that an inquiry be conducted under the Environment Protection (Impact of Proposals) Act 1974 in relation to the above proposal for the development of the Ranger resources at Jabiru. During the course of the Ranger Uranium Environmental Inquiry (RUEI) successive Governments stated that decisions on the development of Australia's uranium resources would await consideration of the inquiry's findings.

The RUEI submitted its first report in October 1976 largely covering generic issues (i.e. examination and evaluation of the hazards and problems of the handling and use of uranium in a world context)[2]. The final RUEI report was submitted in May 1977 and it dealt principally with matters specific to the Ranger proposal and the Alligator Rivers Region[3].

After careful consideration of the Reports of the RUEI the Government announced in the Parliament on 25 August 1977 its decision to proceed with the further development of Australia's uranium resources on a carefully regulated and controlled basis having full regard to the protection of the environment and the welfare of the Aboriginal people[4]. (Copies of these comprehensive statements of Government policy are available to the Conference). The Government's decision was taken on the basis of the Inquiry's principal findings

and recommendations. Only in a few cases have the Government's decisions varied from the Inquiry's recommendations and the Government believes that each variation meets the Inquiry's request that it should "just as satisfactorily achieve the same purposes and satisfy the same plans as the Inquiry's proposal"

In reaching its decisions on uranium development the Government had special regard to the issues of nuclear non-proliferation and world energy requirements. As regards the former, it is the view of the Government that only by developing its vast uranium resources can Australia play a real role in strengthening nuclear safeguards and preventing any ill-considered rush to plutonium based energy systems. Only as a major potential exporter of uranium is Australia in a position to command attention and exert influence in the direction of more stringent nuclear safeguards systems. The United States of America, Canada and other nuclear supplier countries have in recent times taken initiatives to strengthen nuclear safeguards. Australia, in its position as a major uranium exporter, strongly supports such nuclear non-proliferation and safeguards initiatives.

As regards the second consideration, the Government recognises Australia's international responsibility as a country rich in energy resources to make its resources available to countries who are less well endowed. In the wake of the World Energy Crisis many countries have no viable alternative energy source other than nuclear power.

Since 25 August 1977 the Government has proceeded with the implementation of its policy and enabling legislation has been passed by the Parliament. The Government hopes that development can get underway during the current dry season.

5. PRODUCTION STATUS AND PLANS

In 1976 the Government announced its policy for new uranium development projects involving investment by foreign interests[5, 6]. Essentially it is that such developments will only be allowed to proceed provided they have a minimum of 75% Australian equity and are Australian controlled.

5.1 Mary Kathleen

At present the only production of uranium concentrate in Australia is at Mary Kathleen. The open-cut mine and treatment plant were placed on a care-and-maintenance basis in 1963; recommissioning occurred late in 1975, the planned nominal capacity being 760 tonnes U per annum. Radiometric sorting of the ore, conventional sulphuric acid leaching, solvent extraction purification and ammonia precipitation are used in this plant. Due to difficulties in commissioning and operation, production at Mary Kathleen during 1977 was only about 50% of capacity. It is now expected that future production will be about 500 tonnes U per annum.

5.2 Other Deposits

As regards the Ranger Project, the Government announced on 25 August 1977 its decision that this Project will proceed on the basis of the Memorandum of Understanding entered into between the Whitlam Government and Peko/EZ. In doing so, the Government stated that it is prepared to honour the Agreement with Peko/EZ which it inherited from the Whitlam Government. The number one ore body of the Ranger Project will be developed first and the ore treated in a conventional acid leach process. The project is planned for an initial capacity of 2,500 tonnes uranium per annum, with expansion to 5,000 tonnes per annum as markets allow.

The status of development of the other deposits referred to in Table 1 (apart from Mary Kathleen) was stated as follows by the Deputy Prime Minister in his statement to Parliament on 25 August 1977.

"Subject to satisfactory completion of the necessary environmental requirements and conclusion of arrangements with the Aboriginal people, the Government will take a decision on development of the Nabarlek deposit by Queensland Mines Limited.

Decisions on the development of the Jabiluka and Koongarra deposits will be taken following the completion of the abovementioned requirements. In the case of Koongarra, it was made clear by the Ranger Inquiry that there would be a considerable amount of planning and investigation to be completed, particularly having in mind the fragility of the environment which could be affected by development at Koongarra.

The Ranger Inquiry recommended that there be sequential development of the mines in the Alligator Rivers Region at appropriate intervals. The existing deposits are at different stages of investigation and there will of course be different environmental and other requirements necessary in each case. This will result, in practice, in mines coming into production at different times. The Government therefore sees it as unnecessary to set down a specific timetable of sequential development and it is satisfied that completion of the requirements, which will be a prerequisite for any development in each case, will result in the Ranger Inquiry's recommendations regarding development being satisfied.

Subject to satisfactory completion of the necessary environmental requirements, the Government will also take decisions on the development of projects in the States.

In coming to these general conclusions on Nabarlek, Jabiluka, Koongarra, on development in the States and on the question of sequential development, the Government is conscious that particular decisions must await the outcome

of environmental procedures. The Government believes it is not appropriate at this stage to come to decisions which could pre-empt environmental consideration or foreclose the Government's intention to take decisions in full knowledge of facts that may arise at a later stage, including the careful monitoring we will maintain of the overall impact of activity on the Alligator Rivers Region."(4)

In regard to the above deposits other than Ranger, production planning has been stated by companies as follows:

- Jabiluka - initial production at a rate of 2,500 tonnes uranium per annum, expanding to 7,600 tonnes per annum within about 4 years;

- Nabarlek - production at a rate of 900 tonnes uranium per annum;

- Koongarra - development at a rate of 1,700 tonnes uranium per annum;

- Yeelirrie - mining to be open-cut technique and the uranium recovered by an alkaline leach process. The Company plans to build a pilot plant to determine design and operating parameters before proceeding to full-scale production at a rate of some 2,000 tonnes uranium per annum;

- Beverley - to be developed by open-cut methods and the uranium recovered by a sulphuric acid leach process. Production is contemplated at about 1,200 tonnes uranium per annum.

6. SUPPLY POSITION

Prior to December 1972 export contracts were entered into by the companies for the sale of a nominal 9,045 tonnes uranium from the Mary Kathleen, Ranger and Nabarlek resources with deliveries in the period 1976 to 1986. The delay in the development of the latter two deposits has necessitated use of the Government's stockpile of uranium concentrate as an interim measure to honour the delivery commitments.

In regard to production and sales, the Government made the following statement on 25 August 1977:

"The Ranger Inquiry assumed that production and sales would begin in 1981-82 at a rate of 2,000 short tons of uranium oxide increasing to 10,000 short tons in 1985-86. These estimates are broadly in line with the Government's assessment of the world market situation in the first half of the 1980s. After 1985, the likely exports that Australia could make would increase substantially. Although actual sales prospects will not be known until Australia actively seeks long term contracts in the market on the basis of actual production, the forecasts

presently available provide a basis on which carefully regulated development can proceed." (4)

On 1 June 1978 the Government announced to the Parliament the details of the nature of regulation and control which the Government will exercise over the export marketing of Australian uranium including the establishment, at the appropriate time, of an Australian Uranium Export Authority which could advise the Minister for Trade and Resources on the range of matters relevant to his control over the regulation and export of Australian uranium.(7)

7. NUCLEAR SAFEGUARDS POLICY

The nuclear safeguards policy of the Australian Government was announced by the Prime Minister in a statement to Parliament on 24 May 1977.(8) The main components of Australia's policy are:

(1) Careful selection of the countries to whom uranium export will be permitted:

- In the case of non-nuclear weapon states, sales will be made only to countries which are parties to the Non-Proliferation Treaty (NPT) - it follows that Australia's customers in this category will be countries which have renounced the nuclear weapons option and which accept IAEA safeguards, covering the whole of their civil nuclear industry;

- In the case of existing nuclear weapon states, Australia requires as a condition of agreement with those states, an assurance that nuclear material supplied for peaceful purposes will not be diverted to military or explosive purposes and that it will be covered by IAEA safeguards - this requirement is additional to the Ranger Inquiry recommendations.

(2) The prior conclusion of bilateral agreements with countries wishing to import Australian uranium. In addition to the undertaking that nuclear material supplied by Australia for peaceful purposes will not be diverted to military or explosive purposes, and that IAEA safeguards will apply, other provisions will include:

so called fallback safeguards - these are contingency arrangements to ensure that continued safeguarding of material already present in an importing country in case safeguards under the NPT at some stage cease to apply;

- prior Australian consent to any transfer of the supplied nuclear material to a third party

- prior Australian consent to enrichment of supplied uranium beyond 20 per cent uranium 235;

- prior Australian consent to reprocessing of supplied nuclear material;

- adequate physical security on the nuclear industries of importing countries.

(3) Sales arrangements for Australian uranium such that the uranium will be in a form which attracts full IAEA safeguards by the time it leaves Australian ownership.

(4) Inclusion in commercial contracts for uranium supply of a clause noting that the transaction is subject to the provisions of the bilateral agreement between the Australian Government and the importing country.

(5) Australia's contributing to constructive multilateral efforts to strengthen safeguards.

(6) Recognition of the need to keep safeguards closely under review to take account of the future evolution of international thinking on this subject.

8. CONCLUSION

In the early 1970's major uranium discoveries were made in Australia and it is now recognised that the country contains a significant percentage of the world's reserves. Geologically favourable areas for the occurrence of uranium are widespread and have not yet been adequately explored. Australia must therefore be classed as a country having a large potential for further uranium discoveries.

Australia's decision, as announced on 25 August 1977, to proceed with further uranium development has received wide acceptance in Australia and abroad. Australia has set itself a policy of carefully regulated and controlled development, paying due regard to proper environmental control and ensuring the welfare of the Aboriginal people. The Government believes that the successful and prompt implementation of its policy is a challenge for all sections of the Australian community and one which Australians are well equipped to accept.

9. REFERENCES

1. "Uranium - Resources, Production and Demand"; Joint Report by OECD Nuclear Energy Agency and the International Atomic Energy Agency; OECD, Paris, 1977.

2. "Ranger Uranium Environmental Inquiry First Report"; Australian Government Publishing Service; Canberra 1976.

3. "Ranger Uranium Environmental Inquiry Second Report"; Australian Government Publishing Service; Canberra 1977

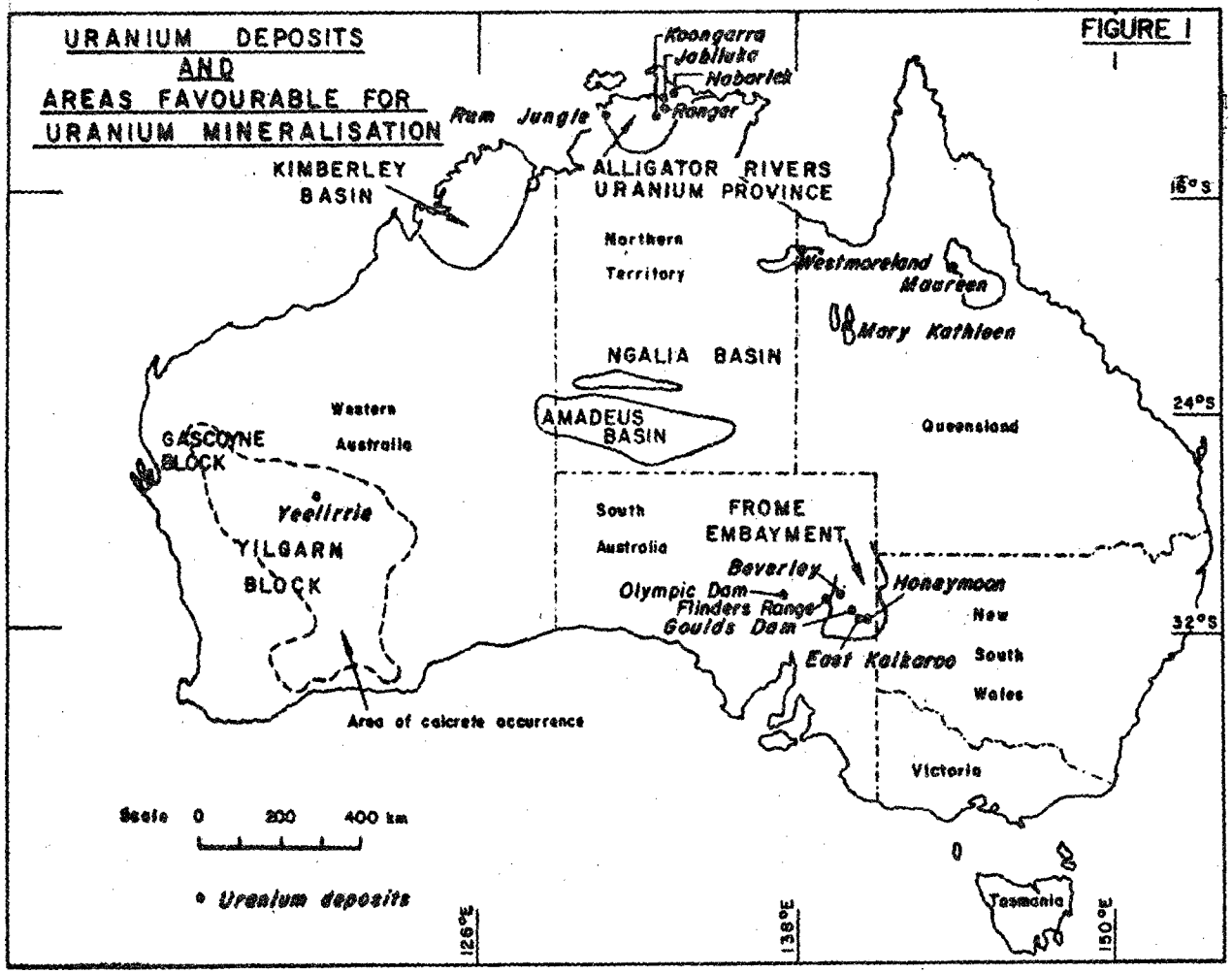
4. "Uranium - Australia's Decisions"; Commonwealth of Australia; Canberra 1977

5. "Foreign Investment Guidelines"; Statement by the Treasurer to Parliament (House of Representatives), Canberra, 1 April 1976 (Treasurer's Press Release No. 62, 1976)

6. "Statement by the Deputy Prime Mininster and the Treasurer"; Canberra, 28 May 1976 (Treasurer's Press Release No. 101, 1976)

7. "Uranium Export Policy"; Statement by the Deputy Prime Minister to Parliament (House of Representatives); Canberra, 1 June 1978.

8. "Government Policy on Nuclear Safeguards"; Speech by the Prime Minister to Parliament (House of Representatives); Canberra, 24 May 1977.


URANIUM DEPOSITS
AND
AREAS FAVOURABLE FOR
URANIUM MINERALISATION
FIGURE 1
Koongarra
Jabiluka
Nabarlek
Ranger
Rum Jungle
KIMBERLEY
BASIN
ALLIGATOR RIVERS
URANIUM PROVINCE
Northern
Territory
Westmoreland
Maureen
Mary Kathleen
NGALIA BASIN
AMADEUS
BASIN
Western
Australia
GASCOYNE
BLOCK
Yeelirrie
YILGARN
BLOCK
South
Australia
FROME
EMBAYMENT
Beverley
Olympic Dam
Flinders Range
Goulds Dam
Honeymoon
East Kalkaroo
Queensland
New
South
Wales
Victoria
Tasmania
Area of calcrete occurrence
Scale 0 200 400 km
Uranium deposits
16°S
24°S
32°S
129°E
138°E
150°E