THE URANIUM RESOURCES AND PRODUCTION OF NAMIBIA

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Abstract

The promulgation of the Minerals (Prospecting and Mining) Act, 1992, on 1 April 1994 and the simultaneous repeal of restrictive South African legislation on reporting uranium exploration and production results, allowed the Namibian Government for the first time to present information for publication of the report "Uranium 1995 — Resources, Production and Demand", by the OECD Nuclear Energy Agency and the IAEA. Namibia, one of the youngest independent nations in Africa, has a large number of uranium occurrences and deposits in several geological environments. The total estimated uranium resource amounts to about 299 thousand tonnes recoverable uranium at a cost of less than US$ 130/kg U, within the known conventional resources category. The most prominent geological type of these is the unique, granite-related uranium occurrences located in the central part of the Namib Desert. A number of large tonnage but low-grade deposits suitable for open-cast mining, were identified between 1960 and 1980, the peak period for uranium exploration. At one of these deposits, Rössing, mining operations started in 1976 and will continue into the first quarter of the next century. The presence of other, so far undiscovered deposits are suspected under thin Tertiary cover within this uranium province. Calcrete-hosted uranium occurrences and deposits are of secondary importance, due to a lower recoverable tonnage of uranium and complications with metallurgical processes. At times of better uranium markets however, at least one of these deposits will receive serious attention. Permo-Triassic age Karoo sandstone-hosted uranium deposits were subject to only limited exploration due to the down-turn of uranium prices in the latter part of 1980s, despite the very encouraging exploration results. As only limited Karoo sandstone-covered areas were tested there is still great potential for further discoveries. The planned output of Rössing Uranium Mine at 40 000 tonnes of ore per day which results in an annual production of 4536 tonnes of uranium oxide, was achieved in 1979. Due however, to the subsequent slump in uranium prices and demand the annual production was reduced by about 50% to the present 1911 tonnes of contained uranium (in 1994). Full production capacity, depending on world markets, can be achieved within a short period of time. In case of improved uranium market conditions, Namibia is in a strong position to increase uranium production and open up new production centrès to strengthen the country's position as an important uranium producer in the world.

1. INTRODUCTION

The promulgation of the Minerals (Prospecting and Mining) Act, 1992, on 1 April 1994 and the simultaneous repeal of restrictive South African legislation on reporting uranium exploration and production results, allowed the Namibian Government for the first time to present information for the publication of the Red Book, a report compiled by the OECD Nuclear Energy Agency and the IAEA.

As the purpose of this paper is provide an overall review of the uranium deposits/occurrences, no great details are given of the geological description of the more than 50 known occurrences nor of the results of reserve calculations or feasibility studies, most of which are in any case, out-dated by at least twenty years. For the location of the most important uranium deposits of Namibia the reader is referred to Fig. 1. In case of further interest the reader is referred to articles in various geological publications, the open file reports of the Geological Survey of Namibia and the soon to be published Uranium Chapter of the Mineral Resources of Namibia

2. URANIUM EXPLORATION

The first significant discovery of radioactive mineralization within Namibia was made in 1928 in the Rössing region by autoradiograph tests on a supposed sample of pitchblende.

As a result of an upswing in uranium market demand and prices, extensive uranium exploration started in Namibia in the late 1960s. Several airborne radiometric surveys were conducted

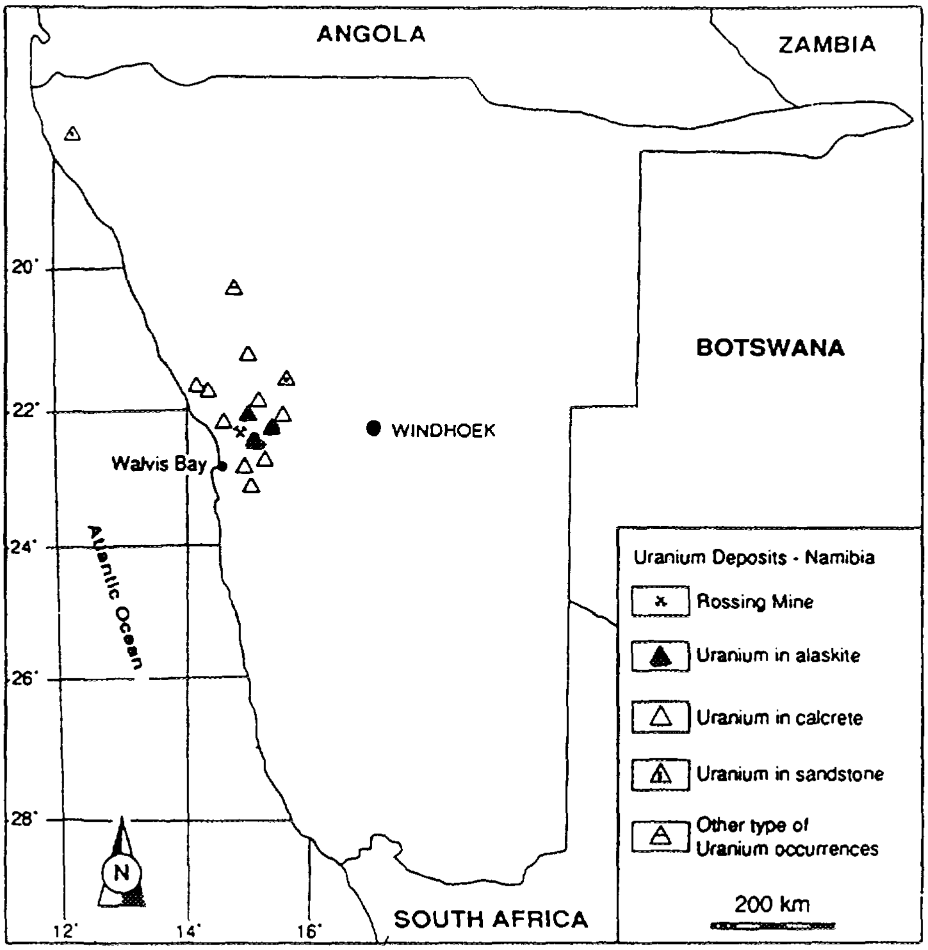

FIG. 1. Uranium deposits of Namibia.

by the Geological Survey during this period and numerous uranium anomalies were identified. Of these, the Rössing deposit where Rio Tinto Zinc obtained exploration rights in 1966, developed into a large scale open-cast mine which started production in 1976.

Development of Rössing combined with a sharp upward trend in uranium prices, stimulated extensive exploration activity, mainly in the Namib Desert. Two major types of deposits were located i.e. mineralization associated with intrusive granitic rocks ("alaskite") and mineralization associated with recent calcrete formations. Of the granitic type deposits, beside Rössing Mine, the Trekkopje deposit has significant reserves. Langer Heinrich, a calcrete hosted uranium deposit is the most promising occurrence within the second category. The combined effect of political uncertainty and the decline in uranium prices caused the rapid curtailment of exploration and development work by the early 1980s. This was indeed unfortunate as the refinement of exploration techniques on this unusual area were poised to locate a number of new deposits.

Since the 1980s, the continued weakness of the uranium market discouraged further exploration activities, except in the immediate vicinity of Rössing Uranium Mine. While uranium exploration in a limited extent continued near Rössing until 1992, exploration for uranium ceased in Namibia since that date. In 1992 uranium exploration expenditure amounted to just over 1 million Namibian Dollars (at par with South African Rand).

However, should a sustained upturn in demand for uranium occur, which may be the case by the end of the 1990s, it remains possible that mining of one of the mentioned deposits will prove commercially viable, with Langer Heinrich generally regarded as having the best potential.

3. URANIUM RESOURCES

Costs were calculated by using data provided by US Bureau of Mines 1993, updated to 1st January 1995. Descriptions, including reserve calculations are available for most uranium deposits of the country excluding some, often larger deposits where mining companies are still the holder of the mineral rights or information is not available.

While the cost of acid leaching uranium recovery is relatively well known, costs are not available for the alkaline leaching technique, which recovery method is essential for the calcrete hosted uranium deposits. In the latter case recovery costs were increased by an additional 50% to take into account the envisaged higher costs.

In view of limited information available for the Estimated Additional Resources Category II and the Speculative Resources Category no estimation for these resource categories were attempted.

3.1. Known Conventional Resources (Reasonably Assured Resources and Estimated Additional Resources Category 1)

The total resource in this category amounts to about 299 thousand tonnes of uranium at a cost of less than US$ 130/kg U, see Table I.

TABLE I. NAMIBIA — KNOWN CONVENTIONAL URANIUM RESOURCES (IN TONNES OF URANIUM)

IAEA Resource Class	Cumulative Cost Ranges		
	< US$40/kg U	< US$80/kg U	< US$130/kg U
Reasonably Assured	78 552	160 587	191 822
Estimated Additional Category I	70 546	90 815	107 513
TOTAL	149 098	251 402	299 335

The bulk of this resource is associated with intrusive granites — locally termed "alaskite" (alkaline leucogranite) in the vicinity of Rössing Uranium Mine, in the proximity of Walvis Bay, the main harbour town of Namibia. See Figs 2, 3 and 4. The total resource excludes few deposits where reserve estimations and therefore cost estimations have not as yet been assessed by the Mining Directorate.

The granite-associated uranium province is restricted to the axial structural zone of the Precambrian Damara Orogenic Belt and is approximately 100 kilometres long and 50 kilometres wide.

A large number of calcrete hosted deposits have been identified and intensively explored, however their total combined uranium content is less than 10% of the total resource of this category. The calcrete hosted uranium deposits are broadly associated with the uraniferous alaskite and were derived by decomposition of the alaskite and the subsequent migration of secondary uranium mineralization to a favourable depositional environment.

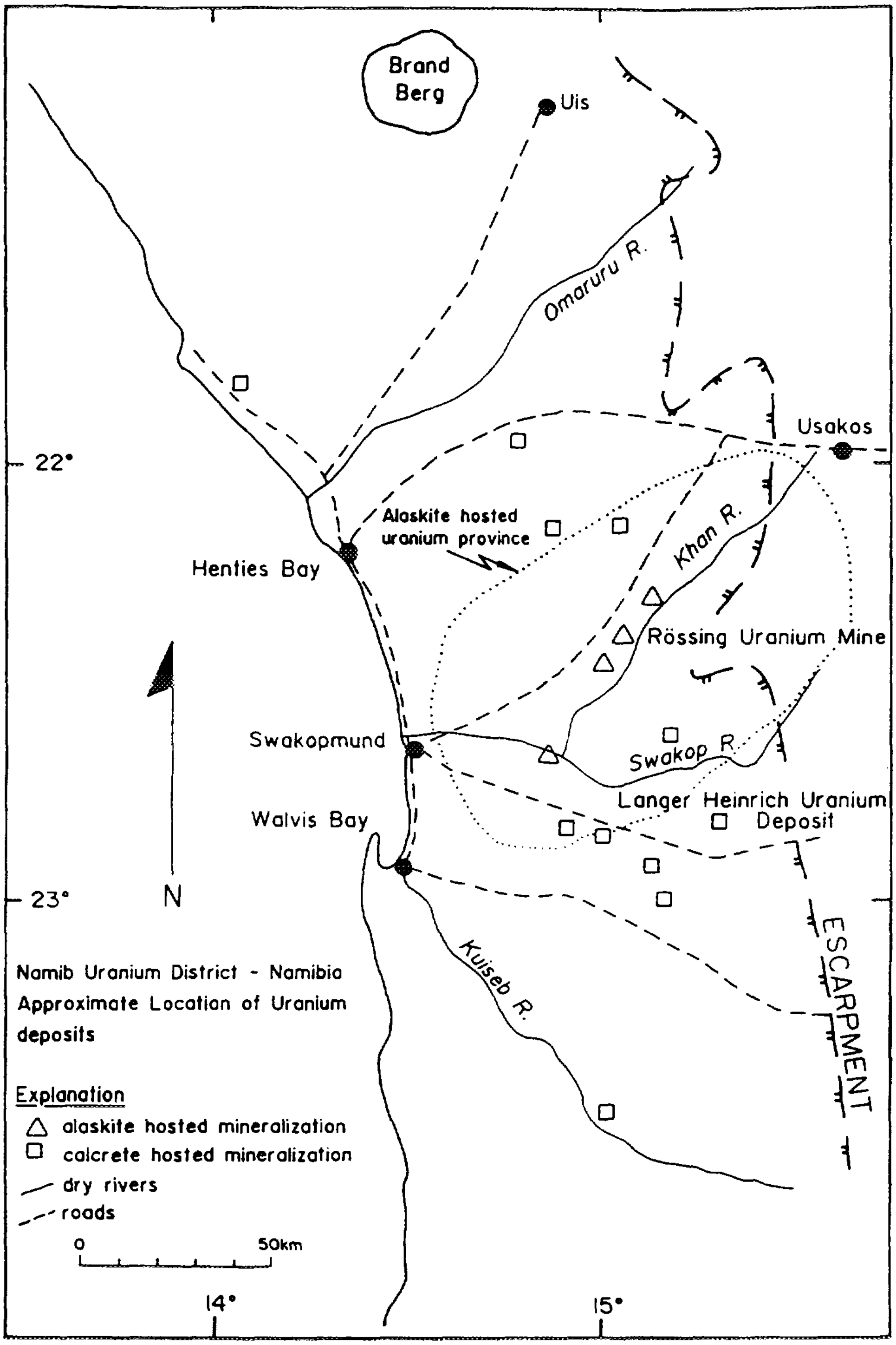

FIG. 2. Location of uranium deposits in the Namib uranium district.

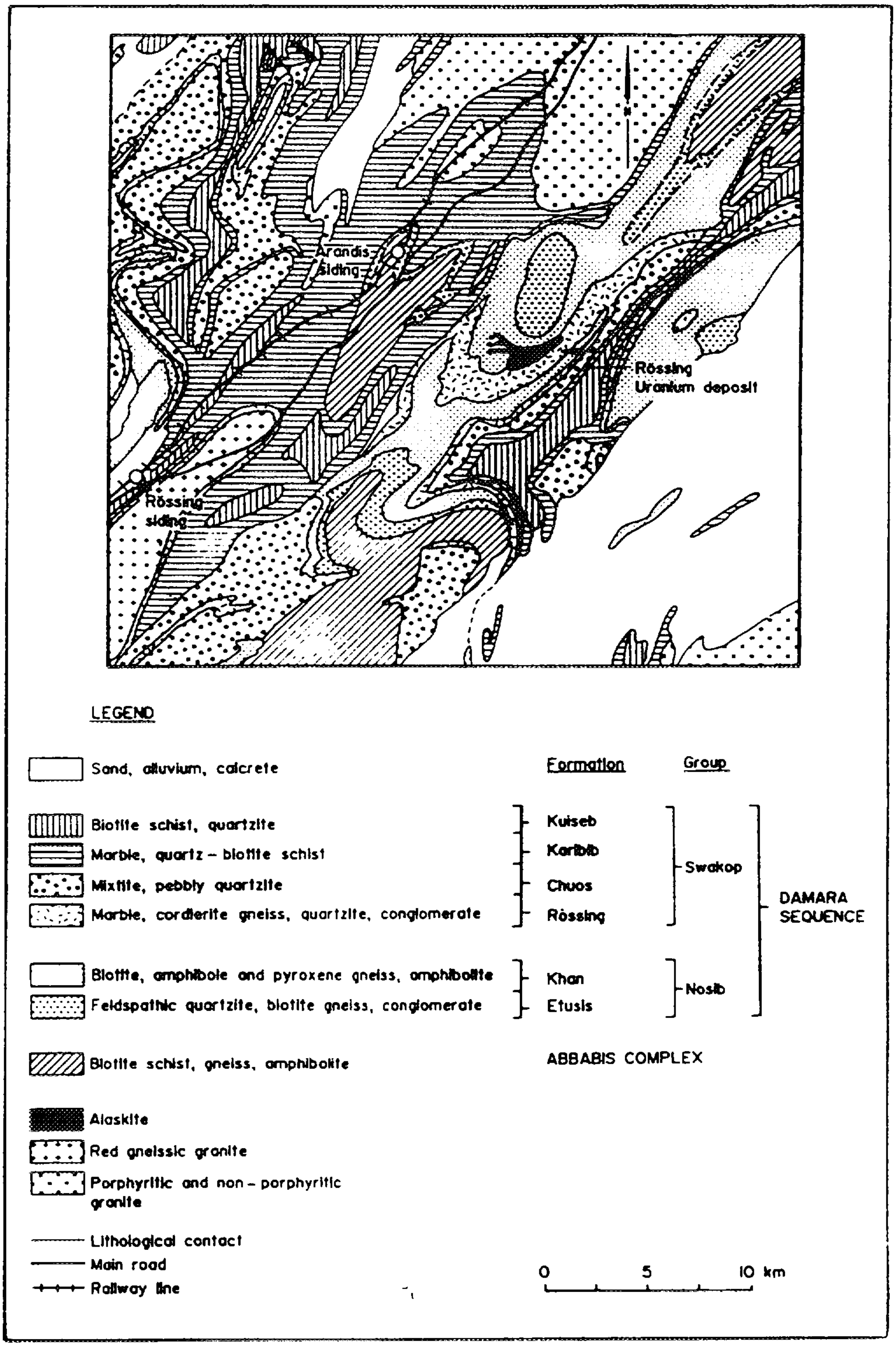

FIG. 3. Geological map of Rössing uranium mine and vicinity.

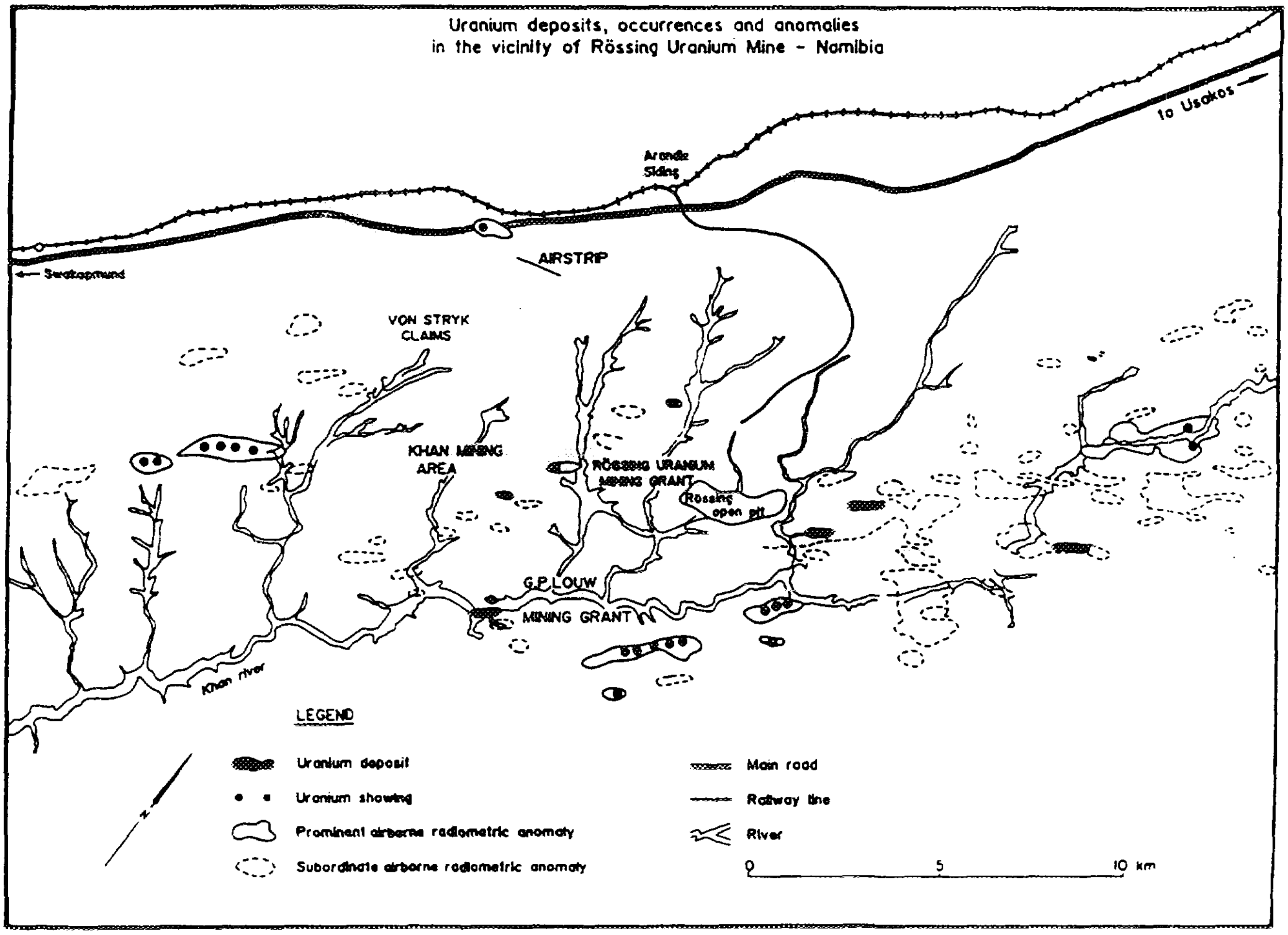

FIG. 4. Uranium deposits, occurrences and anomalies in the vicinity of Rössing uranium mine.

3.2. Undiscovered Conventional Resources (Estimated Additional Resources Category II and Speculative Resources)

Although speculative figures are not provided within the Undiscovered Conventional Resources Category, substantial resources are expected in the following geological types.

3.2.1. Intrusive deposits (IAEA type 6)

The granite-associated uranium province covers approximately 5000 km² of an area which is largely covered by calcrete and or wind-blown semi-consolidated sand. As past investigation concentrated on follow-up of airborne radiometric anomalies, substantial additional reserves, maybe of the size of Rössing, are suspected under the superficial cover.

3.2.2. Calcrete-hosted deposits (IAEA type 10)

Within the calcrete covered terrain, of the 38 major regional airborne radiometric anomalies, eleven anomalies were successfully investigated by intensive drilling, providing proven resources included under the proven resource category. In most cases the generally low grade mineralization is associated with calcrete-filled paleo-river channels. Whilst the existence of additional resources within Tertiary sediments is not discounted, the presence of a large undiscovered resource is unlikely. See also Fig. 2.

3.2.3. Sandstone-hosted deposits (IAEA type 2)

The Permo-Triassic age Karoo sediments were intensively investigated in neighbouring countries in the early 1970s and to a limited extent in Namibia as well. As these sediments are extensively dissected by river systems in the north-western part of Namibia, airborne radiometric anomalies are more pronounced. Ground follow-up and extensive drilling delineated nearly 6 million tonnes of low grade uranium mineralization, which was excluded from the proven resource category due to high cost of recovery. The mineralization is associated with coarse clastic sediments, carbonaceous sulphidic shale and limestone. Additional economically recoverable resources may be present within similar age sediment in other, so far unexplored parts of Namibia.

4. URANIUM PRODUCTION — RöSSING URANIUM MINE

4.1. Historical Review — Rössing Uranium Mine

In 1928, Captain G. Peter Louw prospected and found uranium mineralization in the vicinity of Rössing Mountains within the Namib Desert. Over many years he tried to promote the prospect, but only in the late 1950's, a major mining company, Anglo American Corporation of South Africa, prospected the area by drilling and some underground exploration. Due to erratic uranium values and poor economic prospects for uranium, Anglo American abandoned the search.

In August 1966, Rio Tinto Zinc acquired the exploration rights and conducted an intensive exploration programme till March 1973. Surveying, mapping, drilling, bulk sampling and metallurgical testing in a 100 tonnes/day pilot plant indicated the feasibility of establishing a mine.

Rössing Uranium Limited was formed in 1970 to develop the deposit. RTZ was the leading shareholder with 51.3 % (at the time of the formation of the company) of the equity.

In 1972, Rössing awarded a management contract for the design, engineering, procurement and construction of the project to a joint venture of Arthur G. McKee, Western Knapp Engineering Division and Davy Powergas. Mine development commenced in 1974 and the commissioning of the plant and the initial production commenced in July 1976 with the objective of reaching full design capacity of 5000 short tonnes (4536 metric tonnes) per year of uranium oxide during 1977. Due to the highly abrasive nature of the ore, which was not identified during pilot plant testing stage, after some major plant design changes, the target capacity was only reached in 1979.

4.2. Status of Production Capability — Rössing Uranium Mine

At full production the plant's full throughput rate at Rössing Uranium Mine is 40 000 tonnes of ore per day which would provide 4536 tonnes of uranium oxide annually. However, due to weakness in the current market the Rössing operation has been restructured, downsized and is now operating at 50% of capacity. Full production capacity could be achieved within a short period of time, should market conditions warrant.

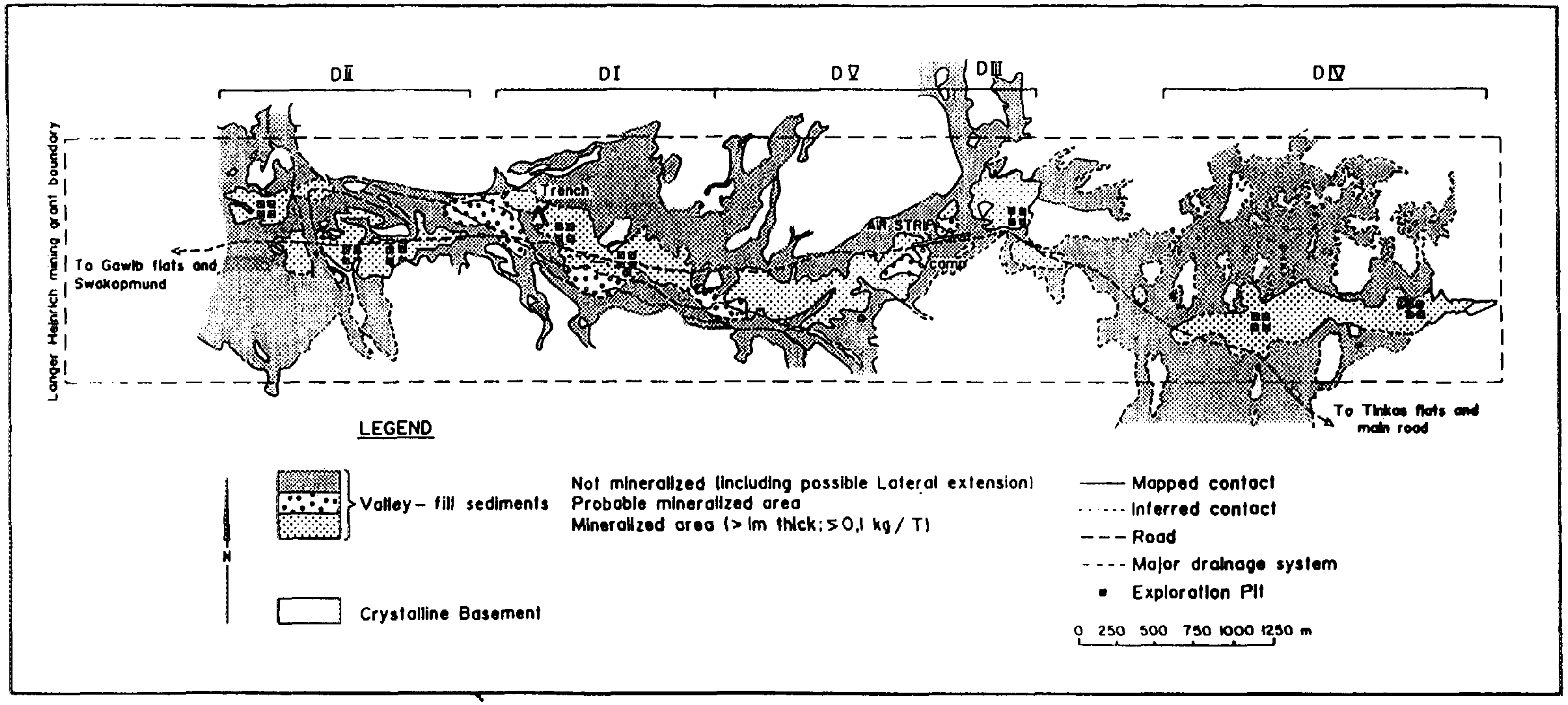

FIG. 5. Simplified geological map of Langer Heinrich uranium deposit.

TABLE II. HISTORICAL URANIUM PRODUCTION — RÖSSING URANIUM MINE (TONNES URANIUM CONTAINED IN CONCENTRATE)

	Pre 1992	1992	1993	1994	Total to 1994	Expected 1995
Conventional Open Pit Mining	51 360	1673	1668	1911	56 612	1962

4.3. Ownership structure and employment in the uranium industry — Rössing Uranium Mine

The present ownership structure of Rössing uranium mine is:

RTZ Corporation	56.3%	IDC South Africa	10.0%
Namibian Government	3.5%	Others	20.2%
Rio Algom Limited	10.0%		

There have been no significant changes in the employment in the uranium industry within the last two years. Employment at Rössing Uranium Limited, the sole producer, is currently 1250.

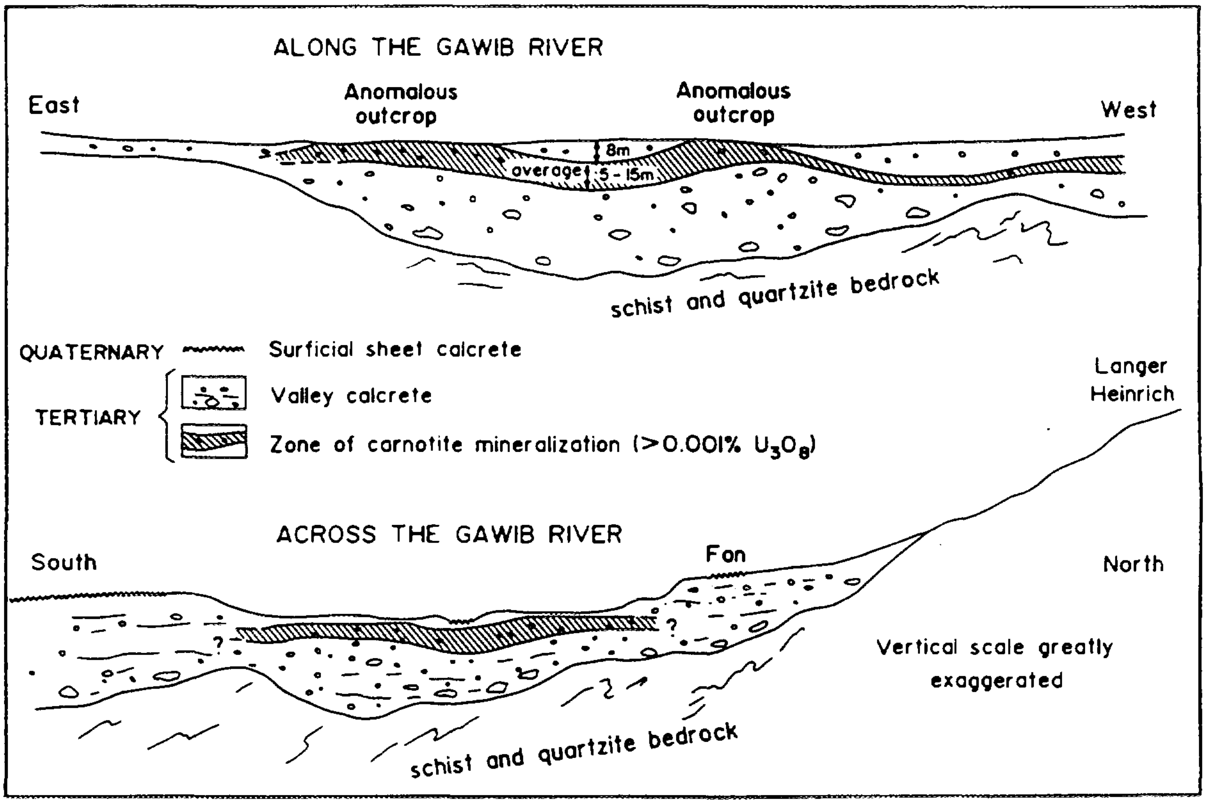

FIG. 6. Simplified sections across the Langer Heinrich uranium deposit.

4.4. Future production centres

Beside the Rössing operation no new production centre is planned for the next five years, even if the uranium market dramatically improves. However, after the five year period, under a favourable market conditions, the planning of at least one additional production centre is envisaged, maybe at Langer Heinrich, where large proven resources are available. See Fig. 5 for the Simplified Geological Map and Fig. 6 for Simplified Sections across the Langer Heinrich Deposit.

4.5. Uranium production, long term capability

Under favourable market conditions Rössing Uranium Limited, the sole uranium producer in Namibia, could return to full production capacity of close to 4000 t U per annum. The existing reserves would be expected to enable production from this source to continue until at least 2017.

Favourable market conditions would also allow the exploitation of at least one additional mine at a rate of about 1000 t U per year.

4.6. Factors influencing long term uranium production capability of Namibia

A number of proven uranium deposits have been discovered in Namibia and there is great potential for the discovery of additional deposits under the Tertiary sand and calcrete cover.

The most important criteria to extend production or opening new production centres is the price and demand for uranium in the world markets. Under favourable conditions some of the already proven deposits could be brought into a production stage. An additional and also important factor is the availability of water for the possible new production centres.

5. ENVIRONMENTAL CONSIDERATIONS

Namibia's constitution requires that the state actively promote and maintain the welfare of the people by adopting policies aimed at ensuring that ecosystems, essential ecological processes and the biological diversity of Namibia are maintained. However, environmental legislation that stems from this provision still remains a draft (soon to be finalized) as the country addresses more pertinent issues of education and development of its people.

Under the provisions of the Minerals (Prospecting and Mining) Act 1992, an applicant for a mineral licence, including the mining licence, has to complete an environmental assessment study and to prevent any damage to the environment from exploration and mining activities. In case of mining, the rights holder is obliged to rehabilitate land disturbed by mining.

Whilst the Namibian environmental legislation and standards remain to be established, the management of Rössing Uranium has adopted standards and performance criteria used by other developed countries. Presently a comprehensive review of environmental standards and performance criteria is being carried out by the Rössing Uranium Mine to develop site specific, risk based environmental objectives and thresholds.

As Namibia's only producing uranium mine and a substantial percentage of the country's uranium resources are located within the Namib Desert, the principal environmental consideration is the management of available water resources.

Potable water for the Rössing Uranium Mine as well as for the coastal towns of Walvis Bay and Swakopmund is supplied from aquifers at the Kuiseb and Omaruru river deltas. To save those limited water resources and to save the cost of pumping over long distances, the management of Rössing undertaken an integrated water management programme, which has resulted not only in the reduction of water consumption of the mine but also substantially reduced environmental impacts. A new tailings deposition method was developed by the operator to minimize the amount of water which is lost on the tailings impoundment due to the high evaporation rates experienced in this area. Addition of carbonate rich tailings also neutralizes the acid mine drainage, a large percentage of which is returned to the mine.

Radiological concerns are catered for, and the recommendations included in the International Commission on Radiological Protection's Publication 60 of 1990 have been implemented at Rössing Mine. The challenge of radiological exposure is thus not with achieving compliance with dose limits, but in the application of the principle of ALARA (As Low as Reasonably Achievable) to reduce radiological exposure. There have been concerns about the potential for the incidence of excess cancers, which are thought to be related to occupational radiation exposure. These can, however, only be addressed in comparison with national cancer statistics, which do not exist in Namibia at the present time.

6. NATIONAL POLICIES RELATING TO URANIUM

Namibia achieved independence on 21 March 1990 and the Minerals (Prospecting and Mining) Act, 1992 was promulgated on 1 April 1994. With the introduction of the Act, a number of South African laws were repealed or amended, including all laws relating to the uranium industry, such as the Atomic Energy Act, 1967, the Nuclear Installations (Licensing and Security) Act, 1963 and all their amendments.

The provisions of Part XIII of the Act relate to source materials as specified by Schedule 1 of the Act. Source material is defined as:

a) uranium, expressed as uranium oxide, of more than 0.006 per cent;

b) thorium, expressed as thorium oxide, of more than 0.5 per cent, and of which the mass is more than half a kilogram.

Section 102 of the Act relates to the possession, disposal, enrichment, re-processing and export of source material, while section 103 specifies penalties for the contravention or a failure to comply with the provisions of section 102.

While the repeal of the South African uranium-related legislations was justified, due to its complexity and reference to enrichment and the use of enriched material in nuclear reactors, which are not relevant to Namibia, the provisions of the Act are not detailed enough to control the safety or the environmental aspects of the uranium industry. The introduction of a new Act or amendments to existing legislation are presently being considered.

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