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INTERNATIONAL URANIUM RESOURCES EVALUATION PROJECT

I U R E P

NATIONAL FAVOURABILITY STUDIES

JORDAN

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C O N T E N T S

S U M M A R Y

Jordanian geology is dominated by the Great Rift Valley System. Most of the country is covered by Cretaceous and Eocene sediments, largely sandstones and limestones. These include phosphorates and bituminous limestones in the Upper Cretaceous. South of the Dead Sea, Mesozoic and Paleozoic rocks overlie exposed granitic Pre Cambrian basement rocks carrying many minor intrusives.

Phosphates provide the main mineral export of Jordan. The Natural Resources Authority (Geological Survey and Bureau of Mines) initiated a survey in 1972 of the distribution of uranium on the phosphorite horizon. In 1974 the Survey calculated that the uranium content of the phosphate areas surveyed up to that time was 5 million metric tonnes U_3O_8. The average U_3O_8 content is approximately 0.02% U_3O_8. The exploitation of such resources would be as a by-product of the phosphate industry and dependent on the rate of phosphate production and the capacity of triple super-phosphate plants, none of which exist at the present time.

In the southern area in Paleozoic and Pre Cambrian areas there are some hopes of conventional type deposits being found but the potential appears to be small.

Category 2. 1000 - 10,000

A. INTRODUCTION AND GENERAL GEOGRAPHY

Jordan (The Hashemite Kingdom of Jordan), an Arab state of southwest Asia, is bounded north by Syria, east by Iraq, west by Isreal and south by Saudi Arabia, the frontier with the last-named remaining in dispute. The 4½ mi. coast line on the Gulf of Aqaba contains the only port, Aqaba. The area is 37,313 sq.mi - (96,640 sq.km.). The capital is Amman.

Physical Geography - The Great Rift valley stretching from the Sea of Galilee (Lake Tiberias) to the Gulf of Aqaba is the key to Jordan's physical features. The hills are deeply dissected especially toward the Rift. Limestones and sandstones produce a rugged landscape, while chalk features are more rolling. The highest point on the ridge is Tall'Asur (3,805 ft.). Soils are thin and poor, except in certain basins. The Rift valley slopes from the Sea of Galilee (685 ft. below sea level) to the Dead Sea(surface level about 1,300 ft. below the Mediterranean; bottom 2,624 ft. below sea level), and contains the lowest dry land in the world. Southward it reaches 721 ft. in the Dead Sea-Gulf of Aqaba water divide. Its width exceeds 3 mi. A complicated series of faults and monoclines marks its edges. The valley north of the water divide was formerly covered by the Dead Sea, which laid down saline deposits (Lisan marls). As the sea retreated,the rivers incised themselves into the old level to form their present flood plains. At Jericho the valley is 7½ mi. wide, with the Jordan Zor accounting for 1 mi. Hill streams have built up salt-free alluvial fans on the Ghor so that salinity increases toward the Jabal al Qattar (the dissected scarp separating Ghor from Zor). Saline soils and underground water hinder agricultural development. South of the divide the valley is choked with sand dunes interspersed with salt marsh. Gentle doming occurred in the south making Ra's al Khashm (6,088 ft.) the highest point. In the north the Jabal 'Ajlun (4,001 ft.) anticline balances that of the Judaean hills. Eastward closed depressions containing mud flats are encountered, probably caused by minor folding, though Wadi as Sirhan at the Jordan-Saudi Arabian border may be a graben (depressed tract bounded by faults). East of the Dead Sea the scarp towers 3,937 ft. above the valley floor. The scarp has been deeply dissected and streams like the Yarmuk, Zarqa', Mawjib and Hasa have captured easterly flowing drainage. Near Ra's al Khashm, Nubian sandstones produce a chaos of wadies with sheer cliffs rising to about 2,000 ft. There near the foot of Jabal Harun lies Petra (q.v.) the Nabataean rock city, entered through a cleft in the rock at times not over nine feet wide. To the east the plateau degenerates into sandstone hills separated by dunes.

Climate - This varies from Mediterranean to desert, but is typified by aridity. Toward the east and south conditions become more continental and the Rift valley is a continental warm area. Mean monthly temperatures are: Amman (2,362 ft.) 8°-25° C. (46°-77° F.). Winter snow and frost are common on the hills but rare in the valley. Winds are dominantly westerly. East winds are hot and dusty in summer. Winter cold snaps in the Jordan valley are caused by northerly winds, as other winds are either southerly or warmed by descent. Precipitation occurs between November and April; 88% of Jordan receives on average less than 7.8 in. per year. The Rift is drier than its surroundings (less than 1 in. at Aqaba to 15.7 in. in the north). The hills to east and west contain the only extensive areas with more than 15 in. Toward east and south rainfall tails off to less than 4 in. The rivers reflect the rain-

fall pattern. Perennial streams flow into the Rift north of At Tafilah, with the Jordan and the Yarmuk the largest. Maximum flow occurs in February and March, and minimum in June and July. The Dead Sea level fluctuates accordingly.

Communications - Asphalt and metaled roads connect Amman with the main towns. The Jordan Royal Hashemite railway, enters Jordan from Syria south of Dar'a and runs approximately for 180 mi to Naqb Shitar where connection is made by road to the port of Aqaba, Jordans only direct access to the sea. The airport near Amman is served by several foreign airlines and there are regular flights to the middle eastern Arab countries.

B. GEOLOGY OF JORDAN IN RELATION TO POTENTIALLY FAVOURABLE URANIUM BEARING AREAS

Jordanian geology is dominated by the Great Rift Valley system. Movements began in the mid-Tertiary period and have probably not yet ceased. The Judean hills consist of a NNE - SSW anticline with strata pitching under the Quaternary deposits of the Mediterranean coastal plain and towards the Rift valley. Lower Cretaceous rocks are exposed at the centre of the anticline but elsewhere the Upper Cretaceous outcrops. The rift disturbances tilted the eastern highlands, which comprise all of Jordan east of the Rift Valley, gently eastwards. Vulcanicity accompanied the rifting and the Jabal Druse lava flows of the north gave rise to gaunt hills and plains. Further east the rolling landscape re-asserts itself and most of the outcrops are Upper Cretaceous and Lower Tertiary limestones and sandstones. In parts of the Rift scarp, outcrops from Cambrian onwards are found. Pre-Cambrian rocks form the Rift scarp in the Shafat ibn Jad.

Most of the country is covered by Cretaceous and Eocene sediments, largely sandstones and limestones. There include phosphorites and bituminous limestones in the Upper Cretaceous.

South of the Dead Sea, in a wedge-shaped area widening southwards, Mesozoic and Paleozoic rocks overlie exposed Pre Cambrian granitic basement rocks carrying many minor intrusives, mainly dykes. The northern part of this area shows copper and manganese mineralisation associated with Lower Cambrian sediments. Radioactivity is known at one locality.

In the Basement Complex area of the south, the geology is very similar to certain areas in neighbouring Saudi Arabia, Sinai and the Central Eastern Desert of Egypt., where uranium occurrences and radioactive anomalies are known. Areas of hydrothermal alteration, metallisation and faulting in the Jordanian Basement Complex might be considered as potentially favourable for uranium and should be prospected.

Phosphates provide the main mineral export of Jordan. Present working areas are near Amman and in the Qatrana to El Hasa areas and other deposits are known south of El Hasa, near Ma'an and near the Iraq border. Although known reserves are substantial, the location of the production areas distant from the export port of Aqaba causing high internal transport costs poses an economic problem.

Exploration of these areas by conventional methods is not regarded as being complete and as the Jordan phosphates are uraniferous they are responsive to radiometric prospecting methods.

Bituminous limestones occur in the Upper Cretaceous and may be of economic interest but their extent and content are not yet known. Although these limestones have not yet been tested for radioactivity, similar rocks in other parts of the world have been found to be slightly radioactive.

Geologically, there are areas in Jordan which might be considered as potentially favourable for carbonatite and rare earth occurrences.

C. PAST EXPLORATION

No systematic radiometric exploration programme has been carried out in Jordan except in relation to the discovery of radioactive phosphate formations.

A UN/UNDP project entitled "Establishment of a Mineral Exploration Unit" was carried out between 1967 and 1970 and as part of its activities consultant advicewas given on mounting a carborne radiometric survey. Except for trial excursions this was not fulfilled during the project.

However in 1972, the Natural Resources Authority of the Jordanian Geological Survey and Bureau of Mines initiated a survey of the distribution of uranium minerals in the phosphorite horizon in Jordan under the direction of Mr. Abu Ajamieh.

Field work which started in 1972 was carried at two stages.

In the first stage Carborne Scintillometer measurements were recorded on roads and desert tracks to delineate areas for further detailed surveys.

The second stage, which is still in progress, started with the selection of radioactive areas, according to the analyses and interpretation of gamma-ray records obtained in the first stage. Two different types of anomalous areas were selected and have been detailed for the evaluation of ore.

These areas are the phosphorite beds and two fault zones on the eastern side of the Jordan Dead Sea graben and the Yarmouk river.

Between 1972 and 1974 some US$48,000 have been spent on covering 450 km^2 in detailed surveys and in completing 4000 metres of drilling and logging in 90 drill holes.

Three selected areas have been investigated by surface and subsurface radiation measurements. Results were correlated with chemical and mineralogical and X-Ray Fluorescence analyses done prior to the radiation surveys. More field work was concentrated on phosphorite occurences in the country. The other two localities are fault zones with hot mineral springs, associated with basaltic eruptions. These latter areas are Wadi Zerqa Ma'in and Mukheiba areas.

D. URANIUM OCCURRENCES AND RESOURCES

The radiation survey has shown two interesting types of radiometric occurrences in the country. The largest occurrence known is that of the phosphorite outcrops. The other is the recently surveyed Wadi Zerqa Ma'in area and the relatively lower radioactive area in Mukheiba on the Yarmouk river.

Uranium Occurrences in the Phosphorite Section

Phosphate deposits all over the world contain traces of uranium minerals. The amount and the distribution of uranium minerals differs from one locality to another due to the varied different physical and chemical factors affecting the deposits. Phosphate deposits exist all over Jordan. Figure No. 1 shows the occurrences of phosphorite beds in Jordan and some new phosphate occurrences discovered by the present survey.

a) The Area Between Suwaqa and Jurf ad Darawish

This area contains the largest known phosphate deposits in the country, $950X10^6$ metric tons of phosphate ore, Prot-ore and sub-Prot-ore.

b) Ruseifa Area

In the Ruseifa area, no detailed radiometric survey has been done. The results of reconnaissance surveys indicate much stronger concentrations of uranium in the phosphate ore.

c) Amman Area

Two important localities exist in this area:

1. Sehab Area: Strong anomalies have been noted but no detailed delineation has been done. Phosphate reserve estimates have not yet been made.
2. Suweileh : Carborne scintillometer anomalies have been recorded but no detailed measurements have yet been done.

d) Other Areas

The vast extension of phosphate deposits in the country will require many years of detailed radiometric surveying. It is as yet too early to estimate uranium content in these other areas.

The occurrences identified are:

1. Ma'an - Ras en Naqab
2. Hattiya - Batten el Ghul
3. Wadi Ruwaishid
4. Iraq border
5. El diza - Tuneib

Uranium Resources in Phosphorites

M. Abu Ajamieh's report[1] calculates the following U_3O_8 contents.

A. El Hasa region

2×10^{10} metric tonnes phosphorite with an average content of 0.0213% U_3O_8 and a content of 4.6×10^6 metric tonnes U_3O_8.

B. Ruseifa Area

110×10^6 metric tonnes phosphorite with an average content of 0.015% U_3O_8 and a content of 16,500 metric tonnes U_3O_8.

C. Suweileh Area

900,000 metric tonnes phosphorite with an average grade of 0.0075% U_3O_8 and a content of 67.5 metric tonnes U_3O_8.

M. Abu Ajamieh's figure for total content of Jordan phosphates at the present time is 5 million metric tonnes U_3O_8.

Other areas in Jordan with evidence of radioactivity and uranium occurrences have also been investigated.

The Graben Escarpment Area

This area which extends from the Yarmouk river on the north to Aqaba gulf in the south (about 350km), is in general a favorable target for mineral exploration. The copper-managnese ores in the south and the iron ore deposit in the north (warda hematite) are good indications of mineralization processes that took place in this important structural zone.

Accordingly, two locations were selected in this area for uranium exploration.

I Zerqa Ma'in Area

The area lies at about 14km to the south-west of Ma'in village and at about 3km east of the Dead Sea shore. The topography is rugged and the road leading to the area is very rough, the distance on the road from Ma'in village is 24km. Very strong radiation has been discovered on the northern side of Wadi Zerqa Ma'in, on the hot spring zone. The anomalous area is about 1.5km long and 600 metres wide. Fifty-nine springs have shown high radioactivity. Spring No. 35 showed extremely high radioactivity and tests showed the presence of radium, thorium and other radioisotopes, but no uranium. A deep seated uranium source may be indicated.

II Mukeiba Area

The area surveyed lies on the Yarmouk river north of Um Qeis village. Fresh water and thermal springs exist in the area, both of which show weak radioactivity possibly of the same type of origin as at Zerqa Ma'in.

E. PRESENT STATUS OF EXPLORATION

As far as is known the Natural Resources Authority of the Geological Survey and Bureau of Mines intends to continue its survey of uranium in Jordan.

F. POTENTIAL FOR NEW DISCOVERIES

The total uranium content of the phosphorite section in Jordan as at present estimated is approximately 5 million metric tonnes U_3O_8. The exploration of these resources is entirely dependant on the phosphate production industry, the rate of production and the capacity of triple super phosphate plants, none of which exist at the present time.

In other areas, there are some hopes of conventional type deposits being found in basement and cover rocks, but on present evidence this potential appears to be small, rated at zero to 3000 tons U_3O_8. Category z.

Category 2

1000 - 10,000

Compiled by J. Cameron
August 1977

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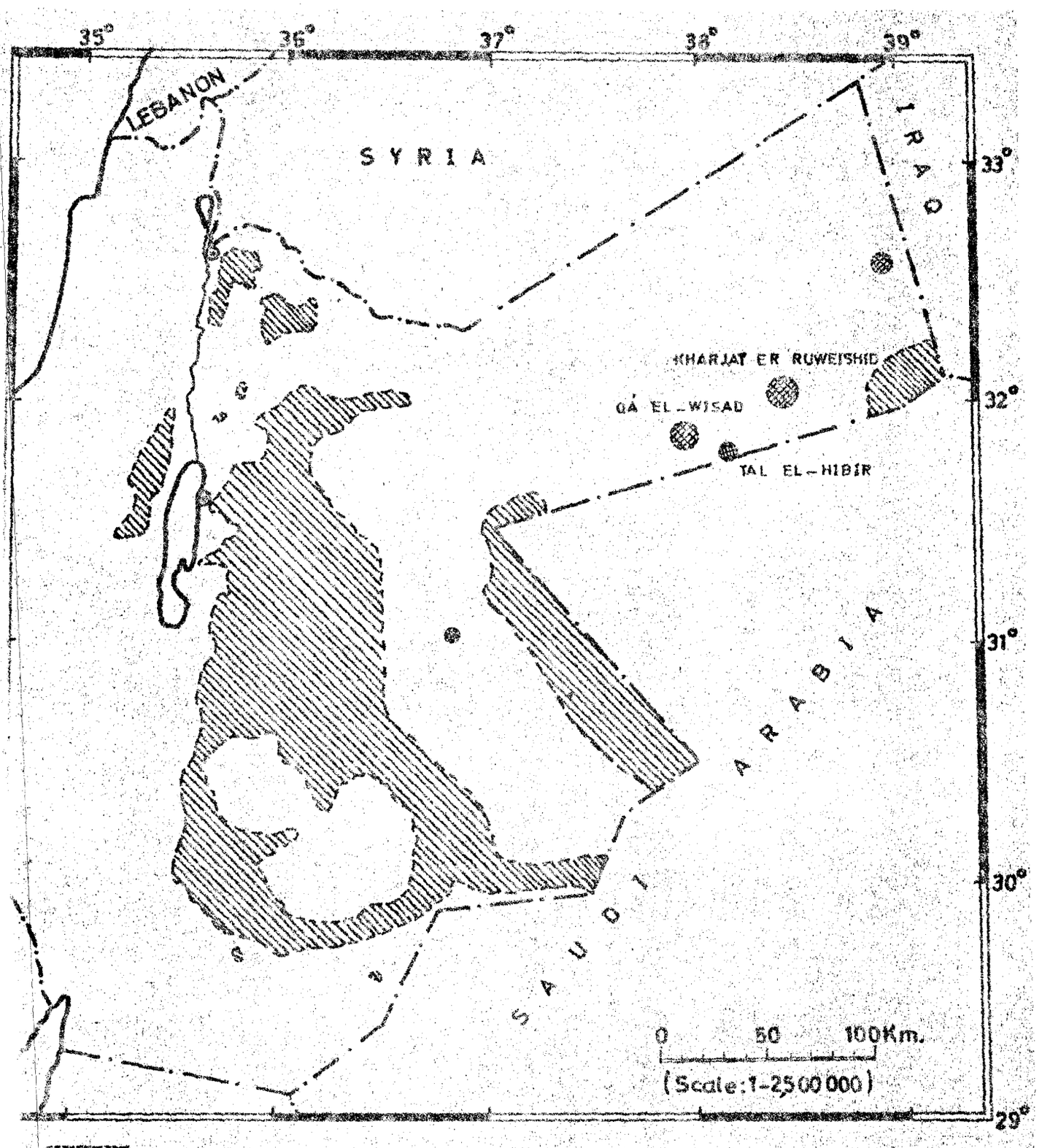
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AREA OF URANIUM OCCURRANCES IN PHOSPHATES AND PHOSPHATIC STARTA
LOCATION OF RADIUM CONCENTIATIONS IN FAULT ZONE ASSOCIATED WITH HOT MINERAL SPRINGS AND BASALTIC ERUPTIONS
NEW PHOSPHATE DISCOVERIES
Drown by: Ismail Ayoub