URANIUM from PHOSPHATES in the UNITED ARAB REPUBLIC

In response to a request from the UAR Government, IAEA sent Professor B. V. Nevsky, a Soviet expert, to make an on-the-spot study of data on the mining and processing of phosphates in the UAR and to examine the possibility of recovering uranium from the phosphate ores. In his report to the IAEA Director General, he has listed the following conclusions:

1. The *uranium content of run-of-the-mine phosphoric* ores in the United Arab Republic is very low and the recovery of uranium from them is therefore hardly likely to be an economic proposition.

2. It is essential to press on with prospecting work in order to discover richer uranic deposits and regions of phosphoritic ores.

3. It is essential to organize scientific research work on the recovery of uranium from the various types of uranium-bearing phosphoritic ores in the United Arab Republic, using mechanical concentrating methods and chemical processing methods.

4. The Agency could assist in carrying out this work either by sending as many technicians as are required to help in planning and undertaking the research work in the UAR or by getting appropriate Member States to carry out this work on preliminary samples of ore (with the participation of representatives of the UAR).

Professor Nevsky's detailed findings are reproduced below (a few technical details have, however, been left out).

Deposits and Present Use

The UAR has several phosphorite deposits: the most important are situated in the Red Sea littoral areas (El Qoseir, Safaga) and in the Nile Valley (Sebaia, Bissaleia). The deposits of phosphorites along the Red Sea littoral are mined chiefly for export in crude form, the Nile Valley phosphorites for processing to meet the UAR's superphosphate requirements. In the period 1936 to 1948 Egypt's annual phosphorite production varied from 291 000 to 515 000 tons; the P_2O_5 content is about 30 per cent. The phosphorites from the Red Sea littoral have a slightly larger content of P_2O_5 than the phosphates from the Nile Valley. In 1944 phosphorite reserves were about 180 million tons. At present the annual output of phosphorites is approximately 500 000 tons, and reserves approximately 200 million tons. Data on the uranium content of UAR phosphorites are fragmentary: it varies from 0.003 to 0.007 per cent (Sebaia phosphorites seem to have a slightly higher content than those of the Red Sea littoral).

The processing of phosphorites in the UAR is carried out in two plants (Kafr-el-Zayat and Abu-Zabal) by the usual sulphuric acid process, with a yield of simple superphosphate (totalling up to 200 000 tons a year), with a content of assimilated P_2O_5 of approximately 15 - 17 per cent. Imported pyrite is the raw material used to produce sulphuric acid.

Under the five year plan it is intended also to produce triple superphosphate, in quantities up to 100 000 tons by 1962-1963 (with a content of assimilated P_2O_5 of approximately 45 - 48 per cent). This product will be for export. The advantages of exporting triple superphosphate are lower transport costs and the possibility of using lower-grade phosphorites. The method of producing triple superphosphate has not yet been finally decided. If the "wet" method (with sulphuric acid) of producing the phosphoric acid needed to obtain triple superphosphate is used, the plant can be constructed in the Suez-Alexandria area, to work with sulphuric acid obtained from crude sulphur mined near Suez. In this case, the necessary capital expenditure (for two sections, each producing 50 000 tons of triple superphosphate) is estimated at about £E 3 300 000, and the production cost of one ton of triple superphosphate at about £E 26.5 (on the basis of 13 Egyptian pounds a ton as the cost of sulphuric acid). This gives an estimated annual profit of about £E 500 000.

It is also possible to obtain triple superphosphate by using phosphoric acid produced by the "dry" (electrothermal) method. In this case, there is no need for sulphuric acid, which is not found in the UAR. Instead, electric power is used (about 3 000 kWh per ton), and the plant can conveniently be built in the Aswan area. The cost of producing one ton of triple superphosphate by this method is expected to be about £E 2 lower.

Recovering Uranium

At the present time, the recovery of uranium as a by-product is only possible when the "wet" (extraction) method of obtaining phosphoric acid is used. The recovery of uranium during the production of simple superphosphate, or during the production of phosphoric acid by the electrothermal process, is not yet feasible.

Recovery of uranium from extracted phosphoric acid is possible by various methods: extraction by organic solvents (alkyl phosphates), selective chemical precipitation, electrolysis and, in some cases, by means of ion-exchange resins.

For an annual output of 100 000 tons of triple superphosphate, about 150 000 tons of phosphorites must be processed, of which about half is used for the intermediary product, phosphoric acid. If phosphorites with a slightly higher content of uranium (approximately 0.007 per cent) are used for producing the phosphoric acid, a total of about 4 - 5 tons of uranium can be produced annually in the form of a chemical concentrate with a uranium content of about 40 - 50 per cent. Capital expenditure for the construction of a uranium extraction plant would be in the region of $400 000 or about £E 200 000. The cost of producing uranium in the form of a chemical concentrate would probably be at least $60 - $80 per kilogramme, which is roughly three times higher than the cost of producing it from normal uranium ores (approximately $20 - $25 per kilogramme), which means that the recovery of uranium as a by-product will not lower the manufacturing cost of triple superphosphate.

Therefore, because of the extremely low content of uranium in run-of-the-mine phosphorites, its recovery is not for the time being an economic proposition. Consequently, the choice of the technological process for manufacturing triple superphosphate in the UAR must be based not on the possibility of extracting uranium as a by-product, but on other factors: the cost and availability of sulphuric acid, the cost and availability of electric power, transport costs, the cost and availability of equipment, etc. For this reason, the "dry" method, using phosphoric acid produced by the electrothermal process, will probably be more useful for the UAR.

Prospects from Other Phosphate Ores

The UAR also has some prospects of obtaining uranium from other types of phosphate ores.

A certain amount of uranium (approximately 0.1-0.3 per cent) is contained in monazites (in the form of rare earth and thorium phosphates). However, production of uranium from monazites is closely connected with the necessity of finding a useful outlet for extremely large quantities of thorium (the proportion is approximately 25 to 1 of uranium) and, even more so, of rare earths (the proportion is approximately 300 to 1 of uranium). Moreover, the market for rare earths is very limited at the moment, and their price unseparated is low (in the USA about 20 cents per kilogramme mixture of sulphates, carbonates or other rare earth compounds).

In the UAR, there are also certain deposits of phosphate ores which are unsuitable for economic exploitation because of their content of phosphorus and additional elements (chiefly aluminium and iron), but which have a slightly higher uranium content (e.g. certain seams of the Kossier region and the sandstone deposits of the Gebel Katrani region near El Faiyum).

It is essential to extend and intensify prospecting work on these deposits. Uranium can be extracted from ores of this type, provided enrichment by mechanical means gives satisfactory results. The enriched uranium-phosphorus concentrates obtained in this way can then be put through the various stages of processing described above, yielding uranium and phosphorus.

When the uranium content is high enough (over 0.1 per cent) these ores can also be processed directly (that is, if mechanical enrichment gives unsatisfactory results) by acid leaching, the uranium being subsequently extracted from the solutions, thus obtaining a weak precipitate (of approximately 20 per cent P_2O_5). Where this process is used, separation of the phosphorites can also be achieved with hydrochloric acid.

Investigation of Processes

Nothing final can be said regarding the sequence of processes or the related indices until the necessary scientific research has been done, including tests of representative samples of ores from the different regions.

First of all, preliminary investigations on a laboratory scale are necessary in order to select the best methods and processes; these must be followed by semi-industrial tests using a few score tons of ore, for perfecting the processes and determining all the indices (consumption of reagents, recovery of the valuable constituents, quality of the resultant products, etc.).

For this purpose, the following investigations will be necessary:

(a) The material composition of the ores;

(b) Study of the possibility of enriching the ores by selective crushing and grinding, followed by screening and classifying;

(c) Study of the possibility of radiometric classification of the ores;

(d) Study of the possibility of flotation enrichment of the ore;

(e) Study of the possibility of enriching the ore by a combination of processes;

(f) Study of different methods of digesting uranium-phosphorus ores and products of their concentration;

(g) Study of different methods of recovering uranium from phosphoric acid solutions;

(h) Study of the different methods of refining the resultant chemical concentrates of uranium;

(i) Study of the different methods of recovering phosphorus from solutions after the extraction of uranium.

To carry out these investigations on the laboratory scale only will probably require from 1 to 1½ years and not less than 4 to 5 highly trained persons, one of whom should have sufficient experience and breadth of outlook to be able to co-ordinate the work as a whole.

On completion of the laboratory investigations an experimental plant should be designed and set up to process not less than 1 to 2 tons of ore daily. Not until full particulars of the process have been worked out in an experimental plant will it be possible to proceed to the designing of industrial plants for the treatment of uranium and phosphorus ores in the UAR.

IAEA Assistance

The Agency could assist in carrying out this work:

(a) By sending to the UAR 2 to 3 sufficiently qualified technicians (dressing engineers and hydrometallurgists) to organize the research work (for a period of six months);

(b) By having the scientific research work on preliminary samples of ores carried out by one or more Member States with sufficient experience in that field, it being understood that 3 to 4 technicians from the UAR could take part in the work (for a period of at least six months).

The better procedure, it is felt, would be the former, since it would make it easier for the UAR to carry out further work in this field. The Agency could later offer to assist the UAR in designing, equipping and setting in motion, first the experimental, and then the industrial plants for the processing of uranium and phosphorus ores.

EXCHANGE AND FELLOWSHIP PROGRAMME

By February this year, IAEA had received and considered nearly 300 nominations from 31 countries for nuclear science fellowships. More than 200 of the candidates - from 29 countries - had been selected for placement in centres of training in 21 countries. Over a hundred fellowships had actually been awarded, and more than forty of the fellows were already receiving training.

This wide scheme of training in the science and technology of nuclear energy stems from IAEA's statutory obligation to "encourage the exchange and training of scientists and experts in the field of peaceful uses of atomic energy".

The obligation is fulfilled through the Agency's exchange and fellowship programme. The programme covers three types of training:

1. General techniques training: to develop skills in the use of some fundamental techniques in the field of nuclear energy;

2. Specialist training: to prepare specialists in the theoretical and experimental aspects of the science and technology of nuclear energy;

3. Research training: to provide advanced training, including active participation in research work; this is for persons potentially qualified to develop and carry out research programmes in the basic sciences and engineering.

The duration of training varies from some weeks to five or six years. The long-duration training is given at universities or educational establishments of university level, and is of special interest to Member States lacking personnel with the requisite university education.

Programme for 1959

Under its 1959 exchange and fellowship programme, the Agency will be in a position to award over 400 fellowships. Some of these will be paid out of the Agency's operating fund, while 130 fellowships have been offered directly to IAEA by Member States for training at their universities or institutes.

There are two new features in the Agency's 1959 programme. One provides for fellowships for scientific research work. These fellowships will be awarded only to persons with special experience and knowledge in this type of work; such fellowships will enable candidates to carry out their own research work in leading scientific centres, using technical equipment not available in their own countries. It is intended that these fellowships should be of two years' duration.

The other feature is exchange of specialists. Under this arrangement, visiting professors will hold special courses in the theoretical and experimental aspects of nuclear physics, radiochemistry, etc., and visiting scientists, engineers and other specialists will give courses in special techniques applieo definite research problems. Besides, at the request of Member States, experts and consultants will be sent to advise on problems related to the development of technical and scientific personnel in universities and other institutes.

Safety with Isotopes (Continued from page 12)

rules for workers exposed to radiation, and now the International Atomic Energy Agency has published the English version of its Draft Manual for the Safe Handling of Radioisotopes. Why should we have both, especially when a lot of careful thinking and a great deal of time has gone into the correlation of these manuals?

"This is the first important example of one organization duplicating the work of another but it is the sort of thing that always happens. We should make up our minds which organization is the most important, then give it the work of co-ordinating all the international nuclear work and approving the programme of the other groups.

"If this does not happen there will be two or three sets of standards in existence and we will find ourselves creating the very conditions we are trying to resolve in other fields ......

"Really the organization that should be given the supreme job of co-ordination should be the International Atomic Energy Agency for that is the only body which is truly international."