

# ATOMIC PROSPECTS IN FOUR AFRICAN STATES

A preliminary assistance mission of the International Atomic Energy Agency visited Ghana in March-April this year; members of the mission also visited three other African States: Dahomey, Liberia and Nigeria.\* As in the case of the six earlier Agency missions of this kind, the visits were made at the request of the Governments of these countries. The purpose was to study at first hand the prospects of atomic development in these countries, to advise the Governments on the broad formulation of atomic energy programs, and to determine how the Agency could assist in the carrying out of these programs.

In each of these countries the members of the mission held extensive discussions with officials and scientists, visited educational, research and technical institutes and acquainted themselves with activities and plans for peaceful atomic applications. The information thus collected, which forms the basis of the mission's reports, would be useful, among other things, in deciding upon the Agency's program of training and technical assistance to these countries. The mission's recommendations on specific requests for assistance will in due course be considered by the Agency's Board of Governors. In the meantime, some of the general information and observations contained in the reports are summarized in this article.

## Organization and Training

In Ghana, a National Research Council has been established for the development of scientific activities, including those concerning atomic energy. In view of a projected expansion of radioisotope work, the mission suggested that it might be desirable for the Government to designate responsibility for the control of import, distribution and safe handling of isotopes to the department or office of Government particularly concerned. When the program is fully implemented and further activities are contemplated, it might be desirable for the Government to consider the creation of an autonomous authority responsible for the development of atomic energy.

Radioisotopes are about to be used in agricultural research in Dahomey but in the view of the mission no special arrangements seem necessary within the Government structure to control these applications. However, when atomic energy is introduced on a larger scale it will be necessary to ensure adequate health and safety measures in respect of the import, distribution and use of isotopes.

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Throughout Nigeria, atomic energy is a federal responsibility, exercised by the Federal Department of Mines and Power. In such matters as health and safety, the Government is advised by a Radiation Protection Panel. The mission thought that the existing procedures would be appropriate until such time as a further expansion of atomic energy activities was contemplated.

In the present context, the mission did not think that it would be necessary for Liberia to have a special Commission or Authority for atomic energy. Some form of health and safety control, however, might become necessary.

As regards education and training, the mission found that the teaching of natural sciences in secondary schools in Ghana was of a fairly high standard and provided a good foundation for university education. The University College of Ghana has well-equipped laboratories, qualified teaching staff and a good library. Nuclear physics is one of the subjects taught in the physics department, while chemistry students study radiochemistry to a limited extent. The University has a small radioisotope unit which could be useful for training and research. Another well-established higher educational institution is the Kumasi College of Technology for applied sciences and engineering. Atomic energy is not yet included in the College curricula; it may be necessary in the near future to introduce a limited amount of teaching in nuclear energy applications.

The educational system of Dahomey is limited at present to middle schools and a lycée; the mission was, however, informed that plans for a national university were being considered. Meanwhile, between 300 and 400 Dahomian students are being trained in universities in France and in Dakar. Assuming that these students will eventually return to Dahomey, they could form a nucleus of scientific personnel and some of them could join the teaching staff of the proposed university.

In Nigeria, the University College of Ibadan has well-equipped laboratories, good teaching staff and a well-stocked library. Of the 1 250 students in the university, approximately 35 per cent are studying science, and nuclear physics is included in the second and third years of the physics course. As for other educational institutions, the University of Nigeria at Nsukka has so far concentrated on arts and the social sciences but from the next academic year it expects to introduce science courses as well. At the College of Arts, Science and Technology at Zaria, preliminary plans have been drawn up for enlarging the present activities into those of a university, including faculties in science, agriculture and engineering.

The university in Liberia has to devote some time to raising the level of knowledge of new entrants before normal university education can be effectively imparted. This becomes particularly necessary in the natural sciences, and at present only a small proportion of the university students specialize in the natural sciences. There is also a shortage of qualified teaching personnel.

### **Isotopes in Agriculture**

In Ghana, important research work is being carried out at the West African Cocoa Research Institute at Tafo, and in view of the importance of the cocoa industry to Ghana the mission thought that the use of radioisotopes in this work should be developed fairly rapidly. The first results have been obtained in entomology; it would also be advisable to start research in soil chemistry, fertilization and plant physiology. The Kwádaso Central Agricultural Station is well equipped for the use of radioisotopes and a program of research will be initiated as soon as the laboratory is completed. The work should initially be carried out in the field of soil fertility, soil fertilization and mineral nutrition of plants.

In Dahomey, the Institute for Oil and Oil Plant Research (IRHO) has facilities for research with radioisotopes; in the Oil-Palm Station, Pobé, studies are about to be carried out on fertilization problems and mineral nutrition of the palm tree, and at the Semé-Podji coconut research station, studies with the help of radiosodium are being made of the absorption and physiological role of sodium. The laboratories of the Niaouli station could use radioisotope techniques for studying fertilization and mineral nutrition in maize, manioc and coffee culture. Interest in the utilization of radioisotopes was expressed at the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM). The Government proposes to establish an agricultural college near Cotonou with the necessary research laboratories, some of which may be operated in conjunction with ORSTOM. The mission also noted an interest in the possibility of utilizing radioisotope tagging techniques to study fish migration.

In Nigeria, the Federal Government Agricultural Research Station at Moor-Road Plantation, Ibadan, is well equipped for classical research and its officers showed much interest in possibilities of using radioisotopes. It would be useful for the station to start using radioisotopes for studies on plant physiology. In the Eastern Region, scientists trained in the use of radioisotopes are working in the Agronomic Research Station at Umudiké. When the laboratories now under construction are completed, provision should be made for the use of radioisotopes for studies in soil chemistry, fertilization and plant physiology. The Samaru Regional Research Station in the Northern Region is carrying out an important research program for the improvement of agricultural yields. Counting equipment is already available and staff trained in the use of radioisotopes are working at the station; research with radioisotopes is expected to begin in 1963. The West African Institute for Tripanosomiasis is pro-

posing to carry out research using trace amounts of radioisotopes, and equipment has been ordered for this purpose. In the Western Region Agronomic Research Station at Ibadan, interest was expressed in seed irradiation; the mission thought that at present such irradiation should be carried out at a scientific center overseas. The possibility of using tritium in problems concerning artesian water supplies in the Nigerian part of the Lake Chad Basin was also discussed; this will be studied in detail when further information is available.

There is considerable interest at the Suacoco Central Agricultural Experimental Station in Liberia in the use of radioisotope techniques in agricultural research. The mission felt that in a few years' time such techniques could be introduced in the study of soils and entomology, and the principal subjects of investigation could be the dynamics of phosphorus in soils and the biology of certain pests. Later, isotopes could be used in assessing the best form and location of fertilizers. At a more advanced stage, the possibility of irradiating seed or plants at a suitable center overseas could be considered. The mission noted that consideration was being given to the application of radioisotopes in studies on the culture of the rubber tree, and was of the opinion that such techniques, which were also proposed to be extended to food plants, would be most useful in developing plant varieties with higher yield and greater resistance to disease.

### **Applications in Medicine**

During the mission's visits to medical centers in Ghana and discussions with medical personnel, interest was expressed in the possibility of using radioisotopes for medical research, particularly for studies of anaemia and metabolic and deficiency diseases. At present, there is no medical school in the University College of Ghana and radioisotopes have not been used in medicine so far. It is, however, foreseeable that such applications will begin in the near future. The mission was of the view that the Government should consider the possibility of including in the proposed school of medicine a section devoted to the medical application of radioisotopes.

In Dahomey, the only ionizing radiation used so far has been in the form of diagnostic X-rays. A modern General Hospital, which is nearly complete in Cotonou, provides for the installation of deep X-ray therapy machines for the treatment of cancer, as well as for the use of a diagnostic X-ray machine. Interest was shown in the possibility of using radioisotope techniques. The mission felt that a small radioisotope laboratory for the application of diagnostic and selected therapeutic techniques might be justified in the near future. This could be done by a small extension of the plans for the new hospital in Cotonou.

The mission was informed that it was intended to introduce health and safety regulations for the whole of Nigeria and that in the near future an organization would be established for general control of radiation hazards. Medical applications of radioisotopes have

not yet been introduced in the country, except for a modest start in research at the Ibadan Medical School. At the Pharmacology Section of the University College of Ibadan tritiated water is being used to study various oedemas, and pharmacological tests using tritiated drugs are being conducted with the aim of following their metabolism. It is also proposed to set up a medical research unit in the University College Hospital at Ibadan, including a cobalt radiotherapy unit. As interest was expressed in the level of radioactive contamination of various foodstuffs, the mission informed the authorities of the assistance that could be given by the Agency's laboratories in the analysis of such contamination. The mission thought that in the Northern Region of Nigeria a small radioisotope laboratory for diagnostic and selective therapeutic techniques could be justified in the near future and this should be considered in association with the planning of the new hospital in the region. Consideration could also be given in the future to the provision of teletherapy units with cobalt 60 or caesium 137.

The mission did not think that at present medical radioisotope techniques could be introduced in Liberia on a large scale. Although teletherapy units for the treatment of cancer are important, the number of cases in Liberia are not yet sufficient to warrant the establishment of such expensive units; the lack of qualified staff and the existence of other more pressing medical needs must also be considered. Besides, the majority of known cases of cancer are found to be well advanced when the patients present themselves for treatment and this greatly diminishes the value of therapy. Teletherapy methods, however, would be most desirable when training facilities and trained staff are available, medical conditions improved and early diagnosis of cancer becomes possible. The mission was of the view that the proposals now under consideration for the establishment of a medical school should include provisions for radioisotope uses in teaching as well as limited diagnostic, therapeutic and research applications.

## Raw Materials

Possibilities of locating deposits of nuclear raw materials in Ghana may be regarded as promising. Ghana possesses a strong and active geological organization, competent to carry out any program of prospecting operations. Moreover, the University College of Ghana provides good facilities for training geologists in its School of Geology. Limited programs of uranium prospecting have been undertaken and prospecting equipment has been supplied to field geologists. Although the development of hydro-electric schemes limits the possibility of any early need for atomic power in Ghana, the mission felt that prospecting for nuclear raw materials should not be neglected, particularly since the country has no resources of natural fossil fuels and geological conditions are unfavorable for the occurrence of fossil fuel deposits. The development of beryl-bearing minerals would be justified under present conditions; it would also be useful to develop thorium-bearing minerals, colum-

bite and tantalite, occurrences of which have been reported in Ghana.

Judging from the variety of mineral discoveries which have been made in Dahomey, its mineral potential must be regarded as promising although virtually unexploited. The lack of a geological survey and supporting services will restrict prospecting for nuclear raw materials in the country, although such materials may ultimately be of great importance because of the absence of known deposits of conventional fuels. Uranium prospecting would be justified on geological consideration, and the traces of beryl already known and the occurrence of acid pegmatites provide encouraging possibilities for further prospecting and development of this mineral. A regional aerial geophysical survey is to be carried out to enable the extent of mineral occurrences to be more clearly understood and it might be profitable to include a scintillation survey as part of this general operation.

Nigeria has a first-class geological organization although at present it is operating below strength because of the difficulty of obtaining trained geologists. This organization would be a valuable asset in any future program of prospecting for nuclear raw materials. Prevailing geological opinion, based on field work already carried out, does not regard as favorable the possibility of occurrences of uranium deposits in what is held to be predominantly a thorium province. The occurrence of beryl is encouraging although no commercial deposits are yet known. Concerning niobium, the position of Nigeria as a major producer of columbite and tantalite is very favorable. Supplies of thorium in the form of thorite can also be assured from columbite-tantalite-tin production. Additional possibilities exist in the placer deposits of monazite.

Liberia has no reserves of natural fossil fuels and although timber supplies are abundant, it is unlikely that these will be considered for use as fuel. The geology of Liberia appears unfavorable for the occurrence of fossil fuel deposits, and hydro-electric resources are comparatively small and sufficient only to meet short-term needs. But there are favorable geological aspects for the occurrence of uranium and other nuclear minerals and it would not be too early to begin a search for such deposits. A limitation on prospecting operations is imposed by the shortage of geological staff. The Bureau of Natural Resources has, however, arranged for overseas training of geologists and has entered into negotiations with an overseas organization for the provision of geologists and equipment to strengthen the existing organization.

## Nuclear Power

In Ghana, large-scale industrial and power development in the future is firmly linked with the proposed development of the Volta River hydro-electric project. This major scheme, when carried out, will provide abundant power for the main industrial needs of Ghana for many years at low cost. In addition to this scheme, other related hydro-electric schemes at Bui and Bamboi are under consideration and, if implemented, would probably fully meet the needs for

power in western and northern Ghana. Although Ghana has abundant hydro-electric potential, it has no resources of fossil fuels and therefore is entirely dependent on fuel supplies from overseas sources. The mission felt that the potentiality for nuclear power development should be kept under review. It noted that consideration had been given to the installation of a reactor for research and training purposes.

The power requirements of Dahomey are at present small and mainly concentrated in the Cotonou-Porto Novo-Ouidah areas. Present production is from thermal power stations using imported oil. There appear to be potentialities in hydro-electric power but no surveys of these resources have yet been undertaken. Expansion of power production will obviously depend upon industrial development; it is understood that the main increase in power consumption will arise from the extension of the port facilities and the establishment of the new town of Cotonou. Even with this expansion, however, the country's power requirements in the foreseeable future are not likely to exceed 10 MW. Nevertheless, consideration of atomic energy developments should not be neglected, since the country's development plan has hardly begun and there are at present no resources of natural fossil fuels. It would therefore be advisable for the country to keep abreast of developments in nuclear power technology.

Nigeria has an efficient and well-organized power system with long-term plans for power generation to meet future industrial expansion. These plans are based on the development of Nigeria's hydro-electric potential, the major project proposed being the Jebba dam on the Niger River. The implementation of this scheme and associated proposals for power transmission through an inter-connected grid system is expected by the Nigerian authorities to provide adequate power for Nigeria until the end of this century. The country also has large resources of oil and natural gas; the natural gas could profitably be used for power

generation on a large scale. It is unlikely that nuclear power in its present stage of development could offer any competition to power available from the conventional sources. As regards possibilities of nuclear power in areas remote from present or projected sources of supply, it is the view of the Nigerian authorities that no such demand is likely to arise which could not be supplied economically from the proposed grid system. However, the economics of transmission might present a situation in which the use of small reactors might be worthy of consideration; research and development in respect of such reactors, therefore, merits study by the Nigerian authorities.

Future power needs of Liberia have been the subject of a comprehensive survey carried out by an overseas organization on behalf of the Liberian Government. In this survey the anticipated needs for power until the early 1970's have been assessed and proposals made for meeting the anticipated demand. The possibility of nuclear power was considered in this survey, but the conclusion was that the anticipated needs could be most economically met by thermal and hydro-electric power stations. Although the Agency mission was in general agreement with this conclusion, it thought that power requirements would be likely to increase at a greater rate than had been anticipated. The conclusion had been based on the then existing knowledge of nuclear power costs but since research and development, particularly in regard to small and medium power reactors, has been progressing, the possibility of nuclear power offering a satisfactory alternative to conventional power within the period covered by the survey might be considered. This assumes even greater importance when considered against the background of high electricity costs, the high rate of proposed industrial development in Liberia and limited hydro-electric resources. For these reasons, the mission recommended that the power situation should be the subject of periodic review by the Liberian authorities and developments in nuclear power should be included in this study.