Nuclear raw materials: Developing resources through technical co-operation

An overview of technical assistance through IAEA-supported projects for the exploration and development of uranium resources

by Mohamad Tauchid

As the principal fuel for the world's nuclear power plants, uranium has become a valuable source of energy in many countries. Not a naturally abundant mineral, uranium is present in the Earth's crust with an average concentration of just two to four grams per tonne. This makes it about as rare in Nature as tungsten or arsenic, but not as rare as cadmium, mercury, or silver.

Higher concentrations of uranium occur in certain geological environments that eventually can become resources and economically minable reserves after exploration and development. Most of the world's known uranium resources are found in a few well-defined uranium provinces. Uranium also can be recovered as a by-product or coproduct of gold and copper mining, and from production of phosphoric acid.

Over the past 30 years, the IAEA has been actively involved in assisting countries interested in exploring and developing their uranium resources. Since 1959, when the first IAEA technical co-operation project in the field of nuclear raw materials was launched, activities have grown to encompass a range of technical services and projects. Presently, the Agency's Division of Nuclear Fuel Cycle and Waste Management is executing 42 technical co-operation projects. *(See graph.)* Most of these projects concern the exploration and development of uranium and its subsequent industrial processing and use as nuclear fuel. The technical co-operation projects are being carried out in 21 countries: Algeria, Argentina, Chile, China, Democratic People's Republic of Korea, Egypt, Gabon, Indonesia, Islamic Republic of Iran, Madagascar, Malaysia, Mali, Mongolia, Pakistan, Philippines, Portugal, Syrian Arab Republic, Thailand, Venezuela, Viet Nam, and Zambia. Also being supported are two regional training courses, one in Africa and the other in Asia and the Pacific.

This article presents an overview of the IAEA's technical co-operation activities in the field of nuclear raw materials, particularly looking at recent developments and trends influencing future directions.

Types of project requests

One question frequently heard of late — in light of prevailing abundant commercial supplies of uranium and low market prices — is why a country still wishes to explore or produce uranium.

Based on the number of requests that the IAEA receives for technical co-operation and assistance in this field, some answers emerge:

- Some countries wish to explore and eventually produce uranium to meet their present or projected domestic needs in connection with established and/or planned nuclear power programmes.
- Some countries are interested in building on the experience they gained during the uranium exploration boom of the late 1970s and 1980s. They specifically seek to capitalize on the large amount of exploration data they obtained and on the techniques they acquired for assessing their mineral resources in general and for studying environmental conditions.
- Some countries primarily are interested in preserving and/or cataloging valuable information on uranium geology, exploration, and production that otherwise might be lost. This information is considered highly useful for future studies and evaluations of uranium and other mineral resources.

Most projects being supported by the IAEA fall into the first category, which is directly related to uranium exploration, development and ore processing. The majority of these projects

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Scientists study geological maps during a uranium training course in Saskatchewan organized through the IAEA's scientific fellowship programme.

are in Asia and the Middle East. For these projects, one noticeable trend is the greater emphasis being placed upon considerations of economic viability and environmental acceptability, as opposed to purely exploring for and producing a needed mineral commodity at all costs. A number of these projects are, in fact, concerned with assessing the feasibility of uranium projects. In other cases, the focus is on the reassessment of known uranium resources on the basis of their economic viability, particularly in countries moving from centrally planned economies to market economies.

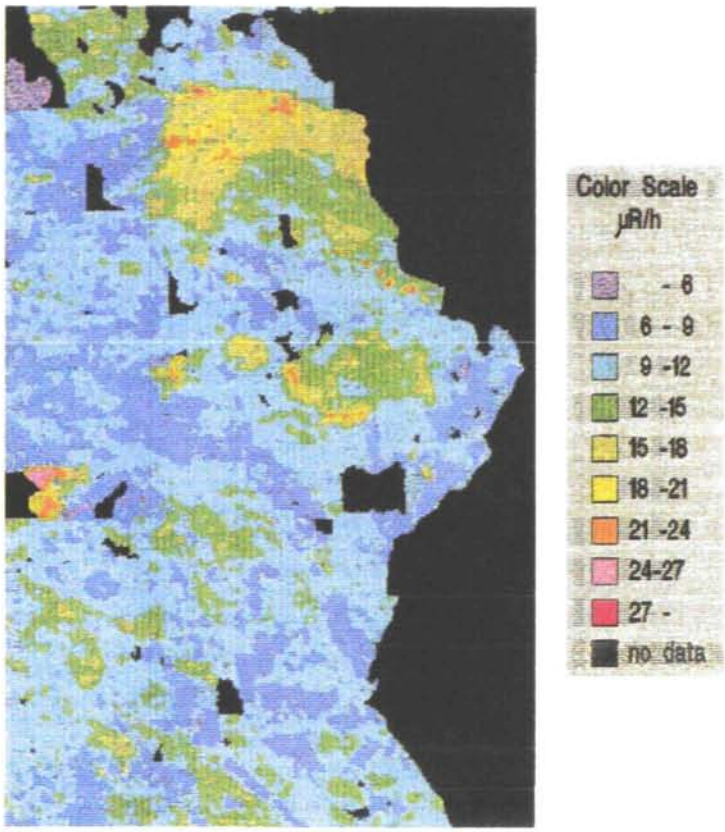
Assessment of mineral resources and environmental studies

A growing number of IAEA-supported projects today concern the re-analysis of information and samples collected during the uranium exploration boom of the 1970s and early 1980s. The data are useful for the general assessment of mineral resources, and for providing systematic baseline information for environmental monitoring and related studies.

Exploration for mineral commodities, including uranium, normally includes extensive geochemical and geophysical surveys covering very large areas, often an entire country. Such activities are very costly. During the 1970s and 1980s, for example, a 7-year programme in the United States known as the National Uranium Resources Evaluation was done at a total cost of more than US $150 million. Other examples include a $20-million geophysical survey of Thailand in the mid-1980s, and a $30-million airborne radiometric and magnetic survey covering about 40% of Iran in the late 1970s.

These surveys, which were done for a specific objective, generated an enormous amount of data and samples. Frequently the data were processed or analyzed to meet the immediate objectives set out at the time. Today the information often serves broader purposes. Analytical techniques have improved, for example, to facilitate more sensitive and complete chemical analysis of the previously collected geological and geochemical samples. Additionally, advances in calibration procedures and computer data processing now enable quantitative reporting of results that can more easily be correlated with data from other areas or countries. In this connection, the Agency through a number of its publications contributed significantly to the standardization of gamma-ray environmental surveys and the required calibration.

Within the scientific community, awareness has grown about the usefulness of uranium exploration data, particularly that obtained from radiometric surveys. The data can be used in the search for other mineral commodities, including aluminum (bauxite), copper, gold, tin, tungsten, and rare earth elements. The awareness correspondingly has generated greater interest in reprocessing "old" survey data using modern analytical techniques. Such information is used, for instance, to improve existing geological maps of surveyed areas and countries, particularly where the quality of these maps are questionable because of excessive ground cover, such as forests. An added benefit is the possibil-



The map shows levels of natural radioactivity in areas of Portugal. Produced with the IAEA's assistance, the map shows levels ranging from zero to 27 microrem per hour. Lower levels are in shades of lavender to green; mid levels in yellow, and higher levels in orange, pink, and red. Similar maps have been produced for Malaysia and other countries under IAEA-supported projects.

ity of producing a map of natural radioactivity, an essential ingredient of environmental monitoring and related studies in cases of accidental radioactive contamination.

Among the IAEA's technical co-operation projects, a number are related to these types of activities. By way of example, they include projects in:

Malaysia. In 1980, the Geological Survey of Malaysia conducted an airborne radiometric and magnetic survey covering more than 30 000 square kilometers in the Central Belt Area of Peninsular Malaysia. The results were initially used to outline areas that might be of interest for uranium exploration. In 1990, the IAEA was requested to review the quality of the survey data and its potential usefulness for other purposes. The review recommended recalibration and reprocessing of the data. In 1992, new sets of maps were produced at a very modest cost that now are being used as the baseline for a programme on mineral assessment of the Central Belt Area, including radioactive minerals. Taken together, the natural radioactivity and ternary radioelement maps represent almost a new geological map of the area.

Portugal. The IAEA currently is assisting the Serviço de Fomento Mineiro (newly renamed Instituto Geologico e Mineiro) of the Directorate General of Geology and Mines in producing a natural radioactivity map of Portugal. The project is co-financed by the Gabinete de Protecçao e Segurança Nuclear, whose responsibilities include environmental issues particularly related to radioactivity. Portugal has a long history of uranium exploration and production, and most of the country was surveyed by vehicle-mounted and ground-based radiometric equipment in the 1950s and 1960s. Under the IAEA project, a study was done on the recalibration of these old surveys. It was found that much of this old data can be reprocessed to produce a map of the country's natural radioactive environment. This information is being combined with results of recent airborne gamma spectrometric surveys. A new truck-mounted, 256-channel gamma spectrometric system is being acquired for the project so that a wider range of environmental studies can be done.

Zambia. The IAEA has assisted the Zambian Geological Survey Department in improving its analytical laboratory and computer processing facilities. From uranium exploration activities in the 1970s, systematic regional geochemical surveys mapped the entire country. Fortunately most of the geochemical samples were properly stored, which is often not the case in many countries, and the samples could be re-analyzed.

Under the current IAEA-supported project, the Government hopes to generate new information that will be useful for promoting the country's natural resources potential. Such a geochemical map also will serve as an excellent baseline for environmental studies.

The above examples, as well as other similar IAEA technical co-operation projects, provide a vehicle for contributing to the realization of an international geological mapping project of the International Geological Correlation Programme, the United Nations Educational, Scientific and Cultural Organization, and the International Union of Geological Sciences. The project includes the mapping of radioelements using radiometric techniques, and the IAEA is the leader of the project's steering committee on radiometric methods. The second phase of this 5-year project was approved early this year.

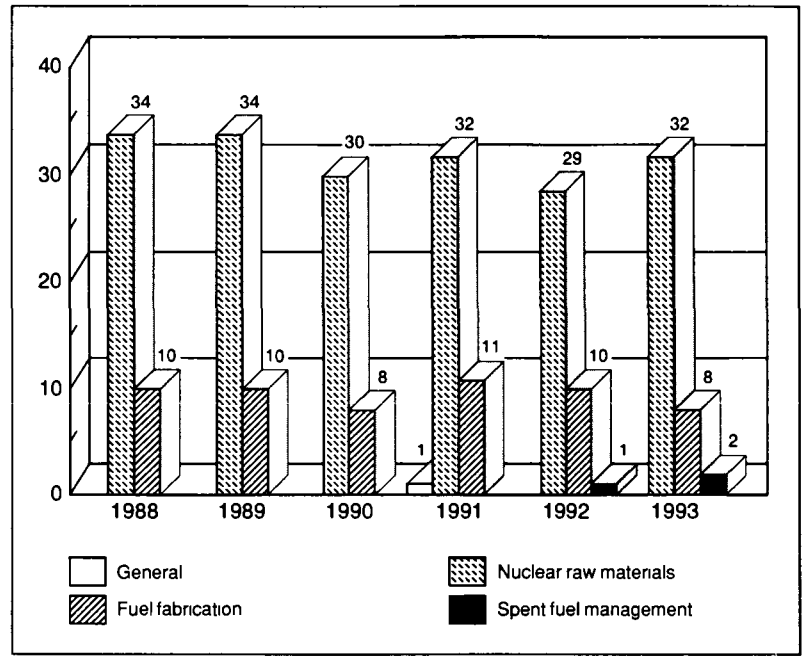
Preservation of exploration data

Another type of IAEA technical co-operation project concerns the organization and preservation of data on uranium exploration and related activities. Without such an effort, all the information that previously was collected at very high cost is in danger of being lost forever. Much of this information represents a valuable asset, which otherwise would need to be collected again. It is useful for evaluating future natural resources and mineral commodities, not just uranium. Almost all these projects are in Africa, where the economies of a large number of countries are based on mineral production. However, over the past 30 years the growth of African mineral production has lagged behind that of other regions, particularly Asia and Latin America. The lack of exploration is an important factor contributing to this decline.

Many parts of Africa have a wealth of geological and exploration data generated during the colonial periods and from more recent surveys performed under various aid programmes. However, most of the data were generally not organized and therefore difficult to find and use. Through IAEA technical co-operation projects, the efforts of a number of African countries were supported to establish computerized databases for inventorying information about geological and uranium exploration, thus preserving valuable data for easy retrieval and use. It has been said that dissemination of basic geological, geochemical, and geophysical information is as important as exploration itself in the promotion of a country's mineral resources potential. In this connection, the IAEA recently held a regional training course in Lusaka, Zambia, for 17 specialists from 12 African countries. The course focused on the use of computerized databases in mineral exploration and development, particularly for uranium resources.

Fellowships and training courses

Important parts of IAEA technical co-operation projects are fellowships and scientific visits that are arranged for selected scientists from developing countries. Requests for these services in the field of nuclear raw materials exploration and production continue to surpass those for other fields of the nuclear fuel cycle. With the decline of uranium exploration activities worldwide, however, it has become very difficult to place IAEA scientific fellows. The Agency depends on the generosity of a small number of countries (China, Canada, India, and to a lesser extent, France) that still regularly accept IAEA trainees in the fields of uranium geology, exploration, ore processing, and mining.



IAEA technical co-operation projects in the nuclear fuel cycle, 1988-93

To overcome this chronic problem, more and more national training courses have been organized to meet the specific needs of the requesting country. One benefit from such a course is that more technical staff may be trained at the same time. Language difficulties, a common problem, also can be minimized.

Another approach has been the organization of group fellowship training in co-operation with an established institute that serves as host. An example of such group training is a session on uranium geology, exploration, and environmental study being organized by the Department of Geology of the University of Regina in Saskatchewan, Canada. As the site of the world's richest and largest uranium deposits, Saskatchewan is an especially appropriate location for such training.

This approach is complementary to the IAEA's established interregional and regional training courses. From 1969 to 1985, the IAEA organized courses in the uranium exploration field almost annually. This was the time when almost every country had activities in uranium resource assessment. Based on the types of assistance now being requested by countries, interest has shifted. Training courses on pure uranium exploration have become rare, while those dealing with computer applications are more in demand. It can be foreseen that future courses may include topics concerning regulatory and environmental impact studies, as well as safety practices in the development of uranium deposits and production. ❐