The IAEA International Uranium Geology Information System

by Linda Trocki

INTRODUCTION

The IAEA has collected a large body of information on uranium geology on a global scale. Its data gathering and disseminating activities include: administration of technical assistance projects in developing countries, publication, in co-operation with the OECD's Nuclear Energy Agency, of 'Uranium Resources, Production and Demand', sponsorship of symposia on uranium resources and development, and participation in the International Uranium Resources Evaluation Project.

In support of these activities, the Agency also collects technical reports, maps, news clippings, and other documents concerning uranium geology, exploration and mining in developing, and, to a lesser extent, all countries. The resulting large collection of information is stored by country in separate files and is used for the Agency's technical assistance work and resource estimation activities. However, a manual filing system has little versatility. It could take a week to search through all the relevant papers to determine, for example, the status of uranium exploration in the developing countries, or where the major uranium deposits of the world are. These are the types of questions the Agency is called upon to answer.

Part of the Agency's function is to supply Member States with information regarding all aspects of the nuclear fuel cycle. To fulfill this function and to satisfy the Agency's internal data needs on uranium resources, an information storage and retrieval system is required which:

- systematically stores the essence of all the important reports, maps, etc. on uranium resource activities,
- is readily available to the Agency and to Member States,
- is indexed not only by country but by hundreds of different subjects so that a piece of information is easily retrievable.

A computerized filing system is being built that fulfills the above requirements in the following ways: (1) all pertinent information is extracted from publications and maps and stored systematically in the computer; (2) access to this information is through terminals within the Agency and telecommunication links could make it available to Member States; (3) the entire body of data can be searched to retrieve the desired information in a matter of seconds.

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A bonus of computerizing the data is the ability to analyze or evaluate the information instantly. Resource assessment (estimation of the amount of natural resources recoverable from a given region) requires an enormous quantity of information, and computers are playing a larger role in the data handling. And, as an international nuclear energy organization, the Agency makes assessments of total world uranium resources to predict whether global supply can meet demand in the future. Similar exercises are performed by various organizations which are also building computerized information files on global coal, oil and geothermal resources The uranium geology file will complement these other energy resource files which could be used together for co-ordinated planning of total energy supply. It will also complement the IAEA's Energy and Economic Data Bank.

ASSESSING WORLD URANIUM RESOURCES

Uranium resources of the future will come not only from uranium deposits which are known today, but also from deposits which have not yet been discovered (Present uranium reserves are adequate to supply world needs for approximately the next fifteen years Ref. [1].) Therefore, resource assessment is not simply a matter of adding up the number of tonnes of uranium that are economically recoverable today from the world's deposits; it must take into account the amount of economically recoverable uranium that is likely to be

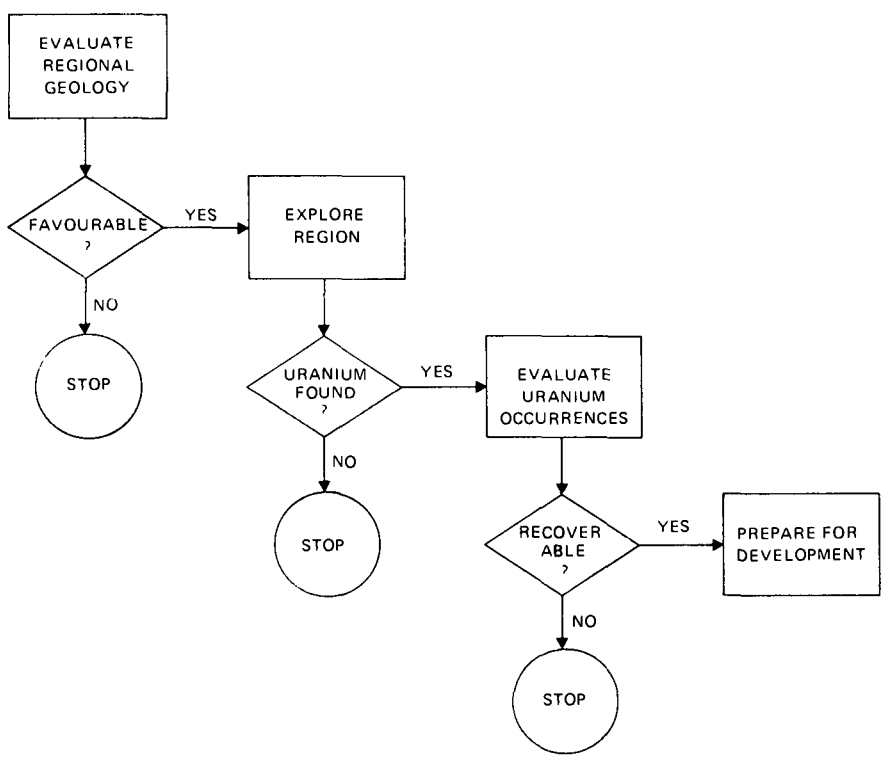


FIGURE 1. Sequence of events in uranium resource development.

discovered or become available in the near future. For this reason, it is necessary to evaluate:

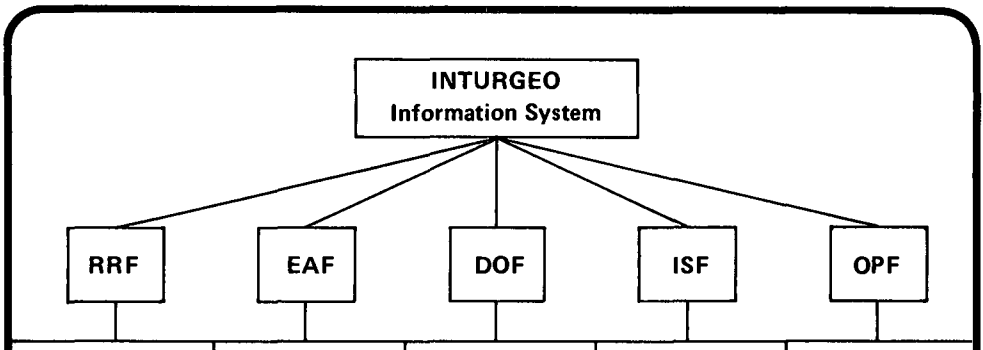
- the geology of regions which are favourable to uranium mineralization, i.e which have potential for new uranium discoveries,
- the amount and results of uranium exploration which has been done in a specified region;
- all known uranium deposits and occurrences;
- all ore processing plants,
- national 'uranium statistics' and policies toward developing uranium resources (See Figure 1).

To accomplish this, the information is stored in five separate computer files which correspond to the above subjects. They are: (1) Regional Reference File (RRF); (2) Exploration Activity File (EAF); (3) Deposit/Occurrence File (DOF); (4) Ore Processing File (OPF); and (5) International Summary File (ISF). These five files constitute the information system, which has been named INTURGEO – INTernational URanium GEOlogy Information System (See Table 1, Figure 2).

The physical distribution of known uranium resources illustrates why it is necessary to consider all of the topics covered by INTURGEO. Eighty per cent of the world's known uranium resources occur in only four countries: Australia, Canada, South Africa and the USA Ref. [1] Does this represent the natural distribution of uranium on the earth's surface? It is unlikely. This distribution of known resources is largely a function of the intensive exploration that has been performed in these countries and which has produced a large amount of data on uranium. As more data become known on uranium occurrences in other parts of the world, through exploration and evaluation, it is likely that South America or other areas of Africa will emerge as potential major suppliers of uranium in the future.

Table 1. Contents of INTURGEO

File Name	Purpose
1. Regional Reference File RRF	To describe the geology of regions so that uranium potential can be assessed.
2. Exploration Activity File EAF	To summarize the uranium exploration performed in a region so that need for further exploration can be evaluated.
3. Deposit/Occurrence File DOF	To characterize uranium occurrences so that they can be classified and compared.
4. Ore Processing File OPF	To describe individual uranium ore processing facilities so that ore processing methods and their effectiveness can be compared.
5. International Summary File ISF	To summarize uranium statistics on a national basis so that this information is readily available.



RRF	EAF	DOF	ISF	OPF
ID Number	ID Number	ID Number	ID Number	ID Number
Region Name	Area Name	Deposit Name	Country Name	Plant Name
Location	Location	Location	Location	Location
Size	Size		Size	Capacity
Uranium Resources		Uranium Resources	Uranium Resources	
		Owner-Operator		Owner-Operator
		Uranium Production	Uranium Production	
		Mill Name		
Level of Exploration	Level of Exploration			
	Exploration Detail	Discovery Method		
Gelogic Environment		Host Rock Geology	Uranium Geology of Country	
		Regional Geology		
		Deposit Type		
		Mineralogy		Ore Type
		Deposit Geometry		
			Geographical Statistics	
			Expl & Mng. Organizations	
			Uranium Laws	
				Process Used
				Special Features
				Production Costs
Maps	Maps	Maps		
References	References	References	References	References
Recorder	Recorder	Recorder	Recorder	Recorder

FIGURE 2. Schematic comparison of the files in the INTURGEO system.

DESCRIPTION OF THE INTURGEO FILES

The files are defined on a geographical basis, each record describing a particular location, or reference area In the Regional Reference File (RRF) a record covers a prescribed area, which can be political, geological, physiographic, or any other appropriate selection. In the Exploration Activity File (EAF), the reference area is the specific area covered by an individual survey. A record in the Deposit/Occurrence File (DOF) describes a specific deposit, occurrence or anomaly. The reference area of the International Summary File (ISF) is defined by national or international boundaries. A record in the Ore Processing File (OPF) will describe one ore processing facility.

The Regional Reference File systematically stores information on the geology of a region so that its uranium potential can be assessed. The method chosen to describe the geology systematically is to code information from a geologic map of the region. Such a map uses different colours to show the different geologic units which cover the surface of the region; a geologic unit comprises rocks of the same age, and, usually, the same type. So a 500 million-year-old granite is shown in a different colour on the map than a 200 million-year-old sandstone. A geologist determines the percentage of the area covered by each unit and records this percentage with the name of the unit, its age, rock type, organic content, alteration and other data.

An example follows of how information in the file can be used. A particular sedimentary geologic unit named the Karroo Supergroup occurs in seven countries in southern Africa. Uranium has been discovered in the Karroo in three of these countries, and it is a rock which is favourable for the discovery of more uranium occurrences. Therefore, if the Karroo covers 30% of a particular region, the region has definite uranium potential and should be evaluated by a geologist. A very simple task to perform with the RRF would be to make a list of all regions which contain the Karroo for use in uranium evaluation. The computer could also be used to search for other geologic units that are similar to the Karroo in age and rock type, but have been named differently.

It is hoped that this file can be used to assess the favourability of unexplored regions by comparing their geologic characteristics with those of regions which are known to contain abundant uranium resources. For this reason, other data describing the region are also stored, such as the uranium production of the region, and the level of uranium exploration activities in the region.

The Exploration Activity File characterizes the uranium exploration for a specific region so that the uranium favourability of the region and the need for further exploration can be assessed. For example, a record in the file on a portion of Madagascar would contain a description of all exploration surveys performed in the region. This includes the survey operator, the date, how the survey was done (e.g. by airplane with a spectrometer, or on the ground by collecting stream sediment samples), the number of areas with uranium anomalies identified by the survey, the cost, and a summary of the results. The past and present level of exploration activity in the region is also contained in the description. By having a systematic description stored in the computer of all the exploration which has been performed in a region, it will be possible to determine whether an area has been adequately explored, or warrants further work. Other analyses such as which exploration technique is most successful in a given environment, could also be performed in the file. An instant summary of exploration activity in a region, or country, will, of course be possible with this file.

The Deposit/Occurrence File stores geological data that characterize uranium ore deposits or occurrences so that they can be compared and classified. The characterization of the geologic setting of a given type of deposit provides the geologist with a set of criteria that can be used to judge the favourability of other regions by seeing whether the characteristics match in the two regions. For example, most of South Africa's uranium resources occur with gold in quartz-pebble conglomerate-type deposits. This type of deposit is restricted to a certain type of sediment that is older than two billion years and that overlies basement rocks generally older than 2.6 billion years. Other deposits of this type occur in Ontario and Brazil. This type of geologic environment occurs in other parts of the world and, by similarity, has uranium potential. But more data are generally needed to characterize other types of deposits. The geology of the host rock (geologic unit in which the deposit occurs) is described in the file in detail, as well as the minerals of the deposit, dimensions, grade (% uranium), owner, resources, production, other commodities present, and how the deposit was discovered Therefore, the file can be used for different types of analyses For example, a grade-size distribution could be determined for all deposits of a region, or resources and production could be totalled on a regional or country-wide basis. Information from the Regional Reference File could also be combined with the deposit data for that region for a sophisticated correlation of uranium occurrence with regional characteristics. The results might be used to make an estimate of the uranium potential of similar areas where adequate geologic information exists but in which little exploration has been performed Mathematical geologists are currently working on this technique.

The Ore Processing File will characterize uranium extraction operations for individual facilities. The results of a questionnaire to Member States formulated by the NEA/IAEA Working Group on Uranium Extraction will be computerized as soon as they are received. It will be possible using data from this file to choose the optimum ore processing technique for a given type of ore. An estimate of total manpower, energy requirements, and materials necessary to mine and process the ore should also be possible. These requirements are important considerations for countries preparing to mine and process uranium

The International Summary File summarizes uranium information on a country or other political region This includes the country's uranium potential, resources, past uranium production, organizations active in exploration or mining as well as official attitudes toward uranium resource development. This file is a source of information for the IAEA's Energy and Economic Data Bank on uranium resources and production. It also provides up-to-date answers to questions such as: "What is the status of uranium exploration in Niger? "; or "Which countries have greatest potential for the discovery of additional uranium resources? ".

One record, i e. collection of information on one country, should serve as a good summary of uranium activity in the country. A record will be maintained for all countries with uranium potential, or all countries which use and/or produce uranium.

DATA GATHERING

INTURGEO was designed at a consultants meeting in April 1978, and was implemented on the computer by February 1979. The implementation required approximately 38 person-weeks of work that included: data definition, preliminary coding, testing and demonstration, form preparation, programming for data entry and verification, and data acquisition. Four files are working and information retrieval is successful.

Approximately 450 records exist in INTURGEO at present, i.e there are 450 descriptions of geologic regions, exploration areas, uranium occurrences, or countries in the RRF, EAF, DOF and ISF. This amount of data constitutes a small fraction of what will be ultimately needed for effective application. In other words, INTURGEO is in an infant state with much more data required before full potential can be realized. The present data have been entered into the file by one IAEA staff member and one consultant from the United States Geological Survey. This information was coded onto special forms designed for the purpose. This has been considered the 'draft' stage of the data base.

Experience acquired during this initial coding and experimentation with the data on the computer has identified other items which need to be added, or changes that need to be made in the structure. New forms will be printed soon to incorporate these changes and INTURGEO will be ready for large-scale data acquisition.

Building the data base is no small task. Extracting the required information from various publications and maps for each country will require a considerable amount of time and effort, especially the data for the Regional Reference File which must be calculated from a map For this reason, the help of national organizations will be sought for data acquisition for their country.

The main task for 1980 and 1981 will be data acquisition. This will be accomplished by sending forms to various national organizations for completion; engaging short-term consultants to code data that already exist in the IAEA; having technical experts, working in the field for the IAEA, complete data forms on their work; or possibly purchasing data. Whatever the means employed, a large-scale effort is necessary to code and enter all of the data. During 1980 and 1981, INTURGEO's main use will be storage and retrieval of data In 1982, the full range of application should be possible.

APPLICATIONS OF INTURGEO

After most of the data has been entered, INTURGEO could be made available to all Member States, initially by telecommunication links direct to the Agency's computer. In the future, it would seem more appropriate to have a copy of the data base reside on each continent so that it is more easily accessible to Member States. The computer language used to query the data base is similar to simple English and designed for the non-expert.

By serving as an information storage system, INTURGEO will function in an educational capacity. It could serve as an 'expert' on uranium resources who has a perfect memory, so that the inexperienced geologist could use the data base as an 'instructor' to answer his questions regarding uranium geology, exploration, and development. It will provide a complete, well-indexed set of case histories and will produce neatly formatted tables as a standard output, suitable for inclusion in reports. It is hoped that the contents of the data base will be published periodically, as another means of disseminating the information.

INTURGEO will also be used in resource assessment Resource assessment has commonly been based on the opinions of experts who examine geologic data from a given area and make an estimate of the uranium potential. The accuracy of the estimate depends, of course, on the amount and quality of data available (i.e. how much uranium exploration has been done and how well the geology is defined). However, given the subjective nature of the process, estimates can vary considerably among experts. As an aid to the estimating

procedure, INTURGEO will provide a distillation of geologic information on the region that can be used directly. The data can also be analysed using computerized methods being developed by mathematical geologists to remove some of the subjectivity from the resource estimate. These mathematical methods numerically compare characteristics of a region of interest with those of areas having known uranium resources. These techniques are best suited to a computer because they require large amounts of data and processing. While the results are much more objective than an assessment based purely on human opinion, they are, of course, only as good as the input data and do rely on the knowledge of the person applying the method to evaluate the results. In other words, the computer does not provide all of the answers, but rather it functions as a sophisticated tool to handle the huge quantity of information required for intelligent resource appraisal.

In the above discussion of the contents of INTURGEO, examples were used to show the type of information stored and why it is important to record this information. The most immediate reward of building the computer files is to be able to use them to answer questions which formerly required time-consuming data compilation. For example, a recent INFCE exercise required information on national uranium law and policies regarding uranium development. It took a week to obtain and compile this information from various documents for each country. If the data had all been coded for the International Summary File, it would have taken only minutes.

Use of INTURGEO should also aid the Agency's technical assistance work. For example, the Exploration Activity File could be used to monitor the results of surveys performed in the countries of interest and to provide summaries of exploration activity in a given region. This would help to identify areas which are unexplored, or need more exploration.

In conclusion, INTURGEO will allow instant retrieval of specific data and the combination of uranium resource data in thousands of different ways. INTURGEO's advantages have been recognized by various national and international organizations concerned with assuring the world of adequate uranium resources for the future. Some monetary support has been received from them, and more will be required as well as donations of manpower to the effort. The results of this international effort will be the most complete, up-to-date information system on world uranium resources in existence.

Reference

[1] OECD/IAEA (1977) Uranium Resources, Production and Demand, Organization for Economic Co-operation and Development (OECD), Paris (December 1977)