

# The Formation of Uranium Ore Deposits

*( A report on an IAEA Symposium held in Greece in May)*

The increase in uranium production which will be required during the remainder of this century is unprecedented in the history of mineral development, and poses a major challenge to uranium geology and exploration. The first effects of the recent energy crisis are already reflected in increased "forward" prices for uranium, and a renewal of activity and investment in prospecting for new mines.

Although planned about two years ago, the IAEA Symposium on the Formation of Uranium Ore Deposits held in Athens in May, was particularly timely. Forecasts of uranium requirements until the end of the present century, published in mid-1973 by NEA/IAEA, show very large and increasing annual demands and the total requirement up to the end of the century has been estimated at as much as three million tonnes uranium. Looking further ahead, a study group on reactor strategies, convened by the IAEA late in 1973 to study longer term requirements, indicated the probability that up to the years 2020/2030 a quantity of as much as 10-12 million tonnes uranium might be required. Taking into consideration the lead time required to bring mines into production, the annual discovery rate of new uranium reserves will have to rise from the recent average of 65,000 tonnes per year to 230,000 tonnes in 1990. Such figures give some idea of the exploration effort which will be required to find the necessary uranium to fuel the nuclear power reactors of the future.

Although uranium is a fairly rare element, comprising, on an average, only 1-2 parts per million of the earth's crust, many types of rocks, particularly primary igneous rocks such as granites, contain uranium in concentrations up to 50 ppm. Such rocks are considered to be the sources of many of the higher grade concentrations, which have already been found and exploited.

The problem for geologists is to acquire the necessary knowledge of the chemical, mineralogical and geological controls which cause the movement and eventual deposition of uranium and thus enable them to identify favorable host areas and locate individual deposits.

Probably no other metal received such a concentrated mineralogical and geological study as uranium did in the period from 1946 to 1960, but despite all the intense scientific and exploration activity at that time, a total world reserve of the order of only 7000,000 tonnes uranium resulted. In contrast, the world is now facing very much larger requirements, as shown above, and the need is, therefore, for even greater geological research. Obviously the knowledge and understanding of how uranium ore deposits are formed is fundamental to any exploration effort.

The Athens Symposium followed the recommendations of a panel meeting in April 1970 on uranium exploration geology. It was attended by 220 participants representing 40 countries and two international organizations; 43 papers were presented.

#### SUPPLY CHALLENGE

An overview of the supply challenge of uranium was given by Mr. Robert D. Nininger, of the USAEC, who acted as chairman of the Symposium. He outlined the major topics and problems to be discussed during the conference, with the aim of meeting this challenge: "Uranium deposits in sandstone and quartz pebble conglomerates presently represent the preponderance of uranium resources. Yet there is a question whether geologic limitations on the occurrence of such deposits may preclude their discovery in numbers sufficient to meet the eventual resource needs. New types of deposits, low in grade but larger in size, representing the equivalent of the porphyry copper deposits, may supply the bulk of future resource additions. Further investigation is needed on the characteristics of such deposits and the means of their identification. Similarly, additional investigation is needed to determine whether limits on the more conventional deposits do, in fact, exist, and, if not, what advanced approaches to rapid identification of additional such deposits may be employed."

"The world probably cannot rely on the very low-grade deposits such as most uraniferous black shales for both and environmental economic reasons. There is probably a minimum grade between 100 and 500 parts per million below which uranium deposits cannot be effectively exploited for nuclear power."

Mr. Nininger noted that the Symposium marked the end of the initial period of expanding activity in the field of uranium raw materials, and a much-needed beginning of fuller international co-operation and exchange of information in the critical area of uranium geology and exploration.

## Principles of Modern Uranium Exploration

by John W. King, an IAEA Expert on Nuclear Raw Materials Prospecting, formerly in Mexico, and now Project Manager in Turkey.

Exploration for uranium has grown in a quarter of a century from an activity conducted in wartime secrecy in a half dozen countries, to one pursued as openly as industrial competition permits in some 50 countries. Reserves of more than 2 000 tons are known in each of 16 countries who have combined current production capability in excess of 30 000 tons annually. This reserve and production capability must be augmented soon by increased exploration worldwide to meet the demand for nuclear energy that is expected late in this century.