BOOK REVIEWS

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Recognition and Evaluation of Uraniferous Areas

Publisher International Atomic Energy Agency (Distributed by Unipub, Inc.)

Pages 295

Price $21.00

Reviewer P. K. Kuroda

In the introduction of this book, R. D. Nininger (Division of Nuclear Fuel Cycle and Production of the U.S. Energy Research and Development Administration) states: "The critical nature of the world uranium supply problem has been understood by uranium geologists for many years, but its recognition by the nuclear industry is a recent development." According to Nininger, "—we have only about 30 years to find all the uranium for the nuclear power programme. After 50 years there will be no longer any need for uranium, assuming that the development of nuclear power continues as forecast, whereby breeder reactors and, later, fusion reactors take over." He estimates that an annual production level of uranium required by the year 2000 will be at least 240 000 tons per year. This is a quantity twice the size of any of the four or five largest uranium deposits now known and of the same magnitude as the principal uranium provinces of the world! Can the uranium geologists meet this goal?

A Technical Committee Meeting was convened in Vienna in November 1975 by the International Atomic Energy Agency. It was attended by 51 experts from 23 countries. This book contains the papers, discussions, and panel reports presented at the meeting. It is expertly edited and readable. It gives an excellent review on various efforts being made by the uranium geologists. The experts often do not agree among themselves, and several of the papers are followed by heated discussions among the participants. The space devoted to the discussion amounts to about 38 pages or roughly 13% of the 295-page book, and these discussion sections are sometimes more interesting than the main text.

The papers were presented by the participants in four sessions:

1. Distribution of Uranium During Formation of the Earth's Crust and Crystallization of Magmas
2. Distribution of Uranium in Rocks as a Guide to the Recognition of Potential Uranium Ore Deposit Districts
3. Metallotectonic Control of Uranium Distribution
4. Recognition of Uraniferous Areas and Evaluation of Their Uranium Potential.

Two Panel Reports are presented in Session 5: Some General Concepts of Uranium Distribution and Uranium Distributed Within the Earth's Crust and Rocks as a Guide for Prospecting. Nininger presents an excellent overall review of these topics in his introductory paper. With regard to topic 2, for example, he comments that in some areas of the earth, regional enrichment may be useful as a guide to ore deposits, while in others, there is no significant relationship between ore formation and the uranium content of the regional rocks. Therefore, we should not look on such enrichment as a prerequisite to ore formation and thus be dissuaded from exploring areas that could be productive in the absence of uranium enrichment.

With regard to topic 3, Nininger comments that although any discussion of the fundamentals of uranium geology must deal with global tectonic theory, one important possible replacement or modifier may well be the growing concept of impact geology, about which most developers and supporters of the plate tectonics theory are hardly aware. The process of meteorite impact was probably a major, if not *the* major, contributor to global tectonics, according to Nininger. The reviewer was somewhat puzzled, however, that this important suggestion did not seem to have received much attention of the participants at the Conference.

Session 4, which covers topic 4, begins with a paper entitled "Where to Prospect for Uranium" by S. H. U. Bowie (Institute of Geological Sciences, Geochemical Division, London, United Kingdom). He argues that "the distribution of uranium in the sialitic crust would not be expected to be uniform because of early crust-mantle mixing by convective motion. Hence, provinces can be expected in which uranium is enriched and others in which uranium is depleted. The recognition of uranium provinces is thus of great importance in uranium deposit discovery."

According to Bowie, "the problems of the immediate future in relation to the discovery of new fields do not lie in detailed petrographic or mineragraphic descriptions of host rocks and ore minerals or in classification into types depending on minor differences in mineralogical composition, temperature of formation or wall-rock alteration. Rather they should be aimed at such problems as how to recognize major uranium provinces, at obtaining more quantitative data on the environmental conditions of uranium accumulation and preservation, and at understanding the role of organic material in uranium solution and complexing." He also questions the generally accepted view that the earth's atmosphere was devoid of oxygen prior to about 2.2 billion years ago. These thought-provoking ideas led to a heated discussion by the participants.

The book contains several interesting case histories of the uranium prospectings currently in progress in various parts of the world: Meghalaya, northeastern India; uraniferous area of mainland Argentina; the Arjeplog-Arvidsjaur uranium province, Sweden; Northern Black Forest, Germany; recent volcanoes and uranium mineralizations north of Rome, Italy; southern Cape Province, South Africa; the use of remote sensing method in uranium exploration in the U.S.; and uranium prospecting of areas covered by lake waters in Canada.

Paul K. Kuroda (BS, PhD, University of Tokyo, 1939, 1944) was appointed assistant professor of chemistry at the University of Tokyo in 1944. He came to the U.S. in 1949 and spent three years at the University of Minnesota as a research fellow. He was then appointed assistant professor of chemistry at the University of Arkansas in 1952, promoted to associate professor in 1955 and to professor in 1961. He served as an associate chemist at Argonne National Laboratory during the year 1957-1958.

He has been active in research in the fields of nuclear and geochemistry for many years. He is noted for his theory on the existence of natural reactors (1956) and his research on the occurrence of plutonium in the early history of the solar system. He has a list of approximately 260 publications.

Thermal Analysis of Liquid-Metal Fast Breeder Reactors

Authors	Y. S. Tang, R. D. Coffield, and R. A. Markley, Jr.
Publisher	American Nuclear Society (1978)
Pages	395
Price	$39.65
Reviewer	L. Bernath

The authors have undertaken the difficult task of providing a reference text to satisfy the needs of knowledgeable engineers and to serve as an introductory text for the uninitiated. In doing so, they have fallen somewhat short of the mark. Rather, they have produced a compendium of *American* thermal analysis techniques—and, even here, they have slighted the work of domestic authors less directly involved in the Fast Test Reactor (FTR) and Clinch River Breeder Reactor (CRBR) programs. As a consequence, one cannot find a comparison of *foreign* thermal analysis methods with those employed domestically; rather, the Westinghouse, U.S. Energy Research and Development Administration-approved methodologies are presented to the virtual exclusion of all others.

Similarly, in reviewing design criteria and philosophies, detailed presentations of the FTR and CRBR designs are provided, while descriptions of reactors that have successfully operated for many years, namely, Phenix, PFR, BN-350, as well as smaller earlier plants, are either superficial or nonexistent. Thus, *unproven* design bases and techniques are presented as most desirable and most likely to be successful, with no comparison of these with results from time-tested operational fast breeder reactor systems, currently being scaled to commercial plant designs. Thus, the British CFR and French-German Superphenix are not even mentioned! As a consequence of the myopic view, we find in Fig. 1-3 a "Diagram of an LMFBR Power Plant" that is specifically the CRBR Plant and atypical of plant designs much farther along toward commercialization. Specific nontypical features of the CRBR include: recirculation steam generators, relatively low steam turbine throttle conditions, and the "hockey-stick" design of superheaters and steam generators.

This text suffers from several technical flaws, e.g.,

1. Chapter 1 is a "sales pitch" for the liquid-metal fast breeder reactor; the comparison in Table 1-I utilizes obsolete information for the helium-cooled breeder. (More accurate data appear in CONF-74050 by the U.S. Atomic Energy Commission.)

2. Lithium-8 is identified as the primary activation product of concern with lithium coolant; it dissociates almost instantaneously into helium atoms.

3. It is stated (p. 11) that fast reactor control system response is "required" to be more rapid than for thermal reactors. Such a statement is not strictly accurate and is misleading. Speed of response requirements depends on the *margin* between limitations on operational or safety parameters and the full-power value of that parameter. Thus, for a "fast" system with wide margin, the control system response required may be significantly less stringent than for a "slower" system with a very small margin.

4. The description of core-restraint concepts assumes that the reader possesses a working knowledge of "steel swelling" phenomena (not described) and is aware of the sensitivity of fast reactor stability to fuel motion effects (also not described). Hence, the reasons for core restraint remain a mystery to the "uninitiated" reader.

5. Fuel-cladding chemical interaction in blanket rods may be more serious than implied on p. 51, due to the presence of excess oxygen which, in the core fuel, can be avoided by specifying a reduced oxygen-to-metal ratio, but cannot be avoided with pure UO_2.

It also suffers from editorial inconsistencies and oversights, such as:

1. Inconsistent designation of references in early chapters, both superscripts and parenthetical.