advanced LMFBR fuel element. It reveals, in the words of the organizers, that "much remains to be done," but it also points to the proper direction for the future effort.

Donald R. Olander is professor of nuclear engineering at the University of California, Berkeley, and principal investigator in the Materials and Molecular Research Division of the Lawrence Berkeley Laboratory. His research and professional interests are in the fields of reactor fuel element materials and chemistry, chemical kinetics of gas-solid reactions, and uranium enrichment by the gas centrifuge. He is the author of Fundamental Aspects of Nuclear Reactor Fuel Elements.

Migration of Uranium and Thorium—Exploration Significance

Author	John W. Gableman
Publisher	The American Association of Petroleum Geologists, Tulsa (1976)
Pages	168
Price	$15.00
Reviewer	William C. Peters

One of a series of monographs otherwise devoted to the geology of oil and gas resources, this volume reflects the widening scope of the American Association of Petroleum Geologists to include all energy minerals. The author's viewpoint—that the world is not faced with an early depletion of usable uranium—is of interest to the entire nuclear community. The book is, however, written for geologists involved in the search for uranium ore deposits rather than for scientists and engineers concerned with the broader aspects of uranium and thorium resources. The treatment is heavily geologic and related entirely to the natural processes of uranium and thorium concentration that can be expected to result in orebodies. Thorium deposits are considered, but the emphasis is on uranium. There is no coverage of the specific locations and characteristics of individual uranium and thorium deposits.

Gableman, a long-time participant in uranium exploration for the federal government and for private industry, introduces his study in a chapter dealing with the low discovery-efficiency index (success related to effort) experienced during recent years. He considers the lack of success a result of narrow geologic concepts rather than the results of an exhaustion in discoverable deposits. In the remainder of the volume, the author discusses relevant geologic observations and develops a detailed argument for giving broader limits to the geologic and geographic setting of potential deposits than those now used in exploration efforts.

Early chapters deal with the global distribution and geochemistry of uranium and thorium. Later chapters deal with the mechanisms of transfer from the earth's mantle to the crust and the migration of radioelements within the crust. Special consideration is given to the geologic history of continental margins, sites in the pattern of plate tectonics where many concentrations of ore minerals are born. In several chapters, the additional processes of mobilization, redistribution, and fixation—processes that can lead to the formation of uranium and thorium orebodies—are discussed.

Gableman's most emphatic geologic argument is for the derivation of sandstone-type uranium deposits from concentrated thermal brines of possible mantle affiliation rather than from dilute groundwater acting over longer periods of time. He cites abundant evidence, but a great many geologists who do not share his view will find the evidence equivocal. A specific weakness in the development of Gableman's proposition for broader conceptual models of uranium deposits is his minimization of ample and widely accepted evidence supporting the transport of uranium in meteoric groundwater systems.

In one respect, the volume is poorly balanced; the scale of observation changes between global and local several times in successive chapters. Another shortcoming is the uneven treatment of uranium and thorium geochemistry under several headings. Still, Gableman's book is a unique and scholarly review of the broader aspects of uranium and thorium deposits. His purpose, to stimulate exploration in new terrain, is achieved.

The book is not for the general reader, but it is strongly recommended to all uranium exploration geologists. The collective decline in their discovery-efficiency index may well have its roots in their need to appreciate the underemphasized processes of mineralization discussed by Gableman.

William C. Peters (PhD, geology, University of Colorado) is professor of mining and geologic engineering at the University of Arizona, where he teaches mining geology and mineral exploration. Prior to his academic appointment, he was chief geologist at the Bingham Canyon Copper Mine, Utah, and exploration geologist for FMC Corporation. He has engaged in uranium exploration throughout the western U.S., in north Africa, and west Africa. He has lectured on exploration geology at several European universities and is the author of more than 30 technical publications.