the products of the intensive work in geology that has been taking place in the USSR since the war. In many cases there is considerable uncertainty as to whether the minerals are in fact new species or merely varieties of known ones. It is often impossible to decide such problems from the published data without direct comparison of actual specimens from the type localities. The free interchange of mineral specimens between East and West would do much to prevent the establishment of two rival nomenclatures.

J. E. T. HORNE

HEINRICH (E. W.). *Mineralogy and Geology of Radioactive Raw Materials.* New York, Toronto, and London (McGraw-Hill), 1958. xiv+654 pp., 84 tables, 201 text-figs. Price 112*s.* 6*d.*

'It has been estimated', we are told in the preface, 'that since 1952 more man-hours have been spent in searching for uranium alone than had been spent in seeking all other metals in history.' One result of this unprecedented activity is the spate of publications on all aspects of the geology and mineralogy of uranium, and to a lesser extent of thorium, from which Professor Heinrich has endeavoured to distil the essence for the present survey. An idea of the magnitude of the task may be gained from the 58-page bibliography containing 1342 entries down to the end of 1957. The outstanding feature of the book is the comprehensive treatment of both mineralogy and geology in one volume. It is divided into two parts, of which Part I (149 pages) deals with descriptive mineralogy and Part II (406 pages) with ore deposits, actual or potential.

Part I begins with a rather sketchy chapter on radioactive minerals in general, which bears signs of hasty compilation. For instance, we are told (p. 21) that ^{40}K emits alpha as well as beta particles. U^{4+}, Th^{4+}, and other ions are described as isomorphous (pp. 8, 10) when it is meant that they undergo isomorphous replacement. As many age determinations are quoted later in the book, a section on the lead method could usefully have been included in this introductory chapter with some guidance on the selection of suitable material and the reliability of results. A discussion of the special difficulties encountered in the identification of uranium and thorium minerals would also have been helpful. This might have included such matters as the unreliability of optical data for identifying many uranium secondaries because of the varying content of zeolitic water; the ease with which some secondaries dehydrate to the meta form; the limitations of powder photographs in identifying

members of isomorphous groups; and the breakdown of normal methods for metamict minerals.

In chapter 2, minerals are classified broadly into uranium and thorium minerals, minerals with minor U, Th, or Ra, and minerals with radioactive impurities. Within each category species are grouped chemically. Doubtful or poorly defined species are relegated to the end of each group. A wider range of species is thus covered than in Frondel's Systematic Mineralogy reviewed above and the principal value of this chapter lies in the inclusion of species excluded from the more detailed work. Thus, amongst those classified here as uranium and thorium minerals are the metamict species fergusonite–formanite, samarskite–yttrotantalite, euxenite–polycrase, polymignite, æschynite–priorite, and zirkelite, together with thucholite and related hydrocarbon complexes. The section on minerals with minor U, Th, or Ra includes baddeleyite, perovskite, radiobaryte, apatite, wavellite, crandallite, xenotime, opal, zircon, allanite, gadolinite, chevkinite, sphene, and thalenite. Eight hydrated uranium minerals, described since Frondel's manuscript was completed, are also included, though the available data on most are scanty. The more important species are described under the headings composition, structure and form, occurrence, and identification. 'Structure' is used in the morphological sense. Chemical analyses are omitted, except for uranium and thorium. Occurrences are recorded very fully (an index of localities contains about 2130 place-names). In most cases physical properties are not described in the text, but are tabulated with those of related species. The notes on identification are not always adequate, for X-ray data, if given at all, comprise only the strongest three or four lines.

The second and larger part of the book covers the whole range of uranium and thorium deposits described in a very extensive literature. Uranium, in particular, occurs in many environments whose diversity has only become apparent in recent years. The complex geochemistry of uranium results from its ability to substitute extensively for thorium, rare earths, and calcium, to oxidize readily to the highly mobile uranyl ion, and above all to be precipitated as uraninite from hydrothermal solutions over a very broad range of temperature and pressure. The precise classification of deposits adopted in a book of this sort is perhaps of little consequence, since classification cannot be wholly divorced from genesis, over which controversy is as keen as ever. What is important is that the mineralogy and geology of the various deposits should be succinctly described and the theories of origin objectively stated. This the

author has done. Where he has no personal experience of the deposit, as with the Rand, he does not attempt to adjudicate, but where on familiar ground, as in the Colorado Plateau, he records his own conclusions. United States deposits perhaps have more than their fair share of attention on the grounds of economic or geological importance alone, but it would be ungracious to quarrel with that.

The book ends with the very full bibliography already mentioned and separate indexes for mineral species, localities, and subjects.

There are a few misspellings, notably 'thucolite' (no second h) throughout the book and 'montroesite' and 'paramontroesite' in chapter 10. Parentheses are used instead of braces to denote forms and cleavage, and instead of brackets to denote zone axes. The half-tone illustrations are excellent.

J. E. T. HORNE

The Geology of Uranium. Translated from Вопросы геологии урана [Problems in the Geology of Uranium], Supplement no. 6 of the Soviet Journal of Atomic Energy, Atomic Press, Moscow, 1957. London (Chapman & Hall Ltd.) and New York (Consultants Bureau Inc.), 1958. vi+128 pp., 61 tables, 90 text-figs. Price (bound) 48*s*.

This is not an introduction to uranium ore deposits, as the title suggests, but a collection of a dozen unconnected papers. There are three on various aspects of uranium geology, six on uranium minerals, and three on radiometric techniques.

Two of the geological papers discuss the role of metamorphic processes in concentrating uranium in certain Palaeozoic sediments. A third is on the origin of uranium mineralization in coal and has appeared in somewhat different form in the proceedings of the second Geneva conference;[1] comparison of the photomicrographs accompanying the two versions shows discrepancies in the magnifications quoted. These geological papers suffer from the usual Russian omission of localities and sketch-maps. The uranium content of coal is given only in relative units.

A paper by Polikarpova amplifies his earlier description of the uranium silicate nenadkevite,[2] rejected by Fleischer[3] as 'an unnecessary name for what is probably a variety of coffinite'. Several photomicro-

[1] Z. A. Nekrasova, Proc. 2nd U.N. Int. Conf. Peaceful Uses At. En., 1958, vol. 2, p. 412.

[2] See Min. Mag., 1958, vol. 31, p. 967, and M.A. 13–385.

[3] M. Fleischer, Amer. Min., 1957, vol. 42, p. 441.