overall regolith? This practical advice and numerous other simple but important statements are found throughout this volume.

The average exploration geologist urgently wants to find the next orebody as quickly and as efficiently as possible and, of course, ahead of the opposition. The geologist has to be sure that he has collected enough samples of the right kind as well as in the geologically meaningful sites. He also has to be familiar with the analytical methods available and be able to interpret even the most subtle geochemical results. This early phase of exploration is most critical as it is the guide for the expensive follow up drilling phase. Therefore the correct techniques have to be applied relevant to the expectations of the overall programme. Any help in establishing the correct procedure is most welcome.

The authors have produced a well integrated story and have addressed all these aspects adequately. They thoroughly discusss the overall duricrust in great detail and with abundant case histories of gold and base metals. They lay stress on the processes involved in the dispersion or concentration of metals in this environment. The interpretation of the geochemical data including a very adequate account relative to gossans is discussed in relation to the local weathering history. The graphs are generally clear and the abundant block diagrams I found particularly pleasing; they will be useful field guides, especially for the young geologists. A very substantial bibliography is included and the appendices will be frequently referred to.

Considerable emphasis has been placed on the practical aspect of exploration. This includes preparation of the exploration programme based on the logical considerations to be followed from a knowledge of the target area's weathering history and its present topography, to determination of sample locality and guidance in the selection of indicator elements and analytical methods suitable for the task involved. I thought that perhaps platinum considerations could have been given a section on its own rather than be distributed in several sections.

The chapter on diamond exploration and the accompanying summary was clear and concise and presented a simple to follow exploration guide, but I was surprised not to see any mention of the very rich Western Australian diamond mine at Argyle. My enquiries provided the answer that no geochemistry was undertaken as the exploration was based on heavy mineral sampling. I think that this is a major omission.

A few comments on the very large carbonatite at Mount Weld in Western Australia are relevant. Some of these comments are taken from a more recent reference (Duncan and Willett [M.A. 91M/4026]), than that used in the book. Mt Weld contains a particularly fine example of the development of a large *REE* orebody in the regolith and perhaps should have been given more stress. The concentrations of the two principal *REE* ore minerals, secondary monazite and churchite ($YPO_4 \cdot 2H_2O$), have reached very high amounts. The monazite in a number of one to two metre drill sections reaches over 40%, while the yttrium content of the main Y-rich zone is over 0.5% with very high *HREE*. Such concentrations of these minerals bear witness to the intensity of the chemical processes that can occur in the regolith. Regoliths or other carbonatites should be looked at carefully for churchite as it is a fibrous mineral and may be easily lost and go undetected in drilling fluid. The Table 111.3–4 has an error. The niobium reserve should read 273 Mt at 0.9% Nb_2O_5 at a cut off of 0.5%, while an additional reserve for the combined $LnO + Y_2O_3$ is 1.31 Mt at 23.6% grade using a cut off of 20.0%.

The chapter 'Summary and Procedural Recommendations' should be read first as it is a clear statement of the problem and how attempts to solve it may be understood, programmed, attacked and interpreted. For each of these sections the authors helpfully refer to the relevant detailed sections and stress the importance of understanding the development of the regolith if geochemical exploration is to have any chance of success.

This will be a useful reference work for many years as it fills a large gap in the literature. It will be not only of great use to geologists, but also to soil scientists, geomorphologists and environmental geochemists. While the price is not cheap there is plenty of value for money.

J. L. DANIELS

Ivanovich, M. and Harmon, R. S. (eds.). *Uranium-series Disequilibrium, 2nd edition.* Oxford (Clarendon Press) 1992. xxxiv + 910 pp. Price £110.00.

This timely second edition published ten years after the first is appropriately dedicated to John H. Rosholt—a pioneer in the field of uranium-series disequilibrium.

The field covered includes the physical, chemical and geological aspects of naturally occurring

radioactive disequilibrium within the ^{238}U, ^{235}U and ^{232}Th decay series. Theory, analytical methodology and applications dealt with are particularly important to scientists interested in geological, hydrological, oceanographic, palaeoclimatic and archaeological problems. However, it is doubtful if readers with no more than a 'modest knowledge of fundamental physics, chemistry and geology' will be able to follow the more specialised sections.

Subject matter is based on some 1800 papers, the majority of which have been published since 1970. It is unfortunate, however, that of the 33 authors nearly half are resident in the U.S.A. with others divided between the United Kingdom, Canada and Australia. This tends to give an imbalance to global aspects of the behaviour of uranium and thorium nuclides at the geosphere-biosphere boundary.

The sections on nuclear physics, geochemistry and analytical techniques including chemical procedures, radiation spectrometry and mass spectrometry are excellent. In particular, they provide up-to-date information of value to students, scientists and engineers not versed in these subjects.

Following sections are devoted to radionuclides in igneous rocks, surface hydrology, ground water, oceanic geochemistry, estuarine environments, carbonate and sulphate precipitates in fresh water, marine sediments and marine phosphates and carbonates. Dating applications are given in the fields of archaeology, palaeoclimatology, palaeosea levels, landscape evolution and to lead-210 dating applied to sediments. Two sections of considerable practical significance concern (*a*) the application of radionuclide transport in relation to radioactive waste disposal—a subject that has been neglected for much too long—and (*b*) exploration geology. The former, which is based almost entirely on post-1980 publications could have been strengthened by more reference to the physical properties of uranium and thorium minerals as natural analogues in the understanding of radionuclide mobilisation and sorption processes. The latter section is not particularly inspiring, but this, no doubt, is due to the decline in uranium exploration over the past two decades.

The volume is clearly printed and illustrated, as would be expected from the OUP, but it is suggested that if a third edition is contemplated it might better be presented as two volumes: one dealing with appropriate nuclear physics, chemistry, geochemistry, geochronology and analytical methodology; the other with applications. As it is, the volume should be read by all interested in environmental aspects of uranium and thorium nuclides and in particular by scientists and engineers involved in nuclear waste disposal.

S. H. U. Bowie

Reed, S. J. B. *Electron Microprobe Analysis. Second Edition.* Cambridge (Cambridge University Press), 1993. xviii + 326 pp. Price £45.00 (hardback).

The first edition, published in 1975, justifiably became a standard text on the subject, and over the years has been consulted extensively by microprobe analysts. This second edition is a welcome, somewhat overdue, revision which follows closely the original format of a practical approach coupled with sound theoretical principles. As in the first edition, each chapter incorporates historical, theoretical and practical perspectives to describe a specific aspect of electron microprobe analysis. After the introductory chapter, the next three chapters relating to the theoretical and design features of the electron microprobe are little changed. Chapter 5 on scanning, includes sections on the use of colour, storage and processing of X-ray images. Chapters 6 to 8 deal with the principals, theoretical and practical aspects of wavelength-dispersive spectrometry, and Chapters 9 to 10 with energy-dispersive systems. Chapters 11 and 12 provide a detailed treatment of *quantitative* analysis by wavelength-dispersive and energy-dispersive means respectively; together with a comparison of the two. Chapters 13 and 14 cover the more theoretical details of X-ray generation and interaction with the matrix, and Chapters 15 to 16 are devoted to absorption and fluorescence correction procedures, with a worked example of matrix corrections in practice (Chapter 17). Chapter 18 takes a theoretical and practical approach to light element analysis, and the book concludes with useful appendices on data relating to characteristic X -rays.

Those familiar with the first edition will welcome this second edition to their bookshelves. To those new to the field of electron microprobe analysis, I can strongly recommend this book because of its eminently readable style and because it succeeds on several different levels: it provides general background information, it combines a theoretical base with practical appli-