BOOK REVIEWS

Chapman, N. A. and McKinley, I. G. *The Geological Disposal of Nuclear Waste.* John Wiley & Sons, Chichester, New York, Brisbane, Toronto and Singapore, 1987. xii + 280 pp. Price £34.95.

The start of drilling operations in late 1986 at four sites in England identified as possible dumps for low-level radioactive waste was bitterly opposed by local residents, and the resulting media publicity brought the whole question of radwaste disposal to the forefront of public awareness. The appearance of this book in early 1987 was thus very opportune, as it provides a wealth of relevant information, much in a form understandable by the 'intelligent layman'. Unfortunately, it has had little chance to influence debate as, even as the book was being reviewed, the UK Government abruptly dismissed the shallow-burial option, causing work on the four sites to be abandoned and the loss of an estimated £20 million-worth of R & D.

The book opens with a review of the nature of radioactivity and the principles of radiological protection, then describes how radioactive waste arises during the various stages of the nuclear fuel cycle. Processing of the waste to a form suitable for geological disposal is dealt with only briefly and thus readers of this journal expecting an extended discussion on the relative merits of SYNROC *vs.* borosilicate glass will be disappointed. Rates of production in the UK of both nuclear and non-nuclear wastes are tabulated, as are the radionuclides assumed to be present in the different waste forms. These introductory chapters close with a brief discussion on the principles of waste management and alternatives to deep geological disposal (could any responsible government condone—or even have considered seriously—disposal of high-level waste in solar orbit?).

In the main part of the book, a chapter dealing with the multi-barrier repository concept, and the geological hazards that the repository may encounter during its necessarily long lifetime, is followed by chapters describing research into processes which may occur in the 'near-field' (waste, engineered barriers and adjacent host rock) and the 'far-field' (extending to the Earth's surface and biosphere). These and the following chapter on field and laboratory measurement of radionuclide migration draw heavily on experimental and modelling studies of ground-water flow and chemistry in materials ranging from plastic clays to fractured granites. Further chapters describe the construction and operation of a deep repository for long-lived wastes (a mainly theoretical description, although the authors stress that the technology and expertise for this already exist) and the shallow burial of low-activity wastes—a process that has been operating for 40 years. Conversion of all the data generated by studies of radionuclide mobilization and transport from the near-field to the biosphere and the likely risk to man is dealt with in the final chapters. This area is where most uncertainty exists: perhaps the only means of validating models is by investigation of natural analogues (e.g. radionuclide distribution in the Oklo fossil natural reactor, Gabon) and a number of these are described.

Appendices describe the International organizations involved in radwaste disposal, significant national research programmes into this (with the UK programme getting an appendix of its own), and the radwaste literature. Results of studies into radwaste disposal often appear in the 'grey area' of the scientific literature, for example open-file publications and end-of-project reports to government agencies. The book draws heavily on these, as can be seen from the extensive and up-to-date (to 1986) reference list.

This book has its drawbacks—it would have benefited from a more structured approach and more care in the selection and reproduction of illustrations. Some line drawings are excellent, others are poorly reproduced and one (Fig. 6.16) is so simplified as to be misleading. It is, however, essential reading. Scientific research into radwaste disposal cannot be divorced from Government policy as has been demonstrated a number of times recently in the UK. The problem will not go away, and a political decision to decommission nuclear power stations could change the rules overnight. Go out and buy this book and prepare yourselves for a future Great Debate!

D. J. MORGAN

Woolley, A. R. *Alkaline rocks and carbonatites of the World. Part 1: North and South America.* London (British Museum [Natural History]), 1987. 216 pp., 238 figs. Price £40.00.

Although alkaline rocks and carbonatites make up only a very small fraction of all igneous rocks, their

fascinating chemical and mineralogical variation has led to them being subjected to intensive study. In the introduction to this publication, the author points out that 'an understanding of their genesis is essential if we are to understand fully the workings of the solid earth'. He also stresses their economic importance as sources of a wide range of industrial raw materials (e.g. phosphate, vermiculite, Nb, Cu, rare earth elements). Over 2000 localities are now known, including more than 300 carbonatites.

The author compiled this catalogue of alkaline rocks and carbonatites because no world-wide survey had been available previously He has included all occurrences that could be traced in four parts, the first of which deals with North and South America. Parts 2, 3 and 4 (to be published) will deal with, in order: Africa; U.S.S.R.; and Asia, Europe (excluding U.S.S.R.), Australasia, Antarctica, and the oceanic islands.

The main criteria for classification as alkaline rocks are the presence of modal feldspathoids (including analcime) and/or alkaline pyroxenes and amphiboles. Also included are fenites, certain ultramafic and melilite-bearing rocks (e.g. alnöites), and some highly potassic rocks (but not kimberlites). Carbonatites include igneous and metasomatic types as well as some that may be metamorphic in origin.

The catalogue is arranged nationally with each occurrence being assigned a national number. Information includes: geographic coordinates; brief descriptions of complexes (including simplified geological maps), petrographic relations, principal results of some specialized geochemical studies; economic aspects; age data; references to crucial published work for each occurrence, and a full reference list at the end of each national section. A locality index cites both national number and page number.

Part 1 includes data for Canada (165 occurrences), Greenland (44), Mexico (17), U.S.A. (144), Argentina (17), Bolivia (7), Brazil (116), Chile (3), Colombia (3), Costa Rica (3), Dominican Republic (1), Ecuador (1), Guyana (3), Haiti (1), Honduras (1), Paraguay (26), Peru (4), Uruguay (3), Venezuela (2).

The catalogue is well-produced on a large page format (A4) and contains abundant factual information; the reference lists are particularly valuable. One possible problem is that the classification criteria for alkaline rocks has led to the omission of some complexes which are genetically related to other complexes which are included. Thus the Ascutney complex, Vermont, is omitted even though it is undoubtedly a member of the White Mountain Magma Series. There may be other such omissions.

The author is to be congratulated on compiling this detailed catalogue. Some of the occurrences are only reported in obscure journals and survey reports making this comprehensive list particularly useful for geologists working on alkaline rocks. Thus the full catalogue will be an essential purchase for university, survey and mining company libraries as well as for specialist workers, although the latter may eventually find the cost for the whole catalogue rather prohibitive.

C. M. B. HENDERSON

Woods, T. L. and Garrels, R. M. *Thermodynamic Values at Low Temperature for Natural Inorganic Materials: an uncritical summary*. New York and Oxford (Oxford University Press), 1987, xvi + 266 pp. Price £17.50.

In numero veritas! Since the application of thermodynamics to sedimentary geochemistry was pioneered by Professor Garrels, any compilation of thermodynamic data by him will inevitably be vested with considerable authority. In this case, rightly so. A gap in the existing provision of data has been apparent for some time, as none of the other compilations include quite the right mix of aqueous species and rock-forming minerals which is necessary for sedimentary geochemistry.

The thermodynamic data in this text is ordered initially alphabetically (by the name of the first element in the formula, not by its symbol); however, within the listing for each element, the compounds are presented in a fixed (but arbitrary?) order. The data itself comprise the formula, compound name, and state, together with values for the enthalpies, free energies, and entropies under standard conditions. The units are joules, and the sources of data are numerically keyed to a list of references. A valuable feature of the data set is that the range of values (up to 10 in some cases) found for some coupounds gives a good idea of the possible errors in estimating the free energy changes for selected reactions. These values are presented uncritically, but there is a suitable caveat in the introduction as to the dangers of using data from different sources. I will certainly use these tables regularly, and will acquire a set for teaching. They are clearly printed and are robustly bound, and the latter will prove to be a thoughtful feature in view of their potential usage. An essential buy for any serious sedimentary geochmemist at £17.50.

R. RAISWELL

Williams, K. L. *Introduction to X-ray Spectrometry: X-ray fluorescence and electron microprobe analysis*. London and Boston (Allen and Unwin),