BOOK REVIEWS

Albarède, F. *Introduction to Geochemical Modelling.* Cambridge (Cambridge University Press), 1995. 563 pp. Price £60.00. ISBN 0 521 4545 4.

In its publicity, this book is described as being for "the motivated reader", to help "overcome the formal difficulties of geochemical modelling". The publicity is accurate, as Francis Albarède's book is not an easy read for undergraduates, or others, who lack a firm foundation in mathematics. Indeed, it seems to be essential that readers should have experience of mathematics at university level, and this will frighten off many who use geochemical modelling, and for whom an introductory book would be valuable.

The book is long, and about equally split between equations and prose. There are abundant worked solutions within the text, most of which were solved by the author using the software package MatLab on Macintosh desk computers or Sun workstations. The book has been, 'tested' on masters students at Lyon, and it is as well to remember that these students will be amongst the élite in France.

The first part of the book is devoted to general principles, starting with how to tackle raw data (mass balance, working with ratios and why they are important, fractionation). There then follows a chapter on linear algebra (to bring the reader back up to speed with matrices, vectors and orthogonal functions) which leads on to a chapter on numerical analysis, and methods of solving partial differential equations (finite differences). The fourth chapter on techniques is devoted to probability and statistics, including sections on errors and their propagation, Monte-Carlo simulations and principal component analysis. This is followed by a chapter on inverse methods of data analysis, emphasizing least squares methods.

Once the techniques are covered (about 60% of the book), it moves onto their application. The first is to modelling chemical equilibrium, dealing with reactions in solution (taking as an example the calcium carbonate system, and mercury-chloride complexing), and speciation in gaseous mixtures, before moving on to rock systems. After equilibrium, dynamic systems are covered, with residence times, radioactive decay and reactor behaviour (for a single magmatic reservoir, moving on to interacting, multielement, reservoirs). A whole chapter is devoted to transport, advection and diffusion; in diffusion, one section covers variation in diffusion coefficient with time (an interesting concept in itself). This chapter uniquely has appendices, describing the error function, the theta function and Duhamel's principle. The final chapter focuses on magmatic processes, dealing with batch melting and crystallization, incremental processes, open magmatic systems, disequilibrium processes, and a critical appraisal of compatible versus incompatible elements. There are some 13 pages of references, and a four-page index.

The author quite rightly makes no apology for his rigorous mathematical approach. It does mean that this book is hard work, but it should certainly be considered by any who use geochemical data, be they for fluids or rocks (sedimentary, metamorphic or igneous), major or trace elements, or isotopes. It is destined to become a library book, for which it is recommended, but postgraduate courses which require a sound theoretical basis (to which they devote appropriate time) should consider this as a course text, and doctoral students who use geochemical data should work with this book, particularly if they want their work to stand above the crowd of data gatherers.

D. A. C. MANNING

Dunn, P. J. *Franklin and Sterling Hill. New Jersey: the World's Most Magnificent Mineral Deposits.* Franklin, New Jersey (Franklin-Ogdensburg Mineralogical Society, P.O. Box 146, Franklin, NJ 07416, USA.), 1995. xxiv + 755 pp., 420 photos., 300 maps, sections and line-drawings. Published in five parts at $30.00 per part or $150.00 for the entire work (plus surface shipping and handling of $5.00/part or $15.00 for the entire work).

This five-part *tour de force* attempts to outline the history, geology, mining development and above all the mineralogy of these famous deposits, now worked out, but which were particularly rich in zinc, manganese and iron. They have been known for some 300 years and yielded over 33 million tons of ore. Approximately 10% of all known mineral species were to be found here; more valid new mineral species (69) have been described from here than from any other locality and some 10 % of the minerals are unique to Franklin and Sterling Hill.

The work opens with an extensive bibliography of some 1600 items, and Part 1 continues with chapters presenting historical perspectives of the local iron mining and processing, which was under way in the 1740's (including the attempts at working the enigmatic franklinite which resembled magnetite but did not react in smelting as magnetite did), and local zinc mining which was first developed in the late nineteenth century. It is interesting to learn that Sterling Hill was purchased at a Sheriff's sale for £40. Part 2 deals with the quarries in the Franklin Marble, which is the host to all the ores, the beneficiation of the zinc ores, the regional and local geology of the area and, in particular, the gelogy and structure of the zinc deposits. The ores are Precambrian in age and it is considered that the metal content of the protores was in place in sediments before the complex later history of igneous intrusions (granites and pegmatites) and several episodes of regional metamorphism to the sillimanite grade (upper amphibolite to granulite facies). Various genetic theories for these orebodies are reviewed but no comprehensive solution to the various problems posed is yet available. This part of the work continues with details of the geochemistry of the orebodies and the distribution of the elements between the numerous host minerals; as noted earlier by Frondel and Baum (1974) there is a close correspondence between the suite of trace elements found in these deposits and those typical of marine and hot-spring deposits of manganese oxides. The discovery early in the twentieth century that electric arcs from switchgear caused fluorescence in nearby minerals led to the recognition of more than 80 fluorescent mineral species in this area. The paragenetic and textural aspects of the various mineral assemblages in the zinc ore units are considered; silicates are much more common in these ores than might be surmized from the literature.

The remaining three parts are concerned with the descriptive mineralogy of the deposits, starting with the silicates which include over 40 Mn silicates and some 20 Zn silicates, in addition to numerous silicates of Ca, Mg and Fe. In many cases, earlier data on morphology and physical properties are supplemented by new microprobe analyses, and by hand specimen photographs and numerous photomicrographs, together with details on the occurrence and paragenesis for all the major species represented. This style is followed also in giving the descriptive details of native elements, sulphides, arsenides, antimonides, sulphosalts, oxides, halides, carbonates, sulphates, borates, tungstates, molybdates, arsenates, arsenides, phosphates and vanadates, together with brief descriptions of eight unnamed species. The work concludes with appendices on obscure mineral names, a glossary of local terms (e.g. 'Cousin-Jack', a term for Cornish miners, many of whom were brought over to do underground mining), and a description by the mine management of the operations of the Sterling mine in 1966, followed by fairly full subject and mineral indexes.

This is the most important work on these deposits and their minerals since the classic U.S. Geological Survey Professional Paper **180**, by Palache in 1935 (*The Minerals of Franklin and Sterling Hill, Sussex County, New Jersey*) and represents over 20 years of research by the author and cooperation with other geologists, miners and mineralogists interested in Franklin and Sterling Hill. The photographs incorporated in the text are in black-and-white, and the reproduction of these is good, though some of the older but informative views of Franklin and of the underground mining operations are somewhat lacking in contrast but are nevertheless of considerable interest; the numerous maps and cross-sections are clear and helpful. These famous deposits have yielded some magnificent specimens to be seen in mineral museums all over the world and it is exciting to have an up to date record of all the mineralogical data pertaining to the many rare species represented in this unique assemblage. Libraries and others fortunate enough to possess a copy of Professional Paper **180**, will certainly need to obtain this latest production to supplement and expand the record of this classic locality. The Franklin mine closed in 1954 and the Sterling mine closed in 1986, but the Franklin Mineral Museum prospers and has been designated as a New Jersey Historical Site.

R. A. HOWIE

Mitchell, R. H. *Kimberlites, Orangeites, and Related Rocks*. New York and London (Plenum Press), 1995. xiv + 410 pp. Price $89.50. ISBN 0 306 45022 4.

Despite the title, this book focuses on the geographically restricted (to South Africa) group II or micaceous kimberlites (the 'orangeites' of Mitchell) and their lack of genetic relationship with the much more abundant group I or basaltic kimberlites ('archetypal' kimberlites of Mitchell). However, the book also provides a useful update on petrogenetic hypotheses of kimberlite and lamproite, the major primary source rocks of diamond.

Combining previously published mineral chemical characteristics of group II kimberlites with new data, notably those from the PhD thesis of K.M. Tainton, 'orangeites' are described as containing multi-compositional phlogopite and olivine, and some or all of the following: primary fine diopside, *REE*-Sr rich perovskite/phosphates, K-Ba titanates, Zr silicates and variable carbonates. They are characterized by a