

modelling mineral solubilities in fluids of liquid-like density. This requires not only knowledge of the equilibrium constant for the hydrolysis reaction, but has also usually involved assigning atoms to specific complexes in solution, for which activity coefficients are calculated using an extended form of the Debye-Huckel equation. Two chapters, by Pitzer and by Weare, review and apply the alternative 'Pitzer approach' which allows calculations to be carried out for concentrated solutions where the Debye-Huckel equations fail. Complexing as such is ignored, except for weak electrolytes, and instead an extended term model is used that specifically takes into account all possible interactions between 2 or 3 ions in the solution through empirical specific ion interaction parameters. This approach has proved successful in modelling evaporite deposition, but is only beginning to be applied to systems at temperatures above 25°C. Partly this reflects the large body of experimental data needed before it can be applied at all (the available data above 25°C is summarized by Pitzer), but also aqueous electrolytes are increasingly complexed at elevated temperatures.

Eugster and Baumgartner deal specifically with mineral solubilities at elevated temperatures, and summarize the data for free energies and speciation of metal chlorides. They describe solubility and speciation calculations based on assigning atoms to specific complexes, in contrast to the Pitzer approach, but restrict discussion to a small data base well-constrained by experiment. The approach used by Sverjensky is similar in general strategy, but follows the Helgeson school in attempting to predict values of the thermodynamic constants outside the experimental range. Sverjensky develops an equation of state for aqueous complexes and applies the overall Helgeson approach to the problem of Pb solubility.

These 4 chapters provide a state of the art review of the currently viable approaches to mineral-fluid equilibria, but all assume a basic knowledge of the subject to begin with. Alongside them, Brimhall and Crerar have put together an extensive (86 page) summary of ore fluids and the role of thermodynamic modelling in the study of ore genesis. This chapter spans metallogenic theory, the physical chemistry of ore fluids (a useful basis for some of the other chapters) and the formation of a wide range of ore deposits. Although some of the theoretical models used are outdated, this chapter is invaluable in explaining why it is important to grapple with thermodynamics in order to understand ore deposits.

The final three chapters concern the thermodynamics of melts. Berman and Brown contrast stoichiometric and speciation approaches to the

thermodynamics of multicomponent silicate melts and highlight deficiencies in the data base. Ghiorso also reviews melt thermodynamics and the problems of calibrating natural systems, and develops modelling procedures which are applied by Ghiorso and Carmichael in the final chapter to a range of petrological problems: fractional crystallization, assimilation and vesiculation.

It is unlikely that even a tightly edited book could integrate as varied a range of fields as is presented here, and in fact no attempt has been made to link chapters or provide an editorial outline for the uninitiated. Indeed in writing this review, I have not followed the order in which the chapters appear in the book. Overall, this is an enormously valuable volume which should be on the shelves of every geochemist, mineralogist, petrologist and ore-deposit geologist. At \$18.00 it goes without saying that it is excellent value for money. Some of the author-prepared typescripts are less free of typographical errors than others, but the quality is always high, and the difference in type-face between chapters make it easier to find where you are.

B. W. D. YARDLEY

Winchester, J. A. (ed.). *Later Proterozoic Stratigraphy of the Northern Atlantic Regions*. Glasgow (Blackie) and New York (Chapman and Hall), 1988. xiv + 279 pp. Price £69.00.

This 279 page book contains several original articles of value to students of Proterozoic geology mixed in with contributions that are either essentially rewrites of already published work or summaries of scattered earlier papers. Whilst the standard of presentation and illustration of many of the individual contributions is very high, poor reproduction of photographs and poorly draughted diagrams mar others. A lack of location maps for the areas discussed in eight of the articles will not help the reader who is unfamiliar with the geology of the British Isles.

The collected papers deal with some of the rocks and geological events which relate to the time span 1200 to 570 Ma where these crop out, or took place, in some Northern Atlantic regions. Thus we are given accounts of known and supposed 'later' Proterozoic rock groups and events in Scandinavia, East Greenland, Shetland, Scotland, Ireland, Labrador, and Newfoundland. We learn little or nothing however of those occurring in Spitzbergen, the NW Appalachians, the Grenville Province, or the Gothides of southern Sweden.

In some of the papers we are informed in admirable detail of the sedimentology of Proterozoic clastic sequences but are told little of the

evidence for their age and subsequent history; in others we are given details of the geochemistry of metasediments but only passing appraisal of their environments of deposition and their possible palaeo-environmental settings; in yet others we learn details of tectono-metamorphic history but little of possible stratigraphic relationships. Such a diversity of approach is understandable given the differing expertise of the authors and in many cases the problems of interpreting notoriously complex and enigmatic rocks but, for the general reader, such differing approaches, lack of connective tissue, and lack of clear purpose will be confusing.

In the editor's words this book is 'not the result of a specifically convened conference' but is instead 'a collection of specifically commissioned articles'. As such it has not benefited from a refereeing process and has not avoided the trap of being parochial. Including the Introduction the book comprises 18 articles 12 of which deal with rocks from Ireland and Scotland. Of these the editor is author or co-author of five. With notable exceptions it is the papers dealing with rocks outside of the British Isles that provide the most useful information.

Because of this parochialism, the omission of papers concerned with other parts of the N. Atlantic region, and the absence of articles dealing with palaeomagnetic constraints, the book's title and stated purpose are misleading.

Any attempt to synthesise the geological evolution of a region as complex and fragmented as the N. Atlantic borderlands during the Proterozoic is ambitious. It is however particularly so when, for the most part, our only indication of age is derived from very few and often questionable isotopic studies. This attempt clearly demonstrates the need for a dramatic increase in geochronological studies even though these are unfashionable to many of our isotope geochemistry colleagues. Though perhaps understandable, the existence of little and often poor quality isotopic data does not, however, excuse the potentially misleading

speculations concerning the age of geological events that are apparent in a number of articles in this book.

At nearly £70 the book is expensive. Despite this, and the drawbacks outlined above, it is useful as a source of information not otherwise readily available. Were it less parochial it would be of much greater value not only to students of later Proterozoic geology but also a much wider audience.

D. POWELL

Barnes, J. W. *Ores and Minerals: Introducing Economic Geology*. Open University Press. Milton Keynes and Philadelphia (Open University Press), 1988. viii + 181 pp., 81 figs. Price (soft-back) £12.95.

This is an elementary but informative text designed to introduce the more important aspects of economic geology to the non-specialist undergraduate student. The first half of the book is concerned with the nature and properties of ores and ore minerals and how such deposits are extracted. The main features of metalliferous ores in sedimentary, volcanic and intrusive rocks are described, together with a summary of exploration methods used to identify such deposits. The second half of the book deals with the geology of fossil fuels, geothermal energy resources, industrial minerals, and the most vital resource of all, water. An essential theme of the book is the role of the geologist in identifying and developing the Earth's mineral resources. The explicit style and clear graphics will appeal to the non-specialist student; however, the absence of a glossary is surprising since such readers will encounter many new terms and concepts. The level of information provided and broad coverage of subject-matter will ensure that this text will be widely adopted in A-level and first year degree level courses.

N. J. JACKSON