and the editor has quite obviously exerted considerable and appropriate control. The final point in its favour is the lack of any alternative!

R. E. BEVINS

Helgeson, H. C., ed. *Chemical Transport in Metasomatic Processes*. Proceedings of NATO Advanced Studies Institute, Dordrecht, Holland. (D. Reidel) 1987. xxv+782 pp. Price £94·25.

A resort near Corinth and a seaborne geological excursion to the Cycladic Islands in the Aegean might seem unlikely venues for the advancement of geochemistry, but this formidable volume of the proceedings of a NATO Advanced Studies Institute in Greece in 1985 attests otherwise. It is in the nature of NATO-ASI proceedings that a significant proportion of the published material is of a review character. In this instance, two and a half years have elapsed between the ASI and the publication of this volume of proceedings, with the result that some of the material in the proceedings will be familiar, in a different guise, to specialists in the field who are abreast of the current journal literature. Nonetheless, there is much material, both new and old, to challenge and stimulate the specialist and student alike in this diverse volume [M.A. 88M/3788-3815].

The diversity of material is considerable, spanning mantle metasomatism, the theory of fluid transport and metasomatism, the thermodynamics of mineral-grain interfaces, speciation in metamorphic and hydrothermal fluids, modelling of fluid movement and circulation from the scale of the mineral grain to that of the whole crust, and a comprehensive overview of the petrology, geochemistry, tectonics and field geology of the Cycladic Islands of the Aegean. The authors are in the main the leading authorities in these fields. The scarcity of experimental studies in such a large volume on fluid geochemistry and metasomatism is disappointing, given the manifest inadequacy of the experimental basis for thermodynamic data sets for minerals and fluids, but the volume probably truly reflects recent trends away from experimentation towards theory and modelling.

A few papers in this volume do successfully attempt to marry theory or modelling to real geological examples, but the gap between theory and practice is nonetheless apparent in many contributions, and the clearly increasing complexity of metasomatic and fluid-transport theory demonstrated in several papers serves to underline the need for theoreticians, modellers and practical geochemists and geologists to collaborate in bridging this gap.

At £94·25, this volume is only likely to find its way onto the shelves of the specialists in the field of chemical and fluid transport, but it should become a widely-referenced university library text, giving as it does a fair reflection of the state of the art in this field as seen by some of its foremost practitioners. Given the quantity and diversity of its contents, the book is better value for money than might at first be suggested by its high cost.

C. M. GRAHAM

Carmichael, I. S. E. and Eugster, H. P. (eds.). *Thermodynamic Modelling of Geological Materials: Minerals, Fluids and Melts* (Volume 17 in Reviews in Mineralogy), Washington, D.C. (Mineralogical Society of America), 1987. xiii+499 pp. Price $18.00.

Volume 17 of Reviews in Mineralogy continues the high standards of its predecessors and constitutes a remarkably broad ranging review of the application of thermodynamics to geological and geochemical problems. The main emphasis is on thermodynamics involving fluids, and the volume will do a great service in bringing this rapidly evolving field to a wider audience. However the range of geological applications that the volume encompasses is particularly large, spanning sedimentary, igneous and metamorphic rocks, and ore deposits; truly there is something for everyone.

In the first part of the volume the basic principles of the thermodynamics of phase equilibria are developed by Newton, and applied to crystalline solutions by Navrotsky, while Wood describes the approach to more complex systems with multiple solid solutions. All this is good stuff, well written and up to date, but it must be said that this is largely material that has been well reviewed in recent years, by these and other authors. Indeed, while there are some new developments, notably the work on Fe-minerals described by Newton, the examples are mostly drawn from the same groups of minerals as in earlier reviews.

A second group of 7 chapters concerns crustal fluids and mineral-fluid equilibria, from the points of view of both the solvent and its dissolved load.

Two chapters, by Holloway and by Ferry and Baumgartner, are concerned primarily with supercritical fluids in the C-O-H system. Holloway discusses the nature of forces between molecules in the fluid and develops equation of state models before giving examples of equilibrium calculations. Ferry and Baumgartner concentrate on various versions of the Redlich-Kwong equation of state in current use, which they contrast. If you like reading equations, this is the chapter for you.

Five chapters are concerned primarily with

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