Nicholls, J. and Russell, J. K., Eds. *Modern methods of Igneous Petrology: Understanding Magmatic Processes*. Reviews in Mineralogy Vol. 24 (Mineralogical Society of America), 1990. viii + 314 pp., 151 figs. Price $20.00

This is the latest in the line of good value, soft-cover Reviews in Mineralogy which the Mineralogical Society of America is producing to the enormous benefit of the mineralogical community. As usual, there is a galaxy of well-known authors, and the prospective buyer can hardly go wrong. The title, 'Modern methods...' is rather daring and will make a nice period-piece in 50 years or so. Day and Allen's (1905) treatment of phase relations in the plagioclase feldspars, written at a time when Gibbs' work itself was 'modern' and Duhem was 'recent', contains a substantial thermodynamics section which makes some recent work seem far from modern. However, although there is some basic thermodynamics in 'Modern methods...', many of the chapters in this interesting anthology deal with modern quantitative (or semiquantitative) treatments of petrological problems quite distinct from phase equilibria. Most of the book is concerned with 'models' of one sort or another, and in the first article, by Nicholls himself, dealing with principles of thermodynamic modelling, there is a quotation from a paper by H. J. Greenwood which should be remembered by all: 'We should reserve the word "model" for *well constrained*, logical propositions, not necessarily mathematical, that have necessary and *testable* consequences'. The words that I have put into italics seem to me crucial, and as anyone who has been recently to any of the big meetings in the U.S.A. where 'models' abound will know, are not by any means adhered to.

Nicholls' opening chapter is very clearly written and deals with the phase rule, mass balance constraints in multicomponent systems, and calculation of crystallisation paths. The chapter has an open and straightforward style—when things do not work out well, Nicholls says so, and this is refreshing. Chapter 2 is a clear and informative treatment, by Lange and Carmichael, of the thermodynamic properties of silicate liquids, dealing mostly with volume relationships, and the current state of knowledge on the important issue of the partial molar volume of dissolved H_2O and CO_2.

Then follows a chapter on 'Simulation of Igneous Differentiation Processes' by R. L. Nielsen. I am afraid I have to report that this chapter is not a success. For a start, although a large number of computed liquid lines of descent, for major and trace elements, in a variety of magma types are presented, the method of doing the calculations, and more important, the data base, are hardly treated at all. Those seem to me to be exactly the parts of this field which should figure in a review article. The writing is somewhat vague and ambiguous, there are lots of trivial errors, and altogether a difficult subject was turned into an impossible one, for this reviewer. A pity, because a clear, critical treatment of the ifs-and-buts of computer modelling of magmatic evolution is something which might be expected to be a high-spot in a book with the present title.

The next chapter (again by J. Nicholls) deals briefly with the mathematics of fluid flow, particularly the equations for velocity and temperature distribution in simple dykes, and with the relationship between stress regimes and dyke emplacement. It is not an exhaustive treatment of the field but it provides a good guide to the variables involved. There is a strange *non sequitur* between one of the conclusions listed at the end and the preceding text. Apparently, the temperature distribution across a given dyke cannot be predicted from a knowledge of its physical properties and lies in the domain of 'chaotic' phenomena; the text seemed to suggest that it could, in principle be solved, albeit with great difficulty. Perhaps the chaos is implicit in the equations, in which case the author could have helped lesser mathematicians to see this.

An excellent treatment of 'Physical Processes in the Evolution of Magmas' is then provided by S. Tait and C. Jaupart. The chapter is very clearly written, although they do perpetrate the rather unattractive and confusing term 'fractionation density' for the effective density of a crystalline phase when it is represented by a set of equivalent components in the melt. The interplay of the different factors which influence fractionation and layer-developing processes in magma chambers, comes across very clearly, and points to several factors which we really do need to understand to make further progress, such as crystal growth and nucleation rates at low degrees of undercooling.

Chapter 6, by J. K. Russell, deals with magma mixing processes, particularly the thermodynamics of mixing. I found this rather slow-going. The first 11 pages include needless observations on the philosophy of Carl Popper and deal unnecessarily laboriously with the thermodynamics of mixing of melts near their liquidi. This will be familiar to most readers in the form of the mixing relationships of crystalline solutions. Some terms (mixing, mingling and commingling) are used in ways which really need careful

definition. Crystals enter only on p. 13, and then only as liquidus phases calculated using Ghiorso's model for a series of mixtures of a basalt and a dacite. I may be slow in the head, but some sentences seemed extremely hard to understand. For example (p. 166) what does 'The liquidus surface for basalt–dacite melt mixtures is compared to the temperatures derived by mixing the two end-member melts (on Fig. 9)' mean to you?

Chapter 7, by Carmichael and Ghiorso, is about oxygen fugacity and its effect on natural liquids and crystallising phases. It starts with a portentous opening paragraph in which it is claimed that '...the testing of igneous hypotheses has been liberated [by thermodynamic modelling] from the parochial restrictions imposed by simple phase diagrams'. The petrologist who does not compare his phase assemblage with the nearest appropriate phase diagram is liberated only to construct a house-of-cards, it seems to me. The two approaches (really one approach, because they depict the same thing) should always be used in conjunction; the literature is full of temperatures calculated from pairs of phases which a glance at a phase diagram would show cannot conceivably be in stable equilibrium. The rest of the chapter is, however, excellent, dealing with the oxidation state of liquids and the effects of redox state on olivine–liquid, pyroxene–liquid and hydrous mineral–liquid equilibria. And the final paragraph is a justified plea to bring 'wet' methods of Fe^{2+}–Fe^{3+} determination back into routine use, so these authors too have a feeling for the part of the ancient which is necessary to the modern.

Jaupart and Tait return in chapter 8 to deal with the dynamics of eruptive phenomena. This interesting chapter covers the many variables connected with magma uprise and eruption, and draws attention in particular to the importance of the large volume fraction of gas which will be released on crystallisiation of magmas with only a few per cent of dissolved volatiles. Next, G. W. Bergantz attempts to link the chemical evolution of magmas (usually considered with respect to the thermodynamic variables, T and P) with physical processes, usually concerned with time and length. This paper is a good guide to the literature but is written in rather too general terms to be directly helpful. It did remind me rather forcibly of H. J. Greenwood's recommendation that models should be testable and to wonder how, with so many variables, we can hope to do this. The final paper, by K. V. Cashman is on textural constraints on the kinetics of crystallisation of igneous rocks. She deals with crystal nucleation and growth, in simple and then complex systems and then with the coupling of nucleation and growth through the expanded Avrami equation. The treatment is interesting and clear.

This worthwhile volume is an anthology of 'modern methods' rather than an exhaustive treatment. The quality is a little uneven, but the overall value is outstanding altogether, very well worth the modest price. It is a pleasure to be able to end a review in the knowledge that a high proportion of readers will actually be able to afford the product!

I. PARSONS

Wilson, A. J. C. *International Tables for Crystallography. Volume C. Mathematical, Physical & Chemical Tables.* Dordrecht, The Netherlands (Kluwer Academic Publishers Group), 1992. xxix + 883 pp. Price Dfl. 400.00 ($244.00; £139.00).

On any reckoning, this is a formidable volume. It is the latest in the current update of a series which began in 1935 with two volumes of Internationale Tabellen zur Bestimmung von Kristallstrukturen published in German, with English and French abstracts at the beginning of every chapter. Sir William Bragg and Max von Laue were the Honorary Editors, Carl Hermann was the Editor, and there were 16 authors invovled. The compilation ran to 700 pages, and was the result of decisions taken at a Faraday Society Conference in 1929. The preface explained that 'these tables arose from the need of an international standard work with a nomenclature to which all papers on crystal structure might be referred'.

After the 1939/45 war, the Editorial Commission of the newly established International Union of Crystallogrpahy was originally charged with the task of preparing a new edition of the International Tables for the Determination of Crystal Structures, but so much new material was involved that the work was considered as a separate publication and given a new name; The International Tables for X-ray Crystallography, published in English with a dictionary of crystallographic terms in English, French, German, Russian and Spanish. It was intended 'to facilitate the work of three categories of scientists: those who were actually engaged in the determination of crystal structures, those who were using X-ray methods in the study of crystals in general, and students of crystallography'. With Kathleen Lonsdale, one of the contributors to the original 1935 publication as General Editor, the Editorial Commission produced three volumes: symmetry groups, mathematical tables, and physical and