scaling, and the interpretation of the $\delta^{18}O$ record. Clarifying the utility and applicabilty of such techniques will remain a useful pursuit for the near future at least.

Section III will be of most use to mineral physicists and chemists. Here we are introduced to the application of fractal geometry and non-linear dynamics to Mining; Gold Exploration; Self-Organising Fabrics and Geochemical Zoning applied to Agates, Geodes, Concretions and Orbicules; Manganese Dendrites; Nucleation and Growth during Crystallization; Weathering, Bioactive Marine Sediments; and Oxygen Isotope Records. No attempt is made consciously to separate 'geometric' fractals from 'phase space' fractals, although both figure prominently in this section. Again some of the material presented is more mature science than in other parts – for example Peter Ortoleva's classic work on geochemical self-organization has now appeared in textbook form in its own right. However, the general impression is that the physics of pattern formation in mineral physics is currently a hot topic, not least because many mineral-forming processes are now known to be the result of non-equilibrium, non-linear processes. This kind of physical insight stands out of the general crowd of empirical observation and method present in much, but not all, of the rest of the text.

So in the end we have a set of scholarly individual contributions of varying types, subject matter, writing style, perceptiveness and quality. Unfortunate, from the point of view of cohesion normally associated with a book, is the lack of cross-referencing in the text. Most contributions stand alone or can be read in parallel, and not a few of the key results in the ostensibly 'new' material presented have appeared in similar form elsewhere. Also there is comparatively little on the more recent advances in the physics of dynamic complexity (the ordered behaviour of non-equilibrium systems with many degrees of freedom). This is unfortunate because studies such as these are beginning to explain the emergence of fractal geometry in real space in many natural geological, biological and ecological systems.

As the editor states in his introduction: 31 contributions cannot possibly cover all of the possibilities of application within the broad field of the Geosciences. Certainly the prominence given to state-of-the-art material in Mineral Physics and Deformation Processes indicates the early and practical success with the techniques in these fields. Whether or not this insight will emerge in later work on fields as diverse as Global Climate Change, Earth Tides and Earthquake Prediction (?) remains to be seen. In any case the book highlights the idea that establishing fractal behaviour is only the first step in understanding the origin of the spatial order and pattern in the form of scale-invariant geometry in Geoscience, or any other field for that matter.

I. MAIN

Spear, F. S. *Metamorphic Phase Equilibria and Pressure–Temperature–Time Paths* Mineralogical Society of America. 1993 (2nd printing with corrections 1995) xxii + 799 pp., Price $45.00 (+$5.00 shipping). ISBN 0-939950-34-0.

In the last two decades, Professor Frank Spear has had an important influence on many facets of metamorphic petrology, and this most impressive monograph bears witness to just how much of a polymath he is. In his preface, he points out that tomorrow's metamorphic petrologists must be versatile scientists with a detailed working knowledge and understanding of many branches of earth science, from geophysics through mineralogy, isotope systematics and geochemistry to traditional petrology. The aim of this book is to teach the methods, within these disciplines, by which practising research workers can solve questions on the evolution of orogenic belts. To that end, Professor Spear's approach is to apply theoretical rigour to petrological analysis, and he makes no apology for the high density of mathematical equations, phase diagrams, chemical reactions and petrogenetic grids. Thus, the book is primarily a 'how to' manual, rather than a survey of the current state of petrological knowledge. Having said that, it contains (alongside the careful explanations and derivations) a huge amount of up-to-date petrological information, and in many places the review element is further provided for by pointers to extensive lists of references.

Much of the material in the book is at a very advanced level and would therefore be unsuited to form the basis of any but the highest-level undergraduate courses. Here and there are pockets of more basic material that serve to place the advanced stuff in context. The people most likely to benefit from the book are post-graduate students embarking upon their own petrological research projects (I wish I had had access to such a book as a PhD student!) or taking graduate petrology courses, lecturers setting up such courses, and senior researchers who are endeavouring to teach themselves new tricks.

The book is organised in five main sections and comprises 21 chapters in all. The first part is an overview of metamorphic petrology and incorporates historical perspectives as well as explanations of basic concepts and fundamental controls. The second part is an exposition of phase equilibria, both homogeneous and heterogeneous, insofar as they apply to the interpretation of metamorphic rocks. The third part is a discussion of the metamorphism of

several important rock types (pelites, metabasites, carbonates, ultramafic rocks, etc.). The fourth part is concerned with the practicalities of extracting quantitative petrological information from metamorphic rocks, and includes the calculation of phase equilibria, the uses of zoned minerals, the estimation of fluid compositions, and other aspects of fluid–rock interactions. The last part deals with the application of geochronology to metamorphic systems and with the relationships between *P–T–t* paths and tectonic processes.

The organisation of topics is logical and, by and large, the coverage is extremely comprehensive. However, one topic stands out as receiving less than adequate treatment, namely petrography, particularly the interpretation of mineral textures. This is a pity because petrographic study is generally the starting point of detailed petrological work. The book is not entirely without discussion of metamorphic textures but the topic is not, in my opinion, given the prominence it deserves. References to textures are sporadic and nowhere in the book are there any photomicrographs; instead, in partial compensation for this, the author has used the ruse of referring to the colour photomicrographs in Yardley, MacKenzie and Guilford's book *Atlas of Metaniorphic Rocks and their Textures* (1990, Longman) where he thinks fit. This works fairly well, but to my mind is inadequate recompense for the absence of a well illustrated petrographic chapter. Elsewhere, the author uses examples from his own work a good deal, but takes pains to bring in other people's approaches and findings where appropriate. The reference list is extensive (but not exhaustive) and up-to-date. The text is clearly written; complex topics are introduced in a lucid and logical manner and are supported by a plethora of helpful, well annotated diagrams. Typographic and other errors in the second printing (1995) seem to be virtually non-existent.

Professor Spear's monumental book will prove to be an invaluable reference work to all practising metamorphic petrologists for many years to come. No serious student of the subject should be without his/her own copy; borrowing from the library just won't be good enough! For the huge amount of information it contains, it is a real bargain.

G. T. R. DROOP

Klein, C. *Mineralogy Tutorials: Interactive Instruction on CD-ROM*. New York (John Wiley & Sons) 1996. Special introductory price £199.00 (US$395.00). ISBN 0471109967.

This is a highly interactive colourful teaching aid for basic mineralogy and crystallography, that successfully uses 3-D high-resolution graphics and animations to relate atomic scale structures to real mineral morphologies. But it does much more than that. It comes with a short 11 page User Manual, all that is really needed to get you started, since everything about the way it runs is largely intuitive and on-screen Help (bubble type) is available. The main index leads to four individual Modules, within which a constant clear toolbar at the base of the screen allows individual search paths to be retraced and gives the user a high degree of control over rate of progress through the package, including printing (landscape/screendump) and constant access to the main Menu, Help, and Index. Each page of information contains a minimum of text provided as a digest in the top right hand side under Notes, which has been expertly selected to guide the student through, and is largely intuitive. Each Module has a similar appearance but offers subtle variation in clickable buttons, icons and control modes which encourages prolonged exploration. Module 1 (Crystallography – external form) presents symmetry operators using rotatable 3-D models, crystal classes with total symmetry and full-screen photos of real minerals, and Miller Indices from concept to experimental application by the viewer. The unlimited access to 'previous page' works extremely well here for teaching. Module 2 (Crystallography – internal order) presents 1–2 and 3 dimensional animations which clearly illustrate symmetry operators in crystal structures. Module 3 (Crystal and mineral chemistry) uses extensive 2-D and 3-D animated graphics to iliustrate crystal structures, coordination of atoms in mineral structures, Pauling's Rules, and solid-solution mechanisms. The latter includes substitutional, interstitial, omission and exsolution, allowing, for example, user selection of cation distribution in amphiboles to illustrate the effects of composition, end-members and *P–T* phase relations. The colour phase diagrams applied to exsolution are particularly clear. Module 4 (Systematic mineralogy) provides specific information on about 100 common minerals under the groupings of silicates (tecto-, ino-, phyllo-, neso- etc.), oxides and hydroxides (12), sulphates, phosphates and carbonates (13), sulphides, halides and native elements. This section has 'hot' text hyperlinked to additional information, phase diagrams and compositional diagrams (e.g. pyroxenes, with *T–X* cross-section overlay).

In summary, this software is an excellent teaching aid to augment any standard course texts in Mineralogy and Crystallography including those by the same author! It is visually entertaining, and the front end interface gives the user powerful control, from a quick dip (start-up time is a few seconds) to long and entertaining first-level reference work. It is certainly amongst the best I have used so far. It is not