

The book starts with an introduction to the major oxides and hydroxides and their characterization. The emphasis is on the pure oxides and mineralogists may well be disappointed by the lack of comparison with natural minerals. There is no mention of the auxiliary or impurity elements found in natural examples and the description of the occurrence of these minerals begins with their entry into the soil and weathering environments. There is, however, especial interest in the relationship between the methods of preparation and the crystal morphology and surface area of the product. This provides important pointers for mineral genesis in showing that crystal morphology can be influenced by the conditions of formation.

The chapter on methods of characterization is also a disappointment. The authors clearly excel in chemical methods but have problems conveying the details of instrumental methods. The section on quantitative colour will surely confuse even those who know something of the subject. This is unfortunate because the accompanying description of the colours of the oxides and their use is good. Crystallography is mentioned only briefly. This is surely an omission. The mention is in the context of explaining X-ray diffraction. The only purpose of this explanation in the remit of this book can be to provide an introduction to those meeting the method for the first time. I can only feel that this readership will be left bewildered. Here, as in many places in the book, a simple diagram would have conveyed the principal more succinctly and effectively.

There is some confusion over the intended readership of the book. Some words are defined, although I would have thought that 'hygroscopic' and 'supersaturation' would have been familiar or accessible to most readers. The definition of 'equant' as 'equally developed in all crystallographic directions' may be helpful but the definition of 'isometric' as 'equally developed in all directions' is clearly incorrect. 'Somtoids' is used and defined later as 'cigar shaped'. Some chemical shorthand; 'M KOH' for '1 M KOH' and 'RT' for 'room temperature' creeps in without definition. 'WHH' is used and defined although 'FWHM' is the more usual abbreviation. I never did find an explanation of 'BET' or 'pzc'.

The preparation of the book lacks care and the typesetting seems to have been done without reference to the roots of English or common usage. Words are hyphenated to make the lines look pretty so the reader is faced with 'oc-(new line) tahedral' and 'di-(new line) ameter'. 'Ex-ist' and 'be-low' cannot really have been necessary and 'add-(turn two pages of figures) ed' is

ludicrous. There are many other such errors and inconsistencies too numerous to list here.

The book will be well used for the recipes it contains for preparing the iron oxides and hydroxides and it is a pity that the faults are so distracting. A good editor would have removed most of the problems.

J. F. W. BOWLES

Ganguly, J. and Saxena, S. K. *Mixtures and Mineral Reactions*. Berlin, Heidelberg and New York (Springer-Verlag), 1988. ix + 294 pp. Price DM108.00.

This is an advanced book on the thermodynamics of solid solutions and phase transitions, and their application to petrological problems. According to the Preface, it is written 'for an audience with a level of exposure in classical thermodynamics equivalent to that gained at the senior undergraduate level in chemistry in most U.S. universities'. When the first mineralogical application appears (on p. 6) the reader will discover that he or she needs an Honours degree in mineralogy as well, because a high standard of knowledge is assumed. It is a book of reference for experienced researchers or, in the British context, for Geology Ph.D. students who have started to build up a feel for mineral chemistry and thermodynamics and who have a sound working knowledge of mineralogy. I certainly would not recommend it to beginners.

Chapter 1 deals with the thermodynamic functions of solutions: fugacity, activity, Henry's and Raoult's laws. This leads in Chapter 2, to a general treatment of mixing models for non-ideal solutions including ternary solutions; and then the statistical formulation of entropy. It is a pity that no statement is made to the effect that all mixing models are probably approximations and that Avogadro is consistently misspelt. A variety of mixing models is discussed (although in general rather than realistic terms) and finally cation ordering is discussed. Phase separation is dealt with in Chapter 3, showing the relationship between  $G-X$  curves and solvi, and treating spinodal decomposition and homogeneous and heterogeneous nucleation. Yet again, in a thermodynamics text, cooling trajectories are shown (Fig. 3.8 and again in appendix A.IV) on a TTT diagram suitable only for isothermal annealing, leading to the need for a time reversal as processes start, finish, finish again and finally start. To be fair, the authors do get it nearly right in A.IV, but they perpetuate an error in the main

text? The correct form of such diagrams (which are much more interesting to geologists than those for isothermal annealing) was worked out by Huston *et al.* 25 years ago in a metallurgical context. They called them CCT (Continuous Cooling Transformation) diagrams, but they have taken a mightily long time to transform the mineralogical literature. The authors also do not help the reader by using the word 'exsolution' as a texture rather than a process, as in 'Coherent exsolutions are known in alkali feldspars...' This usage can cause great confusion, as it does when the authors tell us on p. 45: 'The qualitative relationships between the strain-free and coherent exsolutions can be elucidated with the aid of [a figure showing subsolvus  $G-X$  relationships with and without a strain energy term]. The strained  $G-X$  relationships are also food for thought, since they imply the existence of coherency strain in compositional ranges where only single phases are stable. Chapter 4 deals with the equilibrium constant and activity, the phase rule, and the generalities of phase transitions are discussed. Fashionable topics like Landau's theory of second-order transformations, and lambda transition, get a short treatment. Most of the latter part of this long chapter deals with the  $P-T$  slopes of equilibrium boundaries and will be rather useful.

In Chapter 5 we start getting into real examples, and mixing models are presented (with much tabulation of  $W$ 's) for garnets, olivines, pyroxenes, micas, feldspars, Fe-Ti oxides and carbonates. Ternary mixing models for feldspars are rather obscurely and somewhat sloppily treated. It is not helpful to be told (p. 120) that 'ternary plagioclase should be considered as a solid solution of three triclinic end members—albite, anorthite and orthoclase. . . The  $KAlSi_3O_6$  [*sic*] could be a fictive triclinic structure'—and then, further down the same paragraph sanidine suddenly appears, without explanation or symmetry, and albite too mysteriously loses a couple of oxygens. Exchange equilibrium, of major elements and isotopes, and then geothermometry, is the subject of Chapter 6. Order-disorder is treated in 7. I know this is a mineral thermodynamics book, but surely it would have been comprehensible to a larger audience if a few real crystal structures had actually been illustrated? Chapter 8 is a rather interesting review of the relationship between atomic interactions and thermodynamic properties. Finally there are three appendices. The first deals with explanatory notes (of certain terms, such as electronegativity, and TTT diagrams) and the second with geothermometers/barometers. If only they had provided some real data sets and told readers how to tell

when a given mineral pair (for example) is in equilibrium and can therefore give meaningful temperatures. It is a pity that the book was completed before the Fuhrman and Lindsley two-feldspar thermometer was published, and the Lindsley treatments of two pyroxenes appeared. These thermometers are substantially better than their predecessors and provide graphical solutions which are much more practical than equations when dealing with 'noisy' sets of mineral analyses from rock suites. A final appendix deals with fluids at high  $P$  and  $T$ .

Altogether this is a useful book of reference, particularly for petrologists who (like the reviewer) are weak at mathematics and cannot remember equations from one day to the next. It would have appealed to a wider audience had it had more mineralogical background and some applications to real data sets. The production is good, although I spotted many more mistakes than those listed on the Errata slip enclosed. The price is steep, but not exorbitant, for 290 pp., and those university libraries (rare in the U.K.) lucky enough to have some funds should certainly be encouraged to buy a copy.

I. PARSONS

Cronan, D. S. *Marine Minerals in Exclusive Economic Zones*. London (Chapman and Hall), 1992. xii + 209 pp. Price £32.25 Hardback.

Now that more than a third of the seas and oceans can be claimed by littoral nations as Exclusive Economic Zones (EEZs)—a state of affairs which will become international law when sufficient states have ratified the provisions of the United Nations Conference on the Law of the Sea III (UNCLOS III)—it is proper that nations begin to take stock of the resources of their new estates. When unrestricted by other claims the outer limit will be 200 nautical miles (nm) and in some cases 300 nm from the nearshore baseline. Some small island states, such as the new nations of the southern Pacific Ocean, have gained immense sea areas. Any populated island with statehood, or part of a parent state, which may be little more than a dot in the ocean could claim a sea area in excess of 125 000 square nm and what is in and beneath those waters. In simple terms the declaration of an EEZ gives 'sovereign rights over the resources of the zone, to exploit the minerals on a beneath the sea-floor and to conserve and manage fisheries'.