

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'.

Just what benefits may ensue from the discovery and exploitation of resources is largely unknown and Cronan's book is one of a number which have attempted to make preliminary assessments. The author directs his attention to the non-living resources, though chose not to address hydrocarbons or alternative energy resources. The structure of the book is to take the broad groups of potential resources, namely aggregates, placers, precious coral, phosphorites, manganese nodules, cobalt-rich crusts and hydrothermal mineral deposits, and deal with each of them separately addressing modes of occurrence, composition and resource potential with selected and appropriate case histories. He avoids the serious economic, political and environmental issues which have yet to be addressed and sticks to telling his readers about what is known to be there.

The book is up-to-date with a great deal of evidence from the very latest reports of exploratory scientific cruises by research vessels of many nations being quoted. While globally we are only at the earliest stage of assessing the quality and quantity of resources, Cronan's book reveals that we have acquired a considerable amount of detail concerning the nature and possible origins of the minerals involved. Readers of the *Magazine* may or may not be interested in the EEZ issue, but they will be attracted to the concise accounts of ore genesis in a range of marine settings presented by Cronan.

This book is not an over-optimistic prospectus for future ocean wealth as was Mero's *The Mineral Resources of the Sea* (1965); rather here is a distinguished authority on ocean minerals giving us a readable and scientific report on the state of our knowledge. There are many line diagrams; some maps, however, require a modicum of nautical knowledge since scales are only obvious from reading off the minutes of latitude. Further, it is not always immediately apparent which areas of sea-floor might be taken to belong to which state. The book is backed by a long list of references to mainly recent works on the subject and readers should be able to add further to their knowledge. The text has been well proof-read, sadly the figures have received less attention, particularly when kilometre scales are added: clearly occasionally the draughtsman just did not take enough care.

*Marine Minerals in Exclusive Economic Zones* adds significantly to our knowledge yet shows how much more exploration is required. It can certainly be recommended.

A. J. SMITH

Salje, K. K. H. *Phase Transitions in Ferroelastic and Co-elastic Crystals*—Volume 1 Cambridge topics in mineral physics and chemistry (Cambridge University Press), 1990. xiii + 366 + xlvii. Price £50.00.

Research into ferroelasticity is entering an exciting stage, where significant insights into the underlying physical principles which generate elastic instabilities are beginning to emerge. This book by Salje aims to introduce the reader to the theory behind ferroelasticity and related behaviour, while illustrating these ideas with a wide range of examples. The book is in two parts. The first, by Salje himself, is essentially a textbook on the subject, while the second part is composed of research papers, by various authors, on more advanced topics.

Chapters 1 and 2 provide a basic introduction to the nomenclature and definitions used in this subject, and present a discussion of the meaning of the terms ferroelastic, co-elastic, etc. Two chapters outlining the ideas behind the Landau potential and spontaneous strain, are followed by a more detailed discussion of the coupling between spontaneous strain and the order parameter. The nature of ferroelastic and co-elastic twins, and the mobilities of domains are analysed in Chapters 7 and 8. The final chapters in this first part of the book, go on to discuss the specific heat and excess entropy of ferroelastics, gradient coupling and strain modulation, and aspects of the kinetic behaviour of ferroelastic and co-elastic crystals.

The second part of the book consists of nine chapters, by different authors, covering such topics as elastic transitions and hard mode infrared spectroscopy, trigger mechanisms in improper ferroelastics, neutron scattering studies, and symmetry analysis of specific transformations. Finally in a considerable appendix, a group-subgroup relationship table, and an extensively referenced list of several hundred ferroelastic and co-elastic phases are presented.

The book is well written and clearly printed. It is a pleasure to see that the many excellent transmission electron micrographs, illustrating important microstructural features, are all well reproduced. The author is to be congratulated on producing such a useful book, however his hope that this book could act as a second year undergraduate text may be a little optimistic. The Part IB Natural Sciences Tripos in Cambridge, invoked as an example of such a second year course, is somewhat atypical, and I feel that most users of this book will be final year undergraduates or even research students. This book