the concepts and techniques described easy to understand and assimilate. At each stage, worked examples are provided which further facilitate the understanding of the subject matter of the book.

The book commences with a review of imperial or 'Anglo-American' units and their metric equivalents, including many archaic units long discarded. This helps clarify misunderstandings that may exist in the literature. It will be particularly useful to those who wish to re-evaluate old databases, maps and mine or exploration records. This is followed by a discussion of metal prices, including inflation indexing and trends. The two short chapters (totalling 12 pages) which deal with reserve evaluation are rather disappointing in that only two methods are discussed in any detail, viz, sectional methods, using rectangular ore blocks centred on individual boreholes, and polygon methods. In the latter case, no indication is given as to the thickness component that should be applied for use on different plan and sectional projections. The whole subject has, unfortunately, been dealt with in a very superficial way and anyone seeking a better understanding of the principles of reserve evaluation will be forced to look elsewhere. This is a pity, for reliable economic evaluation can only be achieved if the mineral inventory has been determined as accurately as possible, given the data constraints at this stage of the exploration programme. The reader is left with the impression that the reserve calculation is a relatively unimportant aspect of mineral evaluation. The section on grade weighting is adequate but no reference is made as to how abnormally high (or low) assay values in an intersection should be treated. The discussion of the specific problem of polymetallic deposits could have been expanded to discuss alternative methods to metal equivalents. Similarly, expansion of the section on the role of mining and processing constraints on reserve evaluation would have been worthwhile.

The book really comes into its own from Chapter 7 onwards when the author clearly shows his expertise in the subject of financial evaluation. A series of short, but well written, chapters on Net Smelter Return; mine life; capital, operating and freight costs for underground and open-pit mines; and finally, operating cut-off grades, then form the basis for the chapters on economic evaluation by Net Present Value and internal Rate of Return methods. Also considered are those aspects of taxation, mine financing and sensitivity analysis that are of particular relevance to the exploration geologist. A set of useful appendices are provided which include metric-imperial conversion tables, typical ore densities, core and sieve sizes, inflation indices and discounting factors.

Though the title of the book, and the unsophisticated nature of the ore-reserve techniques described, both suggest that the purpose of the book is to describe economic methods applicable during the exploration phase of a deposit, there is considerable doubt whether a geologist would be involved in such an analysis at this early stage. The techniques described are really more applicable to a preliminary feasibility study of a deposit at an advanced stage of exploration when a more rigorous assessment of the in-situ and mineable reserve would have been undertaken using considerably more reliable ore-reserve methods. This book is thus seen as a means of making geologists more aware of the economic significance of his/her work and giving him/her sufficient background knowledge to be able to play a more valuable role in the later mine design and feasibility studies.

A. E. ANNELS

Lowenstam, H. A. and Weiner, S. *On Biomineralization.* New York and London (Oxford Univ. Press), 1989. 336 pp. Price £40.00.

'On Biomineralization' is an individualistic review by the authors of the minerals and mineralization processes in biological systems. The topic is one of overlapping interest to several disciplines, including mineralogy, biology, chemistry, biochemistry, medical sciences, and geology. The authors have generally chosen to approach the topic from a biological aspect.

After the first brief introductory chapter, the following chapter presents a general discussion on biomineralization, a listing of the minerals reported to date (almost 60) with their taxonomic distributions, and a brief consideration of the biochemical macromolecules involved. In Chapter 3, the authors consider in some detail the nucleation and growth processes, with an emphasis on whether the mineralization is biologically induced or controlled. Chapters 4–9 review biomineralization within selected Kingdoms and Phyla: Protoctista (Diatoms, Foraminifera, and the coccolith-forming Haptophyta), Cnidaria (including sea anemones and corals), Mollusca, Arthropoda, Echinodermata, and finally, the Chordata. The chapter on the Chordata is the largest, reflecting the intensity of vertebrate research. In the last three chapters, the authors explore areas of personal interest in non-skeletal functions in biomineralization, environmental influences in biomineralization, and finally, the evolution of biomineralization.

It is clear that biomineralization is a research

area in its infancy. Each chapter is packed with observations and descriptions, with discussions on the better understood processes. An example of the details in the text is the section on the tooth formation in chitons. The chiton 'shell' consists of eight overlapping aragonitic plates associated with a fleshy girdle which has aragonite spicules or scales. Chitons generally live in the tidal and subtidal zones, and graze rocky surfaces. The grazing teeth become abraded or fractured at an average rate in a row of every 12–48 hours, and are then discarded. The teeth are a complex structure consisting of a magnetite capping to provide the necessary hardness, and a core comprised of a range of minerals including ferrihydrite, lepidocrocite, dahllite, francolite, amorphous hydrous ferric phosphate, and amorphous silica. After a discussion of the growth of the tooth, the authors comment on the relevant biomineralization principles and environmental factors.

In the chapter on non-skeletal functions involving biomineralization, the authors review four selected aspects. The first is the role of minerals in gravity perception; a technique applicable to plants, protoctists, and animals. The minerals used include baryte, gypsum, calcite and aragonite. The second aspect is a discussion of magnetite, particularly its role in enabling organisms to detect the Earth's magnetic field (examples given are magnetotactic bacteria, euglenoid algae, and the sockeye salmon). Thirdly, the use of ferritin as an iron storage macromolecule is introduced, with an emphasis on the structure of ferritin. Finally, the means by which organisms control ice formation are reviewed. Certain plant bacteria deliberately induce ice formation, whereas fish living in polar waters inhibit ice crystals with glycoproteins.

In considering environmental influences on biomineralization, the problem the authors tackle is one in which organisms form minerals which are unstable in relation to their environment. For example, although sea-water is undersaturated with respect to celestite, a group of planktonic protoctists (the Acantharia) form tests composed of celestite. In spite of this apparent isolation from the environment, the environment does affect certain aspects of the biomineral, including the phase nucleated, the minor and trace element distributions, the stable isotopic composition of the mineral, and its ultrastructure.

The last chapter is dedicated to the evolution of biomineralization in the fossil record. The earliest deduced records to date come from sulphur isotopic studies indicating bacteria could induce mineralization as far back as 2.7 Byr BP. The oldest actual fossils preserving evidence of biomineralization occur at 1.6 Byr BP. Biomineralization evolution is reviewed in three sections: evolution of carbonate mineralization, phosphate mineralization, and silica (opal) mineralization.

It is believed that this book is one which will become a standard reference for some time. It is comprehensive, full of details, very well referenced, and filled with high-quality schematic diagrams, tables, and black-and-white photographs. Obviously a text written for a new field, of interest to several disciplines, is open to criticism of some details or views by those who are specialists. However, one strength of the text lies in its comprehensive review from several viewpoints. The text is considered essential for every university library, and unhesitantly recommended for anyone with some interest in the subject. Within the geological sciences, there are sections of interest for mineralogists, geochemists and palaeontologists. Although generally aimed at the 'state of the art' level, undergraduates will benefit greatly from relevant sections and the clear separation by the authors of principles, observations, and speculations. Apart from the science, there is much in the style of writing which is commendable. For one of the authors, the book comes towards the end of his career, and yet the text expresses the curiosity and amazement of a child. A sense of wonder permeates the text as the reader is taken through an Aladdin's cave, shown a myriad of wonders, questions asked, and future areas of research indicated.

It is clear that biomineralization is a research area still in its infancy. The authors are to be congratulated on the hard work which has gone into a text which is highly informative, and does not get bogged down in details or dead-ends. The whole attitude of this book can be summarized by one comment on a problem of biomineralization processes: 'The solution is probably not super sophisticated or trivial, just elegant and simple!'

A. P. GIZE

Smith, D. G., ed. *Eclogites and Eclogite-Facies Rocks*. Amsterdam and New York (Elsevier Science Publishers), 1988. xxii + 534 pp. Price Dfl. 220.00 ($115.75).

This book belatedly presents a limited selection of papers mostly presented at the First International Eclogite Conference in 1982, together with a 206 page review by Smith on the so-called 'Norwegian Coesite-Eclogite Province'. For most readers unfamiliar with controversies over the interpretation of Norwegian eclogites, the latter is likely to be both startling and fairly indigestible, as the style is rather verbose, at times confusing