

relations, spinodal systems, distribution coefficients, activities and order-disorder phenomena. The final chapters are directed at more specific systems such as pyroxenes, olivines, feldspars and problems such as geothermometry. There is a small discussion of kinetic factors. Finally, there is a brief section on computer programmes.

The author clearly states in his introductory remarks that the book is for advanced students and research workers and I must agree. Perhaps *the* problem that is at the core of this subject, and most approaches to it, is that solution equations are not directly derived from basic thermodynamic laws. The equations can be put into the class of intelligent guesses. At best, some of the most simple, may be "derived" or shown to have some basis in the postulates of classical and statistical thermodynamics. The subject is not simple or straight forward and there is much room for misconception and misuse.

From my reading of Saxena's approach, it is clear that this book is only for the specialist and those with a firm grasp of thermodynamics. I am tempted to comment that those who do not have a firm grasp of a good treatment such as Denbigh "Principles of Chemical Equilibrium" are best advised to leave Saxena alone.

In fact, I was a little disappointed in this book. I think the introductory level could have been set a little lower. From my experience of graduate students in this field, and many research workers, the fundamentals are passed over much too lightly and I see many places where misconceptions will arise. So the book is useful as a summary for the well versed. But do *they* need it? Of course, this is the eternal problem of all who write books.

Early in the book (p. 6) the reader meets the equation for the ideal entropy of mixing; the core concept in all solution theory. I think Saxena could have expanded this section. If the student of solution theory does not firmly appreciate the meaning of chemical potential and the equation

$$\Delta S = -R(x_a \ln x_a + x_b \ln x_b)$$

then he will be lost from there on. If he

does, then the text will become more useful. The next great problems, and often misconceptions involve the precise way in which chemical potentials are described. Saxena appears to fumble on this topic. For example, if there is a mixture XO-YO, one can define  $\mu_{XO}$  as:

$$\mu_{XO} = \left( \frac{\partial G}{\partial n_{XO}} \right)_{P,T,n_{YO}}$$

This has an exact and operational meaning. If I write  $\mu_X$  and mean  $\mu_{XO}$  confusion may arise for

$$\mu_X = \left( \frac{\partial G}{\partial n_X} \right)_{P,T,n_{XO},n_{YO}}$$

also has an exact and operational meaning and is quite distinct. In teaching students, I have always found that it is from this type of problem that their difficulties arise. Saxena is often not sufficiently clear about such things.

Should a future edition arise, I feel that Saxena might well fill out some of these gaps even if some more sophisticated applications were neglected. Applications of many aspects, for example the Gibb's phase rule, are weak or even suspect (p. 46-49).

In many places I felt serious gaps for a book that should be useful. I was surprised to see topics like crystal or ligand-field theory left out when transition-metal solutions are so important. Very important modern works on such topics are not in the bibliography. New techniques for the study of some solutions and the results from electron diffraction and Mossbauer spectroscopy are not mentioned. They are at the centre of modern observations. The discussion on kinetics is quite inadequate yet vital to the subject. Before one plays the complex games of equilibrium, it is well to reflect at length as to whether or not the data warrant the effort.

In summary, I was disappointed. The experimentalist may find the book of some use but not many others. I do not think this book conveys the modern state of a complex, difficult, but important subject.

MS received, April 5, 1974.

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## The Persian Gulf

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Edited by B. H. Purser  
Springer-Verlag, New York,  
471 p., 1973.  
\$29.70.

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Subtitled "Holocene Carbonate Sedimentation and Diagenesis in a Shallow Epicontinental Sea", this book contains 22 papers, most describing new data collected by research teams from Dutch Shell Research, Imperial College of London, and Kiel University. Some of the papers were first presented orally at the International Sedimentological Congress in Heidelberg, 1971.

No region of modern carbonate deposition is more important than the Persian Gulf. The area of accumulation is vast and complex, and its tectonic setting, between the Zagros Orogenic Belt to the north and the Arabian Foreland to the south, is directly analogous to many ancient sedimentary basins. Both the setting and the hot-arid climate differ from the well-known areas of modern carbonates in the Caribbean, and knowledge of both regions is therefore complementary.

The book is directed to the specialist, and only a handful of readers of *Geoscience Canada* will wish to purchase a personal copy. However, there are several papers all sedimentologists should note beyond reading the remarks that follow.

"Regional Sedimentation along the Trucial Coast" (p. 211-231) by B. H. Purser and G. Evans is by far the best introduction to this classic area of *sabkha* evaporites, algal tidal flats, lime mud lagoons, ooid tidal deltas and fringing reefs. Especially welcome to those working ancient carbonates is the portrayal of vertical sequences of facies deposited in each environmental setting.

"Sedimentation around Bathymetric Highs" (p. 157-177) by Purser is required reading for those concerned

with the morphology and facies patterns of isolated reefs like those in the Devonian of Western Canada.

"Sedimentary Accretion along the Leeward Coast of Qatar" (p. 199-209) by E. A. Shinn describes how quartz sand is blown in dune fields for miles across supratidal flats before being deposited on the coastal sublittoral accretion slope. The result is a progradational wedge of quartz sandstone in an otherwise pure carbonate province, long a puzzle to Cambro-Ordovician stratigraphers in North America.

"Distribution and Ultrastructure of Holocene Ooids" (p. 279-328) by J. -P. Loreau and Purser is a wonderfully detailed contribution to a contentious subject. The great variety of settings in which ooids occur is stressed. The authors contend that the tangential orientation of aragonite needles in ooids results from impaction.

"Aragonitic, Supratidal Encrustations on the Trucial Coast" (p. 343-376) by Purser and Loreau points out a variety of laminated encrustations, termed "coniatolites", that resemble algal stromatolites but which are of inorganic origin. This adds to the growing list of structures such as caliche and tufa prone to misidentification as stromatolites in ancient carbonates.

Unfortunately, the statistically-defined facies described by the Kiel University team in the muddy northern part of the Gulf will be very difficult to apply to ancient rocks. Likewise, the studies of *sabkha* chemistry and diagenesis are too ambiguous for confident application to the ancient.

In all, the book is a triumph for Bruce Purser, both as editor and author. We should be grateful also to Springer-Verlag for their continued interest in the limited market of our profession.

MS received, April 11, 1974.

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## Sedimentary Carbonate Minerals

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by F. Lippmann  
*Springer-Verlag, New York,*  
 228 p., 1973.  
 \$21.50.

Reviewed by James R. Kramer  
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The chapter headings are: Introduction, Crystal chemistry of sedimentary carbonate minerals, The polymorphism of calcite-aragonite, The system  $\text{CaCO}_3\text{-MgCO}_3$ , and Petrological summary: reaction series leading from carbonate sediments to carbonate rocks. The quality of reproduction is good, and the diagrams are clear and helpful. Literature references are numerous. The style of writing is clear, concise and objective.

This book is developed upon a strong mineralogical and crystal chemical base. The development of the material is an excellent example of the importance of understanding crystal chemical principles when interpreting natural phenomena. This relationship is developed particularly well with interpretation of aragonite ooids.

The first half of the text on crystal chemistry and mineralogy is a thorough review of the literature. Careful attention is paid to symmetry, ion spacing and comparison of various data. These crystallographic data are related directly to thermodynamic data and mineral stabilities.

The calcite-aragonite polymorphs are considered as to thermodynamic stability and metastability. Metastable formation of aragonite is discussed with respect to cations and with respect to occurrences in nature. The calcite-dolomite stability region is defined, and discussion involving hydrothermal origin as well as a magnesian calcite pathway is developed.

Lippmann then develops the excess carbonate or alkalinity hypothesis as a mechanism for formation of

dolomite. He relates this hypothesis to crystal chemical principles and shows how this theoretical concept is related to practical occurrences of dolomite. He also designates dolomites as organic if the excess alkalinity is due to the reduction of sulphate and oxidation of organic carbon. However, he does not calculate the amount of excess inorganic or organic alkalinity one may expect by these mechanisms.

I find it very difficult to make any negative criticism concerning the coverage of carbonate minerals and their genesis. The aragonite-calcite question and the calcite-dolomite problems are handled in depth and with great lucidity. Perhaps one can argue that organic effects upon nucleation are covered lightly, and one may be a bit frustrated that nucleation and metastability are alluded to as key processes, but never developed with the same rigour as other subjects.

All in all, I thoroughly enjoyed reading and studying the text. I found that I could comprehend the material readily. I highly recommend the text to the low temperature carbonate student and researcher, be he mineralogist, geochemist, sedimentologist or paleontologist.

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