

Levine. This is an emerging area and spectroscopic experiments done with energy-rich molecules have opened up a wish-list of future theoretical work to be done. Semi-classical approaches to chemical dynamics have been around for a rather long time. However, only recently has this method been successfully used to calculate *reaction* probabilities. This exciting development is the focus of the article by Tannor and Garashchuk. Calculation of solution properties of nucleic acids (~6- to 24-mer) is described by Cheatham and Kollman. While this is very interesting, one hopes and waits for results on longer systems, as they are of immense biological interest. The quantum Monte Carlo technique has over the past ten years grown into a very powerful technique for electronic structure calculations. Luchow and Anderson (the originator of the method) point out in their article that at present, this is the best method for electronic structure calculation of large systems such as a silicon crystal with 250 atoms and 1000 valence electrons. Quantum tunnelling is very sensitive to details of the barrier that the system has to tunnel through. Johnson and Kearly describe how this sensitivity can be successfully exploited to extract inter-atomic potentials from rotational tunnelling spectroscopy of small molecular groups. For a very long time, multiple pulse sequences have been a very useful tool in NMR spectroscopy. Recently, femtosecond visible and infrared analogues of these multiple pulse sequences are providing a multi-dimensional view of molecular structure as well as electronic and vibrational motions. Mukamel has written on the theoretical developments *vis-à-vis* experimental advances in optical measurements into the dynamics of complex structure–function relationships in molecules in the condensed phase.

Articles that consider the structure and dynamics in the condensed phase include the work on large-scale conformational (shape) changes of proteins and RNA in solution, studied by small-angle neutron scattering and other techniques. Small-angle neutron scattering is emerging as a powerful tool for probing molecules with dimensions from 10 to 1000 Å in solution, thus spanning length-scales from single molecules to quaternary structure of macromolecular assemblies. Description of macromo-

lecular solvation is a tough theoretical problem. Bashford and Case review the application of a simple method for treating the solvent – using the generalization of the Born model. The application of the method to calculate both static and dynamic properties is illustrated. The theory of crystal growth from atomic scale processes has been reviewed by Jonsson. The review points out the richness of the phenomena involved and the fact that rather small effects can lead to a large change in the morphology of the growing surface. Burgi demonstrates that the old technique of X-ray crystallography can provide dynamic information about motion and disorder in the solid state. Dabbs and Aksay examine the use of self-assembly in the fabrication of ceramic mesoscopic structures. The spatial heterogeneity and dynamics in supercooled liquids turn out to be very complex and this is the topic reviewed by Ediger.

Hansen and Lowen have described the comeback of the traditional classical physical chemistry field of colloids in terms of the theory of electrical double layers, with special emphasis on the effective interaction between charged colloid particles in the bulk or in constricted space. Hemley provides information about the behaviour of molecular materials subjected to pressures well into the multimegabar range (hundreds of gigaPascal). He discusses the evolution of structure and bonding with compression. New technology developments in ESR spectroscopy and information obtainable through their application to problems in the condensed phase has been considered by Freed.

Finally, while some articles in this volume of *Annual Review of Physical Chemistry* are well written and provide a broad perspective of the field, others are very limited and narrow in scope. However, they all provide important references in the field and are useful to the readers. This volume will certainly be a nice addition to all libraries.

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The Two-Mile Machine: Ice Cores, Abrupt Climate Change, and Our Future. Richard B. Alley. Princeton University Press, 41 William Street, Princeton, New Jersey 08540, USA. 2000. 229 pp. Price: \$24.95/£15.95.

Earth's climate is now known to change appreciably over a wide range of time scales; inter-annual to inter-decadal, centuries to millennia, to millions of years. Fairly detailed historical records exist for climatic changes occurring over the past several centuries, but the records become sparse as one goes further back in time. For deciphering longer-term climatic changes one has to learn to *read* the so-called 'proxy' records which are contained in the materials which accumulate as a result of their falling out of dynamic geochemical cycles. Man's curiosity to read these records has led to the discovery of new methods of reading them, as well as for identification of very potent records in diverse geographical locations on the earth, which are suitable for learning about a variety of questions on the past history of the earth: such as the evolution of the atmosphere and the oceans, volcanic and seismic activity, plate tectonics-related phenomena, the geomagnetic field of the earth and last but not the least, how earth's climate has changed in the past.

This book under review deals in considerable detail about the nature of information stored in the permanently frozen, thick ice sheets (which one finds in the earth's coldest Arctic and the Antarctic regions) on the last mentioned aspect, namely palaeo-climates. In the polar regions, the wind is pure, relatively free from volatile compounds, dust and sand particles and the ice which condenses out of the atmosphere is the purest one can find anywhere on the earth. And paradoxically (or interestingly), it is this very pure ice, which holds detailed records of past climatic changes. Ice cores have been studied for the past several decades with climate in mind, but the principal reason for this book is that about a decade ago, two long ice cores were extracted from Greenland ice cap near its highest point. The Greenland Ice Core Project (GRIP), an European consortium, drilled a core at the summit during 1989–1992. The US Greenland Ice Sheet Project 2

BOOK REVIEWS

(GISP2) drilled a core about thirty kilometres west of the GRIP site during 1989–1993. These cores penetrated more than 3 km of the ice layers and revealed new and fascinating clues about how the climates changed in the past ~100,000 years. This study, extensively corroborated by the independent findings of the European and US scientists had led to new ideas of how the earth's climate machine operated in the past, and is the prime reason for the book.

Straightforward and easy to understand answers to the 'why' and 'how' climate questions can be found in the book. Alley leads the reader through recent discoveries about climate changes, such as large temperature shifts (15°F) within a decade or less, possible causes of these changes which serve as amplifiers of small changes in the earth's heat budget. He discusses evidence related to triggers such as the Heinrich events, signifying a prominently ice-rafted debris accumulation at the sea floor, which are found extensively in the North Atlantic. Each of the layers is only a fraction of an inch thick on the east side of the ocean, but the debris layers are much thicker towards north and west of the Hudson Bay and greater than a foot thick just outside the Bay. What brought about these rapid advances of the ice, which had accumulated during cooler periods in the Hudson Bay, and what was the effect of this advance on the ocean and the global climate? The book continuously makes one aware that climate is an end product of complex interaction between the atmosphere, land and the oceans (where most of the earth's heat is stored). Therefore, climate models have to consider their role explicitly, guided by various observational data, the relevance and the importance of which can be appreciated only if *records* with high time resolution are available! A modeler must consider all the facts, which strengthen not only the deduced climatic scenario, but in the final analysis, make it possible to reach a consistent theoretical framework for the observations.

Richard Alley, an internationally recognized scientist for his contributions to the study of the GISP2 and other ice cores, has written the book in a very easy-going style, depicting quite manifestly how he developed his own

thinking while doing research on the ice samples from the GISP2 core. At the drilling site, Alley spent many months each summer hunched over a light table, deep in a snow cave. He concentrated on looking for the subtle dust bands that define the annual layers in the core. The task required tolerance of both cold and monotony. Alley also had a side lab deep underground where the orientation of the ice crystals, which has a strong influence on how the ice responds to stress, was measured. There were always a few students around too. At least half a dozen of them have developed their own successful careers by following through on projects that Alley passed off to them. Alley's main contribution to the GISP2 project was a systematic approach to visual inspection of the core. This low-tech approach identified the abrupt factor of two changes in accumulation that occurred during major climate changes and was crucial for understanding the extent of the flow-induced stratigraphic distortions that occurred in the bottom 10% of the core. The visual observations also played a key role in dating the core by identifying annual layers. He was also a leading force in synthesizing data and concepts from the ice, oceanography and modelling communities.

Throughout the book, the author has tried to simplify the complex climatic processes using simple cartoons and analogies! It is a matter of opinion whether these simplify one's understanding or simply make one believe that one has grasped the basics of the processes. But it is quite clear to me that an inquisitive scholar looking out for a subject for his research would be swayed towards this challenging task of understanding earth's past climates (including what type of climate one may expect in the future, on which the author has spent quite some time towards the end of his book). An important section in the book is the one on 'Sources and related information' which should provide ample information to the reader interested in pursuing the subject in greater detail. An intriguing point is why Alley chose to use non-scientific units in this book: mile, foot and the pound. He chose to do this because, as he comments in Appendix 2, he felt that the *Two Mile Time Machine* sounded better than the *Three-Kilometer Time Machine!* Then, for consistency, he kept

the mile, foot and the pound in the book; but feeling guilty he gave the conversion factors in the Appendix.

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Cretaceous Stratigraphy – An Update. A. Govindan (Guest Editor). Geological Society of India, P. B. 1922, Gavipuram P.O., Bangalore 560 019. 2000. 426 pp. Price: Rs 600/\$50.

The Cretaceous was a pivotal period in the earth's history when an old order of organisms diversified and became extinct, giving way to new life forms of a more modern aspect. It is, therefore, appropriate that special attention be paid from time to time on various aspects of this period, specially in the Indian context. The latest review in this direction is the commendable effort by A. Govindan, who is the Guest Editor of the Franz Kossmat Volume on *Cretaceous Stratigraphy – An Update*.

During the turn of the last century several geologists from Austria visited India and made significant contributions. Franz Kossmat (1871–1938) was one of these. The present volume gives tribute to this man, who highlighted the classic sections of the Indian Cretaceous, first for his Ph D thesis and later made them known globally.

The present volume is divided into seven sections. The first four articles in the section dealing with Cretaceous sea level and stratigraphy lay down the basic principles for Cretaceous stratigraphy in the context of marine oscillations with reference to specific case studies.

The section on palaeontology constitutes the next comprehensive part of the volume and comprises a mixed bag in which a variety of fossil groups ranging from nanofossils to molluscs have been described. Several papers presented as extended abstracts also pertain to this section.

There is only one review paper dealing with the temporal framework of the