REVIEWS

LAKES—Chemistry, Geology and Physics. Edited by Abraham Lerman, Springer-Verlag, New York, 1978, pp. xii+363.

From time immemorial man has been fascinated by the beauty of the Lake. The Sea is somewhat awe inspiring, but the Lake has always been remarkable for its suavity and grace. The mystery of the unseen world of both the Sea and the Lake have nourished the intellectual curiosity of man. While the investigations regarding the seas are well known and treatises have been published, the investigations of the Lakes have not been so very well known and the information is scattered in many sources. The book under review brings together in a single volume the results of the chemical, geological and physical studies of most of the lakes of the world. The Editor, Abraham Lerman, has remarked in his introductory preface, 'The multidisciplinary studies of lake systems, as they have been emerging in recent years, differ from the 19th and earlier 20th century limnology more in measure and scope rather than in their conceptual principles'.

The book is divided into eleven Chapters each covering a particular topic contributed by one or two joint authors. It presents a masterly account, marshalling and reviewing all the important data. Each Chapter is also followed by references to published papers relative to the main topic.

The first Chapter on Heat Budgets of Lakes by R. A. Ray examines how the internal characteristics of lakes determine their thermal interaction with external meteorological factors. Each lake is an individual entity responding slightly differently to its external climate, and in this respect differs from oceans where large advective processes play a major role. The author points out how a lake can be considered as a recording climatic instrument.

Chapter two on water circulation and dispersal mechanisms by G. T. Casnady mainly concentrates on the recent advances in lake hydrodynamics and presents several models.

Chapter 3 on Sedimentary Processes in Lakes by P. G. Sly considers the various factors which influence sedimentary processes in lakes. The more important relationship between particle size, composition and geochemical behaviour are reviewed. The author's work in the Laurentian Great Lakes of North America is presented in some detail to illustrate the various aspects of the sedimentary processes. The author has pointed out how difficult it is to be sure whether ancient sediments are of lacustrine or marine origin, unless there is clear evidence of basin closure, rapid deposition and limited littoral development.

Chapter 4 on Man-made Chemical Perturbations of Lakes by W. Stumum and Baccini, discusses in detail the interference caused by man with cycles that couple land, water and atmosphere. They point out that the stress imposed by civilisation becomes primarily reflected in the aquatic ecosystem and that particularly chemical perturbation of a lake may be related to population density in the drainage system of the lake. The loading parameters are compared for some lakes. The flow of phosphorous from land to water owing to mining of phosphates and its utilisation in industry and agriculture is said to have increased exponentially over the last few decades. The ecological consequences of these and various other factors in the pollution of lake waters and the rapid changes brought about in chemical and biological properties of lakes have been pointed out.

Chapter 5 on Organic Compounds in Lake Sediments by M.A. and W.C. Barnes points out the physical, chemical and biological conditions within the lakes for

following the history of organic compounds like fatty and other acids, hydrocarbons, carbohydrates etc.

Chapter 6 on Radionuclide Limnology by S. Krishnaswami and D. Lal deals with the application of Radio-nuclides for determining radiochronology of sediments and other deposits from contemporary and fossil lakes. The importance of the radio-nuclide studies has been pointed out especially in reconstruction of the recent past environment of contemporary lakes, and in deciphering the past climatic changes and tracing the long term history of glacial and fossil lakes.

Chapter 7 and 8 which are of equal length, together cover nearly a third of the total volume of the book. The Mineralogy and Related Chemistry of Lakes forms the topic of Chapter 7 by B. P. Jones and C. J. Browser. After considering the modern techniques of study and chemical analyses of major and minor elements in lake sediments of a variety of environments and geographic localities, a list of minerals found in such sediments is presented. Surprisingly the total number of mineral phases identified is only twenty. The origin of major mineral groups is discussed.

In Chapter 8 on Salt Lakes, H. P. Eugster and L. A. Hardie point out that salt lakes are common in certain parts of the earth but that they have neither the size nor the abundance of normal lakes, and vary from small chemical ponds to deep perennial lakes like the Dead Sea. The distinction between saline and fresh water lakes is made on the basis of containing 5‰ and over dissolved salts. The conditions for salt lake formation are pointed out and diagenetic reactions discussed. Economically important products, as for example, lithium, potassium, Na_2CO_3, zeolites etc., from salt lakes are enumerated. Several active saline lakes,—the lake Magadi, the Chad, the Dead Sea, the Basque lakes and the Great Salt Lake of Utah, and also a few fossil lakes have been described in detail. Finally, it is shown that deposits of ancient salt lakes signal severe climatic and topographic restrictions, and that on this account are useful in interpreting palaeoclimatic and tectonic conditions.

Chapter 9 by K. Kelts and K. J. Hsii dealing with Fresh Water Carbonate Sedimentation summarises the recent advancements concerning carbonate sedimentation in large fresh and brackish water lakes, with particular emphasis on the study of Lake Zurich. The authors point out that in contrast to oceanic carbonate sediments which are largely of organic origin, the bulk of primary lacustrine carbonates are inorganic precipitates.

Chapter 10 on Stable Isotope Studies of Lakes by F. J. Pearson Jr. and T. H. Coplen presents a general overview of the processes which bring about changes in stable isotope ratio variations, using studies of lakes as example of their operations. Isotopes considered are Hydrogen, Oxygen, Carbon, Nitrogen and Sulphur. It is pointed out that isotope ratio variations are due to fractionation during some physical processes, such as diffusion as a result of chemical equillibria or accompanying irreversible chemical reactions.

Lastly, Chapter 11 which is also the smallest in length (16 pages) by D. Imboden and A. Lerman, deals with Chemical Models of Lakes. The purpose of a chemical model of a lake is said to be to present an accurate and concise description, of chemical processes taking place within the lake. The models are divided into empirical and conceptual models. The authors point out that the lake and its sediments act as open systems which interact with its environments *viz.*, drainage basin and atmosphere by exchange of matter of energy. This Chapter also considers water residence in lakes.

On the whole, the book forms a near enough encyclopaedic treatise, bringing together in a single volume all the important aspects of Limnology. A great deal of

information collected mostly in the last two decades has been presented lucidly with numerous tables, charts, diagrams and other illustrations. The book is bound to be welcomed by scientists and engineers generally, and the graduate students in limnology and related fields of environmental sciences in particular.

The addition of a subject index and an index to lakes given at the end will be found very useful. The printing and get-up of the book is excellent.

M. B. R. RAO

PHYSICS AND CHEMISTRY OF THE EARTH, Vol. 10, No. 2, 1977, Eds. L. H. Ahrens, F. Press, and S. K. Runcorn, Pergamon Press, New York.

Nearly a decade of intensive investigations of the lunar samples returned by the American and Russian space missions have generated such an enormous amount of data concerning different areas of lunar science that most interested readers may be lost on the essential conclusions and broad implications thereof. There is therefore an important need to critically assess the research to date so as to focus on the significant findings and to define the directions for further work.

The two review articles on two distinct aspects of lunar science appearing in the 'Physics and Chemistry of the Earth' Vol. 10, No. 2, 1977 serve precisely the above purpose and should hence be welcome to the fraternity of lunar and earth scientists as a whole.

The first article by D. S. Burnett and D. S. Woolum critically examines the available data on the effects of particle bombardment of lunar rocks as distinct from lunar soil. Five different types of irradiations have been demonstrated experimentally which can alter the physical, chemical or isotopic composition of a lunar rock fragment: (1) interplanetary micrometeorites, (2) galactic cosmic rays, (3) solar flare particles, (4) solar wind ions, and (5) ions and atoms from the tenuous lunar atmosphere. The effects of these particle irradiations serve as tracers to study the various lunar surface processes such as formation time of lunar craters, erosion rates for lunar rocks. The article explains the criteria for particle exposure data to relate to physically meaningful events in lunar history and determines 'to what degree the conclusions which can be drawn *in principle* from such data have *in fact* been accomplished'.

The second article by L. E. Nyquist is addressed specifically to the summary and evaluation of the results of the study of returned lunar rocks and soils by the Rb-Sr method. The Rb-Sr systematics in lunar rocks and soil have been related to the various events in lunar chronology, the main episodes being: (1) formation of the Moon about 4.6 A.E. ago, (2) a period of intense bombardment by planetary debris resulting in the formation of the major lunar basins, (3) the end of this period at 3.9 – 4.0 A.E. ago, (4) a period of mare flooding extending from 3.9 to about 3.2 A.E. ago, and (5) a relatively quiescent period from about 3.2 A.E. ago to the present. In addition, the initial $^{87}Sr/^{86}Sr$ ratios in different lunar materials have provided valuable information on the geochemical evolution of the Moon.

Both the articles are well written and will greatly aid the interested reader to grasp the essential findings from the maze of data which have been obtained in the above two areas of lunar science.

K. GOPALAN