J. Cons. int. Explor. Mer, 37(1): 112–115. Mai 1976.

Reviews

E. D. Goldberg (Ed.): *The Sea. Volume 5. Marine Chemistry*. John Wiley and Sons Ltd., New York, 1974, 895 pp., £ 21.70.

After the devotion of the previous two volumes of *The Sea* to the geology of the sea floor, it comes as something of a relief to find that marine chemistry is dealt with in one volume. It is a tribute to Professor Goldberg and his editorial board that they have managed to confine the rapidly expanding subject of seawater chemistry to one book. Needless to say, the present volume is long, massive (almost 1·8 kg) and, seemingly inevitably, expensive.

The book is dedicated to the late Professor Lars Gunnar Sillén, one of the foremost inorganic chemists of this century who, during the latter years of his life, applied himself to the task of trying to understand the chemistry of sea water. It is most fitting that a major work in marine chemistry, such as *The Sea* Vol. 5, should honour Sillén, because his input to the field has had profound results. By considering the water and sediments in the ocean as a chemical system at equilibrium, an overall model for seawater chemistry was established, against which the field observations could be tested. In some cases the model and field data are in agreement, but in many instances they are not. The real power of the approach is that it enables the ultimate state of the system to be predicted. Discrepancies between the observed and final states for particular components can then be attributed to kinetic/biological effects which are thus identified as worthy of further study. In this way chemical oceanography becomes less an open ended data gathering exercise and more a rigorous branch of chemistry.

The book contains 23 individual chapters subdivided into 6 parts. The first part consists of five chapters under the general title 'Thermodynamics of the Seawater System'. In 'Seawater as a Multicomponent Electrolyte Solution', F. J. Millero reviews physico-chemical approaches to ion-ion interactions in single and multicomponent electrolyte solutions. These ideas are then applied to prediction of the properties (volume, thermal and transport) of sea water and of solutes in the medium of sea water (e.g. activity coefficients, partial molal volumes and enthalpies). There is little mention of explicit sea water models, such as the ion association approach of Garrels and Thompson and that involving specific ionic interaction proposed by Whitfield. In the next chapter A. Disteche examines the effects of pressure on ionic equilibria in sea water. The partial molar volume and dissociation/association constant approaches are used to investigate the effect of pressure on the sulphate and carbonate systems in ocean waters. In 'The Alkalinity–Total Carbon Dioxide System in Seawater' J. M. Gieskes presents a workmanlike synthesis of ideas from chemistry, physical oceanography, marine geology and biology as they affect the oceanic carbonate system. After a brief review of the thermodynamics of the system (which summarises a number of the points made in the previous two articles) topics covered include the distribution of alkalinity and total CO_2 in the oceans, sedimentation and dissolution of calcium carbonate and exchange of carbon dioxide across the air-sea interface. In his equilibrium model of the oceans Sillén assumed that the redox potential was controlled by the O_2/H_2O couple and used a value for the pE of 12·5. This led to problems with the speciation of a number of elements (e.g. N, I, Mn). W. G. Breck in his chapter 'Redox Levels in the Sea' elaborates on the idea that the operative redox potential in sea water is poised by the O_2/H_2O_2 couple, leading to a lower value than used by Sillén. With a lower value for pE many of the multivalent elements cease to present problems. In the final article in this part of the book D. Dyrssen and M. Wedborg present an updated and extended version of the sort of equilibrium calculations of the speciation of elements in seawater used in the Sillén model.

Part II contains three chapters concerned with air-sea interactions. R. H. Bieri discusses the results of oceanic measurements of dissolved noble gases. Some studies appear to show deviations from equilibrium for these gases between the atmosphere and the ocean across the air-sea interface. However, the lack of agreement between the methods used by different workers to measure noble gas concentrations makes interpretation of the data extremely difficult. As shown by W. Seiler and U. Schmidt in their chapter, the situation is somewhat easier for

some nonconservative gases which can show considerable supersaturation in surface sea water. In the last chapter 'Chemical Fractionation and Sea-Surface Microlayer Processes', F. MacIntyre presents an original, and at times amusing, approach to the processes occurring at the very surface of the sea, with especial reference to the fractionation which has often been reported for elements traversing the air-sea interface. From a critical assessment of the available data, MacIntyre concludes that for very few elements has such fractionation been unequivocally demonstrated.

The longest Part (III) of the book is concerned with the sedimentary cycle and consists of nine chapters. In the first of these R. M. Garrels and E. A. Perry develop a steady-state model for the cycling of the elements carbon, sulphur and oxygen in the sediment-ocean-atmosphere system over the last 600 million years. Over this time period the composition of the ocean and atmosphere is argued to have been appreciably constant, but transfer between mineral reservoirs has probably occurred. From their analysis the authors conclude that the rate of photosynthesis is proportional to the amount of carbon dioxide in the atmosphere and that this is probably the main mechanism maintaining the constant composition of both atmosphere and oceans. The next two chapters, entitled 'The Magnesium Problem' (J. I. Drever) and 'The Silicon Problem' (R. Wollast), are essentially concerned with input-output budgets for these two elements in the ocean system. In both cases it appears that the input to the ocean (mainly from freshwater inflow) is too great to be accounted for by well established removal processes. In the case of magnesium Drever argues that the most likely explanation for the discrepancy is because the present-day magnesium flux in rivers is unrepresentative of conditions in the past. For silicon, Wollast favours the reaction of dissolved silicon with clay minerals in marine sediments. Only a small amount of data is presented to support this conclusion and unfortunately there is no cross-referencing to additional evidence in a subsequent chapter by Manheim and Sayles. Of the next three chapters, two are primarily concerned with the use of isotope techniques in marine chemistry. G. D. Garlick reviews the use of stable isotopes of oxygen, carbon and hydrogen, and E. D. Goldberg and K. Bruland provide a much needed critical account of radioactive techniques used for dating marine sediments. A chapter by R. A. Berner dealing with kinetic models for the early diagenesis of nitrogen, sulphur, phosphorus and silicon in anoxic sediments is sandwiched rather uncomfortably between the two articles on techniques. Next comes a chapter by D. S. Cronan on 'Authigenic Minerals in Deep-Sea Sediments'. In this the main classes of minerals found in the oceans, including manganese nodules, are described in terms of crystal structure, chemical composition and geographic distribution, with some discussion of their modes of formation. In 'Composition and Origin of Interstitial Waters of Marine Sediments, Based on Deep-Sea Drill Cores' F. T. Manheim and F. L. Sayles have done a very useful job in summarising the interstitial water results from the Deep Sea Drilling Project. The final chapter in this part of the book is a lengthy, authoritative account of the sulphur cycle in the marine environment (M. B. Goldhaber and I. R. Kaplan).

The fourth part has the general title 'The Impact of Life Processes Excluding Man' and contains three chapters. The first is a well reasoned and thought provoking look by D. W. Menzel at primary production and the origin of dissolved and particulate organic carbon in the oceans. Menzel goes on to argue that very little oxidation of dead organic material occurs below a depth of a few hundred metres. In 'Natural Products Chemistry of the Marine Environment' D. J. Faulkner and R. J. Anderson catalogue 194 different compounds which have been isolated from marine organisms. The authors are obviously writing on a topic which involves presentation of a lot of factual material but the unfortunate reader is not helped by the total absence of any division of the text into sections. H. A. Lowenstam writes on the intriguing topic 'Impact of Life on Chemical and Physical Processes'. Most marine chemists would argue that life has a profound effect on the chemistry of sea water, but its role in physical processes is harder to see. The apparent problem arises because by 'physical' the author does not mean the gamut of processes from ocean circulation to salt fingering studied by physical oceanographers, but rather the incorporation of chemicals into the hard parts of organisms.

Part five is concerned with the impact of man on the chemistry of the oceans. It contains only two chapters ('Heavy Metals, Metalloids and Synthetic Organics' by A. Jernelov and 'Artificial Radioactivity in the Sea' by A. Preston) and it is arguable that it should have been omitted. The topic is large and to do it justice (as in 'Impingement of Man on the Oceans' ed. by D. W. Hood) much space is required. The 37 pages in the present volume are clearly inadequate and the situation is made even worse because Jernelov's chapter is very inadequately referenced.

The book's final section has but one chapter entitled 'Origin of the Ocean' by G. Arrhenius et al. The authors argue against the idea that the ocean and atmosphere developed only after the solid earth

had formed and for the view that the processes which led to formation of the earth contemporaneously played a decisive role in the differentiation which produced the precursors of the present ocean and atmosphere. It is a pity that the authors do not go on to discuss the history of sea water from its beginning up to recent times. This topic is covered, in part, in the chapter by Garrels and Perry but since it is so fundamental to Sillén's ideas it really deserves a more extended treatment.

Viewing the book as a whole one cannot fail to be impressed by the high standard of the majority of the chapters. Obviously in a multi-author book there will be some articles which could have been better, but on the whole Prof. Goldberg and his editorial board have chosen their authors well. It is also refreshing to find that the ratio of non-U.S. to U.S. authors (12:22) is high relative to many other scientific texts, and probably truly reflects the achievements in the field.

On the debit side there is a dearth of cross-referencing between chapters and the reference list for at least one chapter is in bad need of correction and updating. Cross-referencing is important in a book with a large number of authors because it not only helps the reader to pick out underlying themes in the subject but also increases the comprehensiveness of individual chapters. Inevitably some topics are not covered in any depth (e.g. the effect of biological processes on nutrient distributions both with depth and horizontally, trace metals, analytical chemistry of sea water, mixing models, coastal waters, estuaries and fjords). The weighting of different parts turns out rather strangely. As already mentioned, the parts on pollution and the origin of the oceans are too brief, while in the three chapters concerned with air-sea interaction little or nothing is said about some of the most important gases e.g. O_2, CO_2, SO_2. In contrast, Part IV on the sedimentary cycle is unnecessarily long due to the inclusion of two chapters on isotope techniques. A number of the longer chapters would probably have benefited from some compression.

This is certainly a book which every institution in which the study of marine chemistry is pursued must have in its library. It is a great pity that the price will certainly deter many researchers from purchasing a copy for themselves. The publishers presumably cost and price books of this sort on the basis that sales to libraries will constitute the bulk of the copies sold. It would be interesting to know why the publishers do not introduce a dual pricing system for important scientific texts. This system, in which individuals (the libraries of whose institutions buy the book at full price) can purchase it direct from the publishers at a substantially reduced price, is already operated for many scientific journals. In the present case such a pricing policy would enable individual marine chemists to have, at a reasonable cost, a copy of a book to which, because it is the most comprehensive and important one volume text on the topic, they must have access.

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George A. Rounsefell: Ecology, utilization and management of marine fisheries. C. V. Mosby, St. Louis, 1975. 516 pp. $ 26.25.

This text is more than a replacement of Rounsefell and Everhart's book published in 1953; it summarizes much work done since that date. A short historical introduction lists the founding fathers and their successors; an encomium on Dr W. B. Chapman ends: "allowing our foreign fishery policies to be run almost wholly by the larger tuna corporations (who employed him) ..... has resulted in our present position as a second rate fishing nation". The conclusion is wrong and Dr. Chapman's overwhelming and powerful concern was for all fisheries.

The text proper starts with a short description of the physical environment. The distributions of the current systems are presented on South Pole projections which I found unfamiliar, indeed disconcerting. It is essentially a geographical description; I have learned a new word, *exorheic*, which means that the fresh water input to a sea exceeds the evaporation. The primary biological environment is described in terms of the forms of upwelling and the inputs of nutrient into the system.

There are two chapters on limiting factors, physical and biological. Oxygen, salinity and temperature are shown to have particular effects at extremes. The biological factors are the red tides, predation and competition, each of which is a large subject treated very briefly. It is a truism that any population must become limited, but if "limiting factors" are examined in isolation their effects appear only to be shown in the extreme; yet the population is controlled in the middle ranges.

There is a very good description of fisheries throughout the world based on the FAO Tables for 1968. Catches by families and species are grouped as cold, cool, warm and tropical. The value of US catches by species is tabulated for 1967. The per capita consumption is given by countries. The in-