BOOK - REVIEWS


In 1962, Professor Roger Revelle, the then Director of Scripps' Institution of Oceanography and Dean of Research at the La Jolla campus of the University of California, remarked that literature in oceanography was unable to cope up with the progress of the subject and suggested that it would be worthwhile to publish a treatise on ideas and observations in oceanography. Professor Maurice Hill of the University of Cambridge, England, undertook this mammoth task and the outcome of his efforts are well known to oceanographic community. At that time Professor Hill forecasted that there might be another volume on the subject but little did he foresee that further additions would be necessary to keep pace with the progress of the science of Oceanography.

Marine chemists should be grateful to the editorial board for this volume consisting of Professors Goldberg, Arrhenius, Dyrssen and Garrels for bringing out a complete number devoted entirely to marine chemistry. Although during the sixties and in early seventies several treatises on marine chemistry and chemical oceanography have appeared, nothing so comprehensive and covering almost all the fields of the discipline as this has so far been published. Fittingly enough, the book has been dedicated to the memory of Professor Lars Gunnar Sillen, a pioneer in the field of marine chemistry whose paper, 'The Physical Chemistry of Sea Water', presented at the First International Oceanographic Congress in New York in 1959 stimulated research on the subject and is still deemed as a classical work in the field. The present reviewer is proud of his acquaintance with Professor Sillen whose advice and guidance have helped him tremendously to increase his knowledge of the physico-chemical processes of the oceans.

In all 32 scientists, including a Nobel Laureate, have contributed to this volume. Of the 32 contributors, 6 are from the editor's own institute, the Scripps' Institution of Oceanography, and 5 are from Sweden, the home country of Professor Sillen.

The volume contains 23 chapters covering practically all the aspects in which Professor Sillen has been interested. Fittingly enough 8 of the chapters are on thermodynamics of the sea water system which has been the field of speciality of Professor Sillen. The volume
is, perhaps, most useful to post-doctoral and advanced research scholars in marine chemistry and chemical oceanography and as such it is a pretty hard nut for persons of other disciplines to crack.

To deal each chapter separately will enlarge this review and therefore I decided to select a few of my liking to write my opinion about them. The chapters 1 and 2 deal with sea water as a multi-component electrolyte solution and these appropriately discuss the pressure and temperature dependence of the dissociation constants. The paucity of our present state of knowledge on the subject has been clearly indicated in these chapters. The chapter 3 is a general review of the present state of our knowledge on the alkalinity-carbon dioxide system of sea water. The first part of new information in the volume appears in chapter 4. Indeed, the solution presented here would have solved some of the dilemma that was facing Professor Sillen then. Basing his calculations on the \( \text{O}_2-\text{H}^+-\text{H}_2\text{O} \) system Sillen suggested that the average sea water should have a pE value of 12.5. At this pE \( \text{N}_2(\text{g}) \) should have been converted to \( \text{NO}_3^- \) in the ocean. Being unable to arrive at any acceptable explanation, he termed nitrogen in the sea as ‘bug’ in the system. But Breck, in chapter 4, nicely clears this dilemma basing his calculations on \( \text{O}_2/\text{H}_2\text{O}_2 \) couple. This leads to a pE value of 8.5 for the average sea water. At this pE, most of the nitrogen should be present as gas and \( \text{NO}_3^- \) would be of the order of \( 10^{-6}\text{M} \) which is normally the case in the oceans. Chapter 5 presents the equilibrium calculations of the speciation of elements in sea water. However, it adds precious little to our existing knowledge of ion-pair formations in sea water. Moreover, the authors have missed to cite one or two important references. For instance, they calculated that 46.9% of fluoride in sea water should be present as \( \text{MgF}^+ \) at pH 8.12 and 25°C, whereas Brewer et al. (Brewer P. G., Spencer D. W. and Wilkniss P. E., Anomalous fluoride concentration in North Atlantic. Deep-Sea Res., 17, 1970) calculated the same to be about 50%.

The inadequacy of our present state of knowledge about the ion-pair formations and equilibrium conditions of different chemical systems in the sea is evident from the fact that even now we have to use literature constants calculated at 25°C and 1 atmosphere pressure. Sillen himself once remarked “the equilibrium constants have been used at 25°C whereas the average sea water is much colder; calculating \( \Delta\text{H} \) for the various reactions from literature data it will not be surprising to find that there exists a difference”.

Chapters 6 and 7 although titled dissolved conservative and nonconservative gases in sea water respectively, deal with the noble gases and some minor gases of very little significance to chemistry or ecology of sea water. Major gases like \( \text{O}_2 \) and \( \text{N}_2 \) and their thermodynamics have not been treated at length although in part III of the book under the sedimentary cycle, geochemical significance of \( \text{O}_2 \) has been dealt with.

In chapter 18, Menzel has dealt with the problem of particulate and dissolved
carbon and sites of oxidation of organic matter in great details. About particulate carbon he remarks "Below a depth of 400 m there are no further systematic decreases or increases in particulate carbon (italics mine), so that in any given water column variations are small", and about dissolved organic carbon "the bulk of dissolved deep-water carbon is biochemically and biologically inert". These conclusions have been doubted by Gieskes (chapter 3), who suggests that oxidation of organic matter and consequent release of carbon can take place even at great depths. Menzel's hypothesis is that the net results of production, sedimentation and advection processes of carbon in deep water are in a steady state. I hope this interesting hypothesis would form the basis of further investigation. The fine chapter, however, does not contain any illustration—a few would have definitely clarified some points to the readers quickly.

The weakest portion in this otherwise wonderful volume is the chapter 21 which deals with the heavy metals, metalloids and synthetic organics. This chapter has many generalisations and speculations, which are not adequately supported either by illustrations or references. The literature cited at the end is not properly referred to in the text and some references cited in the text are not included in the literature list. The IDOE and NAS reports quoted in the literature list, however, do contain many important references and the inclusion of a few of them would have added to the quality of the chapter.

The volume ends with a superb article by among others a Nobel Laureate in physics. This is a classic example of how research in outer space, specially lunar explorations, can help researches in inner space and the new theories on the origin of the ocean and the ocean-earth-moon system add to our knowledge considerably.

As mentioned in the preface of the book by the editor that there are some overlaps and sometimes conflicts in the presentation. Without editing them and allowing the contributors to present their own views and arguments, the editor has really helped the reader to have both sides of the picture and form his own judgement. Printers' devils are there in the text, although they appear sporadically. But in a volume of this nature, more care of proof-reading is to be expected.

The book is a very valuable addition to the scanty literature in marine chemistry and it is a must for oceanographic institutions and marine scientists. The high price, however, stands in the way of personal acquisition.

The publishers, John Wiley & Sons, are undoubtedly rendering a great service to oceanography by their continued publication of this series. In fact, we are eagerly awaiting the publication of the next volume devoted entirely to marine biology.

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