

ELDERFIELD, H. (ed.). 2006 – *The Oceans and Marine Geochemistry*. Paperback. Elsevier. Volume 6 of the *Treatise on Geochemistry*, H.D. Holland and K.K. Turekian (eds). Amsterdam, 646 pp.

This book is the sixth of a collection of nine volumes (plus a complete index) that make up the monumental 'Treatise on Geochemistry', envisioned as a comprehensive summary of present knowledge and the latest advances in all fields of geochemistry.

This volume is devoted to marine geochemistry, a scientific discipline that has expanded enormously during the last few decades. It is divided into twenty-one chapters that can be roughly grouped into four sections. The first section (Chapters 1 to 6) focuses on the contemporary ocean, starting with a discussion on the physicochemical controls on seawater and continuing with an integrated sequence of chapters addressing key aspects related to the organic and inorganic components of seawater and their cycling. The second section (Chapters 7 to 11) addresses the processes and mechanisms that control the different constituents of seawater, delimitating the applicability and principles of the most promising proxies for studying them. The third section (Chapters 12 to 19) reviews the present knowledge of marine properties and processes in the past, starting with a discussion on geochronometry of marine archives and continuing with a sequence of chapters reviewing work on the evolution of key topics, including sea-level, sea surface temperatures, oceanic circulation and ice-sheet dynamics. This section culminates with a thorough evaluation of the oceanic carbonate cycle and the biological pump and their operation in the past. The last section (Chapters 20 to 21) is the icing on the cake, as it includes a comprehensive evolutionary history of seawater chemistry and composition since the very first presence of a significant amount of water on the Earth's surface during the Hadean, including accounts of provocative hypotheses, major debates and controversies.

Some of the chapters are relatively technical and more oriented to specialist readers. In others, the authors have made great efforts to write plainly, simply and clearly, in order to reach a wider range of audiences. Most of the chapters are well structured, with clarifying introductions and summaries. An important aspect in a book of this type is that most

chapters (although not all of them) devote paragraphs or even whole sections to highlighting the challenges for the future in each field. The book is also well illustrated with relevant figures, some of them in colour. Although we strongly recommend the whole set of chapters, if we had to list 'the magnificent seven', those that we have found more balanced and complete in content and structure, and that provide all the necessary information, including the author's ideas on potential new fields of research, these would be the following:

Chapter 2, by Bruland and Lohan, on the controls of trace metals in seawater, contains a very comprehensive description of conservative-, nutrient- and scavenged-type distributions of these elements in the water column, with examples on paleoceanographic applications. External inputs of trace metals (i.e. rivers, atmosphere and hydrothermal) and their removal processes are well described, with insight into complexation with organic ligands, a topic for which relevant analytical techniques are briefly discussed. Information on relevant reviews to complement this chapter is also given.

Chapter 4, by de la Rocha, on the biological pump—a topic that has received much attention lately for its implications in the absorption and sequestration of atmospheric CO₂—provides a very exhaustive description of its functioning and its impact on the geochemical cycling of micronutrients and trace elements. Key concepts of the quantification of the biological pump and the measurement of new production are also given, and the chapter ends with an overview of the expected evolution of the pump in the future.

Chapter 6, by Eglinton and Repeta, on organic matter in the contemporary ocean, is extremely well balanced and contains all the relevant information that we might seek in this type of publication: a good start with a clear introductory section, references to complementary reviews on the subject, clear and simple writing and a relevant update on the big unknowns that need further research, including the role of microbes in processing organic matter.

Chapter 13, by Edwards et al., on geochemical evidence for Quaternary sea-level changes, is another well balanced chapter, with an up to date summary on the most reliable methods for reconstructing and dating sea level changes in the past. This chapter contains a particularly exhaustive section on ²³⁰Th and

²³¹Pa dating, including a historical overview, examples of applications and discussion of errors, and it ends with a sound list of ideas on future research. The only thing we found lacking was a discussion on isotopic effects, a complex topic that would have probably required several detailed sections or perhaps a whole chapter.

Chapter 14, by Lea, on elemental and isotopic proxies of past ocean temperatures, is one of the two most complete and best structured reviews, together with Chapter 18. It starts with a nice overview of sea surface temperature proxies and their applicability. It then continues with discussions on the oxygen isotopic composition of foraminifera and corals, and deals in greater depth with the magnesium/calcium ratios in foraminifera, which is the Lea's specialty. Strontium/calcium ratios in corals are also discussed in this chapter. One of the particularities of this review is that each sub-section ends with a concise summary and a list of outstanding research issues.

Chapter 15, by Herbert, on alkenone paleotemperature determinations, extensively reviews current knowledge on this paleothermometer, which has gained most acceptance among paleoceanographers. As mentioned below, this chapter is one of the exceptions in which the reader will find details on the analytical techniques used and their latest developments. Having had some expertise in this specific field, we can attest to the rigour and objectivity of this thorough review. Perhaps the only exception is an excessively pessimistic statement regarding the warmest waters that can be reconstructed using the alkenones method. Although Herbert recommends not using it for temperatures above 27°C, we believe that elucidating temperatures with this method is feasible, at least up to 29°C.

Chapter 18, by Sigman and Haug, on the biological pump in the past, is one of the two most complete and best structured reviews, together with Chapter 14. It thoroughly describes all concepts, tools and observations related to the functioning of the pump on a millennial time scale, focusing particularly on its role in the glacial to interglacial oscillation of atmospheric CO₂. Particularly exhaustive is the section on observations, in which detailed information is given on all relevant paleoreconstructions of the biological productivity and nutrient status over the last glacial/interglacial cycles.

While this is undoubtedly an extraordinary compilation of work, we would like to comment on several aspects that would have added even more value to this book. First of all, it is lacking in details or discussions on analytical chemistry and methodological

aspects of the long suite of proxies mentioned in this book. Only a few chapters (e.g. Chapter 2 by Bruland and Lohan, Chapter 15 by Herbert) contain up-to-date syntheses on the latest analytical advances in the field. Since one of the main drivers of the recent expansion in marine geochemistry is the methodological development in structural, elemental and isotopic analysis, it would have been very informative to include key aspects of this in each relevant chapter. There is also a bit of overlapping in some of the sections. Uranium, thorium and/or protactinium isotopes are, for instance, mentioned repeatedly in several chapters (in Chapters 2, 3, and extensively in Chapters 9, 12 and 16). This is understandable because of the wide range of applications that these isotopes offer, but perhaps it would have been more useful for the reader if they had been integrated in one chapter. We also note that the selection of authors is clearly biased towards those in the United States (out of the 33 authors selected, 28 are based in the US, 4 in the UK and 1 in Germany). While we do not question the appropriateness of any of the authors chosen, we believe that a better representation encompassing scientific experts from around the world would have been desirable. Our final point concerns the cost of this volume: When the Treatise on Geochemistry was initially published in December, 2003, it had to be purchased as a whole collection in hardcover at more than €4.000. Fortunately for the tight budget of students and scientists, the individual volumes were recently reprinted in paperback and can be purchased for only €80. The present volume was reprinted in March 2006. In addition, Elsevier offers the possibility of downloading PDF versions of individual chapters to institutions with on-line subscriptions.

Despite these drawbacks, this book is an absolutely recommendable masterpiece, a must have for both students and advanced research scientists, but also for teachers and members of the general public with a basic scientific education who are keen to learn the latest views on the revolutionary scientific discipline of marine geochemistry. All authors should be congratulated for taking on this important task and for coming up with such an impressive end product. It will certainly remain a classic reference book for many years to come.

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