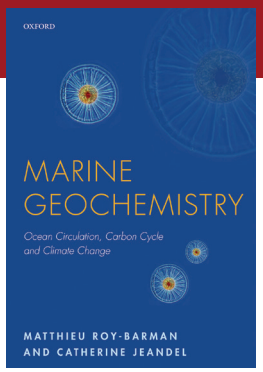
MARINE GEOCHEMISTRY[1]



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Climate change, ocean acidification, coral bleaching, marine "dead zones"... for better or worse, the Anthropocene is certainly proving to be an interesting time for marine science, and particularly for marine geochemistry. Add to this the advent of vast and vastly accessible information, as well as technological advances in analytics and computing, and you are left with a virtually endless potential for scientific inquiry. And certainly the field of marine geochemistry is growing in all directions, as researchers push the boundaries of the science. Marine geochemists can now measure how isotopes of elements found in the oceans at pico-molar levels vary across entire ocean basins, and model what this implies for global change over millennia past and those to come! Heady times to be a marine geochemist. More importantly, it is a critical time to teach and inspire the next generations of marine geochemists so that they may keep forging ahead. As such, *Marine Geochemistry* by Roy-Barman and Jeandel comes at an opportune moment.

Marine Geochemistry by Roy-Barman and Jeandel, is designed as an instructional tool; the textbook to accompany a class, for example. That Roy-Barman and Jeandel's book is written entirely by the authors gives it a continuity of logic and cadence that is beneficial to instruction. The book is written as a very natural narrative that is remarkably easy to read. And while occasional mathematical derivations are needed, these are kept short and to the point (or are put in appendices), thereby maintaining the storyline's flow. Overall, the material is intended for upper-level undergraduates and graduate students, and the authors assume the reader has some mathematical understanding—can understand derivatives—and has a basic knowledge of chemistry, biology and geology. While no prior oceanography is needed, *Marine Geochemistry* would probably not be the best introductory text, as it advances at a fair clip.

Similar to its celebrated predecessor, *Tracers in the Sea* by Broecker and Peng (1982, Columbia University Press), Roy-Barman and Jeandel have adopted the "tracer" perspective to marine geochemistry as a theme for their book, which follows a fairly logical format. The first two chapters describe the oceans and their physical properties (currents, circulation), and the general chemical properties of the salt-water solution (including major and minor salts, gases, carbonate chemistry, redox and trace metals). Chapters 3 and 4 introduce both stable (Chapter 3) and radioactive (Chapter 4) isotopes as tracers in the oceans. Topics covered include the established isotope systems of oxygen and carbon, as well as more novel systems such as boron and iron. As with the entire book, discussions of specific subjects (e.g. strontium or neodymium isotopes) are intermixed with explanations of more general concepts (e.g. mass-dependent versus mass-independent fractionation, clumped isotopes, radioactive decay, isotope mixing) and other fundamental principles. While not always seamless, this approach to interchanging theory and application works well and is remarkably easy to follow.

The shorter Chapters 5 and 6 start integrating all these concepts into simple box models (Chapter 5) and advective–diffusion models (Chapter 6): topics perhaps not expected to be found in a geochemistry text, but illuminating the power of the tracers discussed. Note that these chapters are not instructive of the nuance of modeling, but more the application of the tracers. With a good deal of material covered, the book then sets its sights on a new level of complexity, introducing the reader to *bio*-geochemistry. This is an important chapter that reflects the increasingly interdisciplinary nature of all marine sciences. Roy-Barman and Jeandel offer a surprisingly thorough description of the important features and concepts in marine biology, more than the simplifications that geochemists are wont, and remiss, to make. Of course, a geochemist slant is clear: after all, under whose purview is silica and iron limitation?

Chapter 8 revisits topics introduced in the first chapters but now in greater detail, examining gases in the ocean (and atmosphere) with a focus on carbon dioxide. Inevitably, the discussion evolves into a more detailed description of carbonate chemistry in the oceans, an ostensibly straightforward topic that often turns unpleasant for students. Roy-Barman and Jeandel succinctly and effectively handle the topic, including the concept of alkalinity. Chapter 9 develops ideas of particle–water interactions in the water column and at the bottom of the ocean, both of which have a significant impact on ocean geochemistry. Reflective of the entire book, Roy-Barman and Jeandel's treatment of particles in the ocean is thorough, but not exhaustive. For example, the compendium edited by Schulz and Zabel (*Marine Geochemistry*, 2006 edition, Springer) is almost entirely devoted to the topic of sediment–water interaction as covered in Roy-Barman and Jeandel's Chapter 9. Where Roy-Barman and Jeandel have succeeded in their book is in presenting enough depth in one topic while still able to cover the wide breadth of related topics, so providing a holistic appreciation of marine geochemistry.

The penultimate Chapter 10 describes global ocean thermohaline circulation, a topic where marine geochemical tracers arguably shine brightest. This is logically followed by scaling up the discussion to planetary changes in the marine environment and climate, from the birth of the planet to the most recent and future changes (Chapter 11). As throughout the book, the authors maintain laudable objectivity in discussion of the future changes in marine systems that are being observed and predicted. Generally, the text can be read in a way suitable for instruction of geochemistry to all oceanographers, and can also be read layers deeper for those students specifically interested in marine geochemistry. For further depth into a particular chapter's topic specialized texts should be consulted.

The disappointment I found to this first edition is the lack of Internet-based support, such as online supporting documents, downloadable images, or other teaching tools. The Internet derives its greatest utility in the storage and access of data that is simply not possible for books to compete with. On the other hand, as a means to understand information, the Internet is, perhaps, a teacher's biggest enemy. Even so, works such as the 6th edition of Talley, Pickard, Emery and Swift's beautiful *Descriptive Physical Oceanography: An Introduction* (2011, Academic Press) has found a way to bridge the book–Internet schism. While Roy-Barman and Jeandel unfortunately did not provide suggestions, there are certainly clear avenues for developing a similar collaboration between *Marine Geochemistry* and the Internet. Teachers should find it easy to pick up topics presented in *Marine Geochemistry* for further Internet-based exploration, especially given abundant access to comprehensive established online data (e.g. WOCE [World Ocean Circulation Experiment]) and the newest biogeochemistry GEOTRACES data, all made available online at the touch of a button and facilitated through visualization programs such as Ocean Data View. In fact, there are many instances where Roy-Barman and Jeandel introduce a topic that is ripe for further classroom investigations. Moreover, the authors have developed real-world problem sets for each chapter (answers are also provided). These problems are often extracted or derived from cited published work, which makes it possible for students to go to the original source to read further. Like Gunter Faure's timeless *Principles of Isotope Geology* (2nd Edition 1986, Wiley), the development of problem sets will certainly be an important facet in the success of *Marine Geochemistry* as an instructional tool.

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1 Roy-Barman M, Jeandel C (2016) Marine Geochemistry: Ocean Circulation, Carbon Cycle, and Climate Change. Oxford University Press, 384 pp ISBN 9780198787495; Hardcover US$98.50, £65.00

THE ROYAL SOCIETY OF CANADA NAMES NEW FELLOWS

Dominique Weis (Department of Earth, Ocean and Atmospheric Sciences, the University of British Columbia, Canada) and **David Graham Pearson** (Department of Earth and Atmospheric Sciences, University of Alberta, Canada) were inducted as Fellows of the Royal Society of Canada at the society's Induction and Awards Ceremony on 18 November 2016 in Kingston, Ontario (Canada).

LEFT TO RIGHT: Graham Pearson; Dominique Weis; Maryse Lassonde, President of the Royal Society of Canada (RSC); and Jamal Deen, President of the Academy of Science of the RSC.

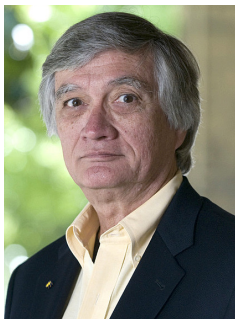
Founded in 1882, the Royal Society of Canada (RSC) is the senior national body grouping distinguished Canadian scholars, artists and scientists. It comprises the Academies of Arts, Humanities, and Sciences of Canada. Its mission is to recognize scholarly research and artistic excellence, to advise governments and organizations, and to promote a culture of knowledge and innovation in Canada and with other national academies around the world. It consists of nearly 2,000 fellows—men and women who are selected by their peers for outstanding contributions in the natural and social sciences, arts, and humanities.

We reproduce Dominque and Graham's respective citations below.

> "Dominique Weis is internationally recognized for her insightful research on the chemical and isotopic composition of Earth's mantle with major impact on our understanding of the world's major large igneous provinces, mantle plumes and arcs, including Kerguelen Archipelago, Hawaiian Islands, and Cascades. Her research has elucidated a crucial relationship between ocean island composition and deep mantle processes. Her work crosses traditional domains of Earth science to encompass pioneering studies tracking the source and fate of metals in the environment."

> "Graham Pearson is a world-leading expert on the origin of deep continental roots and the diamonds they host. His research has transformed our knowledge of how continents form. Pearson's pioneering work on diamonds has revolutionized our understanding of when and where diamonds form and is leading a new paradigm of where Earth's deep water is stored. Graham holds one of Canada's prestigious Canada Excellence Research Chairs."

RODNEY C. EWING ELECTED MEMBER OF THE NATIONAL ACADEMY OF ENGINEERING



In February 2017, the National Academy of Engineering (USA) announced that **Rodney C. Ewing** (founding editor of *Elements* and a professor at Stanford University, USA) was elected as a member to the academy. Election to the National Academy of Engineering (NAE) is among the highest professional distinctions. Academy membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature" and to "the pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education." Rod was elected in recognition for his research on "the long-term behavior of complex ceramic materials to assess their suitability for engineered nuclear waste sequestration." He, along with the other individuals in the newly elected class, will be formally inducted during a ceremony at the NAE's annual meeting in Washington, D.C. in October 2017.

Book Review *Cont'd from page 140*

To date, marine geochemists have likely relied on Chester and Jickells' *Marine Geochemistry* (3rd Edition 2012, Wiley), or Susan Libes' *Introduction to Marine Biogeochemistry* (2nd Edition 2009, Academic Press), or tried to cherry-pick from other marine chemistry, marine geology and isotope texts to make a reasonable supporting text for instruction. While all are benchmark books, each covers slightly different set of topics, and their styles are distinctly different. As a crude generalization, I would estimate that Roy-Barman and Jeandel's book would be more approachable for students than Chester and Jickells, and better for a more advanced student than Libes' text. As a bonus, Roy-Barman and Jeandel's *Marine Geochemistry* also delivers with amusing vignettes and a subtle French undertone that I found très charmant.

In summary, I have name-dropped some definitive texts in this review. *Marine Geochemistry* by Roy-Barman and Jeandel should hold its own among these. This text will certainly become a classroom standard for training new generations of marine geochemists and inspire their amazing research to come.

Brian Haley
Oregon State University, USA