Likens and his students prepared much of the text, with considerable contributions from M. B. Davis and her students and Borman. The crisp, clear text is augmented by numerous excellent figures, tables, and photographs as well as by indexes of taxa, lakes and rivers, and general topics and a thorough set of references.

The book is recommended to ecologists and graduate students engaged in limnological research. It is rich in numbers and is a model of careful data analysis and interpretation. Likens successfully blended many facets of ecology and biogeochemistry and attained his abiding objective, to focus on the ecosystem as a whole.

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## Chemical Oceanography

**Geochemistry of Organic Matter in the Ocean**. EVGENII A. ROMANKEVICH. Springer-Verlag, New York, 1984. xvi, 334 pp., illus. $59. Translated from the Russian edition (1978).

Marine scientists accustomed to searching through dozens of journals and multiauthored volumes for one rare, authoritative summary publication will perk up when they see in print a monograph with this title by one of Russia's most eminent oceanologists. Will the book satisfy the expectations raised by the title? To a great extent, yes. It is a welcome attempt to sum up and put into a global perspective the accumulated results of work on the distribution, composition, and cycling of organic matter in the ocean. The data were gathered over the past 25 years or so and are largely based on the voluminous work done at the P. P. Shirshov Institute of Oceanology of the Academy of Sciences, U.S.S.R. The monograph is worthwhile reading for sedimentologists, geochemists, chemical oceanographers, and generalists of marine science.

The first half of the book deals with the sources of organic carbon in the ocean. It includes a systematic treatment of primary production estimates. Notable here is a discussion of chemosynthetic production, though it does not yet cover the role of mid-ocean ridge ecosystems. It is surprising to learn that marine chemists still do not agree on a global estimate of total dissolved organic carbon in the ocean because methods for measuring such carbon have not been standardized.

The author's treatment of particulate organic carbon generally relies on data from standing stock. Dynamics of organic matter sedimentation includes some data from sediment traps. For all the sections, I find the large data tables particularly informative. At various points it appears that the author thinks that there is a dynamic equilibrium, although not a perfect one, between dissolved and particulate organic carbon, which is ultimately controlled by primary production. The data are vaguely supportive of such a thesis, but a mathematical treatment is lacking.

The highlight of the book is a section on "the absolute masses of organic carbon in the sediments"—in more familiar terms, the flux rates of organic carbon sedimentation. This section is comprehensive and deep. It includes "a concise history of the problem," which I think is intended—rightly—to establish the early leading role of the Russian scientists Arkhangelsky and Strahkov in developing this method for quantifying carbon and sediment accumulation. Romankevich's treatment is intriguing because it seems to skip over the tremendous usefulness of changes in rates of carbon accumulation as a function of climate and productivity (that is, the absolute mass of carbon accumulated during selected time slices for paleoceanographic interpretation). Instead, it favors a more static, long-term, integrative approach aimed at establishing as accurately as possible the size of organic carbon reservoirs in the ocean and sediments. This section also discusses the preservative effect of organic carbon during sedimentation and culminates in a present-day annual organic carbon balance for the ocean that is thorough and appears to be the best available at this time.

There is a transitional chapter on the meaning of nitrogen-to-carbon and phosphorus-to-carbon ratios. Here the status and limitations of the classical geochemical approach are documented. Lack of information on the individual chemical compounds or groups of major nitrogen- and phosphorus-containing organics continues to be a problem. The author hints that the carbon-to-nitrogen ratio of sediments might be inherited from the organics produced at the ocean's surface, which is hard to believe given that the role of preferentially clay-sorbed, nitrogen-rich organic matter is not taken into account. Even the role of inorganic ammonia, which is fixed to certain clay interlayers, is only mentioned in passing.

The second part of the book, which deals with amino acids, carbohydrates, lipids, and humic compounds in the ocean and sediments, would not measure up to the standards and expectations of organic geochemists. It is hardly possible for a single author to complete such a monumental undertaking successfully, for it requires immense diversity and specialization. Romankevich's treatment of these subjects is therefore necessarily at the level of background information.

The final chapter is an excellent summary of the significant conclusions reached throughout the book. It identifies current problems and presents a compartmentalized general cycle of organic matter in the world ocean. Many exchange processes between reservoirs in this super-detailed cycle remain unquantified, but surely this should motivate the curiosity of any worker in the field.

Romankevich has produced an informative book that guides the reader through a tremendously complex subject. Yet the book makes evident that a full explication of the subject would require the efforts of many specialists.

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## Northern Waters

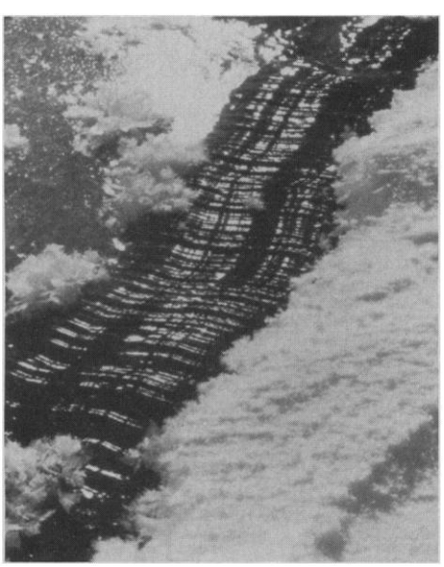
**The Nordic Seas**. BURTON G. HURDLE, Ed. Springer-Verlag, New York, 1986. xiv, 777 pp., illus. $69.50.

"Nordic seas" is a term coined by the authors of the papers in this volume to cover the Norwegian and Greenland seas, the seas around Iceland, and the western Barents Sea. Scientific exploration of these seas began around the turn of the century with the pioneering expeditions of physical oceanographers from Norway, who made measurements of ocean temperature and salinity with standards so close to those of today that their results still remain useful.

*The Nordic Seas* contains ten chapters each reviewing the application to this region of a particular discipline, including climatology, physical oceanography, ice science, marine geology, and marine geophysics. The review approach is especially useful in the cases of marine geology and geophysics, which were the subjects of close study during the 1970's when seismic profiling and refraction, aeromagnetic mapping, and deep-sea drilling produced a particularly thorough set of data on crustal and sedimentary structure. The field studies coincided with a revolution in geological theory wrought by the concepts of plate tectonics, and data were gathered and interpreted in light of that theory. The last two chapters, which make up more than half the book, contain a treatment by Peter Vogt of the results of the field studies of the '70's that will likely be a landmark reference for solid-earth scientists working in this region for many years to come. The chapters

are impressive both for the thoroughness with which the data are covered and for the skill with which they are interpreted. The coverage of magnetism in the region is particularly thorough, the result of a long-term effort by several institutions, primarily the U.S. Naval Research Laboratory. The documentation of the "zebra-stripe" patterns of magnetic anomalies with closely spaced flight profiles should be impressive even to those outside the geophysical community.

The waters of the Nordic seas, their ice cover, and the atmosphere above are the subjects of renewed field investigations either in progress, such as the Marginal Ice Zone Experiment (MIZEX), or planned, such as the Greenland Sea Project. On these subjects the review chapters provide a basis for future research. Several chapters touch on the fascinating question of the importance of this region to global climate. Cold, deep waters formed in these seas flow outward to influence the ocean at locations far from their origin. A systematic description of the water masses and a thoughtful discussion of their formation is given by James Swift. Deep-water formation is important since the ocean, with its high heat capacity, acts as a thermal buffer on climate. We need to know how this deep water is formed and at what rate. The process is particularly difficult to study since it is likely to be highly episodic. As yet, no observation has been made in the Greenland Sea of a water column with uniform properties from top to bottom that would indicate vertical convection, although it has often been speculated that deep convection occurs there.



"Formation of new sea ice in a narrow (3-cm) lead." [Courtesy of Arnold M. Hanson; from *The Nordic Seas*]

The reader interested in obtaining a background on the role played by physical disciplines in the study of the Nordic seas will find this a most useful book. He or she will not, however, find chapters either on marine biology, which is of considerable interest because there are rich fisheries in these seas, or on marine geochemistry, although some of the new results with radioactive tracers are discussed in the chapter by Swift. Finally, the reader will find that the chapters differ in their timeliness, apparently owing to the length of time taken for preparation of the volume. An earlier but virtually identical version of one chapter was published in 1981 as a review article in a scientific journal. At the other extreme, an attempt has been made to bring the collection up to date with an appendix on MIZEX results for 1983–84, although more complete analyses of those data will undoubtedly appear later.

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## An Active Volcano

**Mount Etna**. The Anatomy of a Volcano. D. K. CHESTER, A. M. DUNCAN, J. E. GUEST, and C. R. J. KILBURN. Stanford University Press, Stanford, CA, 1985. viii, 404 pp., illus. $55.

This ambitious book contains a largely successful attempt to synthesize our understanding of Mount Etna, one of the most active and accessible volcanoes in the world. The authors, all from the United Kingdom, represent one of the many research groups involved in long-term study of Etna. The book covers the volcanic and cultural history of the Etna area, the types of volcanic products produced by Etna, the internal anatomy of Etna as determined by geodetic and geophysical study, the petrology of Etna, with an emphasis on magmatic processes, and the hazards of the volcano and the human response to them. The book is profusely illustrated. The line drawings are relevant and well reproduced. The black-and-white photos are relevant but are not all as sharp as one would like.

An interesting and useful history of volcanic activity at Mount Etna and its relationship to the cultural history of Sicily is contained in chapters 1, 2, and 3, which include a useful table of references to early accounts of Etna activity, a table summarizing all historic eruptions of Etna, and a table showing stratigraphic correlations of volcanic activity back to about 300,000 years before the present. Extensive reference is made to a modern geologic map and memoir concerning the geology of Etna prepared by Romulo Romano and colleagues. Etna is in a very complicated tectonic setting, and there is disagreement about the interpretation of the pre-Etnean tectonic history of the region. The authors try to treat all of the alternative hypotheses, with the result that sections on the geologic and tectonic history are confusing and are longer than necessary.

Chapter 4, "Volcanic processes and products," is a good account of the surface volcanic features of Etna. Chapter 6, "Petrology and magmatic processes," goes into too much detail about partially understood petrologic processes. It could more profitably have provided a clear overview of what rock types are present and how they are related to magma chambers and melting zones. The chapter begins with a discussion of isotopic geochemistry, and it is not until a third of the way through the chapter that a table showing the range of major oxide chemistry in the Etnean lava series appears. It was surprising to me that there has been so little emphasis on the study of single eruptions of Etna. Apparently, the 1981 eruption is the first for which a complete set of samples was collected at the different vent

A hornito approximately 6 meters high expelling fragments of lava. When degassing at the vent of a volcano is on a relatively small scale, spatter ramparts build up along the sides of the fissure system and hornitos of various sizes and shapes are commonly formed. Though hornitos typically range up to about 6 meters in height, the two largest hornitos on Etna are each some 30 meters high. Known as the Due Pizzi, they are now slowly being buried by lavas. [Photograph by J. E. Guest; from *Mount Etna*]