# BOOK REVIEWS

BROECKER, W. S. 1974. **Chemical oceanography.** Harcourt, Brace, Jovanovich, Inc., New York. 214 p. $7.95.

In my entire career as an environmental scientist, I have found only three books interesting enough to warrant reading more than once. The first was Elton's *Animal ecology*, which first stimulated my interest in environmental science. The second was volume 1 of Hutchinson's *Treatise on limnology*, which convinced me that limnology was more than just a nice nature hobby. The third is Broecker's little paperback, an elementary textbook.

Texts on environmental science published in the past have always impressed me with the phony way in which biological, chemical, and physical aspects of the ecosystem are dissected apart, then discussed separately as if they were unrelated processes. One never sees the complete ecosystem; while token attention is always paid to holistics, dry, obscure details of ecological trivia occupy 99% of the pages.

Broecker does not make this mistake. He carefully chooses a handful of the most important processes affecting oceanic chemistry, then treats them as they are—without dissecting off relevant physical and biological aspects.

The book is simply written—there is no mathematics for mathematics' sake, as in most chemical and physical textbooks. Differential equations are simply put into words, with the assistance of several well placed and sometimes hilarious analogies. Yet it is not filled with semantic phooey and undefinable concepts like so many of the textbooks that are keeping terrestrial ecology within the realm of soft science.

Limnologists as well as oceanographers should read this book. There are important unwritten messages: while we've been sitting in our leaky rowboats making like Thoreau, chemical oceanographers have quietly and efficiently devised a whole new tool kit based on naturally occurring isotope pairs, allowing them to study processes such as mixing, recent sedimentation, and gas exchange, which we are still inclined to dream about. Many of these techniques have potentially powerful application in freshwater, provided a few assumptions can be tested, but few limnologists have utilized them.

Many terrestrial ecologists and limnologists have been complaining about the large size of their classes in recent years. There is an easy cure for this problem. Hire an oceanographer (even a poor one) who will promise to assign Broecker's text. When students compare its exciting, mystery-novel writing style to the dull scripturelike pedantics of the fodder usually assigned in terrestrial and freshwater classes, the problem will solve itself. We don't want limnology and terrestrial ecology cluttered up with all these bright kids. We must strive to keep our sciences truly immeasurable so that they will continue to seem exciting and marvelous!

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OFFICER, C. B. 1974. **Introduction to theoretical geophysics.** Springer-Verlag, New York, Heidelberg, Berlin. x + 385 p. $19.80.

In his introduction, Officer states his intention to give a coordinated treatment of the whole of theoretical geophysics. One is immediately suspicious of such statements and indeed the reality is short of the goal. Nevertheless, this book is a significant achievement and a valuable addition to the literature. Although fluid mechanics occupies a fair portion of the book, in my opinion this portion would be less than satisfactory as a self-contained text for a short course on geophysical hydrodynamics. In fact, excerpting the book in such a fashion is clearly counter to the author's design. The book is really a survey of applied mathematics illustrated by selected examples from a broad but by no means comprehensive range of geophysics and backed up by short introductions to the physical bases of various disciplines.

Fluid mechanics is covered early and therefore has relatively low sophistication. There are three chapters: the first is a rather straightforward derivation of the equations of motion; the second covers mixing, geostrophic balance, and the Ekman layer; and the third introduces wave motion. All the material is clear, logical, and supplemented by excellent problems. I think the most serious omission is the lack of discussion of the effect of scales of motion on the governing equations. Officer has an obvious and quite reasonable bias against the standard nondimensional number jargon. But it seems to me very useful to show that geostrophic balance follows naturally from slow, large-scale motions, while surface waves are rapid and small scale, and that the Ekman boundary layer is necessitated by the inability of the inviscid geostrophic flow to satisfy the physically necessary boundary conditions. I also miss the Taylor-Proudman theorem in the discussion of geostrophy: there is nothing like Taylor columns to excite students. Most of the chapter on waves is devoted to tides. Being long-surface waves and therefore nondispersive, tides are representative of the simplest sort of wave motion. The interesting aspects of wave propagation: dispersion, group velocity, and

so forth, are covered very well in the context of elastic waves. Short surface waves, internal waves, or planetary waves which could equally well be the vehicle for this material are hardly touched on at all.

Taken as a whole, the book presents a solid foundation for a wide range of geophysics; but it is best in its sections on seismic waves and the traditional solid earth geophysics subjects such as gravity and the figure of the earth. I suspect this book will have wide use as a graduate text in departments where "geophysics" essentially means seismology.

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LORING, D. H., AND D. J. G. NOTA. 1973. **Morphology and sediments of the Gulf of St. Lawrence.** Bull. Fish. Res. Bd. Can. 182. 147 p. + 7 charts. $5.00.

The Gulf of St. Lawrence belongs to a particularly interesting class of large coastal embayments whose geography and geological history are primarily determined by the presence of a major river. It has definite estuarine characteristics; yet because of its considerable size it is an inland sea with a complex system of water masses influenced more by the North Atlantic circulation than by the land drainage. Its location is unique: as a sedimentary basin, it has developed along a major lithological boundary between the Canadian shield (Laurentian region) and the Appalachian province. It so happens that it also stretches over an important and geologically unstable climatic boundary, along what is now the southern limit of the subarctic zone. Consequently, it has borne the full impact of the last glaciation, while at the same time keeping record of the late fluctuations of the ice margin. Under the ice scars, and reshaped into long troughs by the Wisconsin ice-sheets and glaciers, the old Mesozoic drainage is still clearly outlined, indicating the very old origin of this region.

Setting their work against this background, Loring and Nota have given a well balanced and intricate account of the Quaternary evolution of the gulf, integrating new information on its morphology, sedimentology, major element distribution, and depositional history. Before going through the text, one would do well to look at the two large maps which accompany it and nicely bring together the main conclusions reached by the authors. The beautiful bathymetric chart made by the Canadian Hydrographic Service allows one to appreciate at a glance the striking morphology of the sea floor, dominated by the broad U-shaped valleys of the Laurentian Trough system, which are poked with depressions and partly buried under Recent pelites, while the dissected shelves display many features of a well preserved glaciated topography under a mantle of coarse residual deposits. By looking next at the detailed sedimentological map drawn on the same scale, one appreciates fully, as stressed by the authors, how the distribution of the various kinds of surface deposits is intimately determined by the physiography. By controlling the textural properties of the sediments, it in turn ultimately affects the geochemical and mineralogical characteristics of the bottom deposits.

Throughout their study Loring and Nota make much use of textural analysis. This approach is particularly appropriate in an area such as the gulf where marked textural differences exist. It helps to clearly identify the dominant depositional processes on the basis of the contrasting sediment types. There is a wealth of sedimentary facies: modern and relict pelites, residual sands of glaciofluvial origin, reworked tills, glaciomarine sediments, etc. The fairly thick layer of Recent pelites (up to 40 m) in the deeper regions of the Laurentian Trough contrasts with the modest supply of suspended sediments contributed by the actual drainage, emphasizing the importance played by the reworking and winnowing of shelf and slope deposits in modern sedimentation processes.

The information retrieved from the sedimentological data culminates in a careful analysis of the late glacial history of the gulf. The retreat of the ice margin was by no means simple, and several oscillations may have occurred. For a study of this critical period, the upper slope of the Laurentian Trough yields much useful knowledge, particularly the northern edge of the Magdalena shelf which the authors have explored in great detail. Piston cores and seismic profiling have helped to establish the substructure and stratigraphy of vast coalescing fans developed in late Wisconsin times. The presence there of a young till, buried in places under Recent pelites, above a shell horizon which provides one of the few $^{14}C$ dates available in the gulf, supports the occurrence of a glacial readvance sometime after 10,200 years B.P. This correlates well with the post-Champlain St. Narcisse readvance documented elsewhere, and, surprisingly, with a cold phase in northern Europe.

In comparison with regional monographs assembled from the work of many contributors, the organization and presentation of this study are enhanced by the fact that it is the result of the close collaboration of only two authors. Yet it is thorough; the information which it contains has been compiled over a period of 10 years. It is based on a large collection of well distributed sediment samples—some 1,500 of them—including piston cores up to 20 m long, and on many kilometers of echograms and seismic profiling. In analyzing the samples, special techniques were used, in addition to standard laboratory methods, to evaluate for each major element the relative contributions from detrital and nondetrital sources. The numerous charts and diagrams are well drawn and easy to read.