by means of complex interactions. They guide the reader through a plexus of related processes at varying scales that eventually converge to result in a phosphorite deposit. Global oceanic circulation, local tectonism, changing sea level, evolutionary events, calcium and phosphorus enrichment, biochemical (and perhaps inorganic) precipitation, and reworking of initial deposits all play roles leading to final concentrations in generally organic-rich sediments. The contributory processes must act in concert in order for major phosphorite deposits to form, often contemporaneously with records of onshore aridity. Such deposits, as a result, are unevenly distributed in time and space, resulting in phosphogenic episodes and provinces, both in the Proterozoic and Cambrian and also later.

This work is a major and timely resource for students of nonmetallic mineral deposits, mineral economics, and historical geology. It is likely to remain so for decades to come, and one hopes it will soon be joined by the promised three companion volumes.

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Icy Estuaries

Fjords. Processes and Products. JAMES P. M. SYVITSKI, DAVID C. BURRELL, and JENS M. SKEI. Springer-Verlag, New York, 1987. x, 379 pp., illus. $85.

Much has been written about estuaries, but books about "fjords," deep, high-latitude estuaries that have been evacuated or modified by land-based ice, are few. This volume presents an excellent summary of the geological, physical, chemical, and biological aspects of the complex fjord system, as well as demonstrating the interaction of these aspects.

The authors have done their homework, carefully documenting and supporting the information they present. Their 328 pages of text, containing 216 figures and 20 tables, are supported by an additional 38 pages of references, containing more than 1100 citations. As a convenience for readers, four of the book's nine chapters contain summaries of the symbol notation used.

Since I devote most of my time to assessing needs and priorities in several icy-polar disciplines, I was glad to see that the final chapter of the book carefully identifies problems and projects that need to be resolved in fjord oceanography, fjord biogeochemistry, fjord biology, and fjord geology. Suggestions for a methodology and approaches to answering these questions are also presented.

"Characteristic U-shaped profile of McBeth Fiord, Baffin Island." [From *Fjords*]

The authors identify advanced students, research professionals, and environmental scientists in the earth science and oceanographic communities as their intended audience. The book is divided into three parts: an introduction with two chapters that define the fjord environment; a processes and products section that details the fluvial-deltaic environment, circulation and sediment dynamics, subaqueous slope failure, biotic processes, and biogeochemistry; and an implications and applications section that presents case histories of environmental problems caused by various types of pollutants and points to future fjord research needs. The long-standing involvement of each of the authors in fjord studies is evident in the completeness of the presentation. The only aspects of the book with which I find fault are: the very limited mention and attention paid to Southern Hemisphere fjords (of more than 230 fjords presented in the book, only 14 are south of the equator); the failure to include many references to foreign-language sources on Chilean and Argentinian fjords and the fjords of Antarctica, a consequence of not examining the Southern Hemisphere fjords in detail; the omission of any mention of the recent work by Austin Post and Mark Meier on the factors responsible for the advance and catastrophic retreat of tidewater glaciers; and the fact that the authors barely touched on the south-central Alaskan fjords I study.

Despite its few shortcomings, I like this book very much. It nicely blends information from at least ten different disciplines (biogeochemistry, biology, environmental geology, geomorphology, geophysics, geotechnology, glaciology, hydrology, oceanography, sedimentology) into a readable presentation that can serve as both a reference and textbook. There is a place for this book in all earth sciences libraries.

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Wind Processes

Aeolian Geomorphology. WILLIAM G. NICKLING, Ed. Allen and Unwin, Boston, 1986. xx, 311 pp., illus. $39.95. From a symposium, Guelph, Ontario, Canada, Sept. 1986.

The characteristics of aeolian (wind-formed) landscapes and the processes involved in their development have attracted increasing attention in recent years, as a result of the problem of desertification, the recognition that wind action is a significant process on Mars, and the importance of aeolian sandstones as oil and gas reservoirs. The 16 papers in this volume are not, as the editor admits, fully representative of the state of aeolian research today, but they do show clearly the diversity of approaches to aeolian geomorphology and the variety of disciplines involved.

There is a major emphasis in the volume on studies of aeolian processes, especially the mechanisms of sediment transport by the wind. These latter studies are characterized by a rigorous experimental approach and a sound theoretical basis, continuing a tradition established by R. A. Bagnold. Wind tunnel modeling of processes is an

important component of such work, and in his paper Iversen discusses problems of scaling in particle-transport simulations. Despite many years of experimentation, the mechanics of saltation, the process by which most aeolian sand is transported, are still not fully understood. Willetts and Rice consider the effects of grain shape on this process, and Gillette and Stockton describe new instrumentation to measure grain momentum directly. A paper by White indicates how our perception of the fundamentals of aeolian processes can be sharpened by consideration of their operation in different environments and demonstrates in a simulated Venusian atmosphere the importance of spin in saltation paths. Likewise, the field study by McKenna-Neuman and Gilbert provides a new view of aeolian processes in cold climates.

Studies of landforms, especially dunes and their dynamics, are underrepresented in this volume, which reflects the fact that the dynamics of dunes and the controls of dune morphology are the least studied and least understood aspects of aeolian geomorphology. Significant advances in our knowledge will come only after more well-designed and carefully executed field studies have been carried out. In this volume, examples of the kind of work that needs to be undertaken are Livingstone's study of windflow patterns over a Namib linear dune, which indicates the importance of spatial variations in wind velocity in maintaining the form of the dune, and Tsoar and Møller's investigations of the effects of vegetation on linear dune form and orientation relative to the wind.

Modern aeolian sediments and ancient aeolian sandstones are often studied independently of each other. Kocurek, by integrating studies of modern and ancient dunes and their sediments, shows how the deposits of dune plinths, interdune areas, and sand sheets gave rise to the extensive low-angle strata preserved in the rock record. The importance of tectonics in the accumulation of aeolian sediments is often overlooked. Orme and Tchakerian describe how long sequences of Quaternary coastal dunes on the California coast are favored by the presence of subsiding basins.

Although dunes are arguably the most spectacular manifestations of aeolian activity, the importance of dust storms in arid areas is emphasized by Middleton, Goudie, and Wells, who assemble data from meteorological records, satellite images, and deep-sea cores to produce a global picture of the location and sources of major dust storms. Within each source area, however, dust storm frequency is controlled by local surface conditions. Brazel, Nickling, and Lee conclude that, because of its influence on vegetation cover, the amount of winter rainfall in southern Arizona is an important control of dust frequency in Phoenix.

The contents of this volume reveal many of the strengths and weaknesses of current research in aeolian geomorphology. For example, many of the papers reporting field studies lack a significant theoretical background and do not attempt to test hypotheses. This is especially true of the several studies of human impacts on aeolian environments. It is clear that there is a need, as advocated by Greeley in his contribution, to increase interaction between field and laboratory studies of aeolian landforms and processes, to generate models for field testing, and to develop a more rigorous and multidisciplinary approach to field studies of aeolian procesess and landforms.

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