

how one of the men prays to Nature for redemption: "A high cold star on a winter's night is the word he feels she says to him. Thereafter he knows the pathos of his situation."

#### REFERENCES

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ICE IN THE OCEAN. By PETER WADHAMS. Amsterdam: Gordon and Breach Science Publishers, 2000. 351 p., maps, colour and b&w illus., bib., index. Hardbound. US\$67.00, 10% discount when ordered at [www.gbhap.com](http://www.gbhap.com).

Peter Wadhams has produced a well-written, concise monograph on sea ice and icebergs. *Ice in the Ocean*, based on a course that Wadhams taught to final-year geography students at Cambridge, is designed to show "an unashamed bias toward phenomena rather than models" (Preface, p. xi). It covers topics ranging from sea ice to pressure ridge keels, and from ice edge properties to climate change, illustrating each with a wide variety of photographs, images, and figures. Each chapter begins with a personal vignette: for Chapter 3, Thermodynamics of Sea Ice, it is "You are in a Swedish icebreaker entering Independence Fjord, the great ice-choked fjord of Northeast Greenland..." (p. 81); for Chapter 5, Pressure Ridges, "You are in a submarine under the Arctic pack ice..." (p. 140); for Chapter 7, Icebergs, "You are in a sleeping bag in a tent on top of an Antarctic iceberg..." (p. 239). These vignettes illustrate the joys, fears, and difficulties of polar research and make the science more immediate.

The introductory chapter, *Frozen Oceans*, describes the geography of the polar oceanic basins, the ocean currents, and the annual cycles of sea ice extent. It then gives a brief history of polar geographic exploration. The second chapter, *Formation, Growth and Decay of Sea Ice*, discusses the small-scale structure of sea ice, brine pockets, and sea ice desalination. It then describes with many photographs the different stages of sea ice growth and melt, the formation of pressure ridges and very thick ice, and the growth of polynyas. The weakest part of the book is the description

of sea ice microphysics and brine drainage: primarily based on research done in the 1960s, it ignores more modern research, such as John Wettlaufer's theoretical work (1998) and Cole and Shapiro's (1998) beautiful photographs of brine channel networks.

Chapter 3, *Thermodynamics of Sea Ice*, reviews thermodynamic ice properties and summarizes a variety of ice growth models, ranging from Anderson's algebraic degree-day model to the somewhat dated Maykut-Untersteiner numerical model. It also discusses the interaction of ice with solar radiation and the sensitivity of the ice thickness to changes in thermal forcing. Chapter 4, *Ice in Motion*, gives a good term-by-term discussion of the ice momentum balance, followed by discussion of ice drift solutions and the different sea ice rheological models. The material in these two chapters provides the background that readers need to understand the equations used in numerical sea ice models.

Chapters 5, 6, and 7 discuss specific topics: pressure ridges and the ice thickness distribution, the marginal ice zone (MIZ), and icebergs. Whereas the previous two chapters review other people's work, these exceptionally well written chapters reflect Wadhams' own research. Chapter 5, *Pressure Ridges and the Ice Thickness Distribution*, describes different ways of measuring ice thickness, the statistical properties of the ice cover, and the importance of the ice thickness distribution. It also discusses the statistics of pressure ridge keel depths and spacing, as well as the applications of the ice thickness distributions to ice drag and bottom scour. Chapter 6, *The Marginal Ice Zone*, begins with a global survey of MIZ properties. It then discusses how ocean waves are attenuated as they propagate into the pack and their role in determining the floe size distribution. The discussion continues with ice edge bands, ice edge eddies, and the North Atlantic Odden feature, all well illustrated with photographs, field surveys, and satellite imagery.

Chapter 7, *Icebergs*, is the best monograph on icebergs I have ever seen. The chapter begins with the formation of icebergs from the giant ice shelves and continues with discussions of their sizes, shapes, and distribution. Both here and elsewhere, Wadhams presents many intriguing details. For example, he cites observations of 'rogue' icebergs as far south as the Azores (in 1921 and 1948): the southernmost was a poorly documented one at Bermuda. The chapter also describes how icebergs modify the adjacent oceanic waters and their drift and decay. It concludes with discussions of iceberg scour, the climatic role of icebergs, and icebergs as a source of fresh water.

Chapter 8, *Sea Ice, Climate and the Environment*, summarizes a selection of current research topics. These include sea ice and biology, oil pollution, the transport by ice of pollutants such as PCBs and radionuclides, and a thorough discussion of recent climate changes in the Arctic. Finally, the *Further Reading* section is a review of recent literature organized by topics such as sea ice geophysics, ice engineering, and remote sensing. If the book provides the background for a first course in sea ice, this section gives a reading list for a variety of advanced topics.

Problems with the book are as follows: Some of the gray scale photographs and figures (Figures 1.2 and 8.8) are overly dark and have low contrast. Some figures are at such a small scale that they are difficult to read. The Arctic Ocean bathymetry is a contour plot with labeled isobaths, while the corresponding Antarctic bathymetry is a poorly reproduced image, with depths identified by shades of gray. On Figure 1.4, the Yukon River is misidentified as the Yellow. The Arctic sea ice cycle is given twice, once in Figure 1.17 for 1978–88 to show the annual cycle, and again in Figure 8.10 for 1978–96 to show the long-term decrease in ice extent. Also, the analogous long-term Antarctic cycle, which remains constant, is discussed but not shown: thus, the author loses an opportunity to illustrate graphically this curious asymmetry between the hemispheres. In the bibliography, at least one reference (Untersteiner, 1987) is missing. Although annoying, these errors and omissions are minor compared with the overall scope of the book.

The audience for this book includes upper-level undergraduates and graduate students interested in sea ice processes. Other potential readers include researchers in biology, ice engineering, remote sensing, climate, and numerical modeling. If I were traveling to the polar regions, I would certainly carry this book in my duffel.

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**THE PALEO-ESKIMO CULTURES OF GREENLAND: NEW PERSPECTIVES IN GREENLANDIC ARCHAEOLOGY.** Edited by BJARNE GRØNNOW and JOHN PIND. Copenhagen: Danish Polar Center, 1996. Publication No. 1. x + 334 p., maps, b&w illus., bib. Softbound. DKK190 + p&h. Cdn\$35.00.

This collection of papers from a symposium held on 21–24 May 1992 at the Institute of Archaeology and Ethnology, University of Copenhagen, represents the first attempt at a synthesis of Greenland archaeological research covering most of the major geographical regions. As such, it would be a valuable addition to the literature regardless of

its quality: that the submissions are uniformly interesting and individually well presented is a bonus. The book is an indispensable reference, at small cost, to the student of Arctic anthropology, and an interesting read for the arm-chair enthusiast. (To avoid frustration, arm yourself with a Greenland map or atlas before getting too comfortable.)

Contents are divided into sections covering the background (history of research and work currently underway), West Greenland, East and North East Greenland, the Tunit, the Paleo-environment, and Canadian contributions based on what might be described as “nearby and related research.” Here we run into the first minor complaint: the conference sessions were organized one way, the table of contents arranges them in a different order, and the introductory chapter and accompanying map arrange them in yet another.

References are compiled at the end of the volume instead of within each paper, and the publication ends with a useful list of contributors and their addresses. The principal weakness of the work is evident almost immediately: there is a dearth—indeed a total absence in some papers—of maps to place sites and regions in context. A more detailed “setting” map would have been a welcome addition. Even the general map on page 7 lacks an inset of the Canadian Arctic, which would have helped readers to place in context the papers by Helmer, Renouf, and Sutherland, as well as the frequent references to Canadian sites. The profusion of alternative names and spellings of places further exacerbates the map problem. Numerous typos are found throughout the book. However, these few minor issues do little to detract from the wealth of new knowledge provided. Note that we have used spellings as they are found in the volume (e.g., Tunit, Paleo-Eskimo).

The introductory section presents a description of current research into the Paleo-Eskimo cultures of Greenland by Bjarne Grønnow and a somewhat truculent analysis entitled “The Pioneers: The Beginning of Paleo-Eskimo Research in West Greenland,” by Jørgen Meldgaard. Although the memoir is interesting, we wished that Meldgaard had used his encyclopedic knowledge of the region to set the stage for the new constructions that follow.

Eight papers on West Greenland provide a neat picture of the limited situation of Greenland archaeology: the section might better be titled “the south-west coast from Disko Island to Nuuk.” Two papers on “inland” sites located between Nordre Stromfjordi and Søndre Stromfjordi illustrate the limited hinterland in a country covered mainly by an ice cap. The paper by Bjarne Grønnow describing the Saqqaq tool kit from Qeqertasussuk on Disko Island contains exquisite line drawings of a site plan, profile sections, and magnificently informative tools and utensils of stone, wood, antler, ivory, whale bone, baleen, bird bone, and seal bone, as well as several composite tools. The detailed descriptions of the site, tool kit (including useful metric analyses), chronology, and economy are well summarized in the concluding statement: “The Saqqaq people hardly changed their tool kit for