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Book Review
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Glacier Science and Environmental Change, P.G. Knight, ed., 2006, Blackwell Publishing, Malden, Massachusetts, 527 p., USD 249.95, ISBN-13: 978-1-4051-0018-2.

The purpose of this book is to provide a picture of current scientific understanding of key issues that relate the study of glaciers to the broader field of environmental change. To this effect, the editor, Peter Knight, has compiled a collection of 92 chapters divided into five sections, written by a combined 125 authors. Additional color illustrations are available online at www.blackwellpublishing.com/knight. Each section starts with a keynote paper, followed by a series of review papers discussing major themes within each discipline, interspersed with shorter papers presenting more specific case studies. The objective here is not to provide introductory summaries of various subjects, but to provide starting points for further study. This is an appealing change from the standard textbook approach, but at the same time, the wide range of topics covered, plus the seemingly disjointed contributions from the many authors, could leave readers somewhat bewildered as to what the glaciological community considers the main issues to be. In particular, some of the case studies could have been incorporated into either the keynote or review papers, rather than being presented as separate one- or two-page chapters.

The first section—Glaciers and their coupling with hydraulic and sedimentary processes—starts with a keynote introduction by Geoffrey Boulton. The papers in this section primarily focus on such subglacial processes as erosion, sediment transport and deposition, and flow and chemical composition of subglacial meltwater. Clearly, understanding of the genesis of such landform features as hummocky moraine, drumlinoid ridges, and megaflutes is incomplete: John Shaw and several others advocate the dominating role of subglacial water, whereas Douglas Benn and David Evans undertake the task of explaining why the megaflood hypothesis is "unscientific, unnecessary, and inconsistent with the evidence" (p. 42). From a glaciology perspective, this section is the least satisfactory part of the book because it remains unclear how the study of glacial landforms can be applied to reconstructing such paleo-ice sheets and their dynamics as evidence for ice streams or fast glacier flow. Papers in later sections do address this topic to some extent, but it would have been more instructive to provide a discussion here on the relevance of studying modern and past glacial environments for understanding glacier flow and dynamics.

The second section deals with the interactions between glaciers and climate or the atmosphere and oceans. As noted in the keynote introduction by John Andrews, attempting any synthesis of such a large and complex subject is a daunting task. Papers discuss climate interactions on various time scales and highlight the difficulties inherent in establishing cause and effect. For example, as pointed out by Gerard Bond, two opposing explanations for Heinrich events and Dansgaard-Oescher oscillations have been proposed. One view is distinctly glacier-centered and argues that free internal oscillations in the Laurentide Ice Sheet caused recurring armadas of icebergs to be discharged into the Atlantic Ocean. The opposing climate-centered view posits that some as-of-yet unknown climate mechanism resulted in increased iceberg discharges, perhaps through direct forcing of the ice-sheet mass balance or through changes in the deep circulation of the North Atlantic. The chapter by Shawn Marshall provides an excellent overview of the current status of numerical modeling of ice sheets for paleoclimate studies.

Section three—Changing glaciers and their role in earth surface evolution—contains a number of papers discussing how the geomorphological record can be used to reconstruct paleo-ice sheets and their dynamics. This set of chapters could, perhaps, have been better placed in the first section, to make clearer the role of glacial geology in reconstructing glaciers and ice sheets, thereby improving our understanding of their dynamics. Remaining chapters in section three discuss the Antarctic and Greenland ice sheets as well as mountain glaciers in various parts of the world. For the mountain glaciers, geographical emphasis is rather biased toward South America (four chapters). A review of mass-balance trends of mountain glaciers around the world would have been a more valuable contribution than the handful of case studies included in this section.

Section four focuses on glacier dynamics and modeling of glacier flow. Despite more than half a century of experimental and theoretical investigations on flow and deformation of glacier ice, many questions remain and even the applicability of the commonly adopted constitutive relation—Glen's flow law—remains under debate. Clearly, as pointed out by Bryn Hubbard, more quantitative relations need to be supplied by field glaciologists regarding ice deformation and the nature of basal motion. Tools available to glaciologists—interpreted in the broadest sense—are discussed in the last section of the book and include traditional ground-based observations and remote-sensing applications, as well as numerical modeling. In their keynote chapter, Richard Alley and Sridhar Anandakrishnan

argue that our ability to observe is the most important factor in making glaciological progress. The chapter by Jonathan Bamber presents an excellent overview of how remote sensing has revolutionized glaciology and provided unique opportunities for observing glaciers and polar ice sheets. Other chapters in this section discuss advances in subglacial instrumentation, ice-core stratigraphy, and laboratory experiments in glaciology. Some of the chapters on mountain glaciers and glacial sediments and landscapes appear to be somewhat out of place in this section and perhaps should have been included in previous sections.

The collection of papers in this volume represents a challenging smorgasbord of glacier-related research that offers many suggestions for future research directions. The order and grouping of various contributions is not always obvious, and more than a cursory perusal of this volume is needed to fully appreciate the range of glacier science covered. While consolidation into a smaller number of contributions would have made the book more accessible—if only by lowering the rather hefty price—the editor is to be commended for compiling this volume. If one message comes across, it should be that the study of glaciers has become highly interdisciplinary with contributions from many different disciplines that, traditionally, have been more or less isolated. In this respect, it is hoped that this book will contribute to a closer collaboration between scientists from various disciplines and bring together theory and observation to improve understanding of the role of glaciers in environmental change—both in the past and in the future.

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