



## Permafrost Hydrology

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## Book Reviews

**PERMAFROST HYDROLOGY.** By Ming-ko Woo. Heidelberg, Germany: Springer-Verlag, 2012. 575 pp. \$349.00 (hardcover). ISBN: 978-642-23461-3.

As climate change threatens the integrity of permafrost worldwide, studies on permafrost are progressing on multiple fronts. Advancements in measurement technologies have enabled mapping and inferred permafrost coverage at an increasingly high precision and large extent. Research steadily makes encouraging inroads into placing permafrost dynamics in the hydrologic context by quantifying water and energy fluxes associated with freeze and thaw cycles under a changing climate. Amid these advances, plus significant field efforts and theoretical studies in the past half century in characterizing permafrost properties and water movement in permafrost regions, the publication of *PERMAFROST HYDROLOGY* is timely. The book offers an extensive review on the status of permafrost hydrology, focusing on physical processes. Notably, many pages are spent on historical perspectives of the discipline, field observations and temperature measurements in permafrost landscapes in the northern hemisphere, and detailed explanations of basic concepts. The author has succeeded in presenting these materials in an engaging and easy-to-digest manner, which reflects on the author's extensive experience in the field and thorough understanding of the basic fundamentals.

The book is organized into 10 chapters. Chapter 1 introduces the discipline of permafrost hydrology, provides detailed descriptions of definitions and basic concepts associated with permafrost, and gives a concise discussion of permafrost distribution and environmental factors that influence its occurrence. This chapter also introduces readers to the dynamics of temperature and moisture profiles in permafrost, laying the ground nicely for more in-depth presentation in the following chapters.

Chapter 2 focuses on soil moisture and heat distribution and their movement in permafrost regions. Moisture and thermal regimes are fundamental and dictate the physics of permafrost formation, integrity, and degradation. Their fluxes and distributions are often coupled and relate to each other nonlinearly. Quantifying moisture and thermal processes can be daunting mathematically or computationally. The author wisely restricted the presentation largely to simple classic analytical forms that are sufficient for first-order understanding of these processes. This makes the content understandable to readers with varying degrees of quantitative background.

Chapter 3, on groundwater, is informative and the first of its kind in scope. It brings in well-established groundwater flow theory to permafrost studies—a much-needed effort. Permafrost is a critical element in studying surface water and groundwater interactions in cold regions, so combining groundwater and permafrost is in order. The presentation on surface icing features from groundwater discharge is vivid, with field photographs and effective conceptual sketches illustrating the ice-forming mechanism. The presentation on groundwater discharge to streams and rivers is relatively thin,

which could be a reflection of an existing gap in research and in the literature.

Chapter 4, on snow hydrology, is a necessary topic to be covered because permafrost regions are under snow for more than 200 days a year. This chapter presents a synopsis of snow precipitation, snow coverage, snowmelt, runoff, and thermal regimes in snow-packs in permafrost regions.

Chapter 5 is devoted to active layer dynamics, a central element in permafrost hydrology. Here the author connects snow, and the seasonal and inter-annual dynamics of the active layer, by way of water infiltration and heat fluxes across the ground surface. The author shows abundant temperature data in both the snowpack and in the active layer and relates seasonal surface hydrologic features to active layer thickness changes. Also noteworthy is a list of findings on modeling ground thaw and active layer thickness. The reference list offers a comprehensive, if not exhaustive, summary of the state of the art and, at the same time, exposes the limitations of current model capabilities because of their largely one-dimensional nature, and because only conductive heat transfer is considered in most models.

Chapter 6 expands the one-dimensional processes in the vertical direction, discussed in Chapter 5, to lateral directions and includes surface runoff and subsurface flow in watershed slopes. Chapters 7 through 9 examine hydrologic behavior of lakes, wetlands, and rivers in permafrost regions. Finally, in Chapter 10, the author steps back and takes a broad view of water balance at basin scales, with a particularly detailed discussion on stream characteristics and their relation to various elements in a basin.

What stands out about this book? The topical coverage is expansive, which makes the book a valuable resource for holistically studying permafrost hydrology, and it serves as a starting point for people who wish to pursue further research in this area. The degree of detail on each topic varies from basic to intermediate, which makes the book accessible to readers of varying backgrounds or prior knowledge on the subject. The illustrations and photographs are unique. The mostly black and white photographs, reflecting the author's extensive field experience spanning many decades, offer a rare window into these isolated high-latitude and high-altitude landscapes. Many simple sketches illustrating basic concepts are effective and should be appreciated by experts or non-experts alike. Because of the black and white photographs, simple sketches, and some equations not being presented in the most stylish typesetting, I cannot help but be reminded that the book is old fashioned in its presentation. Yet I found the book engaging and informative, and most importantly, the coverage of topics related to permafrost hydrology has an impressive breadth and proper depth. Finally, the author thoughtfully provides a glossary for quick reference for definitions, and he notes the latitude and longitude of photo sites that are remote and may be difficult to locate.

This book could be suitable for upper-level undergraduate students, graduate students, researchers, and practitioners interested in permafrost or cold region earth science in general. The fundamental knowledge conveyed in the book should allow readers to continue into advanced studies on permafrost. One potential short-

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coming, if using it as a textbook, is the lack of exercise problem sets. Another cautionary note is that although modeling is increasingly used in permafrost hydrology studies, this book, in the interest of space, gives it scant treatment. Readers should be alerted that modeling studies that fully couple temperature and water flow deserve more attention in studying permafrost hydrology.

In summary, this is an excellent book on permafrost hydrology. It is impressive for its comprehensive and systematic coverage, and unique for the presentation of field data and explanation of concepts at a proper level. I believe this book will become an invaluable reference for many for years to come.

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SHIPWRECK AT CAPE FLORA: THE EXPEDITIONS OF BENJAMIN LEIGH SMITH, ENGLAND'S FORGOTTEN ARCTIC EXPLORER. By P. J. Capelotti. Calgary, Canada: University of Calgary Press, Northern Lights Series No. 16, 2013. 269 pp. \$39.95 (softcover). ISSN (print): 1701-0004, ISSN (online): 1925-2943; ISBN: 978-1-55238-705-4.

A biography of Benjamin Leigh Smith (1828–1913) is probably about a century overdue. It would never have been an autobiography given his diffidence and his refusal to seek personal publicity for the results of polar expeditions conducted between 1871 and 1882. By the end of his life, his achievements had been almost forgotten and were clearly overshadowed by events at the other end of the Earth from that which attracted him.

Leigh Smith was the eldest son in a large family of dissenters. He nursed an ambition to explore the polar regions that could only be realized with the inheritance of wealth in 1870. That allowed him to support his five expeditions to survey the coasts of Svalbard and Franz Josef Land, particularly the south coast of the latter in 1880. These expeditions were important for more than geographic surveys: they included early oceanographic research on the Arctic Ocean and geological and biologic collections that were returned to London. But his real fame derives from his last expedition in 1881 when his vessel, *Eira*, was wrecked on the south coast of Franz Josef Land, which gives this book its title. Following the wreck, the 25 members of the expedition were forced to overwinter at 80°N. After almost a year, Leigh Smith led the expedition with small boats over ice and open water for six weeks to Novaya Zemlya with no loss of personnel—a voyage comparable to that of Shackleton 30 years later.

SHIPWRECK AT CAPE FLORA treats a fine subject and provides a good biography of Benjamin Leigh Smith, for which the author deserves thanks. It is based on extensive research in published materials, diaries, the private correspondence and archives of the Leigh Smith family, and contacts with the subject's descendants. The text is supported by notes, references, an index, and appendi-

ces. Unfortunately, the book is marred by a few typographic errors (e.g. Smith South for Smith Sound [p. 143] and RSG for RGS [p. 218] and especially by the poor reproduction of many of its figures, including the photograph of its author! However, this is carping criticism of what is truly a good read.

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THE VEGETATION OF ANTARCTICA THROUGH GEOLOGICAL TIME. By David J. Cantrill (Royal Botanic Gardens, Melbourne, Australia) and Imogen Poole (Utrecht University). Cambridge, U.K., and West Nyack, New York: Cambridge University Press, 2012 (U.K.), 2013 (U.S.). 480 pp. £85.00 (U.K.), \$140.00 (U.S.) (hardcover, with numerous illustrations, photos, maps, index, and extensive bibliography). ISBN: 978-0521855983.

My first impression from the title, THE VEGETATION OF ANTARCTICA THROUGH GEOLOGICAL TIME, was that this book would be mainly about paleobotanic studies in Antarctica. I found it to be much more. Both authors have carried out extensive field research in Antarctica. Although much of the discussion is centered on the evolution of vegetation through geologic time, the book also discusses global climates, paleogeography, and geology.

The book is divided into 9 chapters, each followed by several pages of cited references. The first chapter provides a concise history of exploration and summary of the geography and geology of Antarctica. The remaining 8 chapters treat the major episodes in the history of Antarctica from the mid-Paleozoic to present. Each chapter includes wide-ranging topics such as global climate change, atmospheric and oceanic conditions, plate tectonics, local geology, and evolution of plants with maps showing localities and illustrations of plant fossils. Stratigraphic charts compare flora in various southern areas. Tables include lists of species for each geologic period. Interesting case studies are included in some chapters, such as “The relictual Cenozoic flora of Antarctica and Valdivian Model.” The following chapter headings give an idea of the breadth of the topics that are covered: (1) Historical background and geological framework; (2) Early to middle Paleozoic climates and colonization of the land; (3) Collapsing ice sheets and evolving polar forests of the middle to late Paleozoic; (4) Icehouse to hot-house: floral turnover, the Permian–Triassic crisis and Triassic vegetation; (5) Gondwana break-up and landscape change across the Triassic–Jurassic transition and beyond; (6) Fern-conifer dominated Early Cretaceous (Aptian–Albian) ecosystems and the angiosperm invasion; (7) The origin of southern temperate ecosystems; (8) The heat is on: Paleogene floras and the Paleocene–Eocene warm period; and (9) After the heat: late Eocene to Pliocene climatic cooling and modification of the Antarctic vegetation.

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