

SIEGERT MJ, KENNICUTT MC II and BINDSCHADLER RA eds (2011) *Antarctic subglacial aquatic environments*. American Geophysical Union, Washington, DC (Geophysical Monograph Series, vol. 192). 246pp. ISBN: 978-0-875-90482-5, hardback, US\$110/AGU members US\$70.

This book is essentially a conference proceedings arising from the 2010 American Geophysical Union (AGU) Chapman Conference, held to discuss the current status of Antarctic subglacial aquatic environments and future plans to explore these environments. The book has a short preface, 13 main chapters and a comprehensive index. Each contribution considers a different aspect of the Antarctic subglacial environments, with contributions on the following aspects: the identification, location, physiography and hydrology of the subglacial lakes; protocols for environmental stewardship and protection of subglacial lake environments; details of the three major scientific programmes that aim to explore Vostok, Ellsworth and Whillans subglacial lakes over the next 3–5 years; assessment of the technological requirements for exploration programmes; and assessment of our current knowledge and understanding of subglacial lakes as habitats for microbial life and as archives of past climate and ice-sheet change. All contributions are stand-alone, and written in AGU journal format, complete with their own diagrams, tables and reference list. The contributions are extremely well written and illustrated, although the use of colour in the book is variable.

The book is divided into three parts. Part I contains contributions covering the history and background of Antarctic subglacial aquatic environments; part II deals with Vostok Subglacial Lake and the recognition of Antarctic subglacial aquatic environments elsewhere on the continent; and part III contains information about future subglacial lake exploration missions.

Part I comprises three chapters on the broad theme of the history and discovery of Antarctic subglacial lakes. In chapter 1 ('Subglacial aquatic environments: a focus of 21st century Antarctic science'), Kennicutt and Siegert set the scene by outlining recent advances in the study and exploration of Antarctic subglacial environments. In chapter 2 ('The identification and physiographical setting of Antarctic subglacial lakes: an update based on recent discoveries'), Wright and Siegert provide an updated and revised inventory of Antarctic subglacial lakes. Their analysis shows how, as exploration techniques have evolved, the total number of lakes identified has grown from 77 in the original radio-echo sounding studies to 387 in 2011. An updated map of the location of these subglacial lakes is presented, showing neatly how the number of lakes identified has grown steadily as new publications emerged. In chapter 3 ('Antarctic subglacial lake discharges'), Pattyn presents a numerical analysis of how Antarctic subglacial lakes interact with the wider subglacial environment and the subglacial hydrological system. A numerical ice-sheet model is used to investigate how subglacial lakes, and their rapid drainage and discharge fluctuations, might affect ice-sheet behaviour.

Part II comprises five chapters on the broad theme of Lake Vostok and the significance of the subglacial lakes that have been recognized elsewhere on the Antarctic continent. In chapter 4 ('Vostok Subglacial Lake: a review of geophysical data regarding its discovery and topographic setting'), Siegert and others discuss the geophysical data used to identify Vostok Subglacial Lake and the likely physical, chemical and

biological processes that occur in it. In chapter 5 ('Microbial communities in Antarctic subglacial aquatic environments'), Skidmore considers the potential for life, including microbes and viruses, in the Antarctic subglacial environments. The conclusion is that anoxic conditions are likely to prevail, and that our knowledge of the microbial and biogeochemical processes beneath the ice sheet is still in its infancy. In chapter 6 ('Subglacial lake sediments and sedimentary processes: potential archives of ice sheet evolution, past environmental change, and the presence of life'), Bentley reviews the potential of the sediment archives beneath subglacial lakes and their potential as archives for information about past ice-sheet configurations, palaeoenvironmental change and the presence of life. The chapter ends with neat conceptual diagrams of sedimentation in these lakes. In chapter 7 ('The geomorphic signature of massive subglacial floods in Victoria Land, Antarctica'), Marchant and others describe the evidence of channels, potholes and scabland created by former subglacial floods in the Dry Valleys. These authors show neatly how the geomorphology of subglacial meltwater features can be used to study water flow at the base of the modern ice sheet. Finally in this part, in chapter 8 ('Subglacial environments and the search for life beyond the Earth'), Cockell and others demonstrate how Antarctic subglacial environments might be used as analogues for understanding inferred bodies of liquid water on other planetary bodies. Liquid water has been inferred for the ice-covered ocean of the Jovian moon Europa and on the Saturnian moon Enceladus.

Part III comprises five chapters documenting the potential for future subglacial lake exploration. In chapter 9 ('Environmental protection and stewardship of subglacial aquatic environments'), Doran and Vincent review the development of the guiding principles for the exploration and sampling of Antarctic subglacial environments. They explain how the environmental and legislative decisions were made concerning plans to sample Antarctic subglacial lakes. In chapter 10 ('Probe technology for the direct measurement and sampling of Ellsworth Subglacial Lake'), Mowlem and others explain the design of the probe that will be used to explore Ellsworth Subglacial Lake. The design of the probe and the sensors that will be used for water sampling and sediment coring are explained. In chapter 11 ('Vostok Subglacial Lake: details of Russian plans/activities for drilling and sampling'), Lukin and Bulat provide information collected during the Russian Federation national project to drill and sample Vostok Subglacial Lake. Further information on the drilling system and technology for exploring the water column of the lake is provided. In chapter 12 ('Siple Coast subglacial aquatic environments'), Fricker and others give an overview of the Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) project. They provide the background to the project, explain its key scientific objectives and the measurement tools and strategies that will be used in the study. Finally, in chapter 13 ('Ellsworth Subglacial Lake, West Antarctica: a review of its history and recent field campaigns'), Ross and others outline plans to gain access to Ellsworth Subglacial Lake. Geophysical surveys show that the subglacial lake overlies a considerable thickness (>2 m) of sediment, so this lake promises to yield an important sedimentary record.

Although much of the information presented in the book is already published in various journal articles, its strength clearly lies in the synthesis of this information and as a

reference text for all aspects of subglacial aquatic research. I am sure it will appeal to glaciologists as well as geomorphologists, geophysicists, Earth scientists, paleoclimatologists, microbiologists and those interested in life in extreme environments. The sections on exploration technology and sampling design mean that the book will be highly relevant to scientists undertaking direct measurement and sampling

of extreme environments on Earth and elsewhere in the solar system.

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