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Antarctica: Global Science from a Frozen Continent

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Book Reviews

ANTARCTICA: GLOBAL SCIENCE FROM A FROZEN CONTINENT. Edited by David H. W. Walton. Cambridge: Cambridge University Press, 2013. 342 pp. $55.00 (hardcover). ISBN 978-1-107-00392-7.

In 1985 Pergamon Press published a volume on Antarctica, edited by David Walton and Nigel Bonner, in its series entitled "Key Environments." The audience was envisioned to include "academic biologists, environmentalists, conservationists, professional ecologists, some geographers as well as graduate students and informed lay people." In 22 chapters that volume reviewed scientific knowledge of the Antarctic continent and subantarctic islands, and it was accompanied by a chapter on "Conservation and Exploitation." In many respects this new book, published 28 years later, brings those topics up to date and adds reviews on other aspects of Antarctica, such as governance.

Of the 11 chapters, 6 discuss scientific research and our current knowledge of the continent and Southern Ocean; the other 5 discuss the history of the continent, living and working in Antarctica, the role of the Scientific Committee on Antarctic Research (SCAR) in Antarctic research, territorial claims and the Antarctic Treaty, and Antarctica in the global change debate. The audience is again viewed as the scientific community and the informed public, but also those in polar management. It is a timely addition to the literature on Antarctica.

The first chapter is an overview of the discovery of the continent and the growing importance of science. This is set in the context of national and private expeditions, the search for resources, territorial claims, and the advent of the International Geophysical Year (IGY) in 1957–1958, which essentially initiated the era of government-funded scientific research conducted by national programs. The last section of the chapter is an informative review of how Antarctica has moved into the collective consciousness of the public through the arts. A parallel can be drawn with the discovery of the Grand Canyon in the American Southwest by early Spanish explorers, who viewed the canyon as simply an impediment to travel. In time, beginning with artists such as Alfred Bierstadt and Thomas Moran, the canyon has become an icon of the North American landscape.

Antarctica is a unique environment today and is the culmination of a long geologic history. Many of the aspects of the continent that make it so important scientifically are the result of large-scale events and processes operating over millions of years. The second chapter, "A keystone in a changing world," highlights important aspects of that geological history and present-day setting. It touches on the bedrock surface, which over a significant part of the continent is below sea level, and the relatively recent discovery of numerous lakes beneath the ice sheets and the recognition that the bedrock-ice interface is of fundamental importance for the stability of the ice sheet. Antarctica is unusual for the lack of earthquake activity, but has volcanoes including the active Mount Erebus. This volcano was seen in action by Ross in 1842, is known to have been active ever since IGY, and is now one of the best studied and instrumented volcanoes on Earth. Antarctica was the keystone in the former supercontinent of Gondwana, the break-up of which led to the isolation of the continent and its central role in today's oceanic and atmospheric circulation. It is also the setting for the potentially unstable marine ice sheet of West Antarctica. Among the fossil discoveries, the remarkably preserved silicified peats of Permian and Triassic age are unique to science. In a broader context, Antarctica played a central role in the distribution of today's southern hemisphere flora and fauna.

Ice is the defining characteristic of Antarctica, and the third chapter provides an excellent summary of the ice sheets and the annual changes in sea ice extent. The variability of the sea ice and its impact on the atmosphere and oceans is highlighted, as well as the role it plays in oceanic circulation. Of course, the ice sheets themselves are equally critical in those circulation patterns, and particularly in the formation of dense waters that circulate around the globe, linking all the oceans together. There is a full and most informative discussion of ice cores and what their records reveal about atmospheric properties over some 800,000 years. The variations and trends in climate have been derived from these data, and the chapter ends with a discussion of the possibility that Antarctica is the "sleeping giant" of climate.

The linkages between the ice sheets and the overlying atmosphere and surrounding ocean are critical for understanding the global importance of Antarctica. Chapter Four, with its apposite epigraph from Mawson, provides an overview of the factors driving climate on a global scale. This leads into the characteristics that make Antarctica so cold, windy, and dry. The importance of weather forecasting for flights to and from Antarctica is no longer a best guess but is now informed by numerous—for such a challenging environment—automatic weather stations and radiosonde locations. Together with numerical modeling, forecasting has been revolutionized but still not to the extent found elsewhere. Station observations, locally for over 100 years but regionally for about 50 years, have demonstrated significant warming in the Antarctic Peninsula. With the addition of satellite data there are clear indications of warming of West Antarctica.

The oceans around Antarctica described in Chapter Five have been famous for their storminess from the time of Captain Cook in the late 18th century, and anyone who has sailed those seas probably has tales to tell. Beyond the discomfort of the sailor, the Southern Ocean is a major driver of oceanic circulation. The properties of the water masses making up the Southern Ocean are intimately linked to sea ice and ice shelves, and thus to Antarctica and its climate. This chapter ably sets out the basic patterns of water mass formation and the various currents, both surface and at depth, that propagate throughout the world's oceans and play such a significant role globally.

The physical characteristics of the continent and surrounding seas are reflected in the faunal and floral adaptations seen in marine and terrestrial life. Chapter Six on Antarctic biota presents an excellent review of the flora and fauna, with life primarily dependent on the surrounding ocean. Birds and marine mammals are the common image of life around the continent, but this chapter documents the abundance of marine invertebrate life and the growing understanding of how the Antarctic waters may be the point of origin for many lower latitude species, a wholly unexpected discovery.

No summary of Antarctic research would be complete without addressing upper atmosphere physics and chemistry, and astronomy

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(Chapter Seven). Antarctica, in conjunction with the Arctic, offers significant opportunities for studies of Earth's magnetic field and interactions with space. Further, the South Pole offers 24-hour observation year-round for some space research, and 24-hour solar observations during the summer months. The astronomical observatories are an integral part of the global array of telescopes for astronomical investigations. It would be interesting to know whether neutrinos have been observed by the detectors forming the IceCube array at the South Pole.

The remaining chapters deal with a variety of less technical topics, starting with a discussion of some of the limitations surrounding safely working and living in Antarctica (Chapter Eight). The Scientific Committee on Antarctic Research (SCAR), originally established to promote the free exchange of data, has been instrumental in facilitating a variety of international programs that would not have been possible without such an umbrella organization, and this is discussed in Chapter Nine. The BIOMASS program, which addressed the Southern Ocean ecosystem, is a prime example. It led directly to the Convention on the Conservation of Antarctic Marine Living Resources, which established an ecosystem approach to fisheries management. SCAR has had a significant role in advising the Antarctic Treaty on scientific matters, and its role is summarized in this chapter.

The Antarctic Treaty, the governing framework for activities in Antarctica, is the subject of the excellent Chapter Ten. The origins of this treaty go back to times of conflicting territorial claims and the Cold War. It is testament to what can be achieved internationally and has been the model on which other international treaties have been based—for example, the Treaty on Outer Space. The history of the treaty and how, by consensus, it has dealt with potentially intractable problems is illustrated in particular by the issue of mineral resource management. Consensus may have been difficult to achieve, but ultimately it provided a way forward and the Protocol on Environmental Protection, although perhaps not ideal, does establish significant and important constraints on all activities.

The final chapter provides a perspective on Antarctica from a global standpoint, in particular with respect to climate change. Much of this is a review of parts of earlier chapters but does look to the need for scientific research that is placed in a worldwide context in which Antarctica is an integral part and in some respects a dominant part. SCAR has, of course, established mechanisms that foster the integration of Antarctic research into global-scale programs under the auspices of other international scientific bodies concerned with the Earth as a whole.

Each chapter has a list of additional readings for those who wish to delve deeper into a particular topic. Most chapters have occasional typographical errors, and it is possible that an expert might not agree with an occasional statement or emphasis. The illustrations are by and large excellent, but many would have benefitted from annotation or a more explanatory caption, or both. For instance, where is the Astrolabe Glacier, which is illustrated in Figure 3.9? How large or small are the invertebrates illustrated in Figure 6.16? A number of illustrations are so dark it is difficult to see detail (e.g., Figure 7.4). I know where Marguerite Bay is (Figure 11.3), but how many lay people would know? These are relatively minor quibbles but additional information would have enhanced the value of such illustrations.

In a multi-author review volume, it is not unusual for chapters to differ in the amount of detail presented, and which topics within disciplines are emphasized, but overall it is well-balanced. As an example of highly relevant research, given the current concern and debate about climate change, the section in Chapter Three on ice cores is especially informative and important. Another example of the profound global implications of basic research in Antarctica was the discovery of the ozone hole. It demonstrates how human activities in the northern hemisphere have had impacts thousands of miles away, not only in the stratosphere but also in contributing to changes in the marine biota off the Antarctic Peninsula. This volume belongs on the bookshelves of researchers who wish to learn more about Antarctica outside their own disciplines, the lay public interested in the continent as a whole, non-governmental organizations, and the management and support staff for the various national programs. I highly recommend this book.

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