

evidence and topics is on the whole well-balanced. I particularly enjoyed reading about the Late Quaternary history of low latitude lakes, which was dealt with very thoroughly. A similar comment applies to the chapter on volcanic activity. The chapters on isostasy and sea-level change were also written clearly and provide a good introduction to those topics. Chapters 11 and 12 outline the effects of isostatic loading by ice and the record of both isostatic and eustatic sea-level change. The book is concluded with a discussion of the links between Late Quaternary climate change and Milankovitch variations in radiative inputs to the Earth.

One aspect, recurrent through the book, that is a little disappointing is the lack of critical discussion of the chronology of past environmental change. Dating control, combined with stratigraphic considerations, is vital to correlations between sites and to our understanding of the timing and rates at which environmental changes take place. Dawson recognises the importance of geochronology in his introduction, but then states that he has attempted to use the dates that 'are considered the most reliable.' The implication is that debates over timing are not dealt with in detail, a stand that is largely confirmed throughout the book. The stated notion that the conventional radiocarbon timescale does not vary markedly from sidereal years is also an oversimplification, which can lead to significant misinterpretation at times where divergence between the two scales does occur.

The book is well-illustrated with line drawings. These are a strength of the volume, and many have been redrawn from the originals to emphasise key points. There are also 16 black-and-white plates that have been reproduced with variable quality.

In summary, Dawson has produced a useful and very readable undergraduate textbook on Late Quaternary environmental change. The caveat is that the undergraduate reader should be aware that a more critical appraisal of the evidence, and particularly the geochronological data, will require a careful reading of the primary scientific papers on which all textbooks are based. The book certainly provides a good starting point for those interested in the shifting nature of Earth's environment during the last 130,000 or so years. (Julian A. Dowdeswell, Scott Polar Research Institute, University of Cambridge, Lensfield Road, Cambridge CB2 1ER.)

**A HISTORY OF ANTARCTIC SCIENCE.** G.E. Fogg. 1992. Cambridge: Cambridge University Press. xxi + 483 p, illustrated, hard cover. ISBN 0-521-36113-3. £55.00.

This is an excellent historical account very much parallel with the author's previous work, *The explorations of Antarctica: the last unspoilt continent* (1990; London: Cassell; reviewed in *Polar Record* 26 (159): 338). The essential difference is that the new work emphasises the development of scientific knowledge of Antarctica, whereas the former was essentially a geographical history. A quotation from George Sarton at the beginning aptly

summarises the author's perception of the significance of the history of science:

Science must be tempered with humanity, and the best way of doing this is to explain its organic development, and also to show all that was really great, beautiful and noble in these civilizations of old, all that our conceited scientists and inventors have too often forgotten and disdained. We must teach reverence for the past, – not simply for its own sake or because it is still full of treasures, – but for the sake of the present which it will aid us to appreciate, and for the sake of the future in which it will help us to walk with dignity.

After an introductory chapter, the author discusses the southern voyage of Sir Edmond Halley in 1700, which is regarded as the beginning of geophysics. The chapter continues with a description of the scientific aspects of the two early Antarctic navigators, James Cook and Thadeus Bellingshausen. The early sealing industry is mentioned only briefly, which is appropriate, for, although their contributions to geographical exploration were large, not much was contributed to scientific knowledge by sealers. More familiar scientific investigations are described in the following chapter, with the contemporaneous British, French, and American expeditions. The competition and cooperation associated with this period is discussed from the aspects of national interests – a theme that pervades the book, as indeed it pervades science in Antarctica.

The period from the *Challenger* expeditions until about 1925 is covered quite rapidly. Undoubtedly this is a very well-known period, but the scope of its contributions to science may have justified somewhat more detail. Sufficient information is given to allow the reader to follow the development of techniques. This theme is followed in the next chapter with descriptions of improvements in ships, electrical communications, motor vehicles for travel over snow, aircraft, aerial survey, construction techniques, and several other items. The expeditions of Richard E. Byrd are used to provide examples of much of this, but indications of the many contributions of other expeditions are given by the photographs.

The modern period of Antarctic science is regarded as beginning at about the time of the Second World War, and the author again emphasises the influence of politics. The economic (and scientific) importance of the whaling industry is again indicated, but it is unfortunate that the German raiders that destroyed most of the fleet are incorrectly described as submarines. Although overlapping territorial claims to the Antarctic were made during this period, some were of considerably longer standing. Methods to resolve some of these difficulties and the drafting of the Antarctic Treaty are examined. These led to the concept of Antarctica as a 'continent for science.' National Antarctic programmes and the role of the Scientific Committee on Antarctic Research (SCAR) in coordinating their scientific programmes after the International Geophysical Year (1957–1958) are treated with comments on the essential distinction between SCAR and the Treaty. The chapter concludes with pertinent observations about private expeditions of adventurers or those expressing political aspirations; examples are given of some

environmental activist groups.

Subsequent chapters divide on the lines of scientific disciplines; oceanography, geology, glaciology, atmospheric, and biology are treated in order. While a portion of this restates earlier chapters, it is a useful approach as often an understanding of modern science is efficiently derived from an appreciation of its evolution. Particular problems — such as conservation becoming sequestered from biology into politics, the proliferation of redundant national stations on King George Island for political rather than scientific reasons, and several other recent anomalies — are discussed. A quote from Georg von Neumayer addressing the Royal Society in 1898 — ‘Understanding of the importance of Antarctic research requires an unusual amount of knowledge, and not in one branch of science only, but in the whole complex of natural philosophy and natural science’ — is given in a most appropriate note on an indispensable feature of Antarctic science.

The last chapter is a postscript giving the author’s thoughts on current developments. His last sentence, ‘Mankind cannot afford an estrangement of science and politics in Antarctica,’ emphasises a major theme in the history of Antarctic science.

The book is well illustrated throughout, showing much careful pictorial research, past and present. A comprehensive bibliography is a most useful compilation. The index is also comprehensive, but arranged in an unusual manner with some very large headings covering entries that would normally be found independently. The book is a good companion to *The explorations of Antarctica: the last unspoilt continent*. (Robert K. Headland, Scott Polar Research Institute, University of Cambridge, Lensfield Road, Cambridge CB2 1ER.)

#### **POLLUTION OF THE ARCTIC ATMOSPHERE.**

W.T. Sturges (editor). 1991. London and New York: Elsevier Science Publishers. xii + 334 p, diagrams, hard cover. ISBN 1-85166-619-2. £70.00.

In 1956 haze observed in the Arctic indicated that that region was no longer an untouched, non-polluted area. However, it took many more years before it could be confirmed that this haze originated in industrial atmospheric pollutants transported to the Arctic from lower latitudes. Only about 10–15 years ago, several intensive international research campaigns about the Arctic atmosphere were started by circumpolar countries. The effort has considerably increased our knowledge about the sources of Arctic atmospheric pollution and about atmospheric transport mechanisms.

W.T. Sturges invited leading scientists in the field of atmospheric studies to contribute to *Pollution of the Arctic atmosphere*, which gives a survey about our knowledge and the research results obtained thus far. It is a comprehensive examination of our understanding of Arctic meteorology, atmospheric chemistry, and long-range transport to this region. I have been involved in the study of organic atmospheric pollutants in the Arctic for many years. I found the book extremely useful, because it summarises the research results spread over a great number of scientific

articles. Furthermore, it gives an introduction into the climatology and meteorology of the Arctic.

The book is divided into 10 chapters, and starts with a survey about international research policies and co-operation in the Arctic. Chapter 2 is a well-written article by W.E. Raatz, which discusses special meteorological aspects of the Arctic. The next three chapters deal with inorganic pollutants, starting with the analysis and presence of such compounds in snow and ice cores. In addition, a short summary is given about the concentration changes of trace gases trapped in ice. It is followed by a chapter about important industrial source areas for heavy metals and other inorganic pollutants in the Arctic atmosphere, including a description of the physical properties and reaction mechanisms of aerosols in the Arctic regions. Chapter 6, which is about sulphur and nitrogen pollutants, takes us back to the beginning of the studies of Arctic haze, then gives a survey about the atmospheric reactions of such compounds in the Arctic atmosphere, and, finally, summarises the results concerning seasonal changes, spatial distribution, and total fluxes in the Arctic.

Chapter 7, about Arctic ozone chemistry, deals with stratospheric atmospheric aspects and reaction mechanisms. Although it summarises our knowledge up to 1990, it is perhaps the only part of the book that might become outdated relatively soon, due to recent results of the intensified stratospheric ozone measuring campaigns. Chapter 8 is about persistent organic pollutants and pesticides, and includes information on their presence in the Arctic atmosphere, in precipitation, and in the northern freshwater system. Furthermore, it includes a survey about sources, distribution between particles and vapour phase, and deposition mechanisms. This chapter examines the different behaviour of organic and inorganic pollutants in the atmosphere. It also underlines the threat to the Arctic ecosphere caused by persistent organochlorines, due to their efficient long-range transport properties and their bioaccumulation in the food chain.

Chapter 9 discusses the problems originated by human activities in the Arctic, such as oil, natural gas, and mining operations, which led to substantial local atmospheric pollution in Alaska and some regions in western Siberia. It also includes other emissions, such as car traffic and residential heating. The last chapter gives an outlook concerning climate changes related to Arctic aerosol pollution. Unfortunately, it is not followed up by a survey about climate changes caused by radiatively active trace gases in the atmosphere.

In conclusion, this book can be highly recommended both as a text book and a reference about our present knowledge of Arctic atmospheric pollution. The chapters can be read independently, and there is very little overlap of information. The book is generally free of printing errors, and I could not find any seriously weak scientific aspects. The literature cited in most chapters is up-to-date and covers the period up to 1990, the year before the book appeared. However, as so often with books where the chapters were written by different authors, the index is a