

Book reviews

Ice composition and glacier dynamics

RA Souchez and R D Lorrain

Springer Verlag, Berlin, Heidelberg, New York (1991).
207 pages. DM 198. ISBN 3 540 52521 1.

The chemical composition of ice plays an important role in regulating the dynamics of glaciers and ice sheets; at the same time analysis of the ice can help to characterize this behaviour and hence provide an independent test for ice flow models. In this timely book, the authors, who draw on extensive research experience in this field, consider the evidence that can be used to infer aspects of the present and past dynamic behaviour of glaciers, ice caps and ice sheets and also review progress to establish links between ice composition and ice flow.

Divided into two parts, approximately half the book is used to cover the basic principles of the physical and chemical properties and behaviour of the glacier system. The core of the book is contained in the second half which examines the distribution of isotopes and impurities in ice as an indicator of ice flow. This section culminates in a much more detailed appraisal of the role of chemical processes in the behaviour at the basal zone of both land-based glaciers and floating ice shelves. Finally, a brief essay sets the overall perspective for the topic within the framework of global changes.

The first part of the book introduces some important concepts, although the treatment of different aspects is rather uneven — for example the section on ice flow mechanics is remarkably brief considering the title of the book, whereas the section on stable isotope composition is much more detailed, even focusing on individual experiments and specific case studies. Although this technique is used extensively later in the book to elucidate glaciological processes, some of this detailed information can at times rather confuse the argument because the descriptions, whilst quite detailed, are not completely self-contained. In some areas, the treatment of basic nomenclature and principles of the stable isotope fractionation process is rather unclear, consequently the more detailed development of models of e.g. isotope fractionation studies during freezing, based on experiments carried out by the authors will only really be accessible to stable isotope researchers who would, anyway, not require a basic introduction.

The second part of the book starts by reviewing how gas content, stable and radioactive isotopes, and mineral particles can be used to reconstruct the flow pattern and configuration of ice sheets in the past, as well as giving information suitable for testing ice dynamics models of the present-day ice sheets. An intriguing section examines the evidence from ice buried

since the last glacial maximum which helps to reconstruct even the thermal regime of the Pleistocene ice sheet at its maximum extent. Some consideration is given to the related influence of impurities on the flow behaviour of ice, although the results are conflicting due to the interplay between opposing behaviour of soluble and insoluble components.

In some respects all this appears to be mainly setting the scene for perhaps the most important part of the book, which also lies closest to the personal interests of the authors, focusing on the basal zones both of ice caps and icesheets, alpine glaciers, and floating ice shelves. The dynamics at the base of the ice sheets can be elucidated in part from the properties of the basal ice. The book considers evidence from several ice cores that have penetrated both the Greenland and Antarctic ice sheets, supplemented by complementary information from the marginal zones where ablation reveals, at the surface, ice from the basal sequence. The role of co-isotope (^{18}O & D) analysis to characterize basal freezing processes is especially well developed. Further, the role of mineral matter in ion-exchange within the basal ice is considered in relation to the origin of water refreezing at the ice-bed interface — a topic that has been extensively researched by the authors. Related studies on the stable isotope composition of basal ice containing clay and silt aggregates suggest that isotope exchange with hydroxyl-bearing minerals may also be significant, which has important implications for the interpretation of isotope data in the sediment-laden basal ice from deep ice cores.

The contact zone between glaciers and ocean is one of the key areas in relation to the problem of interaction between ice sheets and climate change. A short section is devoted to this topic which helps to whet the appetite but takes little account of recent work.

The book is weighted towards areas of personal interest to the authors, and some aspects of basal processes are treated in fine detail — down to detailed descriptions of specific case studies. In places the book reads like an extended review article in a journal rather than a 'text'. The assumed fluency in terminology would be expected by a specialist reading a review article but might create some difficulties for a reader in an allied discipline or a graduate student trying to understand the broader implications of the topic. Nevertheless, the book fills an important gap in the review literature and will make a useful starting point for researchers seeking to exploit the obvious further potential in this field to provide a more complete understanding of glacier dynamics.

DAVID PEEL

An annotated bibliography of Antarctic invertebrates (terrestrial and freshwater)

William Block

British Antarctic Survey, Natural Environment Research Council, Cambridge (1992).

263 pages. £25. ISBN 0 85665 1486.

This comprehensive bibliography of Antarctic invertebrates covers more than 1100 spp. of terrestrial and freshwater free-living animals plus some ectoparasites from a land mass of 4.5 million square miles defined as the subantarctic, the maritime Antarctic and the continental Antarctic zones.

To put this in perspective, about the same number of species have been recorded from the 4000 hectares of the Moor House National Nature Reserve in Northern England, and at least four times as many from a mere 1500 hectares of Wytham Woods, Oxfordshire.

These 1100 species are recorded in 1430 references arranged alphabetically by author; four fifths of the references relate to work on the subantarctic islands plus South Orkneys and South Shetlands. The records begin with the French Coquille Expedition of 1822–25 and end with late 1990 works.

Each reference has a useful abstract covering the taxonomic group, ecology, physiology and systematics where appropriate. In addition, there are excellent indexes, the first outlining the broad classification used and the remainder listing species within taxa, species in alphabetical order, authors, subjects (very comprehensive) geographical regions; and expeditions, all related to the individual references.

With growing interest in biodiversity, this meticulously executed volume provides an invaluable data base for this fascinating, though greatly impoverished fauna. But in addition, an increasing number of the studies recorded deal with physiological mechanisms which will need to be accessed by a wide group of biologists interested in adaptation to extreme conditions and in ecological processes taking place in simplified communities. They will find themselves well served by this volume.

J.B. WHITTAKER

BAS GEOMAP Series Sheet 2, Aeromagnetic anomaly map of West Antarctica (Weddell Sea sector), 1:2 500 000

Compiled by *M.P. Maslanyj, S.W. Garrett, A.C. Johnson, R.G.B. Renner* and *A.M. Smith*

British Antarctic Survey, Natural Environment Research Council, Cambridge (1991)

37 pages. £15 ISSN 0 951 888 6.

This publication represents a major regional compilation and interpretation of aeromagnetic data covering an area of nearly 2 000 000 km² in west Antarctica. The area of coverage includes the Antarctic Peninsula, Ronne Ice Shelf and Ellsworth Land. It is bounded by the South Shetland Islands, the Whitmore and Thiel Mountains, and Berkner Island. Over 114 000 line-kilometres of total-field aeromagnetic data, with flight-line spacings varying between 15 km and 30 km, were used in the compilation. These data were derived from surveys flown between 1973 and 1987, initially by the British Antarctic Survey (BAS) and subsequently in a joint project between BAS and the United States Antarctic Research Program. The data set represents a very significant and hard-earned contribution to earth science research in the area, particularly considering the navigation technology available during the earlier years of surveying, the limited amount of time available in each field season, and the often inclement weather and geomagnetic conditions.

The rationale behind the research programmes was one of reconnaissance surveys aimed at delineating regional crustal structure as well as areas for future detailed surveys. For this reason, flight-line spacings were 15–20 km in areas of short wavelength anomalies, and 30 km in areas of longer wavelength anomalies such as the Ronne Ice Shelf. Tie lines were flown at up to 150 km spacings. Diurnal variations of the magnetic field were monitored and corrected for, although logistic constraints were such that certain data were acquired in the southern regions during active auroral periods. All profiles were reduced to a common epoch using the International Geomagnetic Reference Field (IGRF) 1985 coefficients. Levelling was achieved by minimizing differences at the intersection of flight- and tie-lines. The reduced profile data were gridded at a coarse interval of 6 km necessitated by the flight line spacings. The data have also been heavily filtered in order to reduce inaccuracies of navigation and altitude control and the problems of noise associated with external field variations. Despite the limitations of grid cell size and filtering, the compiled data fulfil the research objectives of the surveys, providing an excellent map for the delineation of regional crustal structure and a valuable data base for inversion and modelling of specific anomalies. The map is in colour with contours at 50 nT intervals. A monochrome image of the data is included as a figure.

The text is fully balanced, including a comprehensive reference list and chapters covering the data acquisition phase, the tectonic setting of the area, the data processing procedures, a description of the regional magnetic anomalies and the relevant rock magnetic properties. A chapter is devoted to both qualitative and quantitative interpretation which follow well thought out procedures. Selected profiles have been modelled over key features such as the Pacific Margin Anomaly, magnetically anomalous crustal blocks (eg. the Haag Nunataks), and the subglacial basins. Depths

to magnetic basement were derived by applying the Werner deconvolution inversion routine, yielding valuable information on the possible thickness of sedimentary cover. Some of the key insights that have arisen from this study are: the Pacific Margin Anomaly, the dominant feature of the map, is continuous over 2000 km and extends from the Antarctic Peninsula across Thurston Island; it represents a batholith complex with a series of mafic-intermediate intrusions associated with the convergent margin; the crystalline basement of the Haag Nunataks may also lie beneath the Sentinel Range of the Ellsworth-Whitmore mountains and the Ronne Ice Shelf; the Ronne Ice Shelf may be underlain by up to 15 km of sedimentary and metasedimentary rock.

The report, which includes a colour copy of the compiled map at a scale of 1:2 500 000, is a professional, handsome product, with clear figures and a well written text. It is a major contribution to Antarctic earth science research both in terms of improving our knowledge of the geology of the area, and in terms of serving as a valuable base for further interpretation or delineation of future detailed surveys. It sets the pace for extending both regional and detailed aeromagnetic coverage and compilations, ultimately over the whole of the Antarctic continent.

BRANKO CORNER

Arctic ecosystems in a changing climate: an ecophysiological perspective

Edited by *F S Chapin III, R L Jefferies, J F Reynolds, G R Shaver & J Svoboda*

Academic Press, London (1992).

469 pages. £63. ISBN 0 12 168250 1.

Long rumoured to be in the making, this key volume is finally published. With 42 contributors and 21 chapters it is a significant and welcome addition to the bookshelf of polar ecologists.

Since the origin of the book was an NSF funded conference it is perhaps not surprising that 28 of the contributors come from the USA, six from Canada and four from USSR. Only four come from Europe. In terms of geographical coverage the book is largely focused on Alaska and Devon Island, and although Arctic Scandinavia and Siberia are mentioned (especially in the Soviet papers) the volume would suggest that there is little relevant research from these latter areas.

Many might imagine from the title that this volume is devoted entirely to speculation about possible future changes. Do not be misled! Hiding behind the topical title is a range of valuable reviews of Arctic ecology which deserve to be widely used not only by Arctic ecologists but by those from other analogous habitats in the Antarctic and alpine regions. Chapin sets the scene very well in the first chapter, although

his suggestion that ecophysiology has at present reached a plateau and needs a new focus might not be accepted by all. Certainly his clear analysis of how it might play an important role in predicting the effects of climate change could be usefully paraphrased in grant applications!

The volume is organized in four parts— I. The Arctic System, including climate, hydrology, vegetation description, phytogeography and plant succession; II. Carbon Balance, covering the effects of global change at ecosystem, community and species levels, vascular and cryptogamic plants, Arctic tree line; III. Water and Nutrient Balance, including water relations, nutrient pathways and cycling, nitrogen fixation; IV. Interactions, including plant population responses, secondary metabolite production, grazing and modelling. In a final chapter the editors try to draw all the strands together and frame some conclusions.

The book is well edited and remarkably free of mistakes (although cryptogram occurs several times!). A few of the figures were rather poor having been apparently printed from colour originals (e.g. p.15). Some of the halftones, especially in Chapter 4, are really appalling and fail to provide any clear picture of vegetation structure.

The volume is interesting, and stimulating. Not all chapters really address the problems of change induced by global warming, in some cases because the material is descriptive only and in others because the data are inadequate for the purpose. Nevertheless, all the chapters make good reading and many fascinating questions are raised. For instance in Chapter 8 Semikhatova *et al*, looking at photosynthesis and respiration, suggest that the energy costs of acclimation need to be taken into account for carbon balance calculations since such physiological adjustment has a high carbon cost. Do Arctic species have a difference in the molecular structure of the enzyme proteins which is partially responsible for their high respiration rates? Are carotenoids important for photosynthesis support because of low nitrogen limiting chlorophyll production rather than as protective pigments?

In Chapter 9 on growth and phenology Shaver & Kummerow make the telling point that scaling up from species studies to community models is fraught with difficulties, whilst in Chapter 14 Billings and Bledsoe highlight the same scaling problems with nitrogen studies. But, at least in the Arctic, whole-ecosystem experiments are providing data to validate simulation modelling. Equally important for those unfamiliar with the Arctic flora are the data showing that even though present temperatures are sub-optimal for growth increased temperatures may fail to improve growth because of nutrient limitations. In Chapter 7 Oechel & Billings had noted that elevated temperatures would have little effect on soil respiration unless oxygen availability was improved

In their final summary chapter the editors very neatly pull together some of the important conclusions of the earlier chapters. Perhaps the most telling point they make is that understanding and modelling the functioning of ecosystems demands a different approach than previous studies. Longer

time scales, more complex communities for field experiments and the difficult investigation of feedback processes at the community level are important challenges for polar ecologists. This book might not be about the Antarctic but there is a great deal of immediate value in it for Antarctic science.

D.W.H. WALTON

International conference on the role of the polar regions in global change. Proceedings of a conference held June 11–15 1990 at the University of Alaska Fairbanks

Edited by *G. Weller, C.L. Wilson and B.A.B. Severin*
Geophysical Institute, University of Alaska Fairbanks (1991).
2 vols. 778 p. \$45. ISBN 0 915 360 10 1.

There is no lack of talking activity in the global change field but are we moving any further forward? Conferences on global change abound and increasingly, so do their proceedings. This one was clearly focused on the polar regions and brought together over 400 scientists from all disciplines. The editors state in the Preface that “the goal of the conference was to define and summarize the state of knowledge on the role of the polar regions in global change, and to identify gaps in knowledge”. The two volumes contain all the contributions — invited, contributed and poster. Not surprisingly the results are difficult to digest and I am not sure that they altogether meet the conference goal.

The editors and organisers have done their best by dividing over 200 contributions into seven major themes (Detection and monitoring of change; Climate variability and climate forcing; Ocean-sea ice-atmosphere interactions and processes; Effects on biota and biological feedbacks; Ice sheet, glacier and permafrost responses and feedbacks; Palaeoenvironmental studies; Aerosols/trace gases) and by using the output of panel discussions to provide recommendations for the future. Nothing surprising in the recommendations which, in many cases, emphasize themes that have been with us for decades (e.g. cataloguing programmes to identify endangered data sets, foster international co-operation, develop a truly bi-polar approach, encourage students and scientists to be interdisciplinary, etc). No harm in reminding everyone of these but I suppose I had expected less of the motherhood exhortation and rather more gritty and focused recommendations for the polar regions. Tucked away at the back of Volume 2 it will also be easy for the casual reader to miss them altogether.

There are problems with using the volumes. Within each major section the papers did not seem to be ordered in any particular way - perhaps the editors felt this was not possible given the widely disparate nature of the contributions. Whilst

it makes it harder for the reader to find what he is principally interested in, it will have the advantage of making him search through ancillary material he might otherwise have skipped! A second difficulty is the chronic unevenness of the contributions—some are outline research proposals, others a single paragraph which says little more than the title does and others are useful (if abbreviated) summaries of progress in specific fields. I think a more rigorous editorial policy on inclusion would have been helpful in structuring the volumes and removing some of the rather less useful offerings.

Volumes such as these are meant to be ephemeral. They provide a temporary index of interests for the part of the scientific community that attended and an opportunity to focus interests, in this case across disciplines but on the polar regions. For most people there will be only a few contributions of interest, and, although not expensive, I doubt that many individuals will buy copies although libraries should have them. Check the volumes for your area of interest — there is likely to be something of interest. I am sure that the chief value of this conference lay in the discussions between individuals and the initiatives arising from these and not in the published papers. Global change is a big, big subject and perhaps we have yet to find the right formula for drawing the essential strands together at regular intervals. As was apparently said in the panel discussions, perhaps there is too much emphasis on planning and reports and more time needs to go into the science. For that we need a bureaucratic revolution!

D.W.H. WALTON

The ecology of recently-deglaciated terrain. A geocological approach to glacier forelands and primary succession

John A. Matthews

Cambridge Studies in Ecology, Cambridge University Press, Cambridge. 1992

386 pages. £60. ISBN 0 521 36109 5 hardback

Glacier forelands, the terrain exposed by retreating glaciers and other major icefields, afford ecologists and soil scientists with the ideal natural arena to investigate the fundamental process of succession. Although individually small in extent these sites serve as unique field laboratories in which the catena of biological and pedological change can be studied as an interactive ecological continuum. This process commences with the immigration (or survival from an earlier ice-free era) of propagules and the sequence of stages that constitute primary colonization, their establishment as scattered populations, and their subsequent development towards communities through the process of primary and secondary succession. Such recently deglaciated surfaces offer exceptional opportunities for understanding these processes, for developing more general ecological concepts

and for testing hypotheses. The great value of such sites is that the age of the surfaces and the timescale over which ecological change has occurred is often accurately known. Few other natural systems have played such an important role in the development of ecological theory.

John Matthews has devoted a lifetime of research to this very subject and, in doing so, has brought together almost everything there is to know about it in his book. It is the outcome of his 20-year research programme centred on one site, the Jotunheimen area and in particular the Storbreen glacier foreland, in central Norway. The aim of the book, Matthews admits in the Preface is twofold: "first, to review thoroughly and for the first time, available information on the ecology of recently-deglaciated terrain; second, to appraise critically the methodology currently employed in such studies and to contribute to the development of a new approach in this field (the geoecological approach)" "to provide an integrated and interdisciplinary theoretical framework for this research". This treatise certainly achieves its aim, providing an exceptionally comprehensive insight into the subject. The author has thoroughly researched the literature (over 900 references cited), from the earliest to the latest, and given a clear and authoritative insight into this fascinating interpretation of fundamental ecology.

The book is divided into seven chapters. Relevant information has been extracted from countless published and personal works and rearranged according to a logical structure. The author very considerably defines the technical terms and subheadings whenever they are first encountered. The *Introduction* provides the reader with a very brief definition of glacier forelands, primary succession, chronosequences and geoecology. There follows a short chapter on The nature of timescales (glacier variations, dating techniques, terrain age sequences), then two on environmental features: The physical landscape (glaciation, proglacial modification,

climatic environment, spatial variation and change in the landscape) and Soil development. Chapters 5 and 6 concern phytoecology and constitute the bulk of the book. Plant succession: patterns and environmental factors includes vegetational chronosequences, inferred successional trends, spatial variation and successional pathways and environmental controls on successional sequences. Plant succession: processes and models covers biological processes of colonization and succession and the application of models, ranging from those that emphasize the pattern of succession to mechanistic models concerning underlying processes. The final chapter on The ecological significance of recently deglaciated terrain is effectively a discussion and draws attention to weaknesses in previous studies and the areas where there is an urgent need for more detailed or integrated work. Perhaps the author's most pertinent comment is "Despite a relatively long history of investigation, the full potential of glacier forelands for ecological research has yet to be realized". This is certainly the case in the Southern Hemisphere where very little work has been undertaken, notably in South America. Also, there has been remarkably little emphasis on the importance of microbiota and cryptogams in the initiation of primary successions.

This is a monumental effort by John Matthews who has provided a most valuable contribution to successional ecology. It should prove an invaluable mine of information and a reference source to all ecologists interested in colonization and succession processes. It is copiously illustrated, although photographs are few and of rather poor quality. If there is a fault with the book's content, it must be that no consideration has been given to the role of invertebrates or, indeed, to higher fauna in the development of communities and the succession towards climax vegetation. Perhaps the data does not exist, in which case this is another area to which research should be directed.

R.I. LEWIS SMITH