Reviews

POST, A. and E. R. LACHAPELLE. 1999. *Glacier ice. Revised edition*. Seattle, WA, University of Washington Press, in association with International Glaciological Society, Cambridge, England. 144 pp. ISBN 0-295-97910-0, paperback. $27.95.

Years ago, when as a student I became interested in glaciology, my friend Michael Hambrey had this wonderful large book *Glacier ice*, which I envied him. I would leaf through the pages, marvelling at those wonderful ice-scapes, and wonder if I would ever see any those incredible glacial phenomena myself. Unfortunately, by the time I decided to buy my own copy, the book was out of print.

Many of us who are involved in glaciological research are delighted that the IGS has, in collaboration with the authors, Austin Post and Edward R. LaChapelle, and the University of Washington Press, undertaken to publish a revised edition of this classic in glaciological literature.

Glacier ice aims to illustrate the fascinating and large variety of glaciological phenomena for the benefit of both scientists and laypersons. It was conceived after many photo-graphic reconnaissance flights during the 1960s along the north Pacific Coast of North America and the interior ranges of Alaska. As a result, the book lavishly shows almost all phenomena on and around glaciers, with a strong emphasis on North America. It does not attempt a global coverage, although it concludes with a chapter on "Temperate, subpolar and polar glaciers" which involves Greenland and Antarctica. Very few — but interesting — examples are from the Alps, the Himalaya and central Chile.

The stunningly beautiful aerial photographs which Post took with a large-format camera form the book's backbone. All the illustrations are in black and white, which, together with the excellent definition maintained in even the darkest of shadows and brightest of snowfields, lends the book an artistic flavor that has always reminded me of Ansel Adams' work. Terrestrial photos are added where necessary to complement the aerial views; they give a new scale to the pictures taken "from above". Some of the photo sequences are arranged like stories. In particular I like the series showing the gradual development of localized cirque formation via more and more extensive glacial erosion right up to the development of isolated, steep mountain peaks (figs 107–111).

All the pictures are described in brief but highly informative texts which take the reader on a guided tour of glacier formation and mass balance, flow, fluctuations, surges, a multitude of surface features and landforms created by glaciers. The prose is straight to the point and very clear. Despite being familiar with many aspects of glaciology, I was particularly impressed with such diverse sections as the formation of ice cups in firn and the repeated slow advance and fast retreat of actively calving tidewater glaciers.

Having first been published in 1971, has the book dated? Although few changes have been made to the text, several new pictures have been added in this edition to show recent events such as the eruption of glacierized Mount St Helens, Washington, in the chapter "Glaciers, volcanoes, and jökulhlaups", and the dramatic retreat of Columbia Glacier, Alaska, with "before and after" views. Re-reading the text, I was surprised to see how up-to-date it still is. A brief but thoroughly revised bibliography, including some Internet addresses, leads readers to modern sources of glaciological information.

Most probably it was the authors' intent to retain the limited geographic coverage of the original edition. As a European reader I naturally would have liked to see some more Alpine, Scandinavian or even truly tropical glaciers included, but that would perhaps have entailed too much of a change in the style of the book. While I agree with the smaller format than the original, which makes the book more bookshelf-friendly, I miss the original hard cover, which, alas, might have made it too expensive. Modern image-processing techniques could have removed the scratches on some photos from Chile and Antarctica, which clearly were handled by people less expert than Post. Also, I never managed to find the arrow referred to in figure 102.

I find little wrong with the text, and the following minor points do not detract from its overall quality. On page 106, readers might get the impression that water-pocket ruptures are confined to glaciers on volcanoes. Tragic accidents in the Alps have shown that this is not the case. On page 111 is a reference to the no longer generally accepted idea of air cushioning of large landslides. Strangely absent from the chapter "Effects on the landscape" are the many beautiful lakes dammed by terminal moraines, which are such an integral part of beautiful mountain scenery such as that of the Alps or the Rocky Mountains.

Students of glaciology, naturalists and mountain-climbers will find the glossary of glacier terms very useful. Glaciological "novices" will gain immensely from reading *Glacier ice*, and "old hands" will be glad that the book has been resurrected, so we can once more dream about flying over those vast icefields and towering mountain ranges of Alaska and British Columbia.

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VAN DER VEEN, C. J. 1999. *Fundamentals of glacier dynamics*. Rotterdam, A. A. Balkema, x + 462 pp. Hardback edition: ISBN 90-5410-470-8, EUR 74.50/$88.00/£52.00. Student paperback edition: ISBN 90-5410-471-6 EUR 36.00/$42.00/£25.00.

If Paterson's classic text *The physics of glaciers* may be considered a bible of modern glaciology, then this recent book by Kees van der Veen is probably one of the newly unearthed gospels. *Fundamentals of glacier dynamics* preaches the basic mathematical techniques used by scientists in the analysis and understanding of glacier flow. Rather than provide an overview of current research interests, it gives a dedicated account of the nuts and bolts of better-established models and theories, and the rationale behind their interpretation and validation. Accompanying the wealth of mathematical detail is a concise explanation of the underlying assumptions and derivations. Both analytical and numerical solutions are discussed, as well as comparison of results with field data. A textbook with such emphasis on modelling has been long overdue in the glaciology world.

But the book is not just a compendium of models. Van der

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Veen pulls together different themes by his centrepiece — what is known as the force-budget technique. The stresses controlling glacier motion may be separated into their "lithostatic" and "resistive" components, and this enables momentum conservation to be viewed in terms of a balance between terms that represent the effects of gravity, basal traction, lateral drag and longitudinal stress. As argued by Van der Veen, this facilitates a clearer visualization of the workings of the equations than if (perhaps more commonly) the isotropic–deviatoric stress decomposition were used. The author proceeds to demonstrate this in a variety of applications, covering the dynamical aspects of ice-sheet, valley-glacier, ice-shelf and ice-stream flows alike.

Not surprisingly, the structure of the book is straightforward, starting with developing the elementary tools and ending with models of the grand ice sheets of Greenland and Antarctica. Chapter one contains a brisk introduction to ice and climate; here, readers less familiar with the geosciences may find the prose rather dry and unstimulating. But though the book certainly does not open with a bang, it makes up with what follows. Chapters two to four give excellent accounts of the deformation behaviour of ice, the governing equations of glacier flow, and basal sliding. Once the scene is set, chapters five to nine follow through with a competent treatment of various topics in glacier mechanics and thermodynamics, with impressive continuity and coherence. These include laminar flow, flows dominated by longitudinal stresses or lateral drag, temperature control on ice viscosity, parameterization of surface energy balance and mass balance, and so on. Many classical results and some of their more sophisticated counterparts are there, ranging from Vialov's ice-sheet profile, Robin's solution for the temperature distribution in an ice sheet, Weertman's equations for ice-shelf spreading, to the more recent numerical models by Huybrechts and others. Steady-state and time-dependent models are both considered. Particularly valuable are frequent references to the technicalities of numerical solution, although these are limited to finite-difference methods. (The entirety of chapter eight is devoted to these.) Then chapter nine steps back to take a broader look at glacier fluctuations and potential feedback mechanisms in glaciers by invoking low-order models. The final three chapters deal with more specific modelling problems concerning mountain glaciers, Greenland and Antarctica, respectively, each beginning with a succinct summary of the physical characteristics of these ice masses.

A key to the book, and a major difference between it and earlier ones, is the way in which the mathematics is presented. Throughout, the style of writing is somewhat similar to Paterson's, but here the subject matter is tightly focused in order to illustrate the modelling approach. The author discusses the merits and weaknesses of each model at hand, so that the effect of successive refinements or approximations can be well appreciated. The presentation is tailored for course-teaching at graduate level, assuming only a basic background in calculus and differential equations. The book is therefore also much more accessible than the earlier works of Hutter and Lliboutry, and is likely to occupy an important niche in the market. In this introductory textbook, Van der Veen clearly achieves the goals he has set out.

At a deeper level, Van der Veen is also quite successful at getting across the philosophy of mathematical modelling. In isolated places, his writing hints at the endless cycle of iteration between model-building and field measurements, whereby our understanding is advanced. For instance, my favourite passage, found in chapter five, cautions that "there is nothing wrong with developing hypothetical models, but claims that such models apply to actual glaciers or ice sheets, when measurements indicate otherwise, reveal more about the modeller than the model about the glacier" (p. 132). How delightful and appropriate!

Having said many good things, the book is not without blemishes. The competent reader will notice that a large number of equations appearing in the text are plagued by errors. Though many of these are typographical and relatively easy to correct, this is nevertheless a nuisance. Other than that, the text is well illustrated and adequately cross-referenced. If you want to know about things like subglacial till, ice cores or glacial geomorphology, then there are much better places to look. But if your main interest is to acquire the skills to model glacier motion, this book should certainly be high on your shopping list. The more experienced researcher will also find it useful as a reference and teaching aid.

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