

## REVIEW

DREWRY, D. 1986. *Glacial geologic processes*. London, Edward Arnold.

AS ONE of the happy band of practising glacial geomorphologists who periodically undertakes research projects in glaciated areas and also attempts to explain to undergraduates why and how glacial land forms and sediments are and were created, I eagerly delved into this new book by David Drewry seeking better understanding and new lecture notes. There were mixed fortunes, however, because of the various strengths and weaknesses of the book. Drewry gives two main reasons for compiling such a book. One is that a background knowledge of primary physical processes is essential to understand "the geological role of ice"; the second is to bridge the gap between purely glaciological texts and the community of geologists and geomorphologists who deal with the products of ice activity. To achieve these aims, the author has produced a book with 14 chapters, approximately 181 figures, 32 tables, and almost 600 references.

The intention of the first chapter is to provide a brief summary of fundamental ice and glacier physics relevant to appreciating later sections of the book. Topics selected include structure and composition of ice, its deformational behaviour, large-scale dynamics, and thermodynamic processes. Overall, these sections are descriptive rather than discussive and explanatory (a trait which, I am afraid, runs through much of the book); consequently, I doubt whether undergraduates will understand exactly what "sliding" and "lubrication" at the ice-bed interface really mean. Chapter 2 is a balanced presentation on melt water, in which topics include the role of melt water, sources, location and flow, lakes, normal discharge, and catastrophic events (jökulhlaups). Chapters 3-6 deal with various aspects of glacial erosion, a separate chapter being devoted to the three main processes - bedrock failure by crushing and fracture, abrasional wear, and mechanical and chemical erosion by melt water. Although there is a curious mixture of quantitative framework and qualitative description, I found the chapters on bedrock failure and abrasion the most useful in the book. Applying principles of fracture mechanics and tribological and engineering concepts, Drewry has gone some way in helping us understand the real-world mechanisms of bedrock erosion beneath glaciers. For example, experimental work and observations with industrial rock-cutting equipment show that abrasion (e.g. striation) is not a continuously smooth process but comprises jerky steps; examination of glacial striae under high magnification bears this out.

The main processes associated with melt-water erosion are well described in chapter 5, in which mechanisms such as abrasion, cavitation, dissolution, and carbonation as effective agents in bedrock wear are emphasized. The efficacy of such erosion is underplayed, however; for example, one photograph of a relatively small pothole is used as illustration and no reference is made to the giant relict channel systems so abundant in areas formerly covered by ice sheets. Chapter 6, on erosion rates and ranking, occupies only seven pages because, as Drewry so rightly points out, there is a dearth of field data.

Logically, the following three chapters consider mechanisms of debris entrainment, transport, and deposition. Basal entrainment of debris and its arrangement into basal sequences are such important processes in glacial geology that they demand more exhaustive treatment than is given in chapter 7. Compared to the intensive discussion of erosion processes in previous chapters, very scant attention is given to this topic and very few references are cited. The chapter is somewhat descriptive and deals with the subglacial, supra- and englacial entrainment of sediment, and their characteristics. Chapter 8 describes the migration of debris, changes in clast size and shape, and fabric development. A more comprehensive chapter follows on processes of till deposition and re-sedimentation. This relies heavily on key theoretical work by Boulton and Hallet, and on the field observations of Lawson. As with the Boulton-Hallet theories on erosion, Drewry provides an accurate statement of each quite different approach. However, the lack of a personal assessment of the relative merits of the two models, to provide readers such as undergraduates with some help in judging which is more realistic or a more promising platform for further development, is a weakness that also typifies other sections of the book. Chapter 10 is a reasonably balanced treatment of glaci-fluvial processes and sedimentation, and discusses sediment in glacial melt water, transport and discharge, sedimentation in glacier and pro-glacial melt-water channels, facies association, and channel evolution.

The last four chapters deal with topics that are normally considered inadequately in texts on glacial processes. Drewry has logically extended his subject matter to environments contiguous with, but outside, glacier margins to assess glaci-lacustrine, glaci-estuarine and glaci-marine processes, and sedimentation. The themes covered range from physical processes in glacial lakes to sediment involved with ice shelves, sea ice, and icebergs. Since vast marginal zones of Northern Hemisphere ice sheets and of the expanded Patagonian and Antarctic ice sheets during glacial maxima terminated in lakes or shelf seas, understanding modern analogues will help interpretation of former glaci-aquatic sedimentary environments.

This book has gone part way to achieving one of the initial aims - that of providing background knowledge about glacial geological processes. Shortcomings include the reluctance by the author to impart his own viewpoint on controversial issues, the somewhat "thin" treatment of key topics such as debris entrainment, and the complete absence of the current "hot" theme of deformable glacier beds. The second aim of gap-bridging fails because so little attention is given to palaeoenvironments in which the geometry and distribution of land forms and sediments produced by former ice masses can perhaps be better understood with reference to processes discussed in the book. Nevertheless, David Drewry has made a brave and successful attempt to produce a book that is different. Its focus on quantification of some glacial processes and on the value of mechanical and engineering concepts makes it a unique contribution. All who dabble in glacial geology and geomorphology will find it a most useful addition to their reading.

CHALMERS M. CLAPPERTON