

GLACIERS AND LANDSCAPE: A GEOMORPHOLOGICAL APPROACH. By DAVID E. SUGDEN and BRIAN S. JOHN. London: Edward Arnold, 1976. 9¼ x 6¾ inches, soft cover, 376 pages, illustrated. £5.95.

It is perhaps appropriate to have had the opportunity to review this stimulating new approach to glacial geomorphology while virtually sitting along the margins of the Grosser Aletschgletscher and rediscovering the simple fact that most textbooks tend to overidealize and, by careful choice of illustrations, seek to convince the reader that glacier landscapes are overwhelmingly "glaciated". It has been difficult convincing oneself that the spurs above the Rhone Valley near Brig, at an altitude exceeding some 2,300 metres, were part of a glacier landscape!

There is a freshness and spirit about this work, the basic tenets and objectives of which may be paraphrased as follows:

- (a) there may be a need for a more glaciological type of geomorphology and a more geomorphological type of glaciology, yet the gap between the two continues to widen;
- (b) there is a vast amount of new material available from Scandinavia and North America which has yet to be integrated into the main body of glacial geomorphology; much of this relates to the Pleistocene ice sheets and introduces a new dimension into a subject which is still dependent, contrary to general belief, on ideas of Alpine glaciation;
- (c) "scale" is used as a major theme: the most extensive features in space, such as *ice sheets* and *landscapes* have also to be considered on the longest time scales; smaller *valley glaciers* and *landforms* are best considered on shorter time scales;
- (d) the authors present numerous hypotheses and models which, they say, are unlikely to survive prolonged scrutiny, but are used in an attempt to encourage questioning and disbelief;
- (e) glacial geomorphology in the nineteen sixties and early seventies can be categorized as:
 - (i) heavy on chronology, light on studies of process-form relationships;
 - (ii) thin on links between glacial geomorphology and glaciological theory;
 - (iii) thin on the application of polar evidence to glacial problems.

The book attempts to tackle these shortcomings, and the authors have indeed produced a geomorphology text from a geomorphological point of view at a time when

it has become fashionable for geographers to try to turn themselves into glacial geologists, stratigraphers and statisticians, and largely fail as geographers. The layout of the book follows logically from these stated tenets and objectives.

Part I is devoted to glaciers and glacier dynamics; Part II to glaciers, their distribution in space and time; Part III to the erosional processes and effects of glaciers; and Part IV to the depositional processes and effects of glaciers. Part V provides special treatment for meltwater, its processes and effects, as a glacier subsystem.

This overall rationale has been needed for a long time and the authors have produced a *tour de force* in logic, clear discussion and geographical expertise. The glaciological chapters are quite sophisticated, up-to-date on current research, and are very well linked to — and in fact are an integral part of — geomorphology. In this respect, the authors have succeeded in one of their main aims: the production of a more glaciological type of geomorphology. This to the present reviewer's mind represents one of the three great achievements of the book. Another is the authors' successful use of simple models to illustrate complicated topics or to raise questions of gaps in knowledge. The third, and perhaps the most important contribution, is the presentation of their concepts of landscapes of glacial erosion and deposition in Chapters 10 and 13.

The criticism that follows reflects, perhaps, the reviewer's own special interests. It is, nevertheless, expressed as an obligation to the challenge for greater effort and new research approaches that the authors propound.

On page 147, the authors make the surprisingly unqualified statement that "ice sheet growth must be the result of excessive precipitation, and the failure of the glacier system to achieve adequate throughput". If "precipitation" were to be replaced by "accumulation", this important sentence would be less misleading. Perhaps some discussion on the higher precipitation — lower temperature conundrum — would have been in order?

On the previous page appears the comment: "Hence it may seem foolish to attempt to create a model for ice sheet growth and decay". It is hard to resist observing that this is entirely out-of-phase with the authors' admirable philosophy of using simple models to generate discussion which, in turn, should result in rejection of the original models and their replacement by newer ones, presumably more closely approximating to the truth, or reality.

Chapter 9 quietly omits any rigorous discussion of cirque formation, leaving the reader to the implied assumption that cirque form derives from glacial abrasion, with periglacial processes operating on the upper cirque walls. When the discussion of freeze-thaw beneath a glacier, on page 160, and the absence of commentary on that time-honoured and tattered hypothesis of nivation, are added to that of the cirque controversy, or lack of it, the outstanding but largely unpublished work of W. B. R. Battle reappears to haunt us. Can it be that these questions are still unsettled?

As stated previously, Chapter 10 (together with Chapter 13) is the highlight of the book. It provides a very concise summation of the authors' attempt to bring order out of the chaos that preceded them, but in it they assume that the continental margins have been glacierized, e.g., all of Greenland, northeastern North America, and northwestern Europe, without mentioning the nunatak hypothesis. Is it possible that so many of us have been working in vain? The implicit assumption that the extreme northwestern Queen Elizabeth Islands have been glacierized, citing only Blake's work of 1970¹ on glaciostatic response in support, and ignoring the crustal flexural parameter factor, is taking conciseness too far. This chapter could have been lengthened profitably by a discussion of these and other points.

Chapter 11 contains interesting sections on melt-out till and supra-glacial flowage, but may be criticized for having too much of certain works of Boulton^{2,3,4,5} and too little straight description of areas of ablation till. And one's pleasure at seeing mention of Carruthers⁶ and the undermelt theory is somewhat dampened by all the credit being given to Boulton for the warning that each till sheet, separated by fluvioglacial material, should not be interpreted as evidence for a separate glacier advance. This reviewer does not wish to appear to be slighting the valuable work by Dr. Boulton, but the warning really epitomizes the intent of Carruthers. Having witnessed, as an undergraduate, the shocked reception that the undermelt theory received from the "establishment" of the time, he feels that some substantial credit is surely due.

While Part IV, dealing with meltwater as a glacial subsystem, is very successful, it also has several disappointing omissions. There is no adequate discussion of the truly massive breakthrough made by Mannerfelt⁷ in his interpretation and usage of glacial drainage channels. He not only emphasised the role of meltwater but showed how to reason that large ice sheets can be proven to have been

climatically dead; how to identify locations of final wasting ice sheet remnants, and even attempted, although probably too optimistically, to calculate annual rates of surface lowering. This not only revitalized Scandinavian glacial geomorphology (with obvious influence from Ahlmann and others) but, with suitable delay and decorum, provided the springboard for smashing the insular and inaccurate rigidity of British glacial geomorphology, and captured the attention of the New World where, at that time *Geografisker Annaler* was scarcely known. One final point in this vein is a statement of regret at the authors' decision *not* to include *proglacial* landscapes, especially since the great Icelandic (and other active and fossil) sandar are the ultimate in terms of glacier system output. The excuse that proglacial forms have been dealt with extensively by Church,⁸ Hjulström⁹ and Mickelson¹⁰ is not enough. These three papers are not particularly accessible, especially to the student, but, more seriously, the omission leaves the book incomplete. Much of the book is extremely concise, and several sections of it could have benefited from fuller treatment. Was this a constraint imposed by the publisher, or an exercise in that great virtue, precision?

The book contains an unusually large number of excellent and highly relevant illustrations. Line drawings and photographs (except 10.1) are a joy and the general feel of the book is superb. Very extensive and varied use of references from many parts of the world bears witness to the authors' mammoth accomplishment in actual reading, and provides the user with a vital tool for further study. Some minor printing errors mar a near-perfect effort, and the privilege of having read some of the page proofs prompts the perhaps ungentlemanly placing of the blame on the publisher. One can only hope that a second edition, surely due soon — since this is the most important text on glacial geomorphology — will be longer.

Jack D. Ives.

REFERENCES

- ¹Blake, W., Jr. 1970. Studies of glacial history in Arctic Canada: pumice, radiocarbon dates, and differential postglacial uplift in the eastern Queen Elizabeth Islands. *Canadian Journal of Earth Sciences*, 7(2):634-64.
- ²Boulton, G. S., 1968. Flow tills and related deposits on some Vestspitzbergen glaciers. *Journal of Glaciology*, 7(51):391-412.
- ³_____ 1971. Till genesis and fabric in Svalbard, Spitzbergen. In: Goldthwait, R. P. (ed.), *Till: a symposium*, Columbus: