

## REVIEWS

DAVID E. SUGDEN and BRIAN S. JOHN. *Glaciers and landscape: a geomorphological approach*. London, Edward Arnold, 1976. viii, 376 p. £12.00 (cloth), £5.95 (paper).

At the turn of the century, it was usual for scientists engaged in glacier studies to be divided into supporters of the geographical method, who first discovered the extent and distribution of landforms, and the supporters of a dynamical approach, who, starting with an analysis of processes and with glaciation proper (physics, physical chemistry of ice, etc.), determined the characteristic features of glacial erosion, without connecting them *a priori* to the resulting landforms.

Since then these points of view have often approached each other, nevertheless syntheses have been rare. The monograph by Sugden and John, which is written from the perspective of a dynamical geomorphology treated from a geographical point of view, is therefore particularly welcome. In their introduction the authors indicate that the content of their work reflects both their interests and their experience. They treat present and past glacierization and, referring continually to glaciological facts and to the abundant literature devoted to them, succeed in a brilliant synthesis reviewing (for we are dealing with a treatise) all the major problems of the development of a landscape by glaciers. Their work constitutes an original and very useful "Summa" since it is true that the development of the sciences related to glaciology have, in the course of the last three decades, produced a mass of observations, measurements and theoretical studies, and that syntheses of these have been lacking. The resources made available since the International Geophysical Year (1957) have allowed an almost complete revision of our understanding in this area, and this leads us to reconsider the essentials of our understanding of glacial geomorphology. We must be grateful to the authors for having retained throughout their treatise a proper regard for what glaciological facts have to tell us of morphological significance.

As it stands, the 376 p. work is a successful book. Pleasant to handle and consult, abundantly illustrated (238 photographs and line blocks), endowed with a very useful index, it consists of five parts: "Glaciers and glacier dynamics"; "Glacier distribution in space and time"; "Glacial erosion and its effects"; "Glacial deposition and its effects"; "Meltwater: a glacial subsystem".

In the first part the authors are concerned with the tool (the glacier), with the problems of glacier dynamics, with the properties of ice, with the movement of ice as related to glacial systems of interest, with the interaction between these different factors and the surface forms, that is to say with the morphology of the glaciers themselves. (A typographical error occurs on p. 23: in the formula for the shear stress, the symbol  $\alpha$  for the surface slope has been omitted.) Readers will appreciate the clarity of their descriptions, the interrelation between illustrations and text, the important didactic effort undertaken in order to dispense with the complexity of the data provided by ice physicists, retaining only the essentials needed for the geomorphology.

The second part of the book is devoted to the spatial distribution of glaciers (temperate glaciers and cold glaciers) and to their evolution with time (Quaternary glaciations and contemporary glaciations). In the first chapter, devoted to the spatial distribution of glaciers on the Earth's surface, the idea is introduced of the response time (p. 97) by which the glacier, as a function of its mass and dimensions, responds to climatic variations with delays varying from one year to several millennia. I am not as sure as are the authors that this idea, which is so useful in discussing cold glaciers (where the plastic deformation of ice is of paramount importance), can always be successfully applied to temperate glaciers. In effect, for the latter, below the firn line, where the climatic conditions are those appropriate for conditioning

the evolution of a single outflow, the phenomenon of *sliding* which doubles the flow of the mass due to plasticity, introduces a series of variables (generally connected with the subglacial hydrology and also the local altitudinal climatic situation) of which the consequences often make useless and vain the search for a response time. The problem is one of particular difficulty for glaciers which have a long tongue with a small surface slope partly below the equilibrium line. The evolution of glacierization with time is the object of two interesting chapters, especially from my geomorphological viewpoint, concerned with long-period fluctuations and ancient glaciations (the Gondwana ice sheet).

Parts 3 and 4 of the work are devoted to glacial erosion and deposition. In their introduction the authors have justified the artificial nature of the separate study of these two often contemporaneous phenomena by their desire the better to understand the main features of glacial erosion. One cannot blame them for this, even though it is essential constantly to remember the interactions between these phenomena. Each part contains, as an introduction, a study of the fundamental phenomena of erosion or of accumulation, the other chapters being centred on the relations that exist between the processes and the landforms we encounter in the field, a geographical approach *par excellence*. The landforms are studied separately from the landscapes in accordance with the master plan of Sugden and John: respect for the notion of scale which gives its true dimension to the geomorphological method.

When considering the work of glacial erosion, the authors have used the large amount of information resulting from the establishment and maintenance of subglacial sites made accessible by the operations of the large hydroelectric companies. Particularly memorable are the pages treating the movement of debris at the glacier bed and the problem of erosion as determined by the different glacial regimes encountered.

The study of the landforms and landscapes resulting from erosion seems to me more conventional. At this level of the text one re-encounters the more classical descriptions of traditional geomorphology. Even though they are more conventional these seem to me just as important, since these chapters are the logical conclusion of those devoted to the study of processes. In the chapters dealing with accumulation, the observations are, in comparison, more original. In addition to the study of depositional processes, I was particularly interested by the typology of moraines and by the zonation of landscapes resulting from glacial deposition.

Sugden and John have devoted a complete part of their work (the fifth) to subglacial water. This is not at all undue. Considering melt water as one of the essential agents of glacial erosion, they have "stuck" to the reality of the following facts: water, particularly in connection with temperate glaciers, plays an important role in the life of a glacier; it is of prime importance when dealing with geomorphological problems. Water is a fundamental element in glacial erosion: there was therefore some danger (to the methodological plan) in leaving this chapter about water out of that part of the work dealing with erosion. . . . Furthermore these latter pages are devoted to glaciofluvial deposits, the majority of which were built up around the periphery of the glacier and not within the glacierized perimeter proper. A delicate problem of planning arose. Despite the reservations above, I approve the subdivision of the text chosen by the authors in that it allows accent to be placed on one of the fundamental processes of glacial erosion (in the wide sense): subglacial streams of melt water (which are distinguished by the water temperature, the sediment load, the extraordinary velocities acquired, thanks to the overburden pressure).

We see therefore that there is in David Sugden and Brian John's book, material for discussion, for reflection, also for questions. The work is well documented and very informative. . . . But to be briefly more critical: why hardly any reference to rock glaciers? Why not more insistence on the morphological effects of glacial catastrophes and in particular ice falls? The style the authors chose for the book explains why they did not want to be exhaustive and complete on all subjects. They made their choice, and we should be grateful to them for

their efforts! The many references they make to diverse authors are a valuable aid and demonstrate their erudition: they have put at the disposal of geomorphologists a large part of recently acquired glaciological knowledge.

*Glaciers and landscape* by Sugden and John? A good synthesis and recommended reading!

ROBERT VIVIAN

GEOFFREY S. HOPE *and others, ed.* *The equatorial glaciers of New Guinea. Results of the 1971–1973 Australian universities' expeditions to Irian Jaya: survey, glaciology, meteorology, biology and palaeoenvironments*, edited by Geoffrey S. Hope, James A. Peterson, Uwe Radok, Ian Allison. Rotterdam, A. A. Balkema, 1976. xii, 244 p. Guilders 39.50.

DURING December 1971–March 1972; and January–February 1973 the Australian universities mounted two multidisciplinary expeditions to the Jaya (Carstenz) mountains of Irian Jaya in western New Guinea. The massif, which rises to 4 884 m, is the only area with ice fields in South-East Asia.

This book presents the scientific results of these investigations. Following a preface by U. Radok, there are 11 chapters and an index covering the general characteristics of the area and its exploration, topographic survey and mapping, glaciology, climate, cryobiology, limnology, vegetation, palaeoenvironmental history, fauna, and human occupation and usage of the area. The most detailed contributions, which reflect the primary goals of the expedition, are the two chapters on the extent and recent history of ice areas and glacier dynamics (I. Allison and J. A. Peterson) and those on climate and microclimate (I. Allison and J. Bennett), vegetation (G. S. Hope) and palaeoenvironments (G. S. Hope and J. A. Peterson).

The principal glaciological findings can be briefly summarized. The ice bodies, with a total area of about 7 km<sup>2</sup>, have been undergoing progressive retreat over the last 100 years or so. Model calculations suggest that this is due primarily to a warming of 0.6 deg per century. Ablation on the Carstenz and Meren Glaciers at the present time may be significantly influenced by the occurrence of black cryoalgae colonies. During the last glacial maximum about 20 000–17 000 B.P. the icefields covered approximately 900 km<sup>2</sup>. The mass-balance data may be rather biased since 1972 was an atypically dry year. Nevertheless, the climatic data make a useful contribution to our knowledge of the New Guinea mountain environment.

The contributions are well written and edited with very few typographic errors. The findings are fully documented and illustrated by 31 figures, 45 photographs and numerous tables. Three fold-out maps in an end-pocket show the general area on a scale of 1 : 250 000, delimiting ice bodies and the extent of the last major glaciation; the Carstenz area (1 : 20 000) based on survey and aerial photogrammetry; and an overlay for the latter showing ice front locations for 1913 to 1974. These maps bear the reference "Gunung Es" originally proposed for the book. The cross-section in figure 9.3 lacks a scale and some locations referred to in the text or figure captions could be more readily identified if symbols had been superimposed on the plates.

The results make a major contribution to our understanding of low-latitude ice bodies and their history. At present prices the volume is good value. It is a worthy tribute to those involved in its compilation and to the sponsors of the expeditions.

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