

unfortunate if, for this reason, glaciologists and other geophysicists should not read the book, for it is indeed a most stimulating one.

Dr. Hapgood and Mr. Pauly both have geophysical axes to grind, being anxious to convince their readers of the truth of their ideas: Dr. A. E. Scheidegger, whose *Principles of geodynamics* (Berlin, Springer Verlag, 1958) has also appeared recently, has played the advocate in the past but now claims to have reached a state of geophysical agnosticism. His book is a most valuable compilation of the various theories of the dynamics of the Earth, with particular emphasis on those relating to orogenesis.

The book begins with a strictly factual, though necessarily very brief, account of the physiography of the Earth, and continues with another short chapter on the geophysical data of seismology, gravity measurements, etc. The third chapter is on the flow and fracture of matter in general and the Earth in particular, and emphasizes our ignorance of the exact rheological behaviour of the Earth. The core of the book consists of three chapters on the Earth's Rotation, Continents and Oceans, and Orogeneses, in which the author substantiates his claim of agnosticism by presenting a number of geodynamic theories and finding at least one serious objection to each of them. Finally, the dynamics of faulting, folding and other smaller-scale phenomena are considered, including the post-glacial uplift of Fennoscandia.

The problem of polar wandering is treated in this book only from the point of view of movements of the Earth as a whole: rapid relative movements of lithosphere and mantle as envisaged by Hapgood and Pauly are not even considered. It seems that a rate of polar wander but little greater than that indicated by rock magnetism is geodynamically permissible. As for continental drift, which, strangely enough, Hapgood dismisses as impossible, Scheidegger finds this the least unsatisfactory of the many theories of orogenesis which he considers.

Dr. Scheidegger's book is a valuable addition to geophysical literature. It is well presented and printed, and a pleasure to read, and one cannot but hope that his next book may be an advance from agnosticism to a geophysical faith, based perhaps on his own contributions to the science, which will prove more viable than those he reviews.

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REFERENCES

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REVIEW

THE QUATERNARY ERA.* J. K. CHARLESWORTH. London, Arnold.

The word "masterpiece" is often misused and it may seem rather odd to apply it to a publication which is by its very nature based almost wholly on the work of others, yet it seems a highly appropriate term for these two volumes. In scientific publications there is an increasing gap between the one-man text-book and the comprehensive summary of a major field of knowledge carried out as a team project. Professor Charlesworth has attempted and brilliantly achieved a task on the latter scale by a magnificent personal effort spread over 35 years.

The first volume is in two parts. Part I, Glaciology, deals principally with 'Land Ice', but with a valuable section covering the increasingly topical 'Sea Ice'. Snow and its dis-

* A short notice of this work appeared in *Ice*, No. 2, July 1958, p. 10-11.

tribution, the Form and Structure of Glaciers and Ablation Effects occupy the first three chapters. Such intriguingly difficult topics as snow line controls and basal melting of ice sheets are neatly handled. The thickness of existing ice sheets and the configuration of their floors are well covered, full use being made of the latest available data from Greenland and Antarctica. In the classification of forms of land ice there is a refreshing absence of dogmatism.

In chapters dealing with ice motion and glacial oscillation the vast mass of documentary material from Central Europe is adequately summarized in English for the first time; and how extremely enlightening it is, both from a historical and a research point of view.

Part II, entitled *Glacial Geology*, is divided into three sections: *Glacial Erosion*, *Glacial Deposition* and *Periglacial Processes*. This part is of the highest interest and value to the student of land forms, and should be available for reference to all students of geomorphology.

With the skill and finesse of a senior judge rather than an advocate, the author leads the reader through the historical morass of glacial erosion controversies. A wealth of information is compressed into 17 lines under the heading of "*Mechanics of Glacial Plucking*" (page 251).

The subject of the major erosional activities of ice is dealt with according to the forms that are produced—rock basins, cirques, "U"-valleys, fiords, etc., an arrangement which tends towards the artificial separation of what is a series of merging forms. This disadvantage is outweighed by the ease with which the text can be used as a reference encyclopaedia.

In the periglacial section the lucid accounts of loess, and of permafrost processes find a rather unexpected bed-fellow in the "*Geological action of sea ice*".

In the chapter dealing with *Glacial Deposition* there is an enormous array of factual data in which, nevertheless, critical assessments are smoothly incorporated. The treatment of push moraines is particularly noteworthy.

Volume II comprises Part III, *The Quaternary Era*, which is also the title of the whole work. It is impossible in a short space to give any idea of the scope of this the largest section of the author's treatise. There are so many facets that arrangement of this part must have been a prolonged anxiety.

It begins and ends with a discussion of facts bearing on the cause of the glacial period. Volcanic and tectonic aspects come in the beginning. Here the positively exciting phenomena of major changes due to Pleistocene crustal deformation are admirably portrayed, while at the end of the chapter the geophysical, atmospheric, planetary and cosmic hypotheses are reviewed in the search for the as yet unknown cause.

The sequence and correlation of Pleistocene changes on the earth's surface, and of its flora and fauna, involve the use of a wide range of highly specialized techniques, largely not available to students of earlier geological periods. Such studies form the foundation of a great variety of fields of scientific research—the swing of climatic belts, migration of plants and animals, man's response to changing environment and major movements of the strand, build up a fascinating kaleidoscope of change.

The enormous range of sources of information drawn upon is indicated by the list of over 200 periodicals included in the author's list of abbreviations.

There are 326 text figures, 32 plates and 96 pages to the index. The reference system consists first of a bibliography of publications with titles, numbered 1-1924, which is restricted to those most frequently referred to in the text, and secondly of several hundred highly condensed references at the end of each chapter.

It is difficult to express in words the gratitude the reader must feel for the author's sustained industry and high level of scholarship and scientific insight. He may be assured that this will be felt by workers in many cognate fields, archaeology, biogeography, palaeoclimatology and the whole field of human activity.

To the publishers also congratulations and appreciation are due for the sponsoring of this major undertaking.