

THE LAKES OF MINNESOTA, THEIR ORIGIN AND CLASSIFICATION. JAMES H. ZUMBERGE. Minneapolis: The University of Minnesota Press, 1952. 99 pages, 2 plates, 48 text-figures. (Bulletin 35, University of Minnesota, Minnesota Geological Survey.)

THE author classifies the enormous number of lakes in Minnesota, describes examples, and provides explanations of the processes that created and modified them. Intended primarily for use within the State, where lakes are economically important at present as holiday resorts, the bulletin is essential to geomorphologists whose interests lie in the glacial modification of relief by erosion and deposition, to limnologists, and to those who enjoy classifying natural features.

The classification, based on readily inferred processes and on present morphology, establishes five main categories of lakes and twenty-seven types. Having read the descriptions and analyses, which are supported by clear and instructive text-figures and photographs, the reviewer considers that the resulting nomenclature is well justified and should be adopted as a standard for any similar region.

Minnesota has a long history of invasions by Pleistocene ice, ice-retreats, deposition of loess and modification of pre-glacial drainage. There is a pre-glacial relief outside the oldest drift areas, and varying degrees of river maturity have been established on the drifts themselves. On the boulder clays and eroded surfaces of the regions covered by the later substages of the last or Wisconsin glaciation there is, as yet, generally no drainage at all. Here lie the lakes described in the bulletin. Some of them are attributed to the later histories of the vast late-Wisconsin lakes Duluth (of which Lakes Superior is a remnant) and Agassiz, while some are related to local glacial history and to the effects of solid geology upon glacial processes. Here a particular discussion arises about the effects of continental ice moving along, and across, the geologically dominated pre-glacial relief. The author invokes Demorest's conception of extrusion flow. It seems that the term and inferred processes are still in need of clarification. Extrusion flow within the body of a great ice mass is regarded sceptically by some authorities.* How far it might be responsible for erosion—sometimes very deep and differential erosion—of the subjacent rock surfaces may well be regarded as still a subject for debate and further investigation.

Recent statements about profoundly thick land ice in the Antarctic and in Greenland occupying a varied rock relief suggest to the reviewer that flow at the base of the ice, where it occurs, is canalized by rock relief and caused to over-deepen the deeper parts. The author adopts the hypothesis of "obstructed extrusion flow" to explain the glacial erosion of valleys transverse to the direction of movement of the continental ice, and makes an interesting case for it, but clearly it is a problem that needs much further study.

Among many other observations the author also has some instructive remarks, supported by sketches, on the creation of ice-ramparts and pressure ridges by lake ice which he associates with the degree of rigidity and expansion of the ice on rise of temperature.

Clearly, therefore, the publication contains much of great interest to glaciologists and this review offers no more than a sample. The bulletin should have a wider scientific public than it may find in the progressive University of Minnesota and the Minnesota Geological Survey which have encouraged the studies and included them in their official publication.

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ALPINE GLACIERS. A. E. LOCKINGTON VIAL. London: Batchworth Press, 1952. 19 × 26 cm., viii + 24 pages, 86 illustrations, 7 diagrams; Index. Price 30 shillings.

THIS book makes no claim to add to our scientific knowledge of glaciers or glaciology. Neither is it addressed to the mountaineer for otherwise it would be open to criticism on account of some

* So far it has not been possible to confirm the existence of extrusion flow by empirical test.—Ed.