

matter whose particles, on being absorbed, have their kinetic energy converted into heat. It may be recalled that long before the discovery of these cosmic clouds Newton envisaged the possibility that an accession of extraneous meteoric or cometary fuel to the sun might lead, sooner or later, to the extinction of all life on the earth.

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HANDBUCH DER GLETSCHERKUNDE UND GLAZIALGEOLOGIE. R. VON KLEBELSBERG. Vienna: Springer-Verlag. Vol. 1 (1948), 403 pages, 55 illustrations; Vol. 2 (1949), 602 pages, 38 illustrations. Price £11 12s. 6d.

GLACIAL recession, which has been so remarkable during the last twenty years, has given a new impulse to research on snow and glaciers. Numerous works on special glaciological subjects and problems have been published in all parts of the world. Nevertheless, owing to the Second World War, much work remained unreported or, when reports were made, many were not easily accessible. It was therefore desirable that the latest results of research should be collected into one work and so made more readily available to science. The older works, such as Albert Heim's *Handbuch der Gletscherkunde* (Stuttgart 1885), and Hans Hess's *Die Gletscher* (Braunschweig 1904), are either out of print or partly out of date. Now, within a few years of each other, two works have been published—first *Gletscherkunde* by E. von Drygalski and F. Machatschek (Vienna 1942) and now the subject of this review. In it the latest knowledge and research are brought together in two volumes, and are illustrated and discussed in masterly fashion. One feels that the author is not merely a theorist but also a research worker who knows the mountains and their glaciers from a lifetime of accurate observation, and that he has thoroughly studied the pertinent literature. It is good to note that in this work there is no trace of any narrow-minded nationalism. The work of glaciologists is treated purely in regard to its scientific value and authors are given full credit for their findings.

The first volume, the *Allgemeiner Teil*, deals with the general aspects of glacier study and glacial geology. We are reminded how this branch of science originated in Switzerland and at the hands of Swiss workers. Nevertheless it soon spread to other parts of the Alps and to the mountains of other countries, bringing under its spell research workers of many nations, not least of whom were the English. The author describes with clarity the formation of glaciers above the snow line, the conversion of snow into firn and glacier ice, and the structure, stratification, foliation and other phenomena of the glaciers. He shows how research on the physical properties of glacier and other ice has occupied scientists for decades, and that nevertheless no definite conclusion has been reached even up to the present day. An important chapter is devoted to glacier movement. This influences not only the morphology of the glacier grains, but also in many respects the banks and the bed of the ice stream and thus impresses its characteristic shapes on glaciated country. It is natural that some readers may find passages in this work where they will differ from the author, but this will seldom occur. Von Klebelsberg describes the morphology of the irregular glacier grains, which are separated from each other by very fine capillary spaces or by films of moisture. He believes (p. 41) that the knotty protuberances on the surfaces of the glacier grains is contrary to the assumption of rolling motion as postulated by Streiff-Becker. The latter on the other hand thinks that such a movement nevertheless does take place, just as in a storage bin coarse-grained, sharp-edged materials, such as coal or broken stones, roll down because the surface protuberances of the grains are worn away. In the case of ice there is the further consideration that particles subjected to heavy pressure not only partly break but change their aggregate state, at least on their surfaces, *i.e.* melt and freeze again.

The great diversity of the relief of the earth's surface and of the climate, causes great diversity

of phenomena in the formation of glaciers, so that these cannot be estimated by any rigid, mathematical formulae holding good in all cases. Careful observations and measurements, depending on place and time and other considerations, are necessary. This is well expressed in the work under review, in which the text gives the names of the research workers who have interested themselves in any special branch of the science and discusses their findings. Each section closes with a bibliography giving full particulars of the appropriate literature.

The second part of the first volume is devoted to glacial geology and describes in full the results of the latest research in this field since the appearance of the great work of Albrecht Penck and Eduard Brückner, *Die Alpen im Eiszeitalter* (Leipzig, 1901-9). As examples we may cite glacial deposits and their shapes, erosion and other features influenced by glaciers and glacial movements of the earth's crust including fluctuations of the sea-level. Von Klebelsberg begins with the discussion of moraines of all kinds, notably with ground moraines, which, as a deposit in flat countries, play a much greater and more important part than do upper moraines, inner moraines or drumlins and erratics. He describes the ground moraines as a mass of very finely divided sandy-muddy grains without selective sorting, mostly unstratified and but little consolidated. They contain admixtures of triturated and scratched detritus irregularly rounded. The conditions of deposition vary. Often the ground moraine lies on smooth, almost polished surfaces, which are very often covered with striae running approximately in straight lines. The deposit is particularly thick where Quaternary formation of ice took place over flat land; it is more consolidated or hardened in the Pre-Quaternary age and is then called tillite. These things are discussed in full detail and also the secondary changes in the moraine rubble, as for instance the events which in regions with periglacial or subnival climate have caused the ground moraines to become built-up deposits or have induced solifluction. The formation of earth pyramids and such like is well described. The chapter on trough valleys is excellent. It should satisfy those who oppose the assumption that these were formed by the overwhelming force of glacial erosion. These authorities prefer to believe that trough valleys are only found where favourable shapes had existed previously. They suggest that they were somehow developed from tectonic depressions or from arc-shaped, hollow clefts in igneous rocks, which were afterwards ground down by the glaciers to the typical round forms.

Von Klebelsberg uses the word *glazifluvial* instead of Penck's *fluvioglacial*, thus conforming with English practice, although the older word is still used in many countries. He emphasizes rightly that it is not correct to name the Quaternary glacial period simply an "ice age," since several much older Pre-Quaternary ice ages have become known. It would be more correct to speak of the "Pleistocene glacial period" in contrast to the "Recent or Holocene glacial period."

The second volume, the *Historisch-regionaler Teil*, deals with the ice ages of all parts of the earth with exemplary thoroughness. The first section gives a survey of the recent formation of glaciers. No glacier region has been forgotten. In the second section, the Pleistocene ice period is described, first of all in its parts, and afterwards various views are given about the origin of ice sheets. Finally the results of the palaeontological and palaeobotanic researches are considered. The third and largest section deals individually with Quaternary glacial formations in all regions of the earth. The whole work gives us a faultless view of all research work in all continents and island regions. For Europeans interested in the subject, it is particularly valuable to be able to survey the regional nomenclature of foreign countries, and to have them available for comparative purposes in a single work.

In the second volume, as in the first, each section terminates with a bibliography, and at the end of the work there is a welcome alphabetical index of names, localities, and the like. The printing is neat and legible; the illustrations are excellent. If the price may appear to be high, those who purchase these volumes are unlikely to regret having done so as their contents will prove to be a rich compensation.

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