REVIEWS

The Mount Everest region. 1:100,000. [London], Royal Geographical Society, [1962]. 17*s*. 6*d*.

This map, compiled and drawn under the supervision of Mr. G. S. Holland, in the Drawing Office of the Royal Geographical Society, and published with the assistance of the Mount Everest Foundation, covers an area of approximately 46 × 40 miles (74 × 64 km.) with Mount Everest very close to the centre.

The heights are given in feet and metres and the contours are at 100 m. intervals. Every part of the map shows the contours mainly in blue and brown, but those taken from less reliable data are given in grey.

The map has been compiled from data received from no less than twelve sources. The names follow the Survey of India spellings, as recommended by the Permanent Committee on Geographical Names, and the control of the map was based on the Survey of India triangulation with the height of Mount Everest given as 29,028 ft. (8,848 m.). No part of the map shows elevations of less than about 15,000 ft. (4,572 m.).

This map will be extremely interesting and valuable to glaciologists, showing as it does in considerable detail the large glaciers running off from the Everest *massif* in every direction.

G. Seligman

A. H. Lachenbruch. Mechanics of thermal contraction cracks and ice-wedge polygons in permafrost. *Geological Society of America. Special Papers*, No. 70, 1962, vii, 69 p., illus.

Large areas of the Arctic are covered by ice-wedge polygons. Shallow troughs, spaced 10 to 100 feet apart (3–30 m.), form a conspicuous network on the ground surface. Beneath the troughs, buried in the permafrost, are generally found wedge-shaped masses of fairly clear ice, commonly some tens of feet deep and several feet wide at the top; I remember my surprise when Dr. Lachenbruch first showed them to me in an exposure near Point Barrow, Alaska.

In 1915, Leffingwell put forward a theory of the origin of ice-wedges that is now widely, but not universally, accepted. During the winter thermal contraction cracks the ground, and in early spring melt water refreezes in the new cracks. In the next winter thermal tension cracks the ground again at the same place, because the ice vein now situated there is a place of weakness. Again spring melt water refreezes in the crack, and so the process continues; an ice wedge begins to grow. Dr. Lachenbruch has set himself the task of seeing whether this idea of the origin of ice wedges is reasonable from the point of view of mechanics, having regard to what is known about the mechanical behaviour of ice and permafrost and temperature changes in the ground. He concludes that it is. Any such investigation is inevitably limited by the fact that not much is known about the mechanical properties of permafrost and dirty ice, and what is known about brittle fracture shows that its details can be rather complex. Nevertheless, a great deal can be done, as Dr. Lachenbruch's very thorough and carefully argued study shows.

He deduces from qualitative observations a set of rather stringent conditions that must be satisfied if Leffingwell's theory is to work. They relate the maximum thermal tension (which varies with depth) to the strength of the material at *two* definite levels: at the ground surface, that is, at the top of the seasonally thawed layer, and, a foot or so lower down, at the top of the permafrost itself, where the ice wedges are. He is at once able to rule out the simple idea that the frozen soil behaves purely elastically—the tensions would be far too high. More remarkably he is also able to rule out a linear visco-elastic behaviour of the frozen soil. But, with a model that combines elasticity with a non-linear viscous behaviour (strain-rate proportional to the third power of the stress), he succeeds in satisfying all the conditions. It