A NEW METHOD OF GLACIER EXAMINATION

It has for some time been obvious that far-reaching results could be obtained by penetrating right through a glacier to its bed. The expense however has always been prohibitive. Recently however Dr. H. Carol, of Zürich, had the ingenious but simple idea of going down through a glacier by means of a glacier pot-hole and has described his experiences in *Les Alpes*, 1945 (pp. 180–84).

He chose a point on the Lower Grindelwald Glacier marked on the Siegfried map as the "Walchiloch" whose present position is some 600 metres west of the Stieregghütte. The time chosen was November when water flow, and snow to block the entrance, would be at a minimum.

The exploration was by no means easy. The party first passed through a slightly inclined tunnel for 50 metres. This ended in a vertical shaft which was negotiated by means of a rope ladder. At the bottom they were about 72 metres below the glacier surface, which is about one-third of the total estimated glacier depth at this point.

Here however they were held up by a narrow and dangerous constriction which was blocked at its end by a large water-filled basin which prevented all further progress. There seems little doubt that if this method were followed up, a place might be found which would provide access to a glacier bed. It is understood that Dr. Carol will repeat his attempts.

It must be remembered that the constant movement of the glacier might overnight open up a suitable means of access but equally well might close it. Therefore this form of glacier exploration must always be a very risky venture.

G. S.

THE CROSS SECTIONS OF GLACIATED VALLEYS

By W. V. Lewis

The typical U-shaped cross-section of glaciated valleys is well known but little understood. If a climatic change results in a glacier occupying a deep river valley, and some erosion is assumed to occur wherever the ice makes contact with the bedrock, then a partial change from the "V" to "U" section is to be expected. A more potent agency in such a change is probably the sapping of the valley sides by the alternate freezing and thawing of melt-water flowing down to, and under, the glacier. This has been briefly suggested by de Martonne and worked out somewhat more fully in the case of cirques.[1]

With regard to the mechanism of vertical erosion by glaciers the Horunger-Fanaråken area of central Norway proved instructive. Ice derived both from the mountains and plateau once converged on the deep glacial valley plunging down past Turtagrø into Fortundalen and the Sogne Fjord. The evidence here presented seemed to confirm the suggestion long held in many quarters,[2] that whereas relatively thin ice masses do little vertical erosion, as they thicken the vigour of down-cutting greatly increases. Such a process of over-deepening would clearly be a cumulative one provided the surface gradient were adequate. This would help to account for steps in the long profiles, and "U-in-U" forms in the cross profiles of valleys without the necessity of invoking separate glaciations, though the latter might well assist in the process.[3]

[1] Lewis, W. V. *Geog. Review*, Vol. 30, 1940, pp. 64–83.

[2] See for instance Cotton, C. A. *Climatic Accidents in Landscape Making*. Christchurch, N.Z: Whitcombe and Tombs, 1942.

[3] Garwood, E. J. *Geog. Journ.* Vol. 36, 1910, pp. 310–339.

A "U-in-U" section seems to be in active formation to-day in the valley occupied by the upper Aletsch Glacier, the glacier sculpturing the lower "U," and bench-ice, hanging well above the main glacier, sapping the higher mountain sides and so forming the upper "U."

But heavily glaciated valleys can have a markedly "V" cross-section. The Rhone Valley below Gletsch is of the steep narrow "V" form although ice several thousand feet thick must have passed through it in the Quaternary Ice Age. The valley below Turtagrø is another example. The best "V" section I have yet seen—still occupied by ice—breaches the rocky head-wall of the U-shaped Stadardalur in S.E. Iceland (see 1 : 50,000 map, Kalfafellstaður N.A.).

These "V" sections always occur when the valley gradient is steep and can frequently be recognized in glaciated valleys in Britain, as in the upper part of the Tal-y-llyn valley due east of Cader Idris, and in the Lake District.[1]

Though we might not accept Garwood's explanation of these anomalous features he deserves full credit for focusing our attention on them. They are mostly not post-glacial in origin, yet their likeness to deep river-cut valleys tempts one to attribute them to the action of streams. Might they not be due in a large measure to melt-water streams, often flowing violently under great hydrostatic pressure, when the glaciers were still present? Recent work by Ahlmann, Seligman and others on the temperature regime within glaciers would seem to have established that such streams usually originate far back in the névé regions, and of this there is much direct evidence. What is doubtful is the depth at which such streams could maintain their channels open against plastic collapse of the ice, but this might well be several hundred feet.

Glaciers are generally assumed to be relatively thin where they break into a complex of crevasses and seracs and flow down a steep stretch of their valleys. Their capacity to erode is assumed to be much less at such points than in the deeply filled basins above and below, whereas with streams it is quite the reverse. Thus towards the end of a glacier, on steep stretches, the sub-glacial streams might do a substantial proportion of the valley cutting. In view of the countless major and minor climatic cycles within the Quaternary Ice Age, considerable stretches of the Alpine and other glaciated valleys must at one time or another have been occupied by the relatively thin terminal portions of a valley glacier, thus giving full opportunity for this form of erosion.

Recently exposed steps towards the heads of glaciated valleys in Norway and elsewhere are frequently not scarred by water-worn notches. This seems to be due to the fact that the steps are so broad and smooth that the streams, when under the ice, were not allowed to remain for any length of time in one position. With narrower valleys, as at Grindelwald, the chances of a sub-glacial stream incising itself sufficiently to become locked in one position are greater and so gorges and V notches would be more likely to develop.

The fact that steps are usually more abrupt and less notched towards the head of glaciated valleys than farther downstream, might lend support to this hypothesis. But whether such assumptions prove right or wrong it seems evident that great volumes of ice can, in certain circumstances, flow through V-sectioned valleys without turning them into the somewhat over-emphasized "U" shape.

[1] Hay, T. *Geog. Journ.* Vol. 102, 1943, pp. 13–20