

In 1926 <sup>1</sup> ice cliffs apparently stretched across the entire end of the glacier and it calved into the sea, as shown in Fig. 16 of the reference cited. The Norsk Polarinstittut aerial photographs of 1936 show a bay-head bar developing, with ice cliffs persisting only at the southern end of the bay. To-day no cliffs remain, and the ice has now retreated some 80 m. from its terminal moraine behind the bar.

The retreat of the ice front is accompanied by an overall thinning of the glaciers, due mainly to ablation, which amounts to about 1 m. per annum. The great ice-cored moraines of these glaciers are an indication of the extent to which this has gone on. Some of these moraines rise as much as 50 m. above the ice snout, and several are accompanied by numerous dirt cones up to 7 m. high.

An interesting aspect of glacial recession in Vestspitsbergen is that of relic pro-glacial features. On the northern flank of Vegardfjella, St. Jonsfjorden, a group of beach remnants of former glint lakes (glacier dammed lakes) is present between 30 and 47 m. above sea level. The effect is of a group of three "parallel roads," and it is clear that a lake was confined between Vegardfjella and the adjoining glaciers Osbornbreen and Charlesbreen. With the retreat of Osbornbreen the water presumably escaped into the fjord.

Small glint lakes are present below Krokfjellet, their outflow being subglacial or englacial. Numerous old lake shorelines are present above these lakes, the highest being about 39 m. above present lake level on the southern spur of Krokfjellet.

The glint lakes between Eidembreen and Vestgötabreen, below Motalafjella, appear to be growing in size, and, whereas only one lake has been shown on the published maps of this area, several lakes now exist. The outflow from these lakes in the summer of 1951 no longer took place from their western ends and down the valley below Jørgenfjellet, but past their eastern end and down ice gorges cut in the snout of Eidembreen. The writer is indebted to Dr. A. K. Orvin of the Norsk Polarinstittut for a pre-publication view of a map showing these lakes. This map differs in certain details from sketches made by the writer in 1951, and it is hoped that a further field season will allow a careful survey of the lakes to be made, and their recent growth to be assessed. With continued glacial recession, this lake site may eventually witness the accumulation of a very large lake or group of lakes stretching almost from Jørgenfjellet to Motalafjella.

*MS. received 6 June 1953*

#### REFERENCE

1. Hoel, A. The Norwegian Svalbard Expeditions 1906-26. *Skrifter om Svalbard og Ishavet*, Bd. 1, Nr. 1, 1929, 104 p.

## AN EXCEPTIONAL GLACIER ADVANCE IN THE KARAKORAM-LADAKH REGION

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DURING my recent travel in the Western Karakoram, and by request of the Pakistan Government, I was able to see, and to make a preliminary study of, a very extraordinary glacier situated in the Stak Valley, which joins the right bank of the Indus River between Skardu and Gilgit.

I refer to the 12 kilometres long "Kutiàh Glacier," so called after the valley in which it had formed itself in a period of about three months. As far as my knowledge goes, no such rapid advance in historic times of a glacial front such as this has been recorded, and I regard it therefore as quite an exceptional phenomenon.

Roughly speaking, one may reckon that this glacier has moved on towards the valley at a mean speed of 113 m. a day, that is to say, at about 4.7 m. an hour.

The Political Agent of Skardu heard about the advancing glacier in the spring of 1953 from the inhabitants of that district. At first, they were disturbed at the appearance of enormous masses of ice in their valley, and then terror-stricken by the continual advance of a glacier already covering a three-kilometre stretch in the Stak Valley, where there were many flourishing villages and cultivated fields.

As a preliminary to a fuller account to be published elsewhere, I will briefly summarize the main information that I was able to collect on the spot in the month of September 1953.

The Kutiàh Valley, with an approximate height of between 2820 and 3900 m., is situated on the southern slope of the Haramosh group. It is almost unknown, since even on the most detailed topographical map of the zone (Sheet No. 43M (Skardu) of the "Survey of Pakistan," scale 1 inch to 4 miles) it is shown without any name and in an entirely arbitrary and conventional manner. A stream with a gravelled river-bed runs through it, the lower slopes being covered with both broad-leaved and coniferous forests. It flows from the south-east side of the Haramosh (7397 m.) into the upper Stak Valley, which runs down to the Indus in an almost constant north-east-south-west direction.

According to the information that I collected at a meeting of the Lambardars (village chiefs) in the Stak Valley nothing abnormal had been noticed in the Kutiàh Valley until the month of March 1953, but from 21 March three glaciers in the upper part of the latter valley, the Kurankar, Nan and Kutsumbur, started to bring huge masses of ice to the main valley, thus filling the river-bed (see Fig. 1, p. 385).

From that day a continual supply of ice flowed from the three glaciers, finally uniting and sinking into a single glacier in the Kutiàh Valley.

The news after the formation of the glacier is more precise, coming as it did from dwellers in some permanent abodes situated on the right side of the lower Kutiàh Valley.

From 21 March the glacier continued its downward movement and development until it occupied the whole of the Kutiàh Valley bottom, pushing forward its high front at an unbelievable speed, burying beneath it the luxuriant woods in the lower valley. Early in May 1953 the glacier front reached the Stak Valley, of which the Kutiàh is a tributary, thus blocking it completely and damming the Stak River waters. But the advance of the ice masses still continued until 11 June, when their progress came to an end. They then occupied about two and a half kilometres of the Stak Valley. Since then the glacier has begun to retreat slightly, while its front has sunk a little.

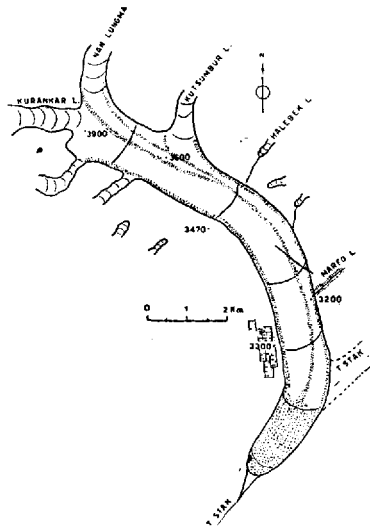
I had the opportunity of visiting the glacier on 10 September 1953, reaching it from Stak-la, as all communications between the lower and upper Stak Valley had been interrupted for some time. On crossing the glacier, just above the elbow formed in the Stak by the confluent valleys, I found its surface completely broken up by crevasses and ice pinnacles, making it very dangerous to cross. I then ascended the right bank up to a height of about 3470 m., where I was able to have a good view of the tributaries that had formed the new glacier.

I will endeavour to explain briefly what I consider to be the causes that may have provoked this singular phenomenon.

It must be pointed out that all the glaciers in the area surrounding the Kutiàh Valley, as well as the glaciers flanking it (with the exception of the three mentioned above), show characteristics of the retreating phase in glaciers. Beneath the present glacier fronts, often half-covered by floating moraines, there exists almost everywhere a terminal moraine, very new, and quite recently abandoned by the receding ice stream. In addition, after my survey of the Stak Valley, I went to the Biafo and Baltoro glacier region, which I had visited twenty-four years before, and there I noticed sure signs of retreat in secondary glaciers, but in no case any signs of advance. These facts go to prove that the progress of the Kutiàh Glacier is both a local and an exceptional phenomenon. However paradoxical the assertion may sound, I believe this continual thinning of the ice cover to be the very reason for this phenomenon, or at least one of the causes of it.

In my opinion, the sudden and extraordinary development of the three lateral glaciers above the Kutiàh Valley was due to a sudden and extraordinary influx of ice into the collecting basins of these glaciers. This could only be brought about by a huge series of ice avalanches in the upper Haramosh regions. The general reduction of the ice cover must have interrupted the continuity between the upper and lower ice masses, so that the former remained with their fronts suspended for more or less extended stretches along the mountain sides. These, I suggest, are the prerequisite conditions for the fall of great ice masses from the high mountain plateaux. In this particular instance, it may be supposed that enormous avalanches of ice took place in some collecting area commanding the three high valleys and from there the ice blocks flowed into the Kutiàh Valley.

This is what happened in 1920 to the Brenva Glacier, only in that case on a very different scale and differing also in detail. There, owing to a large fall of ice and rocks from the upper southern slope of Mount Blanc, a long strip of ice was formed at the bottom of the valley, swelling



*Fig. 1. The Kutiàh Valley, showing the three valley glaciers at its head and its junction with the Stak Valley flowing into the Indus River*

out in a short time and piling up against a buttress of Notre Dame de la Guérison. It moved on towards the valley at an average speed of 50 m. a year in the direction of the village of Entrèves.

It cannot be known when the large falls on the southern slopes of the Haramosh took place. Certainly, however, before 21 March 1953 and most probably at least a month before, which would be the time necessary for the ice flood to travel from the collecting basins to the fronts of the three glaciers.

The immediate cause of the fall may be connected with some seismic tremor, although it is by no means essential that one should look for causes other than the mere disturbance in the equilibrium of suspended ice masses.

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