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THE GLACIERS, SNOW AND AVALANCHES OF MOUNT EVEREST*

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A number of photographs illustrating this article will be found on pages 414–15

IN the spring of 1952 I was given the opportunity of taking part in the first Swiss attempt on Mt. Everest from the south, organized by the Fondation Suisse pour Explorations Alpines. Raymond Lambert and the Sherpa Tensing reached a height of 8600 m., but failed to attain the summit because their oxygen apparatus did not give them enough of this vital gas. In the autumn of the same year a new Swiss expedition followed up the first. Lambert, Tensing and E. Reiss reached 8200 m. and were defeated by the wind and cold. The summit was reached on 29 May 1953 by E. Hillary and Tensing, both members of the British expedition led by Colonel John Hunt.

* Translated from the French by J. W. Glen.

Some observations of the glaciers, snow and avalanches of this region are reported here.

At present the glaciers of Everest are receding visibly. The tongues of these glaciers are generally short, particularly on the south slopes, for the good reason that the steeply inclined valleys soon reach regions too low for the maintenance of ice. It is certain that they were more extensive at an earlier period, as practically everywhere numerous glacier terraces are visible strung along the sides of the valleys. How far these glaciers stretched and at what period is a question which a geologist can answer better than I.

The Khumbu Glacier, which originates in the Western Cwm of Everest, flows westwards in a great fall of seracs and then turns southwards forming a tongue some fifteen kilometres long which descends to an altitude of 3900 m. This tongue is a beautiful glacier, partially covered with magnificent moraines.

The chaotic ice fall descends from 5900 to 5200 m., a drop of 700 m., at the exit of the " Vallée du Silence," the valley which lies between the top of the seracs and the foot of the steep slope of the South Col and Lhotse. The more or less tangled nature of the seracs depends on the rate of flow, itself determined by the slope and by the thickness of the ice. Thus, for example, steeper but less thick glaciers are much less crevassed and vice versa. Since the glaciers in this region are rapidly decreasing in volume, it is probable that in 1921, when Mallory saw the Western Cwm for the first time (it was he who gave it this name), this ice fall was much more lively than at present, and that its ascent was impossible at that time. It is also probable that, as long as the glacier continues to decrease in volume, the ascent through the seracs will become easier and less dangerous each year. Nevertheless, it may happen that at certain periods crevasses completely bar the exit at the top, which seems to have been the case when the expedition led by Eric Shipton was there in 1951.

Immediately after the monsoon the ascent of the seracs is much easier, thanks to the quantity of snow which fills them. But in the dry season which follows the rains cracks form and enlarge rapidly. At the time of the Swiss autumn expedition of 1952 the ice fall could be crossed easily, but a month later nine bridges had to be made using long beams of wood.

Apart from the danger of the collapse of a snow bridge, the climber is exposed to the avalanches coming down from the west spur of Everest, and to the fall of the ice towers between which the track winds. Although avalanches are relatively rare, they constitute, in my opinion, the greatest danger facing the climber in this part of the ascent. New snow hardly ever accumulates on the very steep slopes of the west buttress. As soon as it is laid down in the gullies it is whipped up by the wind and cascades off, so that large snow slides are infrequent. However, the slope which overlooks the seracs is covered with hanging glaciers, which crack and crash down from time to time. A large ice avalanche can reach as far as the middle of the glacier and thus menace the supply path.

An interesting formation which is not found in the Alps, except in embryonic form, is that of *penitentes* of ice; these ice pinnacles develop on the tongue of the Khumbu Glacier at the foot of the seracs at an altitude of between 4500 and 5300 m.* They attain heights of up to 30 m.; they develop especially on the south-east sides of convexities in the glacier, and their tips are tilted towards the sun at its zenith. The sun is usually hidden behind clouds in the course of the afternoon, with the result that *penitentes* are rarer on south-westerly slopes. On coming out of the ice fall, the ice consists of a large number of blocks, accumulated from the avalanches of collapsed seracs. Melting acts irregularly on this disparate ice in such a way that the depressions become deepened. A light, cool wind blows continually at these altitudes keeping the points, by evaporation, at a temperature lower than that of the depressions where the sun's rays act as in a concave mirror. Thus the ice pinnacles become larger and larger, due to the ablation of the ice round them. The little stones covering the glacier cannot remain on these pyramids; they fall off, accumulate at the feet of the columns and accelerate melting still further.

On the Mayangdi Glacier, to the north of Dhaulagiri in western Nepal, I have observed another type of formation of *penitentes*. In the spring a host of glacier tables forms on the surface; as the

* It is interesting to compare this account with that of Professor Lliboutry in this *Journal*, Vol. 2, No. 15, 1954, p. 331.—*Ed.*

sun's heat becomes stronger, most of the tables fall, leaving pinnacles of ice, which resist melting better than the surface round their base.

In the Alps in spring, one can see myriads of snow pinnacles which develop on slopes exposed to the sun during a long period of fine, dry weather.

In the Himalaya, melt water accumulates in the depressions between the ice pinnacles forming little lakes which freeze at night. On the following day, the melt water flows on the surface of these lakes without melting them completely; progressively adding to their surface so that some regions of *penitentes* look like a large number of columns supporting horizontal platforms of ice, disposed at various heights and recalling solfataras.

The snow line is at a height of approximately 5500 m. The deposition of snow is so irregular because of the wind, that it is practically impossible to estimate the annual accumulation from the stratification visible in crevasses and seracs. From photographs taken in the serac field I estimate the width from one annual layer to the next at about two metres, which, with a density of 0·7, gives 1·4 m. of water. Assuming that a third of the layer has melted, this quantity only represents two thirds of the precipitation. The total would thus be 2·1 m. of water a year for the probable snowfall in this region. This figure seems rather small, as there are 12 m. of rain in Assam and 4 m. in the south foothills of the Himalaya. However, it must be remembered that, during the monsoon, it rains more frequently in the valleys than it snows on the high mountains.

Himalayan climbers generally encounter snow fields which remain powdery at 6000 to 7500 m. These melt lightly at the surface and refreeze; the crust rarely bears, and the climber has to break it at each step. Beneath this crust, he sinks into powdery or granular snow, which makes walking very tiring. Once settled, this snow hardens; in the "Vallée du Silence," between Camps III and V, the track was marked so that the porters could travel along a path whose base was hard. Only those who had made the original track had had the tiring work.

At Camp V, at a height of 6900 m., when the weather was calm, magnificent stars of snow, marvellously sculpted, fell slowly practically every day at 5 to 6 p.m.

All along the Cwm, in the "Vallée du Silence," the avalanches are menacing. The principal danger comes from falling seracs. The slopes 2000 m. high, dominating the glacier, are very steep. They give such an acceleration to the moving masses that avalanches easily cross the whole width of the glacier, so that nowhere is the climber completely safe. The danger becomes greater with every snowfall, although at these heights the snow is almost completely blown away and only accumulates lower down.

At the time of our attempt in the spring of 1952, a single little serac tumbled down the face of Nuptse. The distance the debris slid was startling, and gave an idea of the enormous danger from the sliding of a larger block. After an important snowfall a single avalanche was released in the summit gulley of Lhotse, which is a narrow gulley stretching right down to the level of the glacier some 1600 m. below. It did not release a single patch of snow in its course, showing that the cold snow adhered sufficiently at the bottom not to present any further danger.

Lambert told me that the remains of our spring Camp III had been completely swept away by an avalanche which had fallen from Nuptse during the summer, although it lay at a good distance from the north face of this peak.

Even if these dangers are not extremely menacing, they exist all the same, for, in the autumn of 1952, the Sherpa Mingma Dorjé was killed by a small fall of ice. It is splendid that the British were able to reach the summit in 1953; it constitutes a magnificent achievement, and it will be a good thing to leave the gods of the highest peak in the world in peace—they have had much to anger them.

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