The appearance of the hydroxyl emission during the day with an intensity close to that observed at night is of interest in view of the suggested excitation mechanisms.

Bates and Nicolet[5] originally proposed:

$$H + O_3 \rightarrow OH^* + O_2$$

Krassovsky[6], on the other hand, advocated:

$$H + O_2^* \rightarrow OH^* + O$$

Recently, Wallace[7] has examined a model hydrogen–oxygen atmosphere in photochemical equilibrium. He concludes that if the hydrogen ozone reaction is responsible for the hydroxyl emission one would expect a night-time–day-time emission ratio of 8 : 1.

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Sub-glacial 'Supercavitation' as a Cause of the Rapid Advances of Glaciers

THE rapid advance of the Otto Fjord Glacier reported by Hattersley-Smith[1] seems to be very similar to the catastrophic advances which happened in the Alaska Range[2] and in the Andes of Santiago[3]. As observed on the Muldrow Glacier, the flood of the lower part of the glacier is associated with a collapse of the upper one. It is a slip caused by a reduced friction on the bed-rock. It has nothing to do with the real floods observed on temperate glaciers after a sequence of wet years[4].

A decrease of the specific budget can change an accumulation zone into an ablation zone. The ice can rise instead of sink, and basal temperatures are very sensitive to this reversal[5]. This, and the rising of mean air temperatures, can bring the basal ice to melting point on a greater area.

In a swiftly moving glacier, almost all the movement proceeds from sliding, and so Robin's explanation[6] seems inadequate. A sudden destruction of the quasi-statical equilibrium of the glacier can scarcely be explained by a progressive warming of its ice. The phenomenon arises from two facts: (1) Friction is considerably lessened when melting water accumulates between ice and rock, at the lee of any protuberance where 'glaciostatic' pressure is lower. (2) Owing to these water-filled cavities, kinetic friction decreases when sliding increases.

These ideas were advanced some years ago[7,8]; the calculations are summarized and improved here.

Ice can over-ride a protuberance of the bed in three ways: (*A*) by melting and refreezing; (*B*) by plastic deformation (with or without a water-filled cavity on the down-side); (*C*) by generalized 'supercavitation'. The first mechanism is efficient for the smaller protuberances, the last two for the bigger ones, so the movement is controlled by the protuberances of intermediate size. In a former theory, Weertman[9] only brought in mechanisms *A* and *B*.

Weertman's calculation of mechanism *A* must be changed[10] as: (1) for a given stress, pressure melting is probably three times Weertman's value; (2) basal temperature ice contains an appreciable amount of liquid water, which can freeze and so bring heat to the melting side.

For protuberances of height a, width b, length l, mutual distance λ, an approximate value of the slip by mechanism *A* is:

$$v_A = \frac{T\,\Delta u}{JL^2\rho}\,\frac{f\lambda^2}{ab}\left[\frac{K'}{l} + K\sqrt{\frac{2\pi}{ab}}\right]$$

Δu, specific volume difference between ice and water; ρ, density of ice; L, heat of melting; f, friction per unit area; K', thermal conductibility of rock; K, thermal conductibility of ice. The friction is greater as b increases. So the calculation must be made for protuberances of infinite width (that is to say: $b = \lambda$).

To calculate the slide by mechanism B we assume that during a time $\lambda/(2\,v_B)$ the compressive strain is $4\,a/\lambda$. Taking $\dot{\gamma} = B\tau^n$ as the deformation law for ice, a sinus profile for the protuberance, and putting $a/\lambda = r$:

$$v_B = \frac{a}{8\sqrt{3}\,r^2}\,B\left(\frac{2f}{\pi\sqrt{3}r}\right)^n$$

When only mechanisms A and B are acting, the sliding velocity is, taking $n = 3$ and putting $KT\,\Delta u/JL^2\rho = k^2$:

$$v = 2v_A = 2v_B = \frac{2k\sqrt{B}}{3\pi^2}\,\frac{f^3}{r^{3{,}5}}$$

Pertinent values are:

$$B = 0{\cdot}2 \text{ bar}^{-3} \text{ year}^{-1};\quad r = 0{\cdot}1\text{–}0{\cdot}2;\quad f = 1\text{–}1{\cdot}5 \text{ bar}$$

It follows $v = 0{\cdot}34$–$8{\cdot}5$ m/year, which is insufficient, as sliding velocities of 100 m/year or more are commonly observed.

If a cavity filled with water at a low pressure, p, exists on the lee of an isolated protuberance (a fact which, by analogy with hydraulics, may be called 'supercavitation'). then it follows, for $n = 3$:

$$v_B = \frac{8B}{9\pi^3}\,\frac{a}{r^2}\left(\frac{f}{r} + p - \rho g h\right)^3$$

instead of:

$$v_B = \frac{B}{9\pi^3}\,\frac{a}{r^2}\left(\frac{f}{r}\right)^3$$

(h = thickness of the glacier).

This can explain the higher velocities found at melting season or after heavy rain (as was found at the Kongsbre marine front, Svalbard, last summer).

The state of affairs changes completely when water-filled cavities are abundant. The smaller ones are inundated, and the ice pushes only the top of the protuberances. A new calculation (for $n = 3$) has given a velocity of sliding:

$$v_C = \frac{\pi^4 Br}{18}\,a\,\frac{(\rho g h - p)^6}{f^3}$$

Combining the two sliding mechanisms A and C, higher values of the total velocity v are acquainted for:

$$v = 4v_A = \frac{4}{3}\,v_C = \frac{\pi}{3}\,k\sqrt{\frac{2\pi B}{r}}\,\frac{(\rho g h - p)^3}{f}$$

So the kinetic friction f diminishes when the sliding velocity increases, and in some glaciers a catastrophic glacier slip appears as soon as melting point is reached.

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