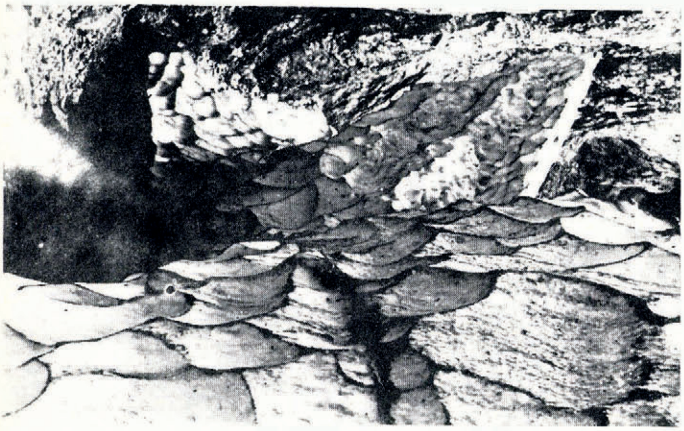

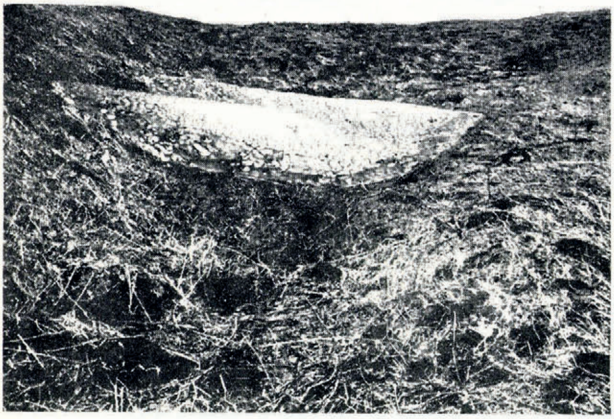

Fig. 1 (above, left). Upper surface polygons on old névé. *Fig. 2 (above, right). Inverted dirt polygons under old* névé. *(Photographs, Dept. of Geography, Leeds University.) Fig. 3 (below, left). Snow-bed with polygons. Mt. Kirigamine, Japan, 1 May, 1954. Fig. 4 (below, right). Details of Fig. 3. (Photographs by H. Suzuki.)* *(See W. E. Richardssn* and *R. D. M. Harper, p. 25.)*

BENDING OF BLUE-BANDS BENEATH HEAVY BOULDERS

Cambridge Austerdalsbre Expedition 1955, Paper No. 3

By G. DE BOER

(University of Hull)

A NEAT demonstration of the plasticity of ice under pressure was seen on Austerdalsbreen, Norway, during the summer of 1955. The camp of the Cambridge Expedition was situated on a patch of moraine, the largest boulders of which must have weighed some hundreds of tons. Ablation of the

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glacier surface had left some of these boulders perched on plinths of ice of limited cross-sectional area, which were thus under very considerable pressure. Two cases were noted in which the blue bands in such plinths had yielded to the weight of the perched block.

One block, about 15 ft. (4·7 m.) high by 10 ft. (3·3 m.) by 25 ft. (8 m.) rested on supports of ice which showed crumpling (below). In this case, the boulder had settled almost vertically, and this,

Fig. 1. Crumpled banding in ice underneath a boulder settling chiefly vertically. Note shape of prominent white band in centre of picture

Fig. 2. General view of the second boulder described

Fig. 3. The ice plinth supporting the upper end of the boulder seen in Fig. 2. The bending of blue bands under the boulder and the fissuring of the ice behind the boulder are well seen

Fig. 4. Close-up of the bending of a blue band and fissuring of the ice behind the boulder

combined with some tilting had produced crumpling rather than bending over of the bands in one direction.

In the second example, the boulder was sliding very slowly downhill and this had caused a very regular bending over of the blue bands in the same direction. The boulder (above) was of irregular shape, approximately 40 ft. (13 m.) long by 28 ft. (9 m.) wide and ranging from 7 to

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over 10 ft. (from 2 to over 3 m.) in thickness, and it and the surface of the glacier beneath it sloped down-glacier at about 14 degrees. The block rested on three plinths of ice, two of which, well underneath the lower thicker end of the boulder, carried most, indeed, in the final stage seen, all the weight of the boulder. The third plinth (Fig. 3, p. 32) which supported the higher end of the block was $18\frac{1}{2}$ ft. (6 m.) long, of which, when first observed on 6 August, only the lower $4\frac{1}{2}$ ft. (1·5 m.) were carrying the end of the block. The plinth stood about $4\frac{1}{2}$ ft. (1·5 m.) above the general level of the glacier surface, and was 5 ft. (1·6 m.) wide at the top beneath the block. At the base of the plinth the blue bands were unmodified and dipped up-glacier at 60 degrees, but about 2 ft. (0·6 m.) below the bottom of the block, began smoothly to bend over so as finally to become nearly parallel to the base of the block (Fig. 4, p. 32). Immediately behind the boulder, the top of the plinth had been shaped into shallow longitudinal grooves and was torn across by fissures running at right angles to the direction of movement of the boulder. They were presumably due to the tension arising from the drag of the boulder and indicated how the ice had become rigid once more when released from the pressure of the block.

Owing to the irregularity of the shape of the boulder and its supports, it would be extremely difficult to make a reliable estimate of the pressure on the plinth which had caused the bending of the blue bands. Indeed this pressure must have been gradually lessening for shortly before the end of the expedition, the end of the boulder lost contact with the plinth, the whole weight having been transferred to the other supports.

ON THE SLIDING OF GLACIERS

By J. Weertman

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Abstract. A model is proposed to explain the sliding of any glacier whose bottom surface is at the pressure melting point. Two mechanisms are considered. One is pressure melting and the other is creep rate enhancement through stress concentrations. Neither of the mechanisms operating alone is sufficient to explain sliding. If both mechanisms operate together appreciable sliding can occur.

Résumé. On propose un modèle pour expliquer le glissement d'un glacier dont le fond se maintient au point de fusion. On considère deux mécanismes : le fusion de pression et l'augmentation de la vitesse de déformation causée par les concentrations de tension. Ni l'un ni l'autre en agissant seul ne suffit à expliquer le glissement. Mais ensemble ils occasionneraient un glissement assez important.

Introduction

Nye[1,2,3] has developed a very successful theory of the plastic flow of ice within a glacier. The later version[2,3] of his theory is based on the creep law of ice which was discovered by Glen[4]. This law is for a temperature close to the melting point,

$$\text{creep rate} = K = B\sigma^n \qquad (1)$$

where σ is the stress and B and n are constants. (The creep behavior of metals is quite similar to that of ice. For this reason the extensive work on the creep of metals is of interest to glaciologists and the work on glaciers is interesting to metallurgists.)

Among the results of Nye's theory is a prediction of that portion of the surface velocity of a glacier which is due to creep within the bulk of a glacier. Nye notes that the total surface velocity is the sum of the velocity due to creep within a glacier plus that due to sliding of a glacier over its bed. The velocity due to sliding can make an appreciable contribution to the total surface velocity.