CORRESPONDENCE

The Editor,

The Journal of Glaciology

SIR, *Ice shelves*

Glaciologists must be pleased to see that a scientist as serious as Dr. H. Wexler has come to their support by studying with success a problem as complex as that of ice shelves.[1]

Generally speaking, I believe that the fundamental problem is one of ice flow.

Taking the Ross Ice Shelf as an example, we can try to get an idea of its mass balance. With a surface area of 510,000 km.^{2} and an accumulation of 17 cm. water (already determined by Shackleton in 1908), the total annual accumulation is 87 km.^{3} water. Neglecting super- and subglacial melting, discharge is mainly in the form of icebergs. The total loss is:

400 m./yr. $\times$ 850 km. (front) $\times$ 250 m. (thickness) = 85 km.^{3} of ice, i.e. 77 km.^{3} water/yr.

Then, there is 87 km.^{3} of accumulation and 77 km.^{3} of loss as icebergs. It would therefore seem that the Ross Ice Shelf is almost in balance.

But in reality it is not, for we must add the contribution of big glaciers (for instance, the Beardmore Glacier) coming down from the ice cap, which is difficult to estimate. It seems sensible that, at its confluence with the ice shelf along a 40 km. front, the thickness of the Beardmore Glacier is about 500 m. and its velocity about 5 m./day; this gives a contribution of 33 km.^{3} water/yr. We must also add the contributions of all the other glaciers. Do these not double the accumulation?

The Ross Ice Shelf is (by rough estimate) balanced and its accumulation cannot be more important than its discharge. We must therefore infer that the discharge as icebergs must be more important than the estimated one. A consequence of this is that there must exist ice streams like those draining the Greenland Ice Sheet. There are active zones and quiet zones, the former having a block-movement, as described by Finsterwalder, which does not obey the ordinary laws of flow.

Until the questions of ice shelf discharge and contribution of glaciers, i.e. the mass balance of the Ross Ice Shelf, have been clarified, I think it will be difficult to solve the problem studied by Dr. Wexler.

By research we must try to determine (1) the contribution of glaciers coming down from the ice cap, and (2) the movement and the loss by icebergs along the front of the Ross Ice Shelf.

These two problems can be solved by aerial photogrammetry without topographic preparation, following the methods developed during the I.G.Y. It would be ridiculous to try classical geodetic methods of velocity determination by following guiding marks with a theodolite.

When the ice streams have been determined and the respective velocities of the front of the ice shelf and affluent glaciers are known, the discharge can be estimated by using known values for thickness.

We hope that such studies will be undertaken in the near future.

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3 May 1960

REFERENCE

1. Wexler, H. Heating and melting of floating ice shelves. *Journal of Glaciology*, Vol. 3, No. 27, 1960, p. 626-45.

SIR, *Recent moraines of a lobe of the Taylor Glacier, Victoria Land, Antarctica*

We have read with interest the letter by Drs. H. J. Harrington and I. G. Speden in the March 1960 issue of this journal.[1] However, after an examination of the photograph attached to that letter the writers would suggest a glacial chronology different from that of the original correspondents.

To us the most striking feature of this photograph is the presence of uniformly well developed patterned ground over the entire valley floor and parts of the valley sides. We feel that a relatively recent retreat such as that proposed by Drs. Harrington and Speden does not allow sufficient time for the development of patterned ground up to the very edge of the glacier. Rather, we believe that the most probable sequence of events is: (1) retreat, with four stillstands, a long time ago; (2) formation of patterned ground during the long interval when the ice edge was either at its present position or further back—the position of the ice edge in 1959 may well represent a relatively recent advance over the

patterned ground; and (3) present day stillstand or slight wastage of the front, permitting the formation of a new moraine ridge.

In support of this interpretation we refer to the recent work of Dr. Péwé. Working in this area Péwé found little or no advance or retreat of the fronts of many glaciers since the time of Griffith Taylor's visit nearly 50 years ago.[2] Moreover, on the basis of a ^{14}C date on algae in ablation moraine in front of the Hobbs Glacier, Péwé has stated that the minimum age for the last, or Koettlitz, ice cover is 6,000 years. Moraines presumed to be of this age which flank the Garwood Glacier are only 200 yards (180 m.) from the present edge of the ice.[3]

Furthermore, the occurrence of mummified seal carcasses in nearly every ice-free area around McMurdo Sound, and the C–14 dating of one of these carcasses (which lay on glacial drift in Taylor Dry Valley) at 1,600-2,600 years of age,[4] furnishes additional evidence that glacier recession has in general occurred quite some time ago.

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30 May 1960

WESTON BLAKE, JR., and JOHN HOLLIN

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1. Harrington, H. J., *and* Speden, I. G. Recent moraines of a lobe of the Taylor Glacier, Victoria Land, Antarctica. *Journal of Glaciology*, Vol. 3, No. 27, 1960, p. 652-53.
2. Anonymous. Quaternary glaciation: McMurdo Sound region. *Transactions. American Geophysical Union*, Vol. 39, No. 4, 1958, p. 787-89. [Abstract of material furnished by T. L. Péwé.]
3. Péwé, T. L. Multiple glaciation in the McMurdo Sound, Antarctica—a progress report. *USNC-IGY Antarctic Glaciological Data, The Ohio State University Research Foundation, Project 825*, Part 9, Report No. 2, 1960, p. 1-27.
4. Péwé, T. L., Rivard, N. R., *and* Llano, G. A. Mummified seal carcasses in the McMurdo Sound region, Antarctica. *Science*, Vol. 130, No. 3377, 1959, p. 716.

SIR,

Distant release of avalanches

I read your recent article on snow and avalanches in the *Newsletter of the Chicago Mountaineering Club*, Vol 13, No. 2, March 1959, and was very interested to note your suggestion that avalanche releases attributed to voices might actually have resulted from propagation of disturbances through the snow for long distances. This coincides with my own opinion, and I thought you might be interested to know that I have from time to time observed evidence of sympathetic or distant avalanche releases in this manner.

Early this winter we observed a striking example here at Alta. A shallow snow cover on north exposures was converted to depth hoar during fair weather in December, and then overloaded by a couple of heavy storms early in January. The avalanche slopes were very unstable, and in one particular case we released a large slab avalanche in the ski area by artillery fire. Adjacent slopes, though not connected ones, also slid with this release, and an observer located further up the valley reported that slides on the opposite side of the mountain also fell at the same time. We were later able to trace cracks in the snow through almost all the areas between these slides up to the farthest one about a mile away over the ridge. There seems little doubt that this single artillery shell initiated cracking and release of creep tension over this wide distance, and that wherever the cracks propagated across an open, steep slope, an avalanche was released.

Last winter we had a similar situation on another area, where a single artillery shell released a whole series of slides along about $\frac{3}{4}$ mile of a long ridge. I have a 16 mm. film of this event which shows very clearly the progressive release of one slide path after another.

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5 March 1960

Avalanche Hazard Forecaster