SIR,

Moulins on Kaskawulsh Glacier, Yukon Territory

In the course of geophysical and glaciological work on Kaskawulsh Glacier (Fig. 1), Yukon Territory, in August 1965, several moulins were examined by the writer and his colleagues on the Icefield Ranges Research Project. The moulins were located near the confluence of the central and north arms of the glacier, about 8 km. below the firn line and 40 km. from the terminus. The elevation here is approximately 1,750 m., and seismic soundings indicate that the ice is about 500 m. thick.

Fig. 1. Confluence area of Kaskawulsh Glacier in July 1965. The central arm is to the right, the north arm to the left

The surface drainage in this area changes significantly from year to year. In the summer of 1964, several square kilometers of glacier surface were drained by two large moulins on either side of the medial moraine a few hundred meters down-stream from the confluence. In 1965 these holes were plugged by snow and the two old basins were combined in a trans-morainal system ending in a 10 m. deep gorge which was cut between May and August 1965, and emptied into another moulin. The latter had been small and had drained only a part of the medial moraine the previous year.

Near the main moulin there is a series of smaller ones associated with the closing crevasses of an ice fall about 1 km. up-glacier on the central arm. They show a relationship to the crevasses quite like that described by Streiff-Becker (1951). Some of the down-glacier apertures were relatively dry and invited exploration (Fig. 2).

Most of the moulins started as nearly vertical shafts but they changed direction and contained more or less prominent ledges at depth. The largest inactive one found was about 2 m. in diameter and dropped vertically for at least 60 m. More typically the moulins were rather tortuous. A manhole-sized shaft that was investigated in some detail dropped at a steep angle for about 6 m. to a small ledge. From here a tight corkscrew passage led about the same distance into a large vertical shaft which dropped to a ledge about 20 m. below the surface (this was at the limit of perceptible surface light). The floor was about 2 m. long, elongated in the direction of the crevasses and contained a plunge pool. The pool was rimmed by blue ice; the surrounding ice was generally bubbly. At the end of this ledge the passage dropped

nearly vertically at least another 10 m., where a waterfall entered from the wall and precluded further exploration. Here the shaft was getting larger and receiving many tributary tunnels.

The moulins were found useful as ready-made seismic shot holes. Time did not permit a thorough study of them or their part in the internal hydraulics of the glacier. The party received a strong impression that the "free ground-water system" discussed by Mathews (1964) is very deep in a glacier the size of Kaskawulsh Glacier. A particularly interesting problem here is the relation of this system to the large evanescent lakes that border the glacier.

Fig. 2. An investigator entering a dry moulin on the central arm of Kaskawulsh Glacier

The writer believes that with the proper equipment, including water-tight suits, extensive sub-surface exploration is feasible.

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SIR, *Similarity of tree growth in northern Scandinavia, polar Urals and the Canadian Rockies*

Growth patterns for coniferous trees in northern Scandinavia and for *Larix sibirica* in the polar Urals summarized by Adamenko (1963) over the past 250 yr. are remarkably similar to the growth of *Picea engelmannii* Parry in the Canadian Rockies over the same period (Bray and Struik, 1963; Bray, 1965). The Canadian growth patterns are more nearly synonymous with those of the polar Urals than of Scandinavia.