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TIME-DEPENDENT INTRAGLACIER STRUCTURES

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ABSTRACT. Using time-domain pulsed radar, the intrastructure of a typical temperate glacier has been studied. Certain features have exhibited a rapid change in structure, and cannot be explained by density or ice characteristics of a stable nature. It is believed these time-dependent structures are related to the internal water system for glaciers.

RÉSUMÉ. *Structures intraglaciaires dépendant du temps.* A l'aide du radar pour sondage-temps, on a pu étudier la structure interne d'un glacier tempéré typique. Certains traits caractéristiques ont mis en évidence un changement rapide de structure, et ne peuvent pas être expliqués ni par la densité ni par des caractéristiques stables de la glace. On croit que ces structures influencées par le temps sont liées au système aqueux interne d'un glacier.

ZUSAMMENFASSUNG. *Zeitabhängige intraglaziale Strukturen.* Unter Verwendung eines im Zeit-Bereich gepulsten Radars wurde die Innenstruktur eines typischen temperierten Gletschers untersucht. Bestimmte Erscheinungen zeigten eine rasche Strukturveränderung; sie können nicht auf Grund der Dichte oder aus Eiseigenschaften stabiler Natur erklärt werden. Es wird angenommen, dass solche zeitabhängige Strukturen mit dem inneren Wassersystem des Gletschers in Zusammenhang stehen.

DURING experiments using radio depth measurements at 620 MHz (Goodman, 1970) on Athabasca Glacier in the Canadian Rockies, several intraglacial reflections were noted. A sounding was obtained in the same location, under the same experimental conditions (except for weather), with a time lapse of nearly 1 month (late August to late September). The results of the two sets of data are shown in Figures 1 and 2. It is clear that the bottom remains unchanged, but the structure of the intraglacial layers at the right of the figures has changed considerably. Robin and others (1969), using a 35 MHz system in Greenland, noticed intraglacier reflections which were attributed to changes in ice density. Russian workers (Rudakov and Luchininov, 1969) have observed similar reflections in a temperate glacier and assigned these to water lenses, cracks and the existence of clear ice. The rapid change in reflected layers observed on Athabasca Glacier eliminates the above explanations for the cause of the rapid time-varying intraglacial reflections.

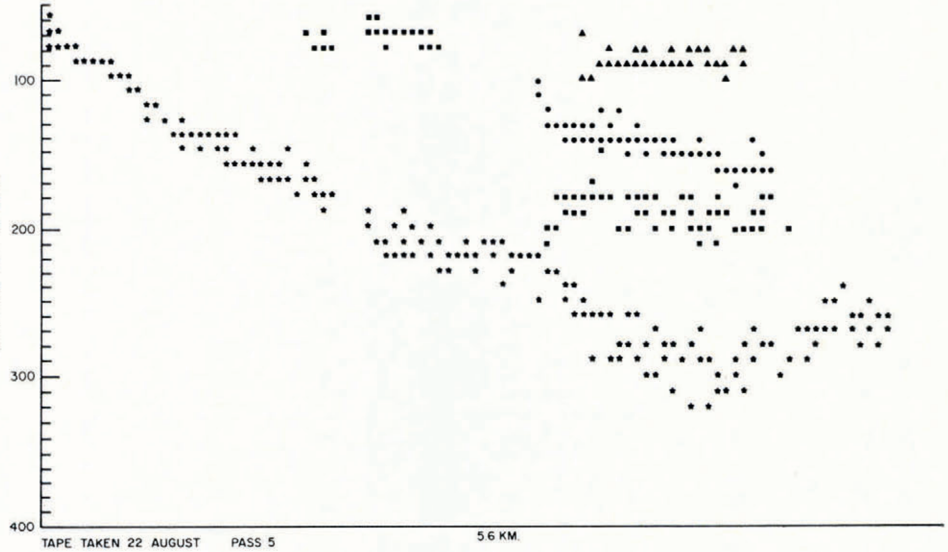

Fig. 1. Data tape taken 22 August. Weather sunny, no recent rain; the various symbols (★, ■, ●, ▲) represent returns of similar intensity and time delay.

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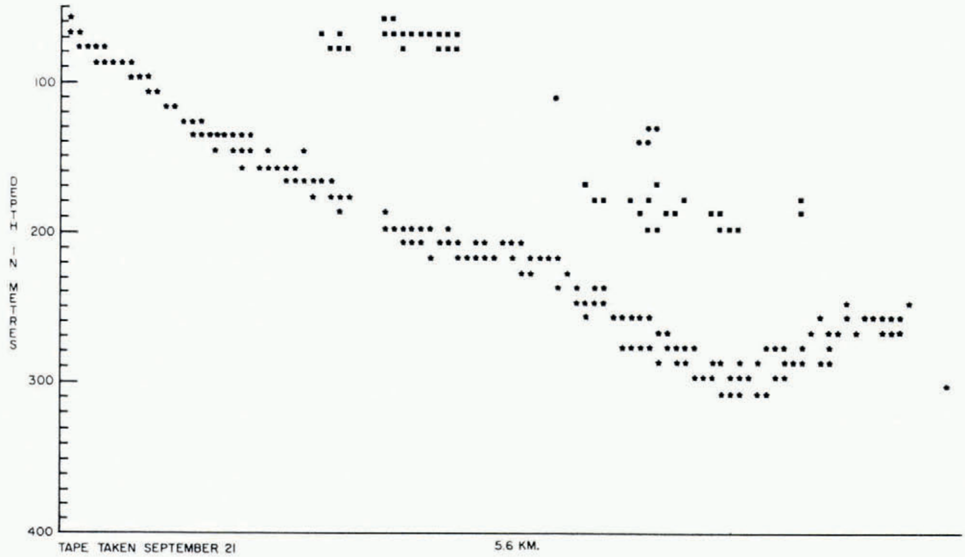

Fig. 2. Data tape taken 21 September. Snow and blowing snow; about 60 cm snow on ice.

There are at least two possible explanations. The reflections could be due to water layers forming and vanishing within the ice. The region, where these layers were observed, was near a large crevasse field. An alternative explanation is that these layers represent glide planes which cause an alignment of the crystal axes. This effect has been discussed by Luchininov and Rudakov (1971). It is difficult, however, to see how these planes could form and disappear so rapidly, since the crystal size must be in the order of a wavelength (50 cm).

The calculations of Smith and Evans (1972) are based on a multi-layer model of water admixed with ice. Using such a structure, it is predicted that a glacier greatly attenuates signals at frequencies above 500 MHz. Experimentally, this has not been observed except under conditions of recent precipitation. If such a multi-layer structure exists, it is rapidly drained leaving only a few well-defined features.

Experiments are in progress to obtain information on the diurnal, annual and spatial behavior of the intraglacier structure.

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