

## Changes in Permafrost Distribution in Northeastern British Columbia

### INTRODUCTION

Systematic observations of the distribution and thickness of the permafrost were made in northeastern British Columbia, Canada, along a traverse extending northeastward from Fort Nelson (58°49'N, 122°41'W) situated at an elevation of about 1000 ft (305 m) above sea level, across the southwest-facing Etsho Escarpment which rises to an elevation exceeding 2200 ft (671 m), and to the boundary of the Northwest Territories at an elevation of about 1500 ft (457 m) (Fig. 1). This traverse in the discontinuous permafrost zone was generally at right angles to the permafrost zonation<sup>1</sup>, crossing from the southern fringe into the widespread subzone. Thus, pronounced changes in the thickness of the permafrost toward the northeast were to be expected. The traverse was underlain mostly by cretaceous shales, with sandstone forming the higher land. During the last glaciation, the Wisconsin Laurentide ice sheet moved southwest across the area which, on melting, left a till mantle. The shales gave rise to silty-clayey till and soils, characteristically associated with ice-rich permafrost which occurs mostly in the overlying organic terrain. The mean annual precipitation of about 17 inches (43 cm), mostly summer rain, and mean annual temperature of about 30°F (-1°C), with a growing season of about 153 days, are typical of a continental interior<sup>2</sup>.

### METHOD

An air-photograph interpretation was made along the traverse, dividing the land-

scape into terrain units on the basis of identifiable vegetation and landform patterns<sup>3</sup>. These units, or Land Systems, were grouped on the basis of common attributes such as thickness of the permafrost into Land Regions, and there is a distinct permafrost zonation. Selected sites were visited for detailed ground inspection. The thickness of the active layer was measured by probing with thin steel rods. During August, when the survey was conducted, the depth of thaw approximated the thickness of the active layer. In wet depressions, or in seismic lines where thermal subsidence had occurred, where there were "windows" in the permafrost, probing at a very low angle (about 30° from the horizontal) beneath the adjoining frozen organic terrain revealed the base of the permafrost. Wherever possible, seismic lines were used for this measurement, since probing is then more likely to indicate the approximate base of the permafrost in the area. In natural depressions a ledge of frozen substrate generally protruded from the surrounding frozen terrain into the depression at a depth of about 18 inches (46 cm), towards the source of water, below which ledge the shape of the permafrost body could not be precisely ascertained. Probing below permafrost bodies from seismic lines and natural depressions in the landscape revealed, however, no inconsistent results within the study area.

### RESULTS

The active layer varied in depth between 18 and 22 inches (46-56 cm) throughout the traverse. Permafrost was first encountered near Snake River where it was very thin and consisted mainly of scattered ice crystals through which it was easy to penetrate with the probe (Fig. 1). The permafrost increased in thickness northeastwards to about 13 inches (33 cm) around the Sahtaneh River.

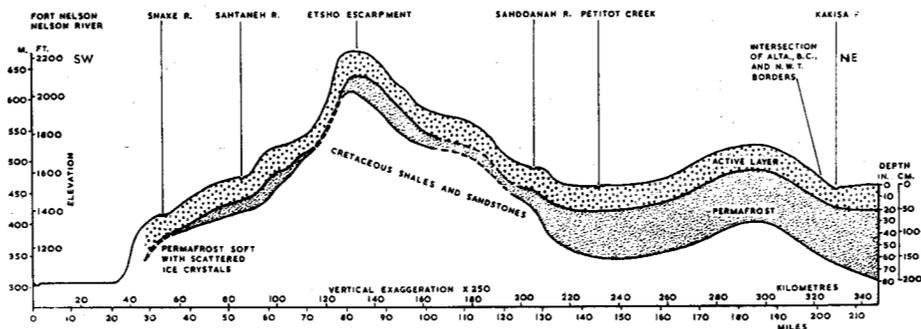


FIG. 1. Longitudinal profile of the terrain across the Etsho Escarpment showing the distribution of permafrost.

On the slightly steeper, upper slopes of the Etsho Escarpment which has maximum insolation, the permafrost was thin and discontinuous. It should be noted that there is a vertical exaggeration of 1:250 in Fig. 1. Behind the crest of the Etsho Escarpment the permafrost was about 20 inches (51 cm) thick. A bench at a lower elevation on the northeast-facing slope of the Etsho Escarpment was very wet because of water draining off higher slopes and, presumably, because of northeasterly-dipping shales forming an impermeable layer which guides ground water to springs along the bench. The permafrost in the substrate below the bench was thinner (about 8 inches, or 20 cm) and penetrable with a probe. The thermal conductivity of the water-saturated ground was much greater than that of other ground, and the continuously icy substrate changed into scattered ice crystals through which it was possible to probe. Northeast of Sahdoanah River, on lower land, the permafrost in organic terrain thickened rapidly to about 40 inches (102 cm), and 60 inches (152 cm) within the Northwest Territories. The permafrost occurred in so-called peat plateaus, an extensive Land System further north<sup>3</sup>.

#### CONCLUSIONS

The thickness and hardness of permafrost in northeastern British Columbia decrease with decreasing latitude toward the southwest, with increased insolation on southwest-facing slopes, and with greater thermal conductivity of surficial layers caused by increased wetness.

#### ACKNOWLEDGEMENTS

This note is based on a field study undertaken for Westcoast Transmission Co. Ltd., and Schultz International Ltd., both of Vancouver, B.C., Canada.

C. B. Crampton  
Simon Fraser University  
Burnaby, B.C., Canada.

#### REFERENCES

- <sup>1</sup>Brown, R. J. E. 1967. *Permafrost in Canada*. Ottawa: National Research Council (Division of Building Research, NRC 9769); Geological Survey of Canada (Map 1246A).
- <sup>2</sup>Valentine, K. W. G. 1971. Soils of the Fort Nelson area of British Columbia. *Canada, Department of Agriculture, Research Branch*, Report no. 12.
- <sup>3</sup>Crampton, C. B. 1975. Landscape mapping in the Mackenzie River Valley. *Arctic*, 28(4): 285-94.

## Relationships between Temperature and Snowfall in Interior Alaska

At the present time there is some uncertainty as to the role of winter and mean annual temperatures in initiating continental glaciation<sup>1</sup>. Although there is no question that cool summers and snowy winters favour glaciation in high latitudes, the possibility must be considered that excessively snowy winters may be warm enough to raise the mean annual temperature. Thus a higher annual mean temperature could be favourable for glaciation. I wish here to present some observations on the relationship between temperatures and snowfall at one Subarctic station (Fairbanks, Alaska).

Temperature anomalies and snowfall were plotted against each other for three separate groups of data. Initially, seasonal mean temperatures (November through February) were plotted against total July-June snowfall for the period 1914-15 through 1973-74. Monthly mean temperature was also plotted against the monthly snowfall total for each of the months November through February over the same period. Finally, six of the snowiest recent months (November and December 1965, February 1966, January 1968 and November and December 1970) were examined for day-to-day relationships between snowfall and temperature.

The daily data showed a definite tendency for snowy days to be above average in temperature, as was anticipated. On a monthly basis, however, Fig. 1 shows that snowy months, except January, had nearly normal temperatures, with months which were unusually warm or cold (as well as some months with normal temperatures) being generally dry. January, the coldest month, did manifest some tendency for snowy months to be warm. (Note that the transitional months, September, October, April and May are not included in this conclusion.) Seasonal figures showed an even more striking reversal, with excessively snowy winters being most often colder than normal. Fig. 2 shows this seasonal relationship. If the data are split into terciles for both total seasonal snowfall and November-February mean temperature, as shown by the lines on the figures, the sixty winters included twelve each cold/snowy and warm/dry, eleven normal for both temperature and precipitation, six each cold/normal and normal/dry, five warm/snowy, three each normal/snowy and warm/normal and two cold/dry. (Three of the five warm/snowy winters were snowy because of excessive