SNOWPACK GRAINSIZE STRATIFICATION AT SCHEFFERVILLE

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ABSTRACT

An intriguing pattern of grain size variations has been observed in snowcover profiles at Schefferville, northern Quebec. Measurements of grain size distributions were obtained at closely spaced vertical intervals in wind sheltered snow covers using an automated sieve shaker at low temperatures (< -15 degrees C). A gradual variation in grainsize distributions with depth was observed. This variation appears to be relatively independent of observable layer structures in the snow cover. The pattern is closely repeatable from one site to another and from one year to the next. One observable trait is that although there is usually a maximum in the largest grain size fractions (>4 mm) at the snow/ground interface, at the same level there is also a marked increase in the finer size fractions (<1 mm). A raised maximum of grain sizes >1 mm occurs at some height (usually around 10 - 40 cm) above the snow/ground interface. The cause of this pattern is, so far, unknown.

INTRODUCTION

In late February 1983 a series of grain size analyses were performed on snow that was sampled from several snow profiles at Schefferville. The analyses were initially undertaken in order to assess the usefulness of sieve analysis for snow grain size determination in very cold field conditions. It was originally thought that perhaps grain size distributions could be employed to distinguish layers deposited by different snowfalls. Upon analysis of the data, however, an intriguing regularity in the grain size variations along the vertical profile was noted at all sites (Granberg, 1984a; 1985).

Sieve analysis is not commonly used for determining grain size distributions in snow. The main reason is that snow tends to agglomerate in the sieve, preventing the separation of the snow aggregate into individual fractions. In cold conditions, however, below about -15 degrees C, sieve analysis produces quite reproducible results (Granberg, 1984a; 1985).

At Schefferville, in the central parts of the Labrador-Ungava peninsula sieve analysis on snow can be performed during much of the winter. This paper describes some preliminary results from sieve analyses that have been performed on snow from wind-sheltered locations over the last few years.

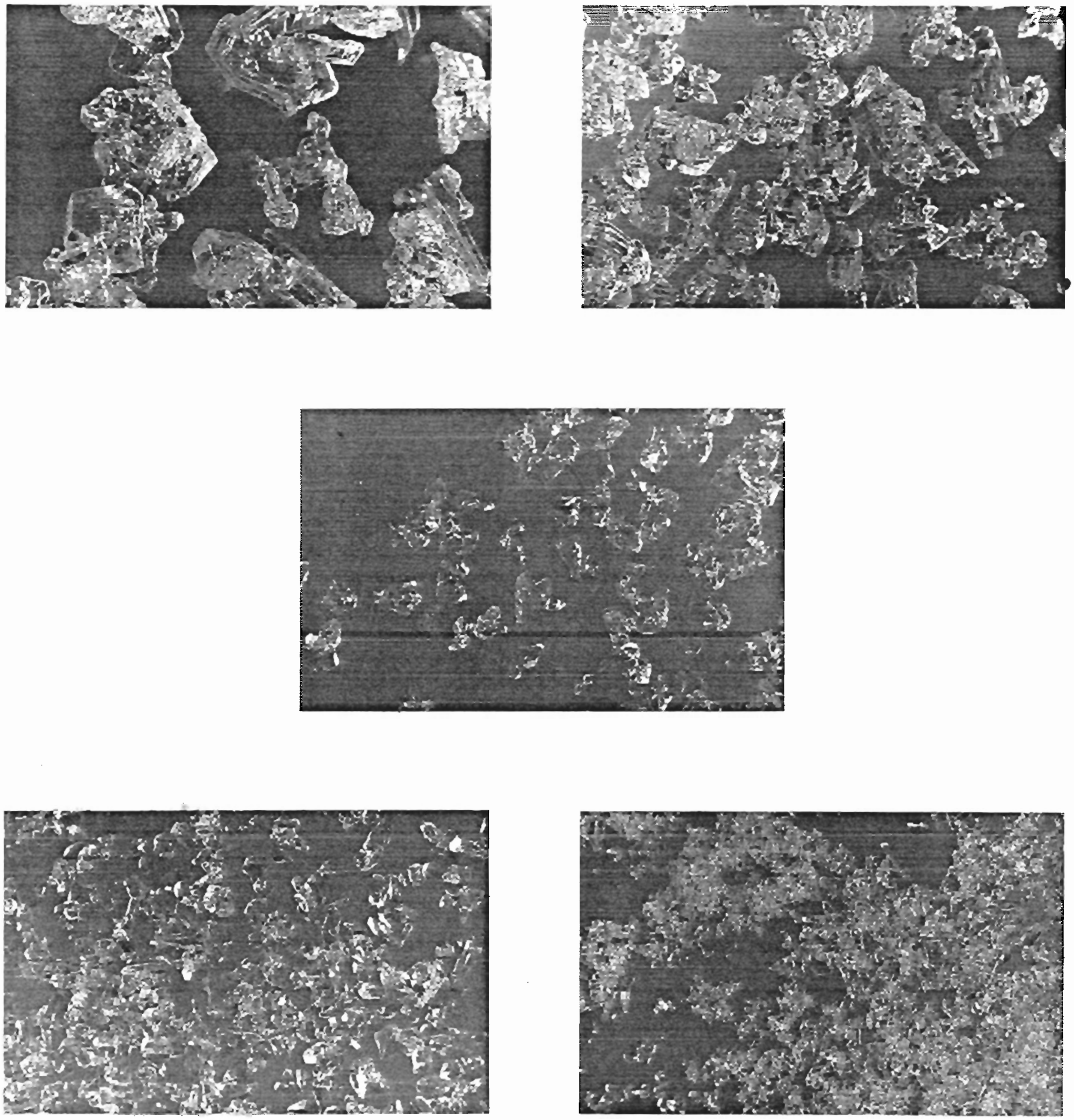
FIELD AND LABORATORY PROCEDURE

Samples were collected at vertical intervals of approximately 10 cm throughout the snow column. A Swedish snow density sampler (Granberg, 1984b; Granberg and Kingsbury, 1984) was used for this purpose. This sampler is essentially a rectangular scoop which is pushed horizontally into the snow pit wall. A hinged lip cuts off the front end of the sample and retains it while a sliding lid cuts off excess snow on top of the sample. The sampler completely encloses the sample (volume is one litre) and both are weighed using a precision spring balance, accurate to 1 g. The sampler measures an unbiased average density, averaged over a 5 cm interval, which is the thickness of the slab it cuts.

After weighing, the samples were transferred to Ziplock plastic bags for transport to the laboratory. All analyses were performed within 36 hours of collecting the samples in the field and at temperatures of -15 to -30 degrees C.

Prior to sieving, the samples were disaggregated by gently hand-kneading the plastic bag until no lumps of snow could be felt. Heavy winter gloves were worn for comfort but also to minimize heat transfer to the sample and excessive crushing of grains.

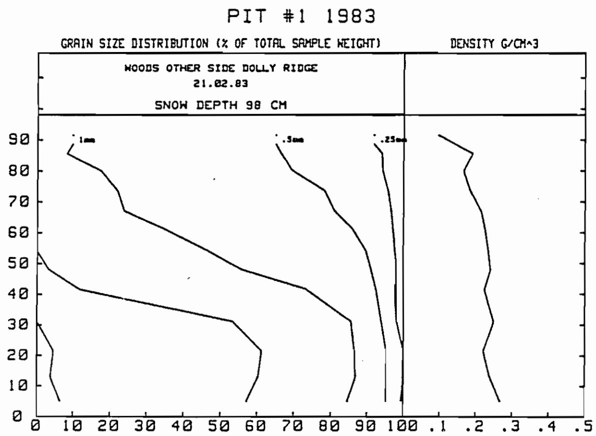
A stack of standard sieves (4, 2, 1, 0.5, 0.25 and 0.125 mm) were used with an automated sieve shaker. Each sample was agitated for an experimentally optimized time of five minutes. The weight of individual sieve fractions were determined using a Mettler 1000 electronic balance.

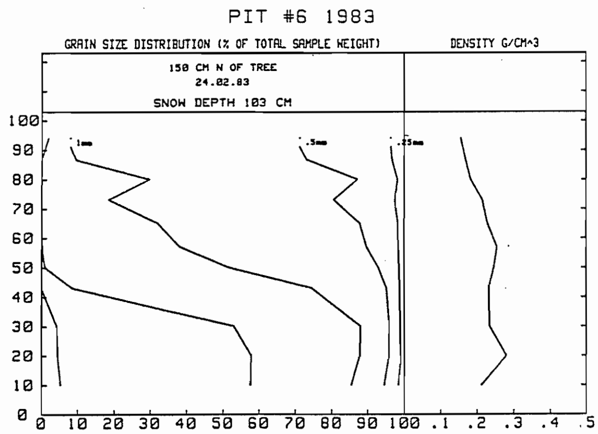


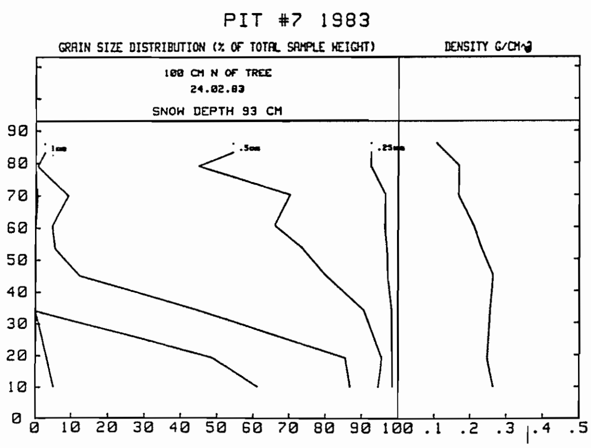
Figures 1-5. Sieve contents in approximately 10X magnification. Figure 1 represents the contents of the 2 mm sieve and Figure 5 the contents of the .125 mm sieve.

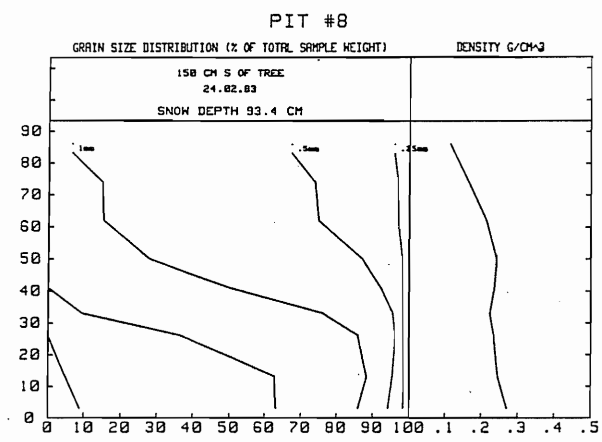
INTERPRETATION OF SIEVE RESULTS

Snow differs from many other materials subjected to sieve analysis in that it is not a granular material but a skeletal substance of interconnected ice grains which has been disaggregated into a granular substance by mechanical disturbance. It is this granular residue retained by each sieve in the stack that gives the grain size distribution. Figures 1 to 5 show grains from different sieve fractions. In the coarser fractions stepped and facetted crystals are common while the finer grain size fractions consist of more rounded grains. In the smallest fraction, needle-like grains may be seen.





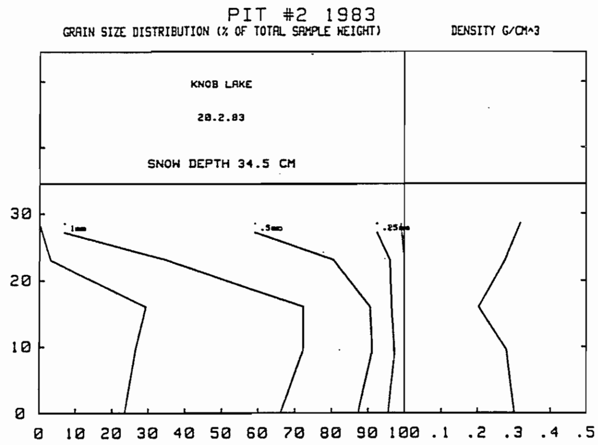




Figures 6-9. Variations in grain size distributions with depth in open woodland near Schefferville in late February 1983.

GRAIN SIZE VARIATIONS IN OPEN WOODLAND IN LATE FEBRUARY, 1983

Figures 6 to 9 show a series of grain size determinations that were made in four widely separated open woodland locations in late February, 1983. A close resemblance exists between the patterns of grainsize variations with depth measured at the different sites. Intuitively at least, one might have expected a strong dependence of the grainsize distributions on the layering produced by individual storm events. However, such a dependence does not seem to exist. Further, one might have expected a gradual increase in the weight fraction retained by each sieve size as the snow/ground interface is approached. This appears to be the case for the coarsest sieve mesh but the finer mesh sizes show a maximum in the percentage of snow retained at a height of 10-40 cm above the ground/snow interface. The reason for this raised maximum is unknown. It does not appear to be related to milling of snow in the sieve by the larger particles present in the snow aggregate near the ground. Nor does it appear to be related to the character of the underlying surface, i.e. it occurs over ice as well as over vegetated surfaces.



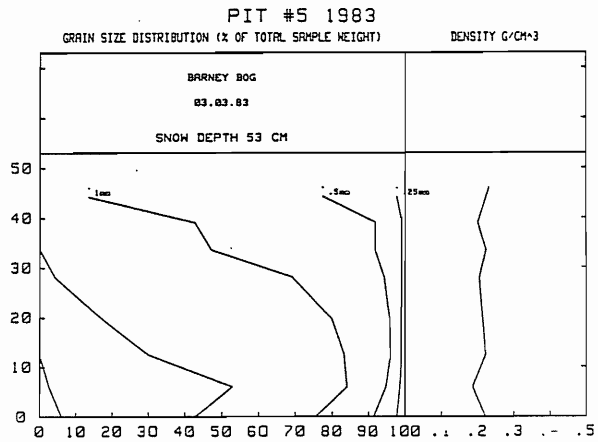


Figure 10. Variations in grain size distribution with depth on Knob Lake.

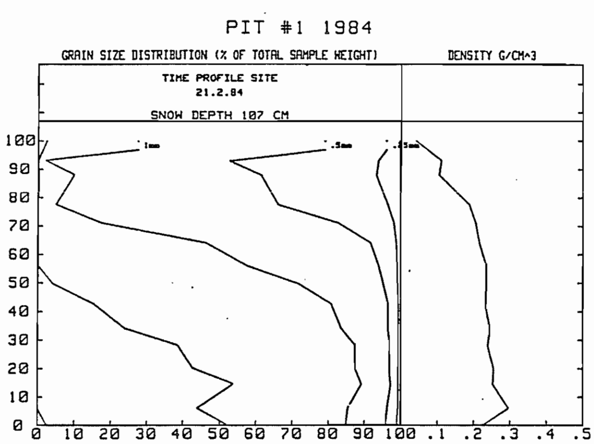
Figure 11. Variations in grain size distribution with depth on small bog.

GRAINSIZE VARIATIONS ON LAKES AND BOGS

Samples from Knob Lake and a small bog near Barney, 30 km NW of Schefferville show a similar pattern of grainsize variation with depth (Figs. 10 and 11). The actual grain size distributions differ from those in open woodland but the general pattern is similar.

GRAINSIZE DISTRIBUTIONS IN OPEN WOODLAND IN LATE FEBRUARY 1984 AND 1986

Repeat surveys were made in late February both in 1984 and in 1986 (Figs. 12 and 13). The same general pattern is evident in both years although the weather and snow conditions were different.



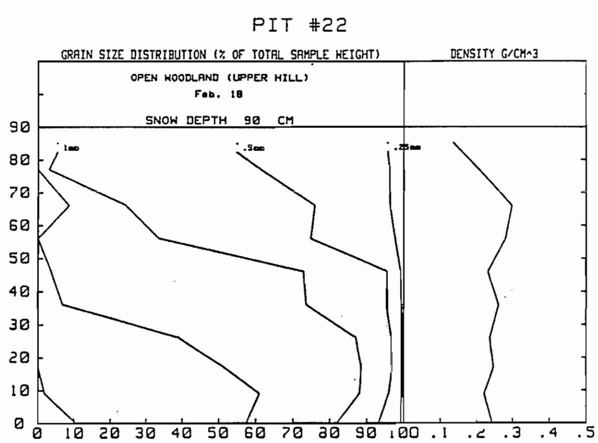
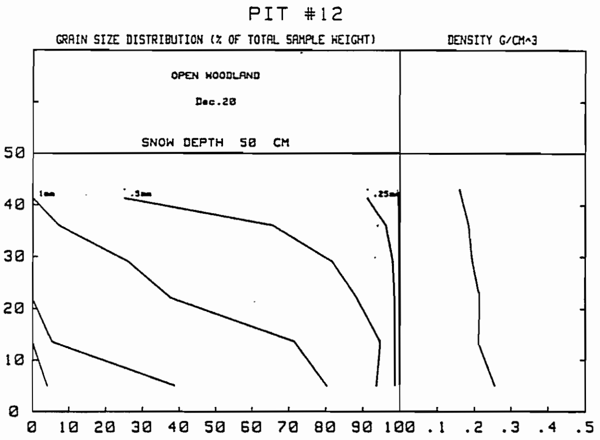


Figure 12. Grain sizes in open woodland, late February 1984.

Figure 13. Grain sizes in open woodland, late February 1986.



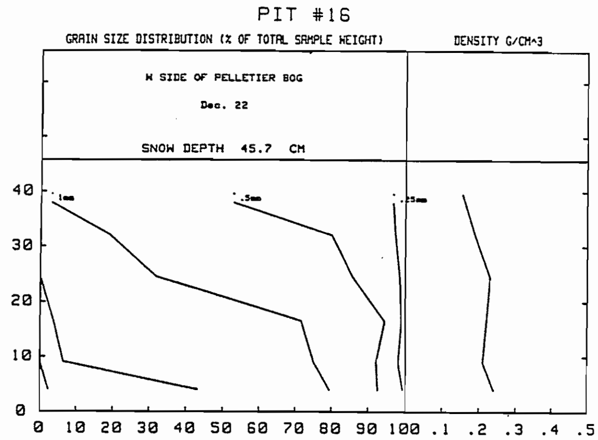


Figure 14. Grain sizes in open woodland, late December 1985.

Figure 15. Grain sizes in open woodland, late December 1985.

GRAINSIZE VARIATIONS IN DECEMBER 1985

A few surveys were made during late December, 1985. Although the results are occasionally difficult to interpret because of the much shallower snow conditions and the smaller number of samples per profile, the same pattern of grainsize variation with depth is observed (Figs. 14 and 15).

CONCLUSION

Snowpack grainsize distributions change with depth in a pattern which varies only slightly over space in open woodland snowcovers near Schefferville. A similar pattern occurs on bogs and lakes. The pattern is repeated from one year to the next with slight variations depending, presumably, on weather and snowfall conditions.

ACKNOWLEDGEMENTS

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