

CORRESPONDENCE

The Editor,

Journal of Glaciology

SIR, *Deducing thickness changes of an ice sheet: comments on the paper by J. F. Nye*

We have read with great interest the article of Nye (1975) in which he corrects an error in our earlier paper (Federer and others, 1970) and proposes a better model for calculating the surface lowering of the Greenland ice sheet. A surprising fact is that the movement of the reference points in the shaft of 40 m depth at Jarl Joset Station does not agree with Nye's prediction. If his model were applicable, the value of $\partial h/\partial t$ should be constant (or a plot of $\delta h/\delta t$ versus depth should at least approach a steady value at the lower layers). According to Nye's equation (3)

$$\frac{\delta h}{\delta t} \rho(z) = a^* \rho_w - V(z) \rho(z)$$

the second term on the right should not be constant. From our measurements, however, we find that $V(z)\rho(z)$ is constant for a dozen reference points from 5 m to 40 m depth (Sury and Haefeli, 1975).

Nevertheless the measured movement of the lowest reference point can be used to calculate the surface lowering according to Nye's model and to compare this value with the final result of the survey, now reported by Seckel (unpublished) in his thesis. From this it is seen that the measured surface lowering is 1.0 ± 0.2 m from 1960 to 1968. The difference between this and the earlier value (1.74 m) is due, among other things, to improved values of the horizontal surface velocity $v_r = 17$ m a⁻¹ and an increased surface slope $\tan \alpha \approx 0.35\%$. Thus the values in our earlier paper (Federer and others, 1970) must be corrected as follows: $v_x \tan \alpha \approx 0.06$ m a⁻¹; $V_r = v_r - v_x \tan \alpha = 0.45 - 0.06 = 0.39$ m a⁻¹; and $V_r^* = 0.27$ m a⁻¹ (not 0.29 m a⁻¹).

The yearly mass deficit (1959-68) now becomes $a^* - V_r^* = 0.193 - 0.27 = -0.077$ m a⁻¹. The surface lowering according to Nye's model

$$\frac{\partial h_v}{\partial t} = -\frac{0.077}{0.69} = -0.112 \text{ m a}^{-1}$$

Thus the theoretical value of the surface lowering between 1960 and 1968 of 0.89 m is in good agreement with Seckel's measurement of 1.0 ± 0.2 m. This suggests that Nye's model can eventually be used for layers which are not too close to the surface.

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SIR, *Ice from different latitudes*

"Not many years ago, Ice was in many parts of the world looked upon as a rarity, and one, too, attainable only at certain periods of the year. Now, however, it takes its place among the necessities of civilized life, and is to be met with at all seasons, in every land where comfort and luxury are known. By the persevering enterprise of our Atlantic neighbours, the 'Wenham Lake' and 'Fresh Pond Ice' are as extensively known, and as highly prized, as 'Barclay and Perkins XX', or the Sparkling Wines of Champagne."

This seems to be a quotation worthy of repetition in the pages of this *Journal* in case there are still any readers who have not yet appreciated to the full the remarkable qualities of ice. The words quoted are those which appear at the start of a very small (and fragile) pamphlet published in Montreal in the year 1849 (Savage, 1849). The little leaflet is one of the prized possessions of the Lande Collection of Canadiana, now in the safe keeping of the Rare Book Department, McLennan Library, McGill University to which it was given by Lawrence M. Lande, a retired notary public whose name has been given to the associated Foundation for Canadian Studies.

The author of the pamphlet was Alfred Savage, a chemist and druggist of Montreal. He had become interested in the design and construction of small buildings for the storage of ice. "An Ice House", he wrote, "is a necessary appendage of every substantial Farmer's dwelling. It is not for the sake of 'Sherry Cobblers' . . . that it has great value in his eyes, but as a means of preserving, in the finest condition, during hot months, his Viands, his Butter, his Cream . . . his whole perishable stock of provisions."

Alfred Savage describes himself as "an old and experienced hand [at building Ice Houses] who has, for the last five years, had proof of the soundness of the statements now advanced. He is mainly indebted for his information, to an excellent article on Chinese Ice Houses, which appeared some six years ago in *Chambers' Edinburgh Journal*. He has also enjoyed the advantage of some suggestions from that enterprising Ice Merchant, N. Wyeth, of Cambridge, near Boston."

Older residents of North America can still remember the wide use of ice houses (some of great size) from which supplies of ice were obtained for servicing the "ice-boxes" to be found in almost every home before the advent of the modern electric refrigerator. Some are still in use in more remote districts. This old record of their construction would not warrant mention in these pages were it not for the comments that the author makes on the properties of ice. He concludes his short (five-page) text with "a word or two on the comparative value of Ice produced in different latitudes."

"Many seem to think that Ice is the same all over the world. No matter whether the thermometer stands at 25 below zero or at 32—the point at which water assumes the solid form—both are alike, say they, in the amount of cold they contain. A cubic foot of the one, they allege, is as dense as a cubic foot of the other. Such, however, is far from being a fact; for scientific men have satisfactorily shown, that the colder the climate in which it is formed, the more compact are its crystals, and the longer it will keep. This being the case, it would appear important that Ice Houses be filled during cold and clear weather; and in purchasing a foreign article, either for storing or immediate domestic use, a preference should be given to that which is brought from the coldest latitudes."

"The climate of Canada is particularly favourable for the formation of Ice. The magnificent River St. Lawrence, (whose transparent water is the wonder and admiration of every traveller) passes through a vast northern territory, where, for three months during the Winter, the thermometer ranges from 5 to 25 below zero. This vast stream is now one mass of the most brilliant Ice to be met with in the world. Its average thickness is twenty-five inches, and always perfectly transparent; while that formed along the American seaboard rarely reaches half this, and cannot, as has been well proved, be kept nearly so long."

"Permit us then to recommend the lovers of this modern and delightful luxury, to purchase the *St. Lawrence Ice*, which is formed from the *purest* water in the world, and which contains a degree of cold far exceeding that produced by either the 'Wenham Lake' or 'Fresh Pond'."

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