SIR, *Seismic refraction measurements on the McMurdo Ice Shelf, Antarctica*

Studies of the McMurdo Ice Shelf, Antarctica, have demonstrated the presence of brine in the ice matrix at depths which are comparable to sea-level, but which also depend on firn compaction and the flowing movements of the ice shelf (Macdonald and Hatherton, 1961; Stuart and Bull, 1963). This layer is important both in physical and chemical studies of the ice shelf (Wilson and Heine, 1964) and in structural studies for airfield construction. The brine is usually detected by drilling from the surface or by electrical resistivity methods but the former is time-consuming and physically difficult, while the latter is difficult to interpret. That seismic refraction measurements may provide a simple and satisfactory alternative is suggested by an experiment recently conducted on the McMurdo Ice Shelf, about 1,200 m. east-south-east of Scott Base.

A portable electronic stop-clock was used to measure the transit time for the first arrival of seismic waves from a sledge-hammer blow on a steel plate placed on the snow surface. Geophones placed beside the plate and at various distances from it provided start and stop signals for the timer. Density measurements in similar situations show that the degree of firn compaction increases fairly smoothly with depth (Stuart and Bull, 1963), and it is reasonable to assume that the seismic velocity increases smoothly from a low surface value and approaches the value for clear ice (3,700 m./sec. measured both on blue lake and glacier ice) at some depth. The effect of brine soaking into firn should be to aid compaction by excluding air and freezing new ice between the cold grains (Wilson and Heine, 1964). This layer would then exhibit a higher seismic velocity.

The experimental results are shown in Figure 1. Error bars are ±1 msec. Using conventional refraction theory for a horizontally stratified medium (Heiland, 1963), the best fit to the data was obtained by assuming a surface velocity of 1,100 m./sec. increasing linearly by 300 m./sec. per metre depth, underlain by a layer with a velocity of 3,000 m./sec. at a depth of 5·9 m. The resulting travel-time curve is also shown in Figure 1.

Since cores from a hole drilled at the site showed a fairly uniform increase in firn compaction to a depth of 5·7 m. where brine soaking was encountered, it is reasonable to associate the brine-soaked firn with the 3,000 m./sec. layer at the 5·9 m. depth deduced above.

Deteriorating weather conditions prevented experiment at places where the brine lies deeper in the ice shelf but the method appears worthy of further investigation, particularly as it could provide a ready method of extrapolating brine levels between well-separated test holes, as well as giving information on the degree of firn compaction.

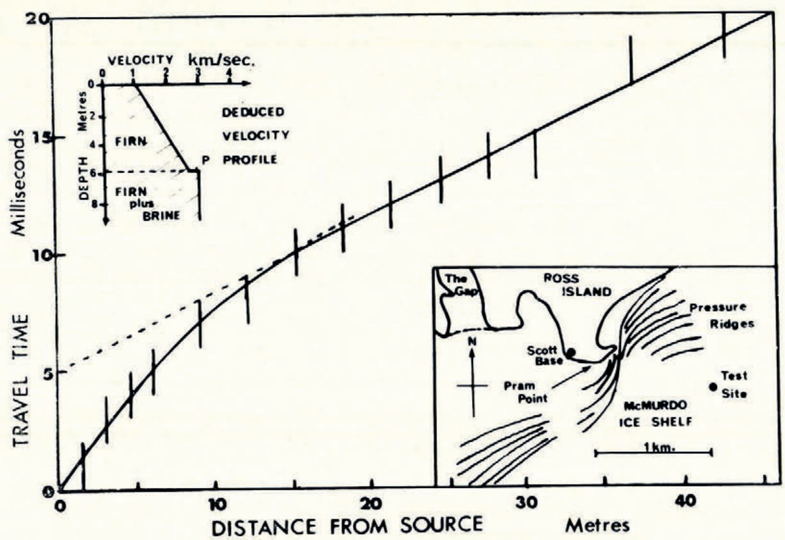

Fig. 1. Seismic first arrival travel-time plot

We are grateful to Messrs D. Palmer, M. Schaefer and R. Hoare for assistance in this experiment, which was carried out during the ninth Victoria University of Wellington Antarctic Expedition.

Victoria University of Wellington,
P.O. Box 196, Wellington,
New Zealand

R. A. I. BELL

Antarctic Division, D.S.I.R.,
Private Bag, Wellington,
New Zealand

A. J. HEINE

1 March 1965

REFERENCES

Heiland, C. A. 1963. *Geophysical exploration*. New York, Hafner.
Macdonald, W. J. P., *and* Hatherton, T. 1961. Movement of the Ross Ice Shelf near Scott Base. *Journal of Glaciology*, Vol. 3, No. 29, p. 859–65.
Stuart, A. W., *and* Bull, C. 1963. Glaciological observations on the Ross Ice Shelf near Scott Base, Antarctica. *Journal of Glaciology*, Vol. 4, No. 34, p. 399–414.
Wilson, A. T., *and* Heine, A. J. 1964. The chemistry of ice-shelf brines. *Journal of Glaciology*, Vol. 5, No. 38, p. 265–67. [Letter.]