TABLE 2. Data on Compressibility of Ice

Data Source	T, °C	Linear Compressibility, Mb^{-1}		Volume Compressibility, Mb^{-1}
		⊥c	||c	
Jona and Scherrer [1952]	-16	3.7	3.7	11.1
Bass et al. [1957]	-10	4.1	4.6	12.8
Dantl [1969]	-10	4.0	4.7	12.7
Richards and Speyers [1914]	-7			12
This paper	-10	3.7	3.6	11

offsets registered with ice at the test pressure decreased to 0 when the pressure was reduced to 0 would indicate that the deformation is entirely elastic. All factors considered, the over-all accuracy of the linear compressibility of ice obtained with this technique is about 10%.

Materials tested. Three types of ice were tested: single-crystal ice prepared by the technique of zone refining, single-crystal ice obtained from the terminus of the Mendenhall glacier, Alaska, and polycrystalline ice prepared in the laboratory. The single-crystal specimens were carefully oriented by optical methods to permit measurements of compressibility in directions parallel and perpendicular to the crystallographic c axis. All specimens were microscopically flawless; they lacked all trace of bubbles and cracks, appeared completely devoid of small angle boundaries, and contained negligible quantities of impurities, dissolved or solid.

RESULTS

Data are presented in Table 1. Linear compressibility of single crystals is given for the two principal directions, parallel and perpendicular to the crystallographic c axis. Small differences between the parallel and perpendicular directions for a particular type of single crystal are probably not too significant when the over-all 10% error in this method is considered. However, both the laboratory-grown crystal and the polycrystalline specimen exhibit a somewhat lower compressibility (3.5–3.6 Mb^{-1}) than the single-crystal ice from the Mendenhall glacier (3.9 Mb^{-1}). If these differences are significant, they could possibly be attributed to the greater elasticity of the naturally occurring ice, which is known to have undergone a long history of annealing recrystallization at the terminus of the Mendenhall glacier.

The mean value of all measurements in the pressure range 0–0.31 kb at −10°C is 3.7 Mb^{-1}. Because of the small difference in compressibility (<10%) between the two principal directions of crystallographic orientation in ice, the volume compressibility of ice should be approximately equal to 3 times the mean linear compressibility, i.e., $3 \times 3.7\ Mb^{-1} = 11.1\ Mb^{-1}$.

Comparisons with published data on the compressibility of ice are shown in Table 2. The data of *Jona and Scherrer* [1952], *Bass et al.* [1957], and *Dantl* [1969] were calculated from measurements of the elastic constants of single-crystal ice; those of *Richards and Speyers* [1914] are a direct determination. Some spread of values is evident. However, the results indicate that the linear compressibilities perpendicular and parallel to the c axis agree within 10%, except for Dantl's data, for which the difference is about 18%, and that the volume compressibilities are in good agreement with the direct experimental value of Richards and Speyers and are in disagreement with the measurements of Bridgman.

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REFERENCES

Bass, R., D. Rossberg, and G. Ziegler, Die elastischen Konstanten des Eises, *Z. Phys., 149,* 199–203, 1957.

Birch, F., Compressibility; Elastic constants, in *Handbook of Physical Constants, Mem. 97,* edited by S. P. Clark, pp. 107 and 119, Geological Society of America, Boulder, Colo., 1966.

Bridgman, P. W., Water in the liquid, and five solid forms under pressure, *Proc. Amer. Acad. Arts Sci., 47,* 441–558, 1912.

Bridgman, P. W., The compressibility of thirty metals as a function of pressure and temperature, *Proc. Amer. Acad. Arts Sci., 58,* 166–242, 1923.

Dantl, G., Elastic moduli of ice, in *Physics of Ice,* edited by N. Riehl, B. Bullemer, and H. Engelhardt, pp. 223–230, Plenum, New York, 1969.

Jona, F., and P. Scherrer, Die elastischen Konstanten von Eis-ein-kristallen, *Helv. Phys. Acta, 25,* 35–54, 1952.

Richards, T. W., and C. L. Speyers, The compressibility of ice, *J. Amer. Chem. Soc., 36,* 491–494, 1914.

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