elastic constants (obtained from the data of Table 5) and from the isothermal pressure derivatives of the adiabatic elastic constants (Table 5) are listed in Table 7. The isothermal pressure derivatives of the adiabatic elastic constants were used instead of the purely isothermal quantities because the conversion would require knowledge of the complete set of the third-order elastic constants [*Thurston*, 1967]. However, the correction is likely to be only small. The results obtained for the lattice parameters are shown in Figure 4. The results differ from those in Al_2O_3 [*Gieske and Barsch*, 1968] in that the linear compressibilities of the two directions in the hexagonal base plane (*b* and *c*) are higher and less pressure-dependent than the linear compressibility in the direction of the hexagonal axis (*a*). The error bars indicate the uncertainty estimated from the errors of the ultrasonic input data. No directly measured data on the pressure dependence of the lattice parameters of forsterite are available for comparison.

REFERENCES

Anderson, D. L., Bulk modulus-density systematics, *J. Geophys. Res., 74*, 3857-3864, 1969.

Anderson, D. L., and H. Kanamori, Shock-wave equations of state for rocks and minerals, *J. Geophys. Res., 73*, 6477-6502, 1968.

Anderson, O. L., Determination and some uses of isotropic elastic constants of polycrystalline aggregates using single-crystal data, in *Physical Acoustics, 3*, edited by W. P. Mason, Academic Press, New York, 1965.

Anderson, O. L., The use of ultrasonic measurements under modest pressure to estimate compression at high pressure, *J. Phys. Chem. Solids, 27*, 547-565, 1966.

Anderson, O. L., E. Schreiber, R. C. Liebermann, and N. Soga, Some elastic constant data on minerals relevant to geophysics, *Rev. Geophys., 6*, 491-524, 1968.

Barsch, G. R., Relation between third-order elastic constants of single crystals and polycrystals, *J. Appl. Phys., 39*, 3780-3792, 1968.

Birch, F., Elasticity and constitution of the earth's interior, *J. Geophys. Res., 57*, 227-286, 1952.

Bogardus, E. H., Third-order elastic constants of Ge, MgO, and fused SiO_2, *J. Appl. Phys., 36*, 2504-2513, 1965.

Bragg, W. L., and G. B. Brown, Die Struktur des Olivins, *Z. Krist., 63*, 538, 1926.

Bridgman, P. W., Rough compression of 177 substances to 40.000 KG/CM², *Proc. Am. Acad. Arts Sci., 76*, 71-87, 1918.

Chung, D. H., The first pressure derivatives of polycrystalline elastic moduli: their relation to single-crystal acoustic data and thermodynamic relations, *J. Appl. Phys., 38*, 5104-5113, 1967.

Fisher, E. S., and H. J. McSkimin, Adiabatic elastic moduli of single-crystal alpha uranium, *J. Appl. Phys., 29*, 1473-1481, 1958.

Gibbs, G. V., P. B. Moore, and J. V. Smith, Crystal structures of forsterite and hortonolite varieties of olivine, *Geol. Soc. Am. Spec. Papers, 76*, 66, 1964.

Gieske, J. H., and G. R. Barsch, Pressure dependence of the elastic constants of single crystalline aluminum oxide, *Phys. Status Solidi, 29*, 121-131, 1968.

Graham, E. K., The elastic coefficients of forsterite as a function of pressure and temperature, Ph.D. thesis, The Pennsylvania State University, University Park, 1969.

Harris, P. G., A. Reay, and I. G. White, Chemical composition of the upper mantle, *J. Geophys. Res., 72*, 6359-6369, 1967.

Kumazawa, M., and O. L. Anderson, The elastic moduli, pressure and temperature derivatives, of single-crystal olivine and single-crystal forsterite, *J. Geophys. Res.*, this issue, 1969.

Leibfried, G., Gittertheorie der mechanischen und thermischen Eigenschaften der Kristalle, in *Encyclopedia of Physics, 7*, Pt. 1, edited by S. Flügge, pp. 104-324, Springer Verlag, Berlin, 1955.

McSkimin, H. J., Pulse superposition method for measuring ultrasonic wave velocities in solids, *J. Acoust. Soc. Am., 33*, 12-16, 1961.

McSkimin, H. J., Ultrasonic methods for measuring the mechanical properties of liquids and solids, in *Physical Acoustics, 1*, Pt. A, edited by W. P. Mason, 271-334, Academic Press, New York, 1964.

Murnaghan, F. D., The compressibility of media under extreme pressures, *Proc. Math. Acad. Sci., U.S., 30*, 244-255, 1944.

Overton, W. C., Jr., Relation between ultrasonically measured properties and the coefficients in the solid equation of state, *J. Chem. Phys., 37*, 116-119, 1962.

Reay, A., Mantle composition and partial fusion of possible mantle material, Ph.D. thesis, University of Leeds, Leeds, England, 1965.

Ringwood, A. E., Mineralogy of the mantle, in *Advances in Earth Science*, edited by P. M. Hurley, 357-399, M.I.T. Press, Cambridge, 1966

5960 GRAHAM AND BARSCH

Robie, R. A., P. M. Bethke, M. S. Toulmin, and J. L. Edwards, X-ray crystallographic data, densities, and molar volume of minerals, sect. 5, in *Handbook of Physical Constants, Memoir 97*, rev. ed., edited by S. P. Clark, Jr., pp. 27–73, Geological Society of America, New York, 1966.

Schreiber, E., and O. L. Anderson, Pressure derivatives of the sound velocities of polycrystalline forsterite, with 6% porosity, *J. Geophys. Res.*, *72*, 762–764, 1967.

Shankland, T. C., Synthetic forsterite, *Bull. Ceram. Soc. Am.*, *46*, 1160–1162, 1967.

Skinner, B. J., Thermal expansion of ten minerals, *U.S. Geol. Surv. Prof. Paper 450D*, 109–112, 1962.

Soga, N., The temperature and pressure derivatives of isotropic sound velocities of α-quartz, *J. Geophys. Res.*, *73*, S27–S29, 1968.

Soga, N., E. Schreiber, and O. L. Anderson, Estimation of bulk modulus and sound velocities of oxides at very high temperatures, *J. Geophys. Res.*, *71*, 1320–1336, 1966.

Thomsen, L., and O. L. Anderson, On the high-temperature equation of state of solids, *J. Geophys. Res.*, *74*, 981–991, 1969.

Thurston, R. N., and K. Brugger, Third order elastic constants and the velocity of small amplitude elastic waves in homogeneously stressed media, *Phys. Rev.*, *113A*, 1604–1610, 1964.

Thurston, R. N., Effective elastic coefficients for wave propagation in crystals under stress, *J. Acoust. Soc. Am.*, *37*, 348–356, 1965.

Thurston, R. N., Calculation of lattice-parameter changes with hydrostatic pressure from third-order elastic constants, *J. Acoust. Soc. Am.*, *41*, 1093–1111, 1967.

Verma, R. K., Elasticity of some high-density crystals, *J. Geophys. Res.*, *65*, 757–766, 1960.