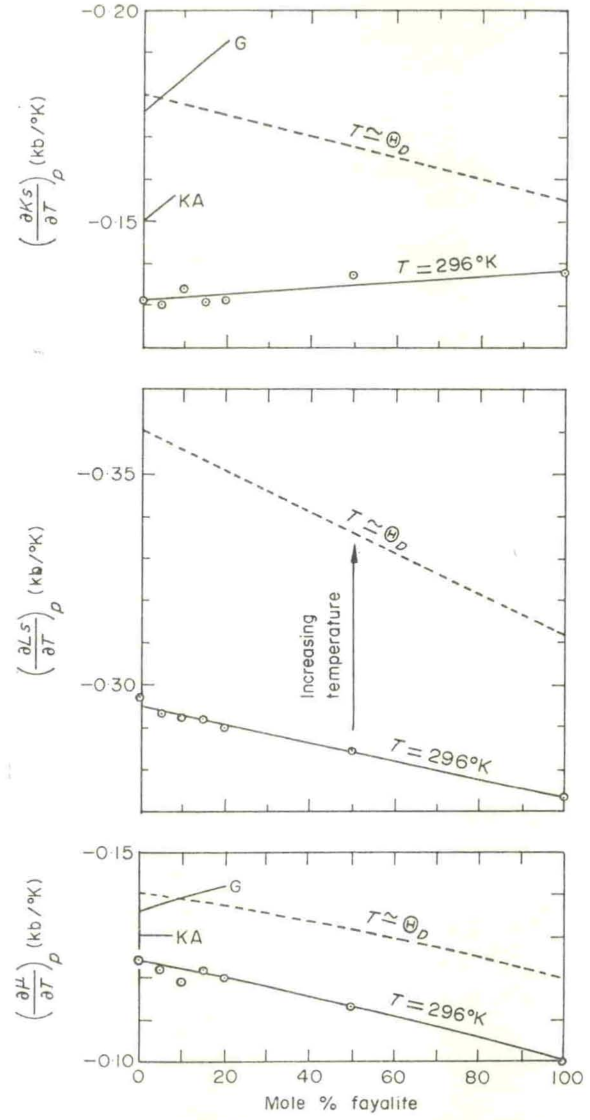

FIG. 4. Variation of temperature derivatives of the elastic constants of olivine with (Fe/Mg) ratio. High-temperature values evaluated at the Debye temperature of each olivine are indicated with a dotted line. (G) stands for Graham's (1970) work and (KA) indicates work of Kumasawa & Anderson (1969); (⊙) are the present work.

the (dK_s/dT) value of forsterite is $-0{\cdot}131$ kb/° K, and for fayalite the (dK_s/dT) value is $-0{\cdot}138$ kb/° K.

Whether an elastic constant is a unique function of volume or not is an important question often asked by geophysicists. The answer to this question forms a basis of the so-called 'Law of Corresponding State' in thermodynamics of solids. An important consequence of the elasticity data reported here is that we can examine the above question in a systematic manner. The elastic constant M_j of olivine can be treated as a function of volume (thus interatomic separation) and temperature.

$$M_j = M_j(V, T) \,. \tag{8}$$

Taking logarithms and differentiating both sides with respect to temperature and rearranging the results, we find

$$\text{(total)} = \text{(implicit)} + \text{(explicit)}$$

$$\frac{d \ln M_j}{dT} = -\alpha_v K_T \left(\frac{\partial \ln M_j}{\partial p}\right)_T + \left(\frac{\partial \ln M_j}{\partial T}\right)_V. \tag{9}$$

Hence, from the present data on both the pressure and temperature derivatives of the elastic constants, we should be able to separate out the *changes* due to temperature from those due to volume. Table 4 lists the pressure and temperature coefficients of compressional (L_s) and shear (μ) moduli along with those of the adiabatic bulk modulus (K_s). The quantities of interest here are $(\partial \ln M_j/\partial T)_V$ which are found from our experimental data; they are listed in the last column of Table 4. If the elastic constants are a function of volume alone, i.e. $M_j = M_j(V)$, then we would expect the quantity represented by the explicit term to be zero. But it is evident from Table 4 that this explicit term is a non-zero value implying the elastic constants are not a function of volume alone.* Most crystalline solids of geophysical interest

Table 4

Test on the volume-dependence Hypothesis of the elastic constants (at 296° K)

Olivine composition, mole %	α_v 10^{-5}/°K	M_j	$\frac{d \ln M_j}{dT}$ 10^{-5}/°K	$\alpha_v K_T \left(\frac{\partial \ln Mi}{\partial p}\right)_T$ 10^{-5}/°K	$\left(\frac{\partial \ln Mi}{\partial T}\right)_V$ 10^{-5}/°K
100 Fo	2·55	L_s	−12·6	+10·4	− 2·2
		μ	−15·6	+ 7·5	− 8·1
		K_s	−10·2	+12·7	+ 2·5
50 Fo	2·43	L_s	−13·1	+10·1	− 3·0
		μ	−16·8	+ 5·9	−10·9
		K_s	−11·0	+13·1	+ 2·1
100 Fa	2·40	L_s	−13·9	+10·2	− 3·7
		μ	−18·3	+ 3·4	−14·9
		K_s	−11·3	+14·1	+ 2·8

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*Geophysical literature concerned with the elasticity often assumes the elastic constants are a function only of volume, but this is clearly incorrect. Anderson & Nafe (1965, p. 3959) found a relationship between the shear modulus and volume for oxide compounds, but this correlation seen by these authors should be re-examined before being accepted. The elastic constants of most alkali halides in which there are prominent central forces between the constituent ions can be treated as a unique function of volume only, as was first demonstrated by Lazarus (1949). A direct translation of this picture of the alkali halides to the system of oxides and silicates is dangerous and often misleading.