For olivine, this correction is found to be small, as compared with experimental errors involved in the K_0 and m values, and is therefore neglected for present purposes.

The calculated volume-pressure trajectories for 100Fo and 100Fa olivines are compared with compression data in Fig. 8. The compression data entered here are those of Bridgman, Takahashi, and McQueen *et al.*; it is seen that the trajectories compare very well with these compression data.

5.2. *Variation with temperature*

Pressure increases the density of olivine, but temperature reduces it; thus there is a critical pressure p_{cr} defined by the pressure, for a given temperature, at which

$$\rho\,(p_{cr}, T) = \rho(p = 0, T = RT)$$

RT refers to an ambient reference temperature. At p_{cr}, temperature effects on density cancel the pressure effects completely. Below p_{cr}, temperature effects on the density dominate over the pressure effects, and above p_{cr} the pressure effects dominate over the temperature effects on the density of the solid. This critical pressure for olivines with different Fe/(Mg+Fe) ratios can be estimated from data on thermal expansion and compression ratio resulting from the equation of state (10) by

$$p_{cr}(T) = K_T(T)\{(p/K_0)\} \quad \text{at } \rho_0/\rho(T). \tag{11}$$

Values of the critical pressure for olivine at three chosen temperatures (700°, 1000° and 1700°K) are listed in Table 7. For example, at 1000°K, p_{cr} for forsterite is about 34 kb and about 26 kb for fayalite.

The Birch equation of state is isothermal referring to the compression ratio $\rho(p, T)/\rho(p = 0, \quad T = RT)$ and $K_0(p = 0, T)$. Suppose, however, we wish to relate all our compression data to the ambient conditions. Then, in accordance with the procedure described earlier (see CWS, p. 5119), we have

$$\frac{\rho(p, T)}{\rho(p = 0, T = RT)} = \frac{\rho(p, T)}{\rho(p = 0, T)} \cdot \frac{\rho(p=0, T)}{\rho(p = 0, T = RT)} \tag{12}$$

under the assumption that the density ratio given by $\rho(p = 0, T)/\rho(p = 0, T = RT)$ is independent of pressure. (This assumption is a practical one and a good approxima-

Table 7

Relative density and 'Critical' pressure of olivine at three different temperatures

Property†	Temperature, °K	Olivine composition, mole % 100 Fo	90 Fo	80 Fo	50 Fo	100 Fa	Probable error, %
$\rho(p, T)/\rho_0$	700	0·9852	0·9853	0·9861	0·9872	0·9883	1
	1000	0·9732	0·9740	0·9744	0·9763	0·9789	1
	1700	0·9440	0·9450	0·9462	0·9500	0·9560	3
p_{cr}, kb	700	19·5	19·4	18·1	16·7	15·1	2
	1000	33·7	32·5	32·3	29·8	25·6	2
	1700	69·5	67·5	65·2	60·1	51·4	5

† The *critical* pressure referred here to as p_{cr} is defined as the pressure, for a given temperature, at which $\rho(p_{cr}, T) = \rho(0, 296°\text{K})$, and is meant to imply the following: Pressure works in the opposite direction of temperature, but at p_{cr} temperature effects cancel the pressure effects on density. Above this p_{cr}, the pressure effects dominate over the temperature effects in solid.

tion, since a factor of three change in thermal expansion changes the density ratio by less than 1 per cent.) Thus we can obtain $\rho(p, T)/\rho(p = 0, T = RT)$ by multiplying the isothermal compression ratio $\rho(p, T)/\rho(p = 0, T)$ by the constant factor $\rho(p = 0, T)/\rho(p = 0, T = RT)$ obtained from thermal expansion data. The results on two chosen temperatures (1000° and 1700° K) are plotted in Fig. 7. Fig. 7 shows the pressure–dependent density of olivine as a function of temperature and Fe/(Mg+Fe) ratio. It is generally seen that olivines of all the compositions are more compressible at high temperatures. It is also seen that the greater the Fe/(Mg+Fe) ratio in olivine the more compressible the olivine becomes at all temperatures.

6. *Application to the Earth*

The elasticity data presented in this paper may aid discussion of the Earth's mantle within a peridotitic model. We have attempted to relate the elasticity data with the bulk sound velocity and density distribution in the Earth's mantle. As noted by Pree (1970b), a comparison of laboratory data with velocity–density distribution of earth models minimizes the errors arising from uncertain temperature distributions in the Earth's interior.

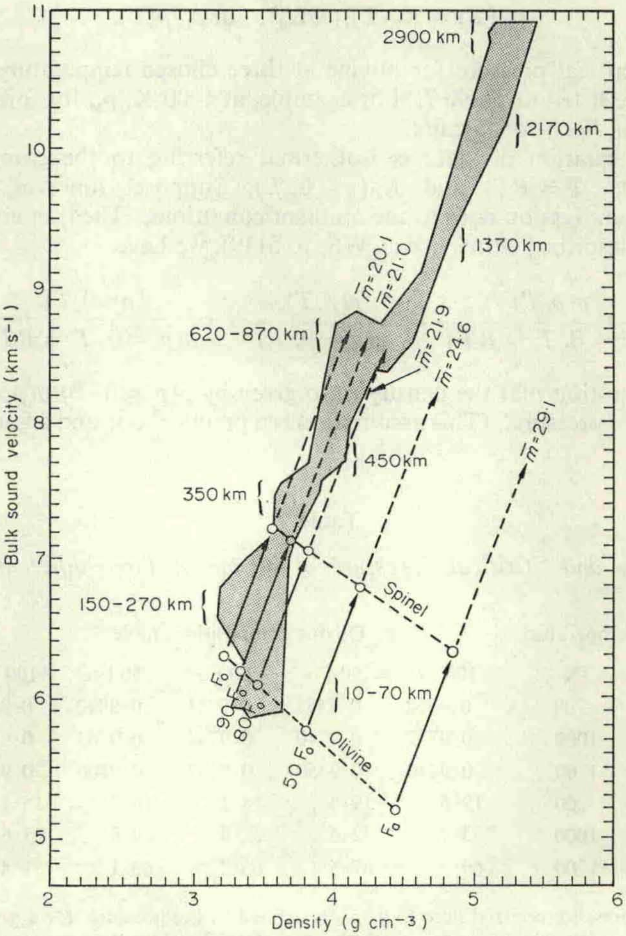

FIG. 9. Comparison of the laboratory $V_\phi - \rho$ relation for olivine with F. Press's solutions of the Earth data.