

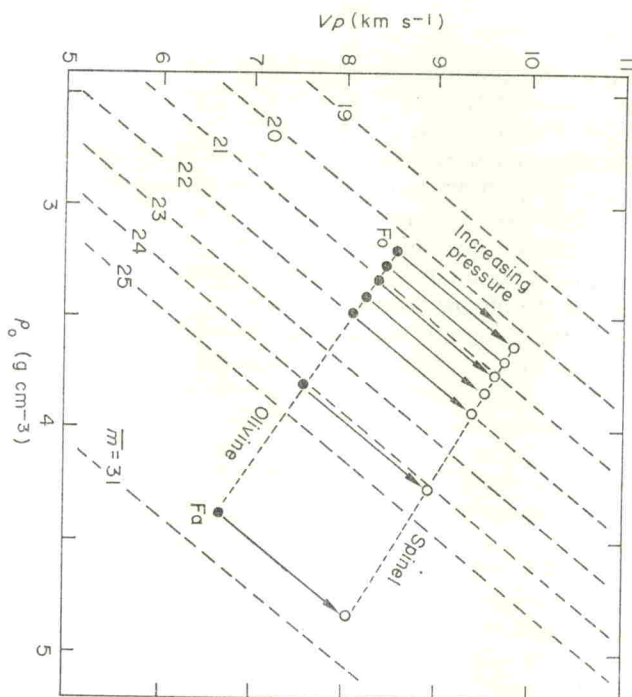


FIG. 5(a). Compressional wave velocity-density-mean atomic weight relation for olivine. The contours of $\bar{m}$ are drawn from Birch's law. The closed circles represent experimental quantities and the open circles show estimated values for the olivine-transformed spinels.

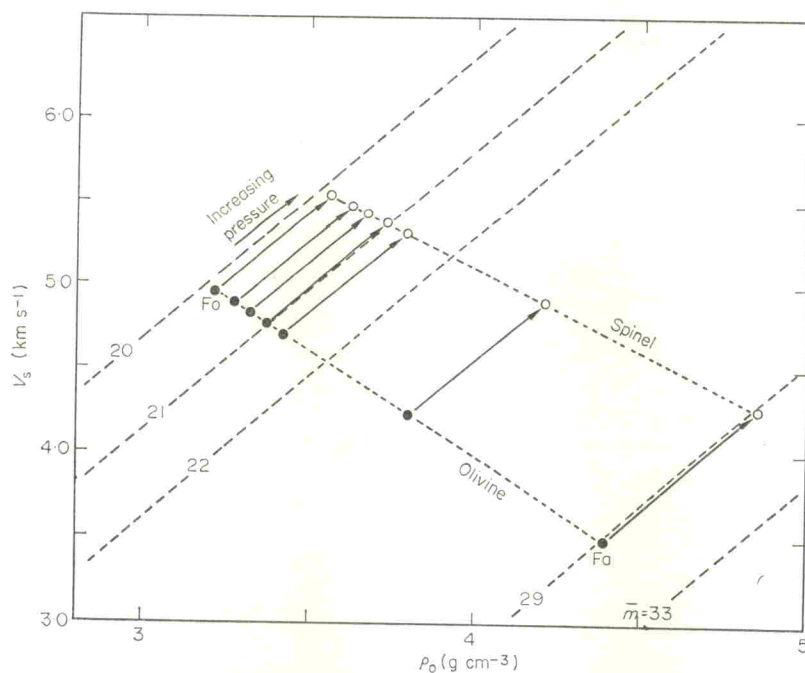


FIG. 5(b). Shear wave velocity-density-mean atomic weight relation for olivine. The closed circles are the present experimental data; the open circles represent estimated values for the olivine-transformed spinels.

Generalization and discussion

As concluded in the previous paper (Chung 1970), the iron substitution for magnesium in the olivine lattice results in a systematic decrease in the velocity of both P and S waves. Iron increases the density but slightly reduces the bulk modulus of olivine, thus making an iron-rich olivine slightly more compressible. The bulk modulus is inversely proportional to volume, as was discussed by Anderson & Nafe (1965) and Knopoff (1967). The mean atomic volume defined by $(\bar{m}/\rho)$ for fayalite is 6.624 cm^3 , whereas forsterite is 6.254 cm^3 ; for fayalite in comparison with forsterite, there is a 4.7 per cent reduction in the bulk modulus, and this is consistent with about 5 per cent increase in the olivine volume.

The velocities of the compressional and shear waves in olivine are plotted respectively in Fig. 5(a) and (b) as a function of density and also of the $\text{Fe}/(\text{Mg} + \text{Fe})$ ratio. The same diagram as Fig. 5(a) has appeared in the earlier report, in which the contours of the mean atomic weight were derived from the well-known Birch's law for the velocity-density-mean atomic weight relation for minerals and rocks. The contours in Fig. 5(b) were drawn in a similar way from the shear velocity-density line for $\bar{m} = 21$, based on work of Simmons (1964), Kanamori & Mizutani (1965), and Christensen (1966a, b). Christensen (1968) established similar contours and found a relation that $V_s = 1.63\rho - 0.88$, where V_s is in (km s^{-1}) and ρ in (g cm^{-3}) . The velocity of the bulk waves (frequently called 'hydrodynamical waves') as a function of density and mean atomic weight is plotted in Fig. 5(c), in which the contours were drawn from the calculated bulk velocity-density for rocks and minerals based on the velocity measurements of Birch (1960, 1961a), Simmons (1964), Kanamori & Mizutani (1965), and Christensen (1966a, b). These calculated data points establishing the contours of Fig. 5 are omitted from the diagrams so that the present olivine data alone can be clearly illustrated.

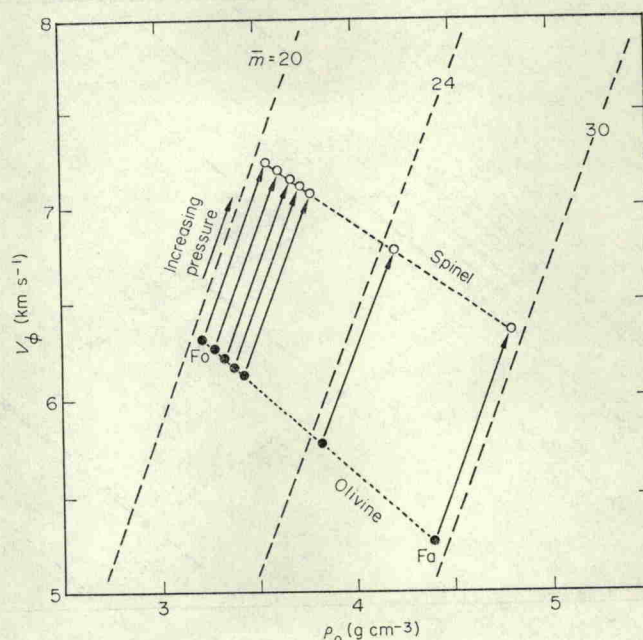


FIG. 5(c). Bulk sound velocity-density-mean atomic weight relation for olivine. The closed circles are the present experimental data; the open circles represent estimated values for the olivine-transformed spinels.