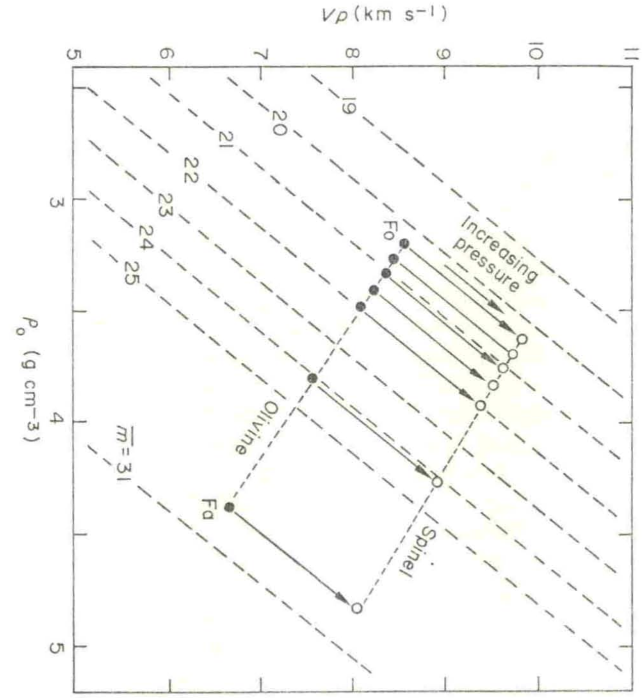

FIG. 5(a). Compressional wave velocity-density-mean atomic weight relation for olivine. The contours of $\bar{m}$ are drawn from Birch's law. The closed circles represent experimental quantities and the open circles show estimated values for the olivine-transformed spinels.

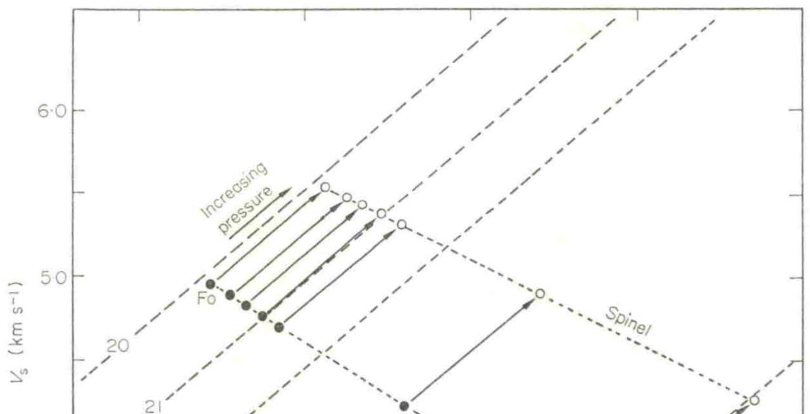

FIG. 5(b). Shear wave velocity-density-mean atomic weight relation for olivine. The closed circles are the present experimental data; the open circles represent estimated values for the olivine-transformed spinels.

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 $6{\cdot}624\ cm^3$, whereas forsterite is $6{\cdot}254\ cm^3$; 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 Fe/(Mg+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 $V_s = 1{\cdot}63\rho - 0{\cdot}88$, 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.

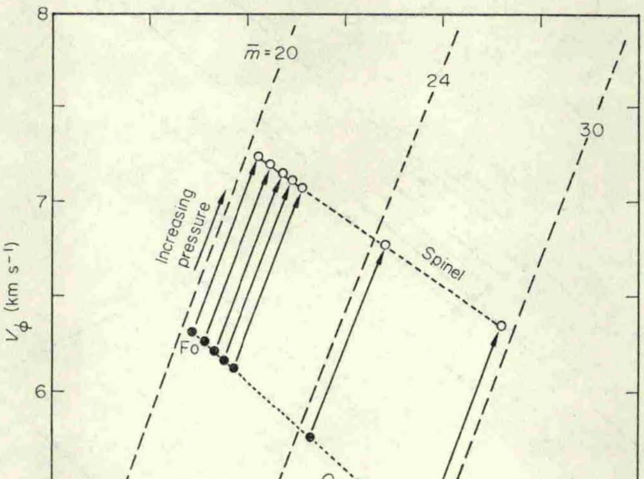

FIG. 5(c). Bulk sound velocity-density- mean atomic weight relation for olivine. The closed circles are the present experimental data; the open circles represent estimated values for the olivine-transformed spinels.