TABLE 3. Literature Data on the Elastic Properties of Various Olivines (evaluated at 296°K and 1 bar)

Property	Forsterite					Peridot		Dunite (at 10 kb)				Hortonolite		Fayalite		
ρ, g/cm^3	3.222[a]	3.021[b]	3.204[c]	3.224[d]	3.222[e]	3.324[f]	3.311[g]	3.312[h]	3.326[i]	3.330[j]	3.300[k]	3.595[l]	3.744[m]	4.068[n]	4.393[o]	4.283[p]
V_p, km/sec	(8.1)	7.586	8.16	8.569	8.593	8.482	8.421	8.42	(8.42)	8.66	8.52	7.4	7.36	6.60	6.74	6.485
V_s, km/sec	···	4.359	4.90	5.015	5.032	4.933	4.887	(4.83)	4.83	4.74	4.80	···	3.90	···	···	3.417
Φ, (km/sec)^2	···	32.2	35.0	39.9	40.1	38.8	39.1	39.8	39.8	44.8	41.9	···	33.9	···	···	···
K_s, mb	1.22	0.974	1.12	1.286	1.291	1.289	1.294	1.32	1.32	1.50	1.38	1.12	1.27	1.04	1.10	1.164
μ, mb	···	0.574	0.769	0.8108	0.816	0.806	0.7908	···	0.776	0.75	0.760	···	0.57	···	···	0.513
σ_s	(0.27)	0.254	···	0.240	···	0.245	0.246	0.255	0.255	0.286	0.267	(0.27)	0.30	(0.27)	(0.28)	···

Values in parentheses are assumed values by the author cited.

[a] *Adams* [1931]; natural forsterite minerals.

[b] *Schreiber and Anderson* [1967]; sintered sample.

[c] *Marsh and Sheinberg* [1969]; hot-pressed sample.

[d] *Kumazawa and Anderson* [1969]; VRH values (arithmetic average of Voigt and Reuss values) from single-crystal data.

[e] *Graham and Barsch* [1960]: VRH values from single-crystal data.

[f] *Verma* [1960]; VRH values from single-crystal data of $(Mg_{0.92}Fe_{0.08})_2SiO_4$.

[g] *Kumazawa and Anderson* [1969]; VRH values from single crystal data of $(Mg_{0.93}Fe_{0.07})_2SiO_4$.

[h] *Birch* [1960]; Twin Sisters dunite (92% olivine + 7% pyroxene).

[i] *Simmons* [1964]; Same as *Birch's* [1960] samples.

[j] *Christensen* [1966]; Twin Sisters dunite.

[k] *Kanamori and Mizutani* [1965]; Horoman dunite (88% olivine + 11% pyroxene).

[l] *Adams* [1931]; 50% Fo + 50% Fa.

[m] *Birch* [1960] and *Simmons* [1964]; Mooihoek Mine hortonolite dunite.

[n] *Adams* [1931]; sample obtained from a blast-furnace slag.

[o] *Mizutani et al.*, [1970]; polycrystalline sample.

[p] *Fujisawa* [1970]; polycrystalline sample.

making Fe-rich olivine more compressible) because the bulk modulus is inversely proportional to volume [see, for example, *O. L. Anderson* and *Nafe*, 1965; *Knopoff*, 1967; *D. L. Anderson and O. L. Anderson*, 1970]. The velocity varies with the inverse square root of the density but it varies as the square root of the modulus-to-density ratio. In the forsterite-fayalite solid-solution series, an increase in the iron content affects only very slightly the bulk modulus (i.e., 1.281 mb for forsterite and 1.22 mb for fayalite) but causes a wide variation in the density.

The compressional velocity in olivine as a function of density is plotted in Figure 1. The contours in the figure are derived from Birch's law [*Birch*, 1961*b*, 1964; *Simmons*, 1964] relating the velocity-density-mean atomic weight of rocks and minerals. Note that the compressional velocity in olivines with different Fe/Mg ratios lie on a dashed line of the forsterite-fayalite isomorph. Not only the compressional velocity as shown in Figure 1, but also the shear velocity and the bulk velocity (though not shown here) were seen to behave in a similar manner for this series of olivine isomorphs.

Olivines are unstable at high pressures and transform to spinel structures with an increase of density to about 10% [see *Ringwood*, 1969]. At 1273°K, the olivine-spinel transformation pressures for forsterite and fayalite are 140 kb and 50 kb, respectively [see *Ringwood* and *Major*, 1966; *Ringwood*, 1969; *Akimoto and Fujisawa*, 1968]. The determination of the sound velocities in the olivine-transformed spinels with the compositions studied here has been an important objective of our laboratory efforts. Thus far, however, we were unable to obtain enough amounts of the transformed spinel materials. While the present report was in preparation, an important paper by *Mizutani et al.*, [1970] was published. These authors, after their successful preparation of a fayalite-transformed spinel sample, performed a measurement of the compressional velocity as a function of pressure to about 6 kb. They found the compressional velocity in the spinel form of Fe_2SiO_4 is 8.05 km/sec at ambient conditions. This value is an approximate 20% increase in the velocity from that of fayalite.

The important datum of *Mizutani et al.* [1970] has been plotted in Figure 1. This datum

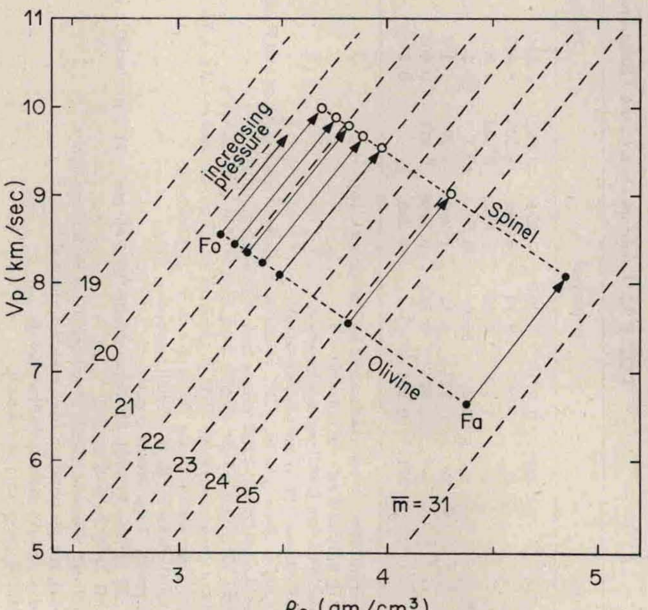

Fig. 1. The compressional velocity–density relation for olivine with different Fe/Mg ratios. The contours are drawn from Birch's law. The closed circles represent experimental quantities; the open circles show hypothetical data points.