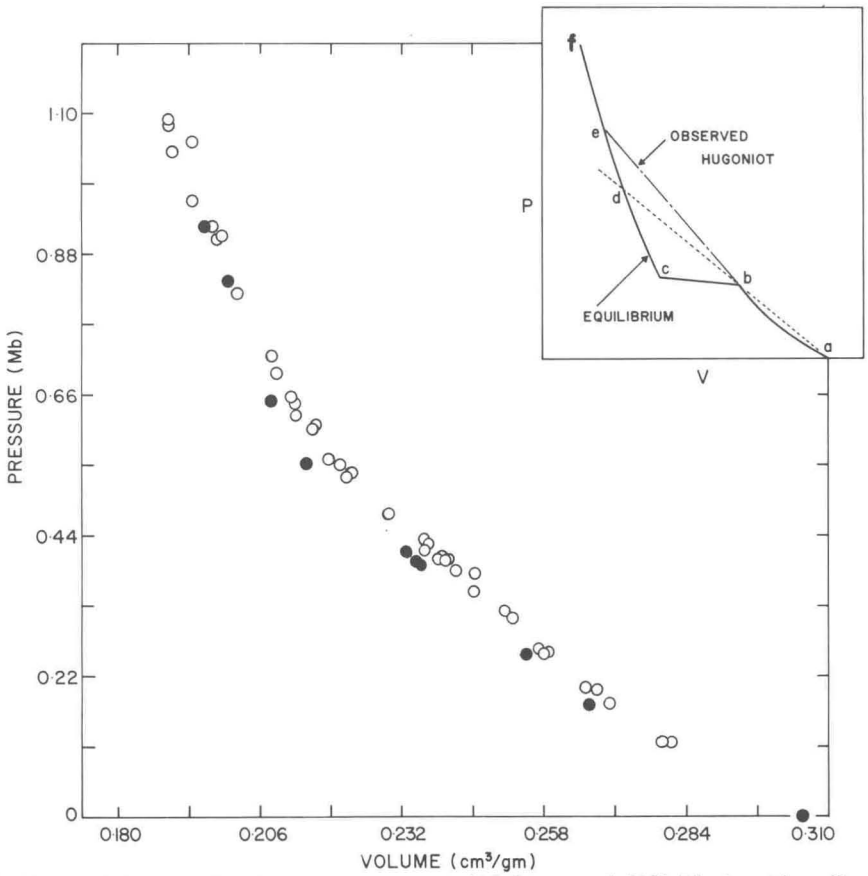

Fig. 3. Display of shock-wave data points for a bronzititic pyroxene of McQueen et al. [15]. The insert is an illustration of a pressure-volume Hugoniot of a solid undergoing phase change. The equilibrium pressure-volume relation is given by the path abcf. Under most shock conditions, the solid-solid transformation begins immediately but does not go to completion; the pressure-volume relation in this case follows a path designated by abef.

sure trajectories are those data points resulting from shock-wave compression experiments of Wackerle [12], Al'tshuler et al. [13] and McQueen [14]. The present trajectory for stishovite, with possible errors as indicated in fig. 2, is seen to match the shock-wave data points in the high-pressure region quite well.

The third example is concerned with an application of the present scheme for a study of high-pressure phases in the earth's interior. Pyroxene, next to olivine, is believed to be one of the most abundant minerals in the upper mantle. Pyroxene subjected to mantle conditions undergoes a number of phase changes. Much of the geophysical literature [17] suggests that pyroxene, with a composition of $(Mg_{0.9}\,Fe_{0.1})SiO_3$ for example, would transform to 1) garnet, 2) spinel plus stishovite, 3) ilmenite, 4) a mixture of close-packed oxides (referred to hereafter as "oxidesmixture") and/or 5) perovskite structure. The use of eqs. (3) and (5), when combined with shock-wave compression data, can permit one to conclude which of these phases is most probable at high pressures. Take the example as follows.

Consider the compression data resulting from shock-wave experiments on a bronzititic pyroxene as displayed in fig. 3. These data on bronzititic rocks of the Bushveld and Stillwater Complexes are from McQueen et al. [15]. These rocks are characterized by high-purity orthopyroxene with an Fe/Mg ratio of about 0.1. Under most shock conditions, the solid-solid transformation begins immediately but does not go to completion; this means that, although the pressure lies slightly above the Raleigh ray through the "mixed-phase"

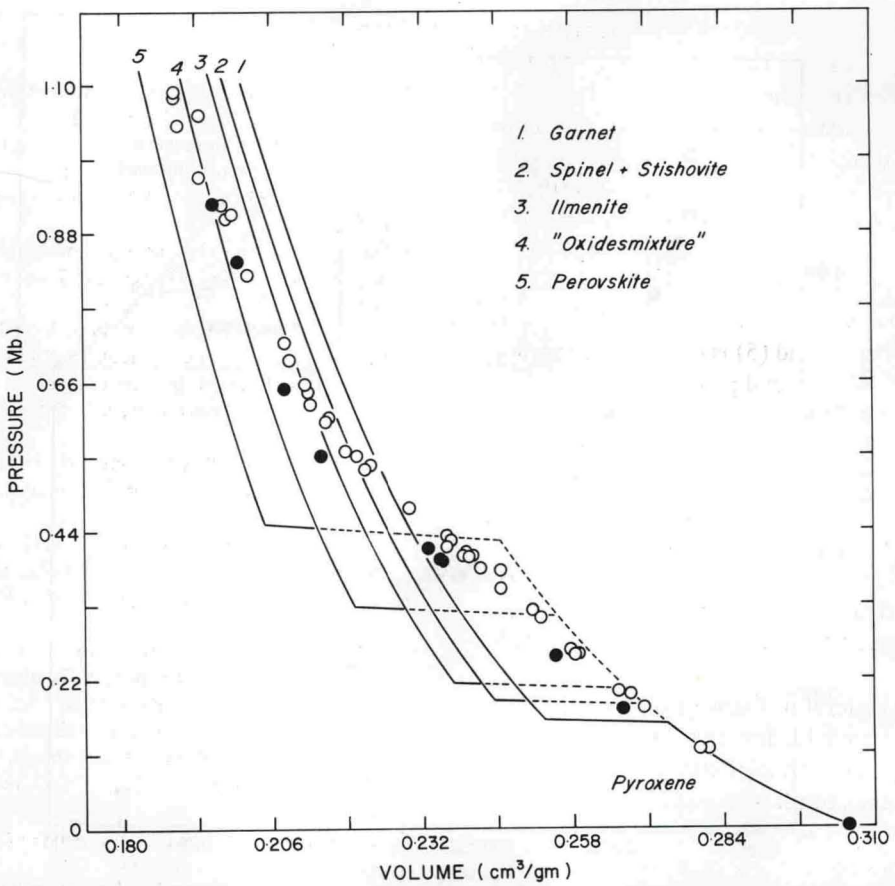

Fig. 4. Analysis of the shock-wave data points displayed in fig. 3 in terms of the possible high-pressure phases of pyroxene. The most probable high-pressure phase of bronzititic pyroxene is *"oxidesmixture"*, as illustrated by the pressure-volume Hugoniot (4) at high pressures.

region as illustrated by the insert in fig. 3, the slope does not increase as rapidly as it would if the material had stayed in the initial phase. Therefore, the data points as displayed in this figure constitute a series of pressure-volume relationships for different phases in metastable conditions. Analysis of these data points would then be possible only for two regions of pressures, one at low pressures where bronzitite is stable and the other at high pressures where this material transformed to the most stable high-pressure phase. The EOS parameters of pyroxene with this bronzitite composition ($\rho_0 = 3.273$ g/cm^3) have been reported by this author [16] as $K_s = 1.06$ (±0.03) Mb and $(\partial K_s/\partial p) = 5.5$ (±0.3). Based on these parameters and using the scheme in this paper (as illustrated by the two examples above), we can find K_s and $(\partial K_s/\partial p)$ values for all possible high-pressure phases listed earlier from eqs. (3) and (5). Results of these calculations are summarized in table 2 (part C). The pressure-volume trajectories * inferred from the usual Hugoniot equation of state [15] are shown in fig. 4; superimposed on these trajectories are those shock-wave data presented in fig. 3. Note that, at low pressures, the pressure-volume trajectory of pyroxene superimposes well on the low-pressure shock compression data. Note also that trajectory (4), labelled *oxidesmixture*, matches the compression data points in the 0.8–1.1 Mb region very well, suggesting that the most stable phase of the bronzitite under high pressures is the *oxidesmixture* of (x periclase + y wüstite + z

* Footnote: See next page.