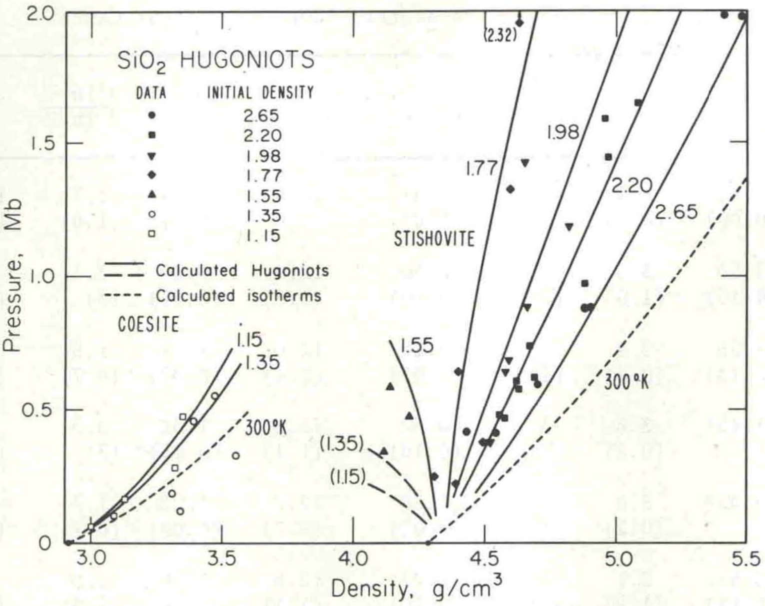

Fig. 1. Hugoniot data of quartz and porous quartz and calculated Hugoniots and 300°K isotherms of 'coesite' and stishovite. Data sources are given in Tables 1 and 2. Calculated curves are from stishovite case 2 (Table 4) and 'coesite' case 1 (Table 6). Numbers labeling curves indicate the initial density of the shocked sample.

The details of the analyses will now be discussed individually for stishovite and 'coesite,' and the effects of assumptions made in the analyses will be noted. However, it will be seen that the preceding general picture is not greatly perturbed.

Stishovite. The results of three different analyses of the stishovite data will now be given. In the first case, standard errors of the pressure of each set of compression data (shock and static) were estimated, and the data were weighted accordingly. (The quantity minimized was $\sum(P_i^c - P_i)^2/\sigma_i^2$, where P_i^c is the calculated pressure, P_i is the observed pressure, σ_i is the estimated standard error, and the summation is over all data points [e.g., *Mathews and Walker*, 1965].) Although K_0 is known approximately from the ultrasonic measurements of *Mizutani et al.* [1972], we preferred to determine it independently from the compression data. Thus the quantities K_0, K_0', K_0'', and $(\partial K/\partial T)_P$ were determined from the compression data, V_0 and α were taken from Table 1, and C_v was calculated from the Debye model. For the calculation of C_v, the Debye temperature given by *Kieffer and Kamb* [1972] as the high temperature limit of the data of *Holm et al.* [1967] was used. The estimated standard errors are listed in Table 3, the resulting values of the parameters and their calculated standard errors are listed in Table 4 (case 1), and the calculated Hugoniots and the 300°K isotherms are compared with the Hugoniot data in Figure 2. It can be seen that this solution does not fit the Hugoniots of the more porous samples

TABLE 3. Standard Errors Assumed for Stishovite Compression Data (All values in megabars.)

Data	Cases 1, 2, and 4	Cases 3 and 5
S1	0.3	0.5
S2	0.2	0.2
S3	0.2	0.1
S4	0.3	0.5
S5	0.3	0.5
S6	0.6	1.0
S7	0.3	0.3
S8	1.0	0.5
S9	1.0	0.1
S10	1.0	1.0
X1	0.015	0.015
X2	0.015	0.015

TABLE 4. Stishovite Parameters Found in Various Cases

Case	K_0, Mb	K_0'	K_0K_0''	$(\partial K_0/\partial T)_P$, kb/°K	α, 10^{-6}/°K	γ_0	$\dfrac{d \ln \gamma}{d \ln V}$	δ_T
1	3.42 (0.09)	4.9 (0.7)	-2 (5)	-0.61 (0.07)	16.4*	1.61 (0.1)	5.7 (1.6)	10.9 (1.6)
2	3.50 (0.15)	3.5 (1.0)	-2 (3)	-0.30 (0.10)	12.9 (1.3)	1.30 (0.15)	3.1 (3)	6.7 (3)
3	3.55 (0.13)	2.8 (0.4)	-2 (1)	-0.20 (0.03)	12.0 (0.5)	1.22 (0.07)	1.9 (0.7)	4.7 (0.7)
4	3.45*	3.8 (0.8)	-3 (3)	-0.32 (0.10)	13.3 (1.1)	1.32 (0.15)	3.3 (3)	7.1 (3)
5	3.45*	3.0 (0.2)	-2 (1)	-0.20 (0.02)	12.2 (0.2)	1.22 (0.09)	1.7 (0.7)	4.7 (0.7)
2*a*	3.57 (0.19)	2.1 (1.8)	27 (20)	-0.23 (0.10)	12.6 (1.1)	1.30 (0.14)	2.9 (2.5)	5.0 (2)
3*a*	3.50 (0.16)	2.2 (1.0)	14 (10)	-0.17 (0.05)	12.1 (0.6)	1.22 (0.08)	1.8 (1)	4.0 (1)

Standard errors due to scatter in the data are given in parentheses.
*Fixed value from Table 1.

very well at all, partly because the data points on the lower-porosity Hugoniots have a greater density and partly because the value of γ_0 is constrained to a high value by the value of α used and the value of K_0 required to fit the lower-porosity Hugoniots.

As a first step toward improving the fit of the higher-porosity Hugoniots, α was allowed to be determined by the compression data, along with the other parameters previously determined. The results are given in Table 4 (case 2) and illustrated in Figure 1, the stishovite curves being those corresponding to the present case. Lowering the value of α to 13×10^{-6}/°K has lowered γ_0 to 1.3 and significantly improved the fit to the higher-porosity Hugoniots. However, the full range of the Hugoniot data is not shown in Figures 1 and 2. The data of *Trunin et al.* [1971*a*, *b*] extending up to 6.5 Mb for the initial densities of 1.77 and 2.65 g/cm^3 are shown in Figure 3. The corresponding calculated Hugoniots and the 300°K isotherm of the present case are also shown (case 2). The 1.77-g/cm^3 Hugoniot curve does not fit the corresponding datum at 2.3 Mb very well.

To further improve the fit to the higher-porosity Hugoniots, the Hugoniot data were assigned new standard errors to weight the porous data more heavily relative to the other data. The new set of standard errors is given in Table 3. The results are given in Table 4 (case 3) and illustrated in Figures 3 and 4. Figure 3 in particular shows that the fit to the 1.77-g/cm^3 Hugoniot data has improved. The value of α has decreased further to 12×10^{-6}/°K.

The values of the zero pressure bulk modulus K_0 range from 3.42 to 3.55 Mb for the three cases considered. These values fall within the range 3.46 ± 0.24 Mb given by *Mizutani et al.* [1972] for the isentropic bulk modulus determined from elastic-wave velocity measurements. The 300°K isotherms for these cases also agree well with the static-compression data of *Liu et al.* [1972]. These data are shown in Figure 5, together with the three calculated isotherms. Also shown are the static-compression data of *Bassett and Barnett* [1970]. These data have been discussed by *Liu et al.* [1972], who suggest that the five highest-pressure data points