TABLE 1*a*. Shock-Wave and Static-Compression Data for Stishovite

Code	Source	No. of Points	Initial Density, g/cm^3	Pressure Range, Mb
	Shock-Wave Data			
S1	*Wackerle* [1962]	12	2.65	0.4 to 0.7
S2	*Al'tshuler et al.* [1965]	3	2.65	0.6 to 2.0
S3	*Trunin et al.* [1971*a*]	12	2.65	0.4 to 6.5
S4	*Wackerle* [1962]	3	2.20	0.5 to 0.6
S5	H. Shipman (private communication, 1969)	5	2.20	0.6 to 1.6
S6	*McQueen* [1968]	34	2.20	0.4 to 0.8
S7	*Trunin et al.* [1971*b*]	2	2.20	0.5 to 1.6
S8	*Jones et al.* [1968]	6	1.98	0.4 to 1.4
S9	*Trunin et al.* [1971*b*]	6	1.77	0.2 to 2.3
S10	*Trunin et al.* [1971*b*]	3*	1.55	0.3 to 0.6
	Static-Compression Data			
X1	*Liu et al.* [1972]	9		0 to 223†
X2	*Bassett and Barnett* [1970]	14		0 to 85†

*May be interpreted as coesite-stishovite mixture (see text).
†Value in kilobars.

The resultant wide spread of the Hugoniots provides stronger constraints on γ. Also, *Mizutani et al.* [1972] have measured ultrasonically the compressional- and shear-wave velocities of stishovite, and thus another constraint on K_s is provided.

In addition to benefiting from the newly available data and using a different form of the equation of state (discussed below), the present analysis determines simultaneously the compressional and thermal parts of the equation of state by adjusting simultaneously all free parameters to give a least-squares fit to all the data. This procedure accomplishes implicitly the two sequential stages of the analysis of *Ahrens et al.* [1970].

Trunin et al. [1971*b*] noted that the Hugoniots of their most porous quartz samples achieved densities significantly less than the density of stishovite and that they extrapolated approximately to the zero pressure density of coesite. On this basis they identified these Hugoniots as representing the coesite phase. Although coesite is stable at room temperature in the approximate pressure range 30–70 kb between the stability fields of quartz and stishovite, coesite has not previously been observed in shock-wave experiments, the transformation usually being directly from quartz to stishovite. There are enough other coesite data (Table 2) that, when they are combined with these Hugoniot data and when it is assumed that they do

TABLE 1*b*. Other Data for Stishovite

Source	Quantity	Value
Mizutani et al. [1972]	Compressional-wave velocity	V_p = 11.0 km/sec
	Shear-wave velocity	V_s = 5.50 km/sec
	Isentropic bulk modulus	K_s = 3.46 ± 0.24 Mb
Weaver [1971]	Volume coefficient of thermal expansion (300°K)	α = 16.4 ± 1.3/°K
Holm et al. [1967]	Specific heat at constant pressure (300°K)	C_p = 7.15 x 10^6 ergs/g °K
Kieffer and Kamb [1972]	High temperature limit of Debye temperature	θ_D ~ 1120°K
Robie et al. [1966]	Density, zero pressure, 298°K	ρ_0 = 4.287 g/cm^3

TABLE 2*a*. Shock-Wave and Static-Compression Data for Coesite

Code	Source	No. of Points	Initial Density, g/cm^3	Pressure Range, kb
	Shock-Wave Data			
S11	*Trunin et al.* [1971*b*]	3	1.35	119 to 322
S12	*Trunin et al.* [1971*b*]	2	1.35	454 to 552
S13	*Trunin et al.* [1971*b*]	5	1.15	65 to 477
	Static-Compression Data			
X3	*Bassett and Barnett* [1970]	11		0 to 80

indeed represent coesite, the equation of state can be approximately determined. The success of this procedure seems to support the coesite identification, but other calculations suggest otherwise, as will be seen.

Trunin et al. [1971*b*] also calculated approximate Hugoniot temperatures and suggested that the boundary separating the coesite and stishovite fields in a pressure-temperature plot represented the coesite-stishovite phase transition line. Hugoniot temperatures have been recalculated here, and, in addition, the coesite-stishovite phase line has been independently calculated from the equations of state of the two phases, the coesite identification again being assumed. There is a large discrepancy between the two approaches. It is suggested that the new phase may in fact be a liquid of approximately the density of coesite rather than coesite itself. Because some of the properties of this liquid are unknown, it is necessary to proceed as if the phase were solid coesite and to examine the plausibility of the results.

ANALYSIS

A complete equation of state must account for both compressional and thermal effects. Previous studies have accounted for these effects by invoking the Mie-Grüneisen equation, incorporating a finite strain description of compressional effects with various expressions for the Grüneisen parameter to describe thermal effects, as was discussed in the introduction. The problem is to find an expression for γ that does not involve overrestrictive assumptions and that has some theoretical foundation.

Thomsen [1970] has considered the question of incorporating the results of the theory of anharmonic lattice dynamics into finite strain

TABLE 2*b*. Other Data for Coesite

Source	Quantity	Value
Skinner [1966]	Volume coefficient of thermal expansion (293°K)	$\alpha = 8.0 \times 10^{-6}$/°K
Holm et al. [1967]	Specific heat at constant pressure (300°K)	$C_p = 7.46 \times 10^6$ ergs/°K
Kieffer and Kamb [1972]	High temperature limit of Debye temperature	$\theta_D \approx 1170$°K
Robie et al. [1966]	Density, zero pressure, 298°K	$\rho_0 = 2.91$ g/cm^3
Mizutani et al. [1972]	Compressional-wave velocity Shear-wave velocity Isentropic bulk modulus	$V_p = 7.53$ km/sec $V_s = 4.19$ km/sec $K_s = 0.97$ Mb