Fig. 7. Shock pressure–specific volume Hugoniot and release adiabat data for fused silica (reproduced from *Rosenberg et al.* [1968]). Specific volumes calculated from our fused silica refractive index data for material shocked to pressures up to 460 kb according to the Gladstone-Dale law fall within the range 0.4 to 0.45 cm^3/g.

tures on shock-densified silicate glasses and found that temperatures of the order of 500°C and higher are required to anneal feldspar glasses in times of a few seconds. We can either conclude that: (1) the lower-bound calculated temperatures do not adequately represent the achieved temperatures, and the temperatures are sufficient for annealing; (2) the high shock pressure has a large effect on the temperature required to anneal the glass; or (3) annealing is not a principal mechanism in the index decrease.

For fused silica, another explanation of the behavior of the refractive index–pressure graphs at high pressure must be considered. We have noted that the pressure range 140 to 300 kb is represented by almost a plateau in refractive index. This range is essentially within the mixed-phase regime of the Hugoniot; if a mixture of the low-pressure fused silica phase and the high-pressure stishovitelike phase persisted after

pressure release, we should expect a continuous increase in refractive index for pressures to 300 kb. However, if the high-pressure phase relaxed to a low-density glass by adiabatic release and postshock annealing, we should expect an averaging of the refractive indices of a severely compacted material and a low-density glass; the result could be the index plateau we observe. Since powder-diffraction studies of some recovered material using 114.6-mm Debye-Scherrer X-ray cameras did not reveal any stishovite, we may assume that adiabatic release resulted in complete relaxation of the compressed material to a low-density glass. This might explain the sharp drop in refractive index of material shocked to pressures within the range 300 to 310 kb, as well as the low refractive index plateau for material shocked to even higher pressures. Thus shock loading to 300 kb or higher transforms the low-

TABLE 4. Postshock Specific Volumes of Fused
Silica
(Calculated by the Gladstone-Dale Law)

Shot Number	Shock Pressure, kb	Postshock Volume, cm^3/g	Release Adiabat[a] Volume, cm^3/g
...	0	0.454	
159	81	0.450 ± 0.001	0.454 ± 0.03
158	82	0.453	
156	92	0.431	
157	132	0.409	
R8	136	0.410 ± 0.003	0.40 ± 0.03
R5	160	0.429	
R1	170	0.427	
R13	180	0.433	
R7	192	0.418	
R2	198	0.406	
R12	200	0.413	
R11	242	0.407 ± 0.004	0.385 ± 0.03
R10	290	0.409	
R9	314	0.434 ± 0.004	0.45 ± 0.04
R14	376	0.442	
R15	418	0.441	
R16	460	0.440 ± 0.003	0.45 ± 0.04

[a] See Figure 7.

pressure 4-fold coordinated silica network to a
high-pressure 6-fold coordinated network that,
on adiabatic release and postshock annealing,
decompresses to a low-density glass with tetra-
hedrally coordinated silica.

POSTSHOCK TEMPERATURES

The Hugoniot and release adiabat data in
Figure 7 have been used to calculate postshock
temperatures for fused silica shocked to states
in the 100- to 500-kb pressure range. Tempera-
tures have been calculated for both multiple-
shock reflection-type experiments (case 1 of
Table 5) and single-shock experiments (case 2
of Table 5).

For case 2 we assume the net thermal energy
resulting from shock compression followed by
adiabatic release is given by

$$E_2 = \int_{298°K}^{T°K} Cp \, dT \tag{2}$$

which equals the difference between the shock
energy given by the Rankine-Hugoniot equa-
tion

$$E_s = (1/2)(P + P_0)(V_0 - V) \tag{3}$$

and the adiabatic release energy

$$E_R = -\int_{V_0'}^{V} P \, dV \tag{4}$$

In those equations, P_0 and V_0 represent initial
pressure and specific volume respectively, V is
specific volume at peak pressure, P, T is post-
shock temperature in degrees Kelvin, Cp is
the specific heat of fused silica at constant pres-
sure, and V_0' is the postshock volume.

For case 1, numerous reverberations of the
shock pulse across the sample add successively
smaller increments to the initial sample pres-
sure until peak pressure is reached (Figure 1).
As a result the total shock energy is given by

$$E_s = \frac{1}{2} \sum_{k=0}^{\infty} (P_{k+1} + P_k)(V_k - V_{k+1}) \tag{5}$$

TABLE 5. Postshock Temperatures of Fused Silica
(Calculated Using the Hugoniot and Release Adiabat Data in Figure 7)

Shock Pressure, kb	Case 1[a] E_1 Thermal Energy, cal/mole	T, °C	Case 2[b] E_2 Thermal Energy, cal/mole	T, °C	T,[c] °C
100	650	80	650	80	0
150	5,720	450	5,720	450	0
250	18,070	1170	19,050	1220	0
300	19,830	1260	23,920	1480	470
400	26,200	1590	38,610	2180	1860
500	28,340	1700	53,690	2820	3310

[a] For multiple-shock reflection-type experiments.
[b] For single-shock experiments.
[c] Postshock temperatures from *Wackerle* [1962].