$$\frac{dP}{dt} \simeq \frac{a_{11}^2 \Delta V}{2V_1^2} \frac{df}{dt} , \tag{6.8}$$

where $\Delta V = V_2 - V_1$.

Setting $f = 0$ in Eq. (6.4) and assuming constant temperature and linear P-V relations for phase 1 and phase 2 near the mixed phase boundaries, they obtained the relation,

$$P = P^{TL} + (P^D - P^{TL}) \exp\left(- \frac{x}{2U_2 \tau_1}\right), \qquad 0 \leq f^{eq} \leq 1 , \tag{6.9}$$

where P^{TL} is transition stress, P^D is driving stress, x is sample thickness, and U_2 is constant plastic I shock velocity. Equation (6.9) was found compatible with data in Fig. 4.3, assuming $\tau_1 = 0.05$ μsec to be constant for $0 \leq x \leq 1$ mm and a final driving stress of 201 kbar. This value represents an approximate upper bound for τ_1 since a 20 percent increase in its value is incompatible with the data, while effects of a decrease are undetectable.

Barker and Hollenbach[15] found that $\tau_1 = 0.17$ μsec was required in Eq. (6.9) to explain their data on plastic I stress decay for equal propagation distances but different final driving stresses.

Substituting Eq. (6.5) into Eq. (6.8) results in

$$P = P^{TL} + (P^D - P^{TL}) \exp\left(- \frac{a_{11}^2 \Delta V^2 J x}{2V_1^2 |A| U_2 \tau_2}\right) , \qquad 0 \leq f^{eq} \leq 1 , \tag{6.10}$$

which describes plastic I decay according to Andrews' model.[27,29] For iron, the term $-C_p \Delta V^2$ in $|A|$ (see Appendix D) exceeds the others by an order of magnitude. This gives $J/|A| \approx V_1 K_s/(\Delta V)^2 = V_1^2/(a_{11}^2 \Delta V^2)$ which makes Eq. (6.10) identical to Eq. (6.9). This shows that, under the assumptions used to obtain Eq. (6.9), $\tau_1 = \tau_2$ for iron. This identity is not a general result, and in transformations where terms other than $-C_p \Delta V^2$ dominate, the value of $|A|$ will produce different values for τ_1 and τ_2.

Equations (6.9) and (6.10) are strongly dependent on the basic assumption that the shocked phase 1 material remains in phase 1 and, at the impact surface, reaches the driving stress at a point on the metastable or extended phase 1 surface. This assumption may be invalidated by the inability to prepare smooth microscopic surfaces. Even the best finely-lapped and polished surfaces contain microvoids which require closing before stress at the impact surface can be sustained. If the effective driving stress were to be thus reduced, τ_2 in the above equation could be increased without violating the data.

Data of Fig. 4.3 show plastic I first decreasing as x increases, then increasing, then decreasing again. This behavior might arise from inaccuracies in measurements which have not been fully accounted for, or from other effects such as shear strength associated with precursor decay or relaxation in the plastic I wave and behind it.

6.1.2. Rise Time of Plastic II Shocks

Rise times of 0.2-0.3 μsec for plastic II shocks have been reported elsewhere;[23] these are consistent with the present