constant. Although trace amounts of impurities have little effect on P^{TL}, 1.5 percent of carbon increases P^{TL} by 5 kbar.[44]

Barker and Hollenbach[15] measured shock release states in iron and showed that the reverse transformation of epsilon to alpha iron is initiated at a stress, P^{TU}, of 98 kbar. The stress for equilibrium transformation lies between P^{TL} and P^{TU}. Their mean value is $P^{T} = 116$ kbar, for which $T = 332°K$ on the Hugoniot.

The 6 percent decay in P^{TL} for wave propagation from 6 to 25 mm described in Chapter 4 is similar to other reported values.[2,15] Measurements on specimens down to a thickness of 1 mm reported in Chapter 4 show that initial decay of the plastic I shock stress is very rapid. This observation is supported by Barker and Hollenbach in measurements on specimens of thicknesses of 3 mm and greater.[15]

Shock compression data on iron show that, for a given volume, measured stress in the mixed phase region exceeds that expected for the equilibrium Hugoniot.[27,28] (See Fig. 4.7.) Transformation begins at 130 kbar and appears to be complete near 200 kbar. The slope, $\simeq -5$ Mbar gm/cm^3 (1 Mbar = 10^3 kbar), of the Hugoniot just above P^{TL} disagrees significantly with the slope for the equilibrium curve, which is about -0.1 Mbar gm/cm^3. The equilibrium value is calculated for conditions of uniform hydrostatic pressure throughout the material. For various reasons, including anisotropy of stress, measured values of stress, P, differ from hydrostatic values,

$\overline{P}$, by unknown amounts, which may account for some of the differences in slopes. It is not certain that measured Hugoniot states in the mixed phase region are in equilibrium. They persist for the experimental time span and will be denoted "quasistatic" states.

Values of P^{TL} for various temperatures are given in Fig. 5.1. The Clausius-Clapeyron equilibrium relation and the equation of state given in Appendix A yield a value of -60.8×10^{-6} Mbar/°K for $\frac{dP}{dT}$. This calculated slope is within experimental error of the observations of Johnson, et al.[45]

5.1.2. Static Experiments

A number of static isothermal compression experiments on iron have shown that the transformation is initiated near 130 kbar and goes to completion for stresses greater than 145 kbar.[32,33,34,35] Giles, et al.[32] found values of 133 kbar for P^{TL} and 81 kbar for P^{TU} along a 300°K isotherm. They also found that the alpha phase persisted for stresses above 163 kbar while Mao, et al.[33] report no signs of alpha iron above 145 kbar. Giles, et al.[32] found that the epsilon phase persisted down to 45 kbar in the unloading process. The mean value for transformation stress, $\overline{P}^{Teq}$, reported by Giles, et al. was 107 ± 8 kbar, which is 9 kbar less than the mean value, P^{Teq}, reported by Barker and Hollenbach.[15] Some of this difference may be due to different amounts of shear stress in static and dynamic experiments.