to the isotherm for our purpose. In order to derive the most reproducible values of K_T' pressure versus η values were obtained from shock wave velocity U_s and particle velocity U_p data [14-15] at pressures above 100 kbar using the relations,

$$P = \rho_0 U_p U_s \tag{3a}$$

$$\eta = \frac{V(0)}{V(P)} = \frac{U_s}{U_s - U_p} \tag{3b}$$

The general procedure involved calculating K_T' as a function of pressure for a given element and selecting only those data where the values of K_T' did not vary by more than 10 per cent over those calculated from at least six consecutive (P,η) points. The occurrence of pressure-induced phase transition at relatively intermediate pressures is well established [15-17] for the metals Ti, Zr, and Hf. McQueen *et al.* [15] estimate that the phase transition pressure for the three metals is 175, 260, and 400 kbar respectively. The phenomenon is revealed in Table 2, where the computed K_T' values are given for Ti. The first two higher measurements at P = 190 kbar when combined with the values at lower pressures give a simple average $K_T' = 4.58$, whereas the third 190 kbar measurement when combined with all the measurements at higher pressures gives $K_T' = 3.34$. The lower-pressure value (4.58), plotted in Figure 1, is presumed to be that for the h.c.p. α phase, whereas the higher-pressure value (3.34) evidently corresponds to the ω phase.

Table 2

Computed values of K_T' as a function of pressure for the metal Ti using shock wave data [14-15]

P, kbar	K_T'	
130	4.34	h.c.p. α phase
140	4.97	
150	5.25	
160	4.14	average value of $K_T' \sim 4.58$
190	4.45	
190	4.38	
190	3.23	ω phase
200	3.43	
270	3.18	
320	3.32	
370	3.39	
370	3.21	
440	3.43	average value of $K_T' \sim 3.34$
460	3.38	
500	3.48	
520	3.43	
700	3.36	
730	3.45	
880	3.27	
1010	3.38	
1170	3.38	

It may be noted that no K_T' value is given in Table 3 for Zr as evaluated from the shock wave data [14-15]. Only those metals for which the computed K_T' values were reasonably consistent over a wide range of pressures well below the known phase transitions are included. In this respect, the Zr data were too widely scattered to be useful. The $\alpha \rightarrow \omega$ transition in Zr is now considered to occur at much lower pressures, at $\sim$30 kbar [17]. A comparison of ultrasonic and shock wave K' values for Hf, Ti, Ag, Au, Re, Pd, and Cu (Table 3) shows that agreement is fairly good between the two considering the uncertainties and errors involved in evaluating the shock wave data.

Table 3

Average values of dK_T/dP for f.c.c. and h.c.p. metals derived from shock wave data [14-15], as fitted to Birch-Murnaghan equation of state

Metal	Molar volume, cm^3	dK_T/dP (shock wave)	dK_S/dP (ultrasonic)	dK_T/dP (ultrasonic)
Th	19.79	3.31		
Hf[a]	13.45	4.13	4.03	4.04
Ti[b]	10.63	4.58	4.31	4.35
Ag	10.27	6.78	6.18	
Au	10.25	6.39	5.19	5.31
Al	10.00	4.98		
Pt	9.10	5.31		
Pd	8.88	5.94		5.42
Re	8.86	4.96		5.43
Ir	8.55	4.90		
Rh	8.30	5.30		
Cu	7.11	5.53	5.59	

[a] from data below 460 kbar

[b] from data below 190 kbar

Table 4 gives the values of K_T' for the b.c.c. transition metals, as evaluated from the shock wave data [14-15] in the manner discussed above. Our recently determined value of $K_T' = 4.03$ from ultrasonic measurements for Nb provides further confidence in the reliability of the models used and the derived K_T' values shown in Table 4 as well as in Figure 1.

Discussion of Results

Figure 1 is a plot of K_T' versus $1/\Omega_o$ (where Ω_o is the initial molar volume) for the metals listed in Tables 1, 3, and 4. Wherever K_T' values were not available, the K_S' values were used (no serious error is involved in this since $K_T' \sim K_S'$). The