Another equation for D_o has been proposed by Zener[39] who treated the impurity jump as an equilibrium thermodynamic process:

$$D_o = \gamma a^2 \nu \exp\left(\frac{\Delta S}{R}\right) \tag{11}$$

In this equation, a is the lattice constant, ν is a characteristic frequency which is not well defined but usually taken to be the Debye frequency, γ is a geometric constant equal to 1 for both interstitial and vacancy diffusion in a fcc lattice, and ΔS represents the entropy increase of the system due to adding one mole of activated complexes.

Using equation 11 and a known value of the isothermal compressibility (K), it can be shown that, to first order:

$$\frac{D_o(P)}{D_o(0)} = \left(1 - \frac{K}{3}P\right)^{3/2} \exp\left(\frac{\Delta S(P) - \Delta S(0)}{R}\right) \tag{12}$$

Using the graphically determined values of D_o, along with Zener's expression for ΔS at zero pressure:

$$\Delta S = \lambda \beta \frac{Q}{T_m} \tag{13}$$

(Where β is a dimensionless quantity equal to .5 for lead; and λ is an empirical constant equal to .55 for vacancy diffusion in a fcc lattice, and equal to 1 for interstitial diffusion), the following values are obtained:

Pressure Kilobars	$\Delta S(P)-\Delta S(0)$ cal/mole ^oK	$\Delta S(P)$ * cal/mole ^oK	$\Delta S(P)$ ** cal/mole ^oK
0.0	0.0	7.26	13.22
12.0	+ 0.03	7.29	13.25
17.5	- 0.27	6.99	12.95
22.5	- 1.24	6.02	11.98
24.5	- 2.01	5.25	11.21
38.0	- 2.08	5.18	11.14

* vacancy mechanism
** interstitial mechanism