This assumption restricts E to the form,

$$E = C_V T + f(V) \ , \tag{A.2}$$

where $f(V)$ is an arbitrary function of specific volume V. Since C_V is constant, Maxwell's equations require

$$\left(\frac{\partial C_V}{\partial V}\right)_T = T\left(\frac{\partial^2 P}{\partial T^2}\right)_V = 0 \ , \tag{A.3}$$

which gives

$$P = r(V)T + y(V) = \frac{\Gamma C_V}{V} T - f'(V) \ . \tag{A.4}$$

The assumption is made that

$$\left(\frac{\partial P}{\partial T}\right)_V = C_V\left(\frac{\partial P}{\partial E}\right)_V = \frac{\Gamma}{V} C_V = \text{constant} \ , \tag{A.5}$$

where Γ is the Gruneisen parameter. Then, from Eqs. (A.4) and (A.5), we find that

$$r(V) = C_V \frac{\Gamma}{V} = b \ C_V = \text{constant} \ . \tag{A.6}$$

Now any path on the thermodynamic equilibrium surface can be used to determine $y(V)$ in Eq. (A.4). Therefore, choosing the compression path along an isotherm is a logical choice because isothermal data are known in the form of the Murnaghan equation. Each phase is represented by

$$P(V_i) = B_{0i}\left(\left(\frac{V_i}{V_0}\right)^{-n_i} - 1\right) \ , \tag{A.7}$$

where the temperature T_0 is held constant, the subscript i indicates the particular phase, and the parameters B_{0i} and n_i are fitted constants. Combining Eqs. (A.4), (A.6), and (A.7) results in

$$P(V_i,T) = b\, C_{V_i}(T-T_0) + B_{0i}\left[\left(\frac{V_i}{V_0}\right)^{-n_i} - 1\right] , \qquad (A.8)$$

which defines any P,V,T path on the equilibrium surfaces.

To complete the definition of the surfaces, the function f(V) of Eq. (A.2) has to be evaluated. This can be done in a consistent way with the use of the following identity:

$$G = E - T\,S + P\,V\ . \qquad (A.9)$$

The use of subscript i is dropped for convenience. To complete Eq. (A.9) an expression for S is required. Since

$$\left(\frac{\partial S}{\partial V}\right)_T = b\, C_V \qquad (A.10)$$

and

$$\left(\frac{\partial S}{\partial T}\right)_V = C_V/T\ . \qquad (A.11)$$

Then

$$S = S_0 - b\, C_V(V_0-V) + C_V \ln(T/T_0)\ . \qquad (A.12)$$