is used for each term in the composite rheology (equation 1.38). The resulting flow law for ice I is

$$\begin{aligned} \frac{1}{\eta_{tot}} &= \frac{A_{diff}}{d^2}\exp\left(\frac{-Q_v^*}{RT}\right) + A_{disl}\sigma^3\exp\left(\frac{-Q_{disl}^*}{RT}\right) + \\ &+ \left(\frac{d^{1.4}}{A_{GBS}}\sigma^{-0.8}\exp\left(\frac{Q_{GBS}^*}{RT}\right) + \frac{1}{A_{bs}}\sigma^{-1.4}\exp\left(\frac{Q_{bs}^*}{RT}\right)\right)^{-1} \end{aligned} \tag{1.40}$$

where the stress and grain size exponents for each flow law have been evaluated to highlight the weakly non-Newtonian behavior of grain boundary sliding and basal slip.

To non-dimensionalize the viscosity functions, each term in the composite rheology (equation 1.38) is divided by a reference viscosity defined by the viscosity due to diffusion creep at the melting temperature of ice. The strain rate from diffusion creep is described by

$$\dot{\varepsilon} = \frac{A_{DF}V_m\sigma}{RT_m d^2}\left(D_v + \frac{\pi\delta}{d}D_b\right) \tag{1.41}$$

where A_{DF} is the diffusion constant, V_m is the molar volume, T_m is the melting temperature of ice, D_v is the rate of volume diffusion, δ is the grain boundary width, and D_b is the rate of grain boundary diffusion. For small strains of order 1%, $A_{DF} = 42$, but for larger strains $A_{DF} > 42$ (*Goodman et al.*, 1981). Here, $A_{DF} = 42$ is used.

The grain sizes of ice in the satellites are likely much larger than the grain boundary width (9.04×10^{-10} m) (*Goldsby and Kohlstedt*, 2001), so volume diffusion dominates over grain boundary diffusion, and the contribution to the strain rate by grain boundary diffusion is negligible. The strain rate for volume diffusion is:

$$\dot{\varepsilon} = \frac{42V_m\sigma}{RT_m d^2}D_{o,v}\exp\left(\frac{-Q_v^*}{RT}\right) \tag{1.42}$$

where $D_{o,v}$ is the volume diffusion rate coefficient and Q_v^* is the activation energy. The parameters for volume diffusion are listed in Table A.2, where the pre-exponential parameters have been grouped as $A = (42V_mD_{o,v}/RT_m)$. The viscosity due to volume diffusion is, therefore,

$$\eta_o = \frac{d^2}{A}\exp\left(\frac{Q_v^*}{RT_m}\right). \tag{1.43}$$