



Models for silicate melts viscosity

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The prediction of viscosity in silicate liquids, over the range of temperatures and compositions encountered in nature, remains one of the most challenging and elusive goals in Earth Sciences. Recent work has demonstrated that there are now sufficient experimental measurements of melt viscosity to create new viscosity models to replace previous Arrhenian models [1],[2] and extend the compositional range of more recent non-Arrhenian models [3]. Most recently, [4] have developed an empirical strategy for accurately predicting viscosities over a very wide range of anhydrous silicate melt compositions (e.g., rhyolite to basanite). Future models that improve upon this work, will probably extend the composition range of the model to consider, at least, H₂O and other volatile components and may utilize a compositional basis that reflects melt structure.

In preparation for the next generation model, we explore the attributes of the three most common equations that could be used to model the non-Arrhenian viscosity of multicomponent silicate melts. The equations for the non-Arrhenian temperature dependence of viscosity (η) include:

a) Vogel-Fulcher-Tammann (VFT): $\log \eta = A + B/(T - C)$

b) Adam and Gibbs (AG): $\log \eta = A + B/[T \log (T/C)]$, and

c) Avramov (Av): $\log \eta = A + [B/T]^\alpha$

We use an experimental database of approximately 900 high-quality viscosity measurements on silicate melts to test the ability of each equation to capture the experimental data. These equations have different merits [5]. VFT is purely empirical in nature. The AG model has a quasi-theoretical basis that links macroscopic transport properties directly to thermodynamic properties via the configurational entropy. Lastly, the model proposed by Avramov adopts a form designed to relate the fit parameter (α) to the fragility of the melt.

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[2] Bottinga Y. and Weill, D., 1972. *Am J Science*, 272, 438-475.

[3] Hess, K.U. and Dingwell, D.B, 1996, *Am Min*, 81, 1297-1300.

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