

A model for calculating the viscosity of natural iron-bearing silicate melts over a wide range of temperatures, pressures, oxygen fugacities, and compositions

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ABSTRACT

A new general model that takes into account the pressure and redox state effect is presented to calculate melt viscosities of natural Fe-bearing melts. This new model is applicable to melts that span a wide range of temperatures (from 733 to 1873 K), pressures (0.001–15 kbar), H₂O content (from 0 to 12.3 wt%), and compositions (from ultramafic, mafic to silicic melts). The accuracy of the model is calculated to be ± 0.23 log units of viscosity, which is within or close to experimental uncertainty. The transport properties, including glass transition temperature and melt fragility, can also be calculated from this model. A spreadsheet to calculate the viscosity is provided in an Electronic Supplement.

Keywords: Melt viscosity, Fe-bearing melts, oxygen fugacity, iron oxidation state, glass transition temperature, melt fragility, volcanic eruption