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Determination of the limiting fictive temperature of silicate glasses from calorimetric and dilatometric methods: Application to low-temperature liquid volume measurements

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ABSTRACT

The limiting fictive temperatures (T_f') of 16 multi-component silicate glasses have been derived quantitatively from heat capacity measurements, following the method of Moynihan et al. (1976). These quantitative values of T_f' closely match temperatures corresponding to the onset (T_{onset}) of the rapid rise in dilatometry heating curves (dL/L vs. T) at the glass transition, obtained on glasses with similar cooling histories. The mean deviation ($T_f' - T_{onset}$) is 5 K, whereas the maximum deviation is 17 K. These results confirm that the T_f' of a silicate glass can be determined from the T_{onset} of a glass dilatometry curve with an uncertainty that is <20 K. An application of the T_f' measurements includes the precise determination of the specific volumes of supercooled liquids at their respective T_f' values (Lange 1997). By comparison with other measurements in the literature, the accuracy of the T_f' method for determining low-temperature, fully relaxed, supercooled liquid volumes is shown. A comparison of volume-temperature models in the literature shows that a linear model (where thermal expansivity is independent of temperature) provides a superior fit of measured volumes in the SiO_2-Al_2O_3-MgO-CaO-Na_2O-K_2O system over very wide temperature intervals (700–1900 K).