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Estimating the viscosity of volcanic and binary melts from the vibrational properties of their parental glasses

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The knowledge of the viscosity of magmas as a function of melt composition and temperature is central in the numerical modeling of the magmatic dynamics and eruptive scenarios. Recent studies suggest that the measure of the viscosity of volcanic melts is affected by the occurrence of nano-scale modification (i.e., crystallization) of the melt structure during the measurement. This challenges the possibility of being able to quantify the crystal-free melt phase contribution to the measured viscosity. Herein we provide a new strategy that allows an accurate estimation of the melt viscosity at eruptive conditions starting from the Brillouin and Raman scattering of parental glasses. Our results show that the ratio between bulk and shear moduli and the boson peak position of glass embed the melt fragility. However, at the moment there are no known reasons why some of these quantities are linked together in such multicomponent systems. At this effort, we also provided a mean to evaluate whether the local structure of glasses may justify this correlation by testing the well-known prototypical binary system Na_2O-SiO_2. Concluding, our strategy allows the estimation of the melt viscosity as a function of temperature avoiding its direct measurement, ridding also the measurement from unwished crystallization.