A multiple-year experiment on viscosity of hydrous rhyolitic melt

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Viscosity data of hydrous silicate melts at low temperatures (meaning high viscosities) are critical for understanding magma fragmentation and welding. Recent advances in viscosity data and models have increasingly combined high-temperature and low-temperature viscosity data to develop non-Arrhenian models. Currently available viscosity data on natural or quasi-natural (such as haplo-rhyolite) silicate melts cover about 16 orders of magnitude, from 0.1 to 10^{15} Pa·s. In order to generate data at greater viscosity, we recently carried out a multiple-year controlled cooling-rate experiment at 1 K/week to examine the viscosity of hydrous rhyolite. The viscosity is inferred from the kinetic experiment using the equivalence between the apparent equilibrium temperature of the hydrous species reaction and the glass transition temperature. Two charges with different water contents were placed in the furnace. Unfortunately, one charge cracked heavily and lost almost all of its water. Hence, viscosity is obtained for only one sample. The viscosity of a hydrous rhyolitic melt containing 0.85 wt% H_2O is $10^{17.22}$ Pa·s at 676 K. The datum is used to test two viscosity models for hydrous and dry rhyolites. The model of Zhang et al. (2003) predicts a viscosity of $10^{17.16}$ Pa·s, in excellent agreement with the datum. The model of Hess and Dingwell (1996) predicts $10^{16.87}$ Pa·s, not far off either. In addition, the datum can be applied to further constrain the hydrous species geospeedometer (Zhang et al., 2000).

References:

1. Hess & Dingwell (1996) Am. Mineral., 81, 1297-1300.
2. Zhang, Xu & Liu (2003) Am. Mineral., 88, 1741-1752.
3. Zhang, Xu & Behrens (2003) Geochim. Cosmochim. Acta, 64, 3347-3355.