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An empirical model for the solubility of H_2O in magmas to 3 kilobars

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ABSTRACT

We present 16 new manometric determinations of H_2O solubility for a range of natural silicate liquid compositions equilibrated up to 3 kbar of H_2O pressure. As the threshold temperature of dehydration of the quenched glasses during measurements of the H_2O content becomes lower as a function both of bulk silicate composition and the dissolved H_2O content, we measured the H_2O released on heating over a range of temperature intervals. For example, alkali-rich samples having a dissolved H_2O content greater than ~6 wt% start to evolve H_2O at temperatures less than 150 °C, whereas more mafic samples and silicic samples with less than 6 wt% H_2O begin to dehydrate at temperatures greater than 200 °C. This behavior is consistent with the concept that alkali-rich liquids can have their glass transition temperatures lowered substantially by dissolved H_2O and that H_2O is released only significantly on heating in the supercooled liquid region, rather than in the glass region. Using these new data, in conjunction with previous data from the literature, we refined and extended the empirical H_2O solubility model of Moore et al. (1995b). The new model works well ($2\sigma = \pm 0.5$ wt%) between 700–1200 °C and 1–3000 bar and can be applied to any natural silicate liquid in that range. The model may also be used for systems where $X_{H_2O} < 1$ in the vapor phase.