Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 734
© 2000 Cambridge Publications

Solution Behaviour of H_2O in Haploandesitic Melts in the Pressure-Temperature Regime of the Upper Mantle

Bjorn O. Mysen (mysen@gl.ciw.edu)[1] & **Kevin Wheeler**[2]

[1] Geophysical Laboratory, Carnegie Instn. Washington, 5251 Broad Branch Rd., NW, Washington DC, 20015-1305, USA
[2] Dept. Geol. Sci., Brown University, Providence RI 02912, USA

The solubility of H_2O in three melt compositions along the haploandesite join $M_2Si_4O_9$-$M_2(MAl)_8O_2$ (0, 3, 6 mol% Al_3O_2, M=Na, K) has been determined as a function of pressure and temperature in the 0.8-2.0 GPa and 1000°-1300 C ranges, respectively. The H_2O-solubility is a linear or near linear positive function of pressure (16-18 mol% H_2O/GPa) at constant temperature for melts with low Al_2O_3 content (*3 mol%). For more Al-rich melts, the pressure-derivative of the H_2O solubility is positively correlated with pressure. The H_2O solubility is a negative near linear function of temperature (1-2 mol% H_2O/100°C) at constant pressure over the entire pressure range investigated. This behaviour, observed for per-alkaline aluminosilicate melts, differs somewhat, therefore, from the temperature-dependence of H_2 solubility in melts of albite and haplogranite composition, where the H_2O solubility changes from regressive to progressive with increasing pressure (Paillat et al., 1992; Holtz et al., 1995). The solubility is negatively correlated with Al_2O_3 content of the melts. Partial molar volume of H_2O in the melt, V_{H2O}^{melt}, was derived from solubility isotherms (1000°, 1100°, 1200°, 1300°C) at 0.8, 1.05, 1.3, 1.65, and 2.0 GPa pressure. In these calculations, it was assumed that the activity of H_2O in melts, a_{H2O}^{melt} can be equated with mol fraction, X_{H2O}^{melt}. This assumption is supported by comparatively small heat of mixing for glasses along aluminosilicate-H_2O joins (Clemens and Navrotsky, 1987) and by the observation that over the pressure-ranges of these experiments (with concomitant large variations in H_2O content of the melt), the ln (f_{H2O}/ X_H2O^{melt}) versus (P-1)/RT functions are linearly correlated. The partial molar volume of H_2O in melt, V_{H2O}^{melt}, thus calculated ranges between 7.8 and 12.8 cm^3/mol, and decreases with increasing Al_2O_3 content. In the pressure-temperature range studied, the ($\delta\ V_{H2O}^{melt}/\delta T_P$ ranges from $-7.1\pm0.8x10^{-3}$ to $-5.6\pm1.3x10^{-3}$ cm^3/mol °C with this negative $(\delta\ V_{H2O}^{melt}/\delta T)_P$ diminishing slightly as the melts become more aluminous. It is suggested that the slight negative temperature-dependence of the partial molar volume reflects temperature-dependent speciation of water dissolved in the melts where OH/H_2O increases with increasing temperature (e.g., Nowak and Behrens, 1995; Withers et al., 1999). The relationship between partial molar volume and Al_2O_3 content of the melt probably is because the water solubility mechanisms in aluminosilicate melts may depend on Al/Si (Mysen and Virgo, 1986). The V_{H2O}^{melt} data were combined with published partial molar volume information for anhydrous oxides in silicate melts to estimate density distribution in shallow, water-rich dacite magma chambers associated with explosive volcanism. For a chamber of constant bulk composition during a comparatively short explosive event such as that of Mount Pinatubo June 1991 or Mount St. Helens in May 1980, the average density of the magma after eruption is ~ 3% higher than before the eruption occurred. Furthermore, the H_2O-distribution in the chamber after eruption is such that the magma is gravitationally unstable with the most dense magma near the top of the magma chamber. The energy contribution of exsolved H_2O to the energy yield of those eruptions was calculated from the volume difference between H_2O dissolved in melt and that in exsolved, aqueous fluid. This energy contribution typically represents 5-10% of the total energy associated with such explosive volcanic eruptions.

Clemens JD & Navrotsky A, *J. Geol.*, **95**, 173-186, (1987).
Holtz F, Behrens H, Dingwell, & Johannes W, *Amer. Mineral.*, **80**, 94-108, (1995).
Mysen BO & Virgo D, *Chem. Geol.*, **57**, 333-358, (1986).
Nowak M & Behrens H, *Geochim. Cosmochim. Acta*, **59**, 3445-3450, (1995).
Withers AC, Zhang Y, & Behrens H, *Earth Planet. Sci. Lett.*, **173**, 343-349, (1999).