

**Experimental study of the effect of concentration of dissolved water on diffusion of H₂O in
haplodacite melts at high pressures**

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Diffusion of H₂O and the concentration dependence of water diffusivity in haplodacite melts (Ab₉₀Di₈Wo₂, mole %) has been experimentally study in a wide range of water content in the melts (0.2–6.0 wt. %), at the P(H₂O) up to 160 MPa and the temperature 1200°C using a new small gradient methodology. Exponential dependence of water diffusion on water content in haplodacite melts at mentioned parameters has been established by a strict experimentally.

Key words: diffusion, water, concentration dependence, melt, temperature, pressure, haplodacite, model, IR-spectroscopy

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The experimental study of water diffusivity in silicate melts was not solved the problem of the concentration dependence of D(H₂O) on C(H₂O) including for polymerized melts such as albite, obsidian, granite, rhyolite and dacite [Shaw, 1974; Nowak, Behrens, 1997; Zhang, Behrens, 2000, ect.]. Moreover, the all diffusion studies which were used a high gradient method, including our results [Persikov et al., 2010] have not been designed in such a way as to provide a definitive experimental determination of the functional relationship between of D_{H₂O} and C_{H₂O} over the full range of water contents for each experiment. A new small gradient methodology to study the dependence of water diffusivity on water content in synthetic and magmatic melts has been developed to provide a definitive experimental determination of this dependence over a wide range of water content (up to ~ 6 wt. %) which is independent of any assumptions regarding such dependence and mechanisms of water diffusion in these melts [Persikov, et al., 2010; Persikov et al., 2010]. Based on our results, we conclude that one approach that would allow such a determination would be determination of (D_{H₂O}) values using experiments that have only a small range in C_{H₂O}, determination of D_{H₂O} for a series of small water gradient experiments that collectively span a wide range in C_{H₂O} could yield a robust model independent form of the variation of D_{H₂O} as a function of C_{H₂O}. The main features of this method are as follows: a) do not assume any functional relationship between D_{H₂O} and C_{H₂O}; b) goal is to build this relationship from multiple experiments (5 -7 runs); c) concentration limits at the ends of profiles vary by no more than ~0.5–1.0 wt. % H₂O. We report here new results of experiments to determine the diffusivity of water (D_{H₂O}) in haplodacite melts (Ab₉₀Di₈Wo₂, мол. %), at 1200°C and P_{H₂O} up to 160 MPa in a wide range of water content up to ≈ 6 wt. % using this methodology.

An internally heated pressure vessel (IHPV) was used to carry out such kind diffusion experiments. Note that the samples run in the IHPV were undeformed during these experiments. Two different types of small gradient experiments were done: first type of hydration experiments for dry haplodacite melts at the T = 1200°C and P_{H₂O} 20 MPa has been described in detail in our resent published paper [Persikov et al., 2010]. Another type of hydration diffusion experiments has been used for water diffusivity in water bearing haplodacite melts. In this case the experiments were included of the three stages: a) first stage was a hydration (saturation) of dry glasses during 3 hours at T = 1200°C and water pressure for example 50 MPa without quenching; b) second stage was a direct diffusion of water into water saturated melt which is started immediately after first stage by isothermal increasing of water pressure up to 70 MPa value; c) third stage was isobarical quenching by turnig off

the power to the heater. Measured initial cooling rates were ≈ 300 °C/min down to 900 °C, followed by ≈ 100 °C/min down to room temperature.

Water contents and concentration-distance profiles of the diffusion samples were determined by Fourier transform infrared spectroscopy (FTIR). D_{H_2O} values were determined by best fitting these profiles using Boltzmann-Matano method [Crank, 1975]. Our results show that D_{H_2O} increases with increasing water content, the increase with water content is exponential for haplodacite melts (see equation at the Fig. 1). This result is disagree with the result of [Zhang, Behrens, 2000] where the linear dependence of $D(H_2O)$ on $C(H_2O)$ has been established. Predicted dependence of $D(H_2O)$ on $C(H_2O)$ in haplodacite melts is represented at the Fig. 1 too which was obtained using a new structural chemical model to calculate and predict the water diffusivity in magmatic melts [Persikov E.S., P.G. Bukhtiyarov, 2009; Persikov et. al, 2010].

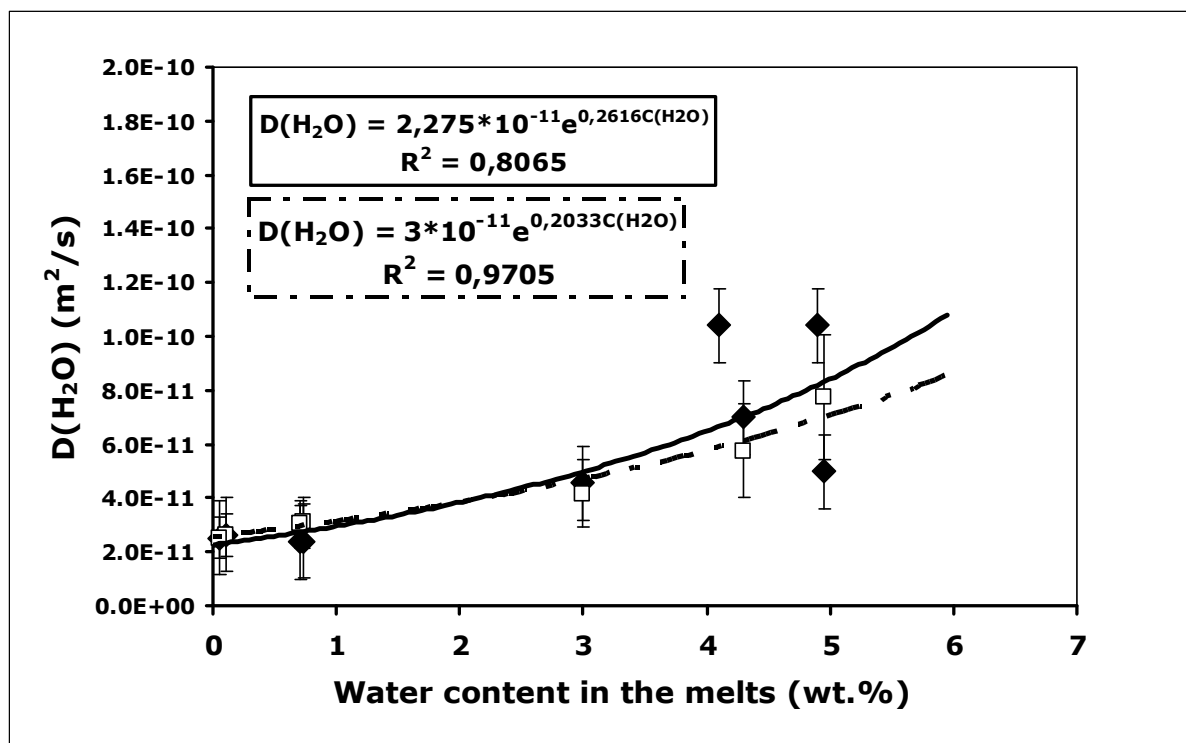


Fig. 1. Concentration dependence of water diffusivity in haplodacite melts, $T = 1200^\circ\text{C}$ and $P(H_2O)$ up to 160 MPa (dark symbols – an experimental data, open symbols – predicting data which were obtained using a new model; [Persikov et al., 2010])

Demonstrably (see Fig. 1), that the experimental and predicted dependencies of $D(H_2O)$ on $C(H_2O)$ are in a good agreement inside of the experimental (± 30 % relative) and predicted (± 35 % relative) data precision. This is an additional evidence that the mentioned model [Persikov et. al, 2010] may be used with the success to calculate and predict the concentration dependence of water diffusivity in magmatic melts.

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