

In-situ IR measurements of water dehydration from hydrous rhyolitic glasses at high temperature

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Dehydration kinetics is essential for a quantitative understanding of dynamics of ascending magma in a volcanic conduit. We observed water dehydration of hydrous rhyolitic glasses (slab of 40 - 100 micrometer in thickness) at 1 bar and 475 to 900 C using in situ IR technique in order to understand the dehydration mechanism and to quantify the dehydration rate. IR absorbance (peak area) at 3550 cm^{-1} corresponding to OH and H₂O molecule was monitored every 90 seconds for about 90 minutes. This IR absorbance at 3550 cm^{-1} decreased with time and the decrease rate was larger for higher temperatures. Kinetic treatments for these dehydration experimental data indicate that the decrease rate of water contents is proportional to the second power of water contents, i.e., $dC / dt = k C^2$, where C is the water contents and k is the rate constant. This implies that the decrease rate of water is controlled by the second order reaction. As a possible step to explain the second order reaction, the formation of H₂O molecule from two OH groups can be proposed because the reaction between water species and silicate phase can be assumed as the interconversion reaction of 2OH, H₂O and O (e.g., Stolper, 1982). The rate constants k obtained by fitting the experimental data to $dC / dt = k C^2$ were plotted in an Arrhenian diagram to estimate an activation energy. The estimated activation energy of 114 KJ/mol is similar to the value of activation energy for water diffusion at 1 bar and low water contents in previous study (Zhang et al., 1991; Zhang and Behrens, 2000).