Discriminating secondary from primary water in rhyolitic matrix-glass of volcanic pyroclasts using thermogravimetric analysis

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The degassing of magmatic (primary) water affects the intensity of volcanic eruptions and it is conventionally thought that most magmatic water is lost upon eruption. Yet, pyroclasts from explosive eruptions, such as the 900 CE explosive Glass Mountain eruption of Medicine Lake volcano, California, contain surprisingly large amounts of water, which may be the consequence of diffusive rehydration of the volcanic glass by atmospheric (secondary) water after the eruption. Discriminating between primary and secondary water in the matrix glass of pyroclasts is important, in order to reconstruct the processes of magma degassing and, hence, constrain its effect on the eruption. Such discrimination has, however, remained a challenging problem, especially because some aspects of water diffusion in silicate glass at low temperatures and atmospheric pressure remain poorly constrained. We analyzed the loss of water from volcanic glasses that were hydrated in the laboratory at magmatic temperatures and pressures, using thermogravimetric analysis. Numerical modeling of the thermogravimetric analyses, which included the diffusion and interconversion of molecular water (H_2O_m) and hydroxyls groups (OH), indicates that Glass Mountain pumices contain approximately 0.3 wt% primary water, and that they gained 1-2 wt% of atmospheric water by diffusive rehydration during the past 900 years. These results confirm that the majority of magmatic water is lost from the magma during explosive eruptions and, furthermore, the integration of experiments and numerical modeling establish a necessary foundation for discriminating between the primary and secondary water content of volcanic glasses, using thermogravimetric analysis.