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Chlorine and hydrogen isotope geochemistry of obsidian glasses: behavior during volcanic degassing at Mono Craters, CA

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Volatile element concentrations (Cl, H_2O, and CO_2) and stable isotope compositions (δD and $\delta^{37}Cl$) of volcanic glasses (obsidians) (n = 30) have been determined toquantifythe behavior of chlorine stable isotopes (^{35}Cl and ^{37}Cl) during volcanic degassing. Pyroclastic obsidian samples werefrom tuff layers representing a single eruptive sequence that occurred around 1350 A.D. in the Mono Craters volcanic field, California. The Cl, H_2O, and CO_2 concentrations recorded by these eruptive obsidians track the chemical evolution of the magmatic system. The H_2O and CO_2 concentrations of the samples range from 0.37 to 2.08 wt% and 1 to 31ppm, respectively. $H_2O$and CO_2 concentrations are strongly correlated and reflect the degassing trend of the eruptive sequence. Chlorine concentrations of obsidians range from 609 to 833 ppm and do not display a strong correlation with either H_2O or CO_2 concentrations. Obsidians were selected from two tuff layers: 1) a lower layer containing average H_2O and CO_2 concentrations of 1.5 ± 0.5 wt% and 22 ± 11ppm, respectively, and 2) an upper layer containing slightly lower average H_2O and CO_2 concentrations of 0.9 ± 0.5 wt% and 6 ± 5 ppm, respectively. Chlorine concentrations are essentially identical between the two layers, averaging 742 ± 58 ppm in the lower layer and 702 ± 75 ppm in the upper layer.

Measured δD values of the obsidians vary between -63 to -74‰ (1σ = ±2‰) and display D/H ratios that decrease with lower total water content following a distillation trend dominated by open system degassing. $\delta^{37}Cl$ values were measured on select samples from each of the two tuff layers. The samples from the lower layer have $\delta^{37}Cl$ values between -1.8 to -2.0‰ (n = 3), whereas the samples from the upper layer have $\delta^{37}Cl$ values between -1.3 and -1.4‰ (n = 3) (1σ = ±0.2‰). Despite the similar Cl concentrations between the two layers, the samples with lower $\delta^{37}Cl$ values have higher Cl concentrations (763 ± 61 ppm Cl) than samples with higher $\delta^{37}Cl$ values (639 ± 33 ppm Cl). The samples analyzed for Cl isotopes span the range of observed H_2O and CO_2 concentrations: a sample with one of the highest H_2O and CO_2 concentrations (2.1 wt% and 26 ppm, respectively) has a $\delta^{37}Cl$ value of -1.8‰; whereas, a sample with one of the lowest H_2O and CO_2 concentrations (0.4 wt% and 3 ppm, respectively) has a $\delta^{37}Cl$ value of -1.4‰. Preliminary data indicates the possibility of minor chlorine isotope fractionation during the eruptive sequence at Mono Craters; however, additional work will better quantify the magnitude of this fractionation.

Keywords: chlorine isotopes, degassing, Mono Craters, obsidian