Isotope fractionation due to vaporization in tektites: An experimental study

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Tektites are natural glasses formed as quenched impact melt ejecta. Because they experienced extreme heating while entrained in a hot impact vapor plume, tektites allow insight into these ephemeral events, which play a critical role in planetary accretion and evolution. The isotopic composition of tektite parent materials may be modified by vapor/liquid fractionation at high *T* in the plume due to preferential loss of light isotopes from the melt through evaporation. Trends from tektite O isotope studies reveal a dichotomy: tektite $\delta^{18}O$ values are ~4.0-4.5‰ lower than their protoliths[1] opposite in direction to a vaporization induced fractionation; yet increasing $\delta^{18}O$ with decreasing SiO_2 in tektites[2] is consistent with vapor fractionation. Copper isotope studies show that tektite $\delta^{65}Cu$ values are 1.98-6.99‰ higher than protoliths[3], with increases in $\delta^{65}Cu$ showing a negative correlation with Cu concentration; trends consistent with evaporation induced fractionation.

To understand how volatilization fractionates O and Cu isotopes, we conducted vaporization experiments at high *T* in an aerodynamic levitation laser furnace. O isotope fractionation experiments used natural tektite material heated to 2150-2200 ºC for 50-90 s while levitated in Ar. Mass losses were from 23 to 26%, reflecting evaporation of Si and O from the melt. The starting tektite had a $\delta^{18}O$ of 10.06‰ and the residues ranged from 13.14‰ to 14.30‰. Cu isotope fractionation experiments used synthetic basaltic glass doped with Cu_2O and heated to 2000-2150 ºC for 30 to 180 s while levitated in Ar. The starting material had a $\delta^{65}Cu$ of 3.69‰, and the residues ranged from 20.26‰ to 21.51‰ after 30 s. Based on the $\delta^{65}Cu$ to Cu concentration relationship, an empirical fractionation factor (α) of 0.9970 to 0.9972 was calculated for the evaporative loss of Cu. These results provide valuable insights into how evaporation fractionates O and Cu isotopes at high temperatures on Earth and other planetary bodies.

[1]Luft et al., *Geochim Cosmochim Acta* **51** (1987). [2]Taylor & Epstein, *J Geophys Res* **74** (1969). [3]Moynier et al., *Geochim Cosmochim Acta* **74** (2010).