

# Evaporations Kinetics of Alkali Elements from Silicate Melts: An Experimental Comparison between Vacuum and 1-bar Evaporations

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Alkali elements (Li, Na, K, Rb, Cs) are excellent tracers of possible volatile-loss processes for planetary bodies, and their relative abundances can provide valuable insights into the volatile depletion history of these bodies. Previous laboratory experiments have investigated volatilities of alkalis in a 1 bar gas-mixing furnace under different temperatures and  $fO_2$ s [1, 2]. However, significant uncertainty still remains and the interpretations are complicated by (1) the complex evaporation and condensation behaviors at the evaporating surface, and (2) poorly constrained transport mechanism for removing evaporating gas species away from the surface [3, 4].

To investigate the relative volatilities of all alkali elements, in this study, we carried out two sets of evaporation experiments at 1400°C using the same composition melts under vacuum and 1-bar conditions. The vacuum experiments were conducted to eliminate the removal of vapor from the melt surface as a possible rate-limiting step.

Vacuum experiments show that the volatilities of alkalis decrease following the order: Na > Cs  $\approx$  Rb  $\approx$  K > Li. However, the evaporation at 1 bar in the H<sub>2</sub>+CO<sub>2</sub> gas mixture with  $fO_2 = IW+2$  shows an opposite trend: Li > Cs > K  $\approx$  Rb > Na. Thermodynamic calculations show that all alkali elements under the experimental conditions vaporize as monoatomic gases thus  $fO_2$  should not affect their relative volatilities. In addition, the chemical homogeneity of run products suggests fast diffusion of alkalis in the melts. More likely, the different volatility trend observed in 1-bar runs is not set by evaporation/condensation rate at the surface but rather controlled by removal of alkalis from the gaseous boundary layer at the melt-vapor interface by a flowing gas. This could explain the relatively elevated loss of Li due to its faster diffusion in the H<sub>2</sub>-CO<sub>2</sub> gas. Overall results show that the transport of elements in the gas medium should be considered when using the 1-bar gas-mixing furnace to constrain the volatilities of moderately volatile elements.

1. Gellissen et al. (2019) *Geochemistry* 79, 125540.
2. Sossi et al. (2019) *GCA* 260, 204-231.
3. Richter et al., (2011) *Meteorite & Planetary Science* 46, 1152-1178.