Vaporization Studies of Olivine via Knudsen Effusion Mass Spectrometry

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Vaporization and condensation are important in a variety of cosmochemical processes, including contributions to the atmospheres of the hot, rocky exoplanets. Constituents of these atmospheres have been estimated from vaporization calculations for various planetary analogs [1], such as the continental crust, basic silicate earth, and moon composition. Experimentally, Knudsen Effusion Mass Spectrometry (KEMS) has been effectively utilized to analysis the vapor species above similar compositions [2-3].

A KEMS instrument is based on a Knudsen cell, which is a small enclosure where near solid/vapor equilbria is attained. The enclosure contains a well-defined orifice which forms a molecular beam of the vapor. This molecular beam is then directed into a mass spectrometer for analysis. This study is conducted on two mass spectrometers—a fast scanning quadruopole instrument for determination of the vapor composition and a magnetic instrument for more detailed anlaysis of the pressures of each species [4].

KEMS is primarily an equilibrium technique. However, kinetics are well-known to play a role in natural vaporization processes, particularly with oxides. These are quantified with the vaporization coefficient, which is defined as the ratio of the flux leaving a surface to the equilibrium flux. For an oxide, vaporization coefficients vary from ~0.5 to 10^{-3} [5]. It is shown how these can be measured by varying the orifice geometry in a multi-cell KEMS experiment.

Initial results for a fosterite-rich olivine ($Fo_{93}Fa_7$) will be presented and compared to theoretical predictions.

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