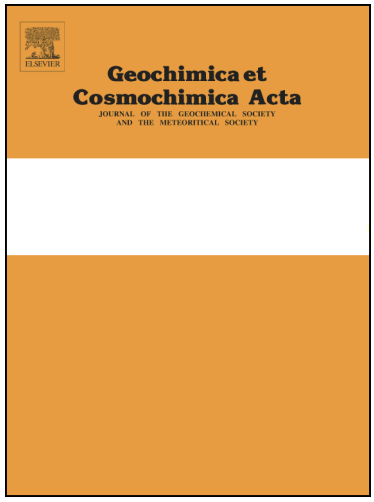

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PII: S0016-7037(17)30150-3
DOI: http://dx.doi.org/10.1016/j.gca.2017.03.012
Reference: GCA 10192

To appear in: *Geochimica et Cosmochimica Acta*

Received Date: 20 October 2016
Revised Date: 1 February 2017
Accepted Date: 1 March 2017

Please cite this article as: Renggli, C.J., King, P.L., Henley, R.W., Norman, M.D., Volcanic gas composition, metal dispersion and deposition during explosive volcanic eruptions on the Moon, *Geochimica et Cosmochimica Acta* (2017), doi: http://dx.doi.org/10.1016/j.gca.2017.03.012

Volcanic gas composition, metal dispersion and deposition during explosive volcanic eruptions on the Moon

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Abstract

Transport of metals in volcanic gases on the Moon differs greatly from their transport on the Earth because metal speciation depends largely on gas composition, temperature, pressure and oxidation state. We present a new thermochemical model for the major and trace element composition of lunar volcanic gas during pyroclastic eruptions of picritic magmas calculated at 200-1500 °C and over 10^{-9}-10^{3} bar. Using published volatile component concentrations in picritic lunar glasses, we have calculated the speciation of major elements (H, O, C, Cl, S and F) in the coexisting volcanic gas as the eruption proceeds. The most abundant gases are CO, H_2, H_2S, COS and S_2, with a transition from predominantly triatomic gases to diatomic gases with increasing temperatures and decreasing pressures. Hydrogen occurs as H_2, H_2S, H_2S_2, HCl, and HF, with H_2 making up 0.5 to 0.8 mole fractions of the total H. Water (H_2O) concentrations are at trace levels, which implies that H-species other than H_2O need to be considered in lunar melts and estimates of the bulk lunar composition. The Cl and S contents of the gas control metal chloride gas species, and sulfide gas and precipitated solid species. We calculate the speciation of trace metals (Zn, Ga, Cu, Pb, Ni, Fe) in the gas phase, and also the pressure and temperature conditions at which solids form from the gas. During initial stages of the eruption, elemental gases are the dominant metal species. As the gas loses heat,