65th MetSoc (2002) Abstract #5269. *Meteoritics & Planet Sci. Suppl.* **37**:A43

MODEL EVAPORATION OF FEO-BEARING LIQUIDS.

D. S. Ebel, Dept. of Earth and Planetary Sciences, American Museum of Natural History, New York, NY 10024 (debel@amnh.org)

Introduction: The evaporation of silicate liquids is an important process to consider in the origin of components of chondrites. Many CAIs show enrichment in heavy isotopes, plausibly due to Mg and Si evaporation while molten [1]. The absence of heavy isotope enrichment of volatile elements in chondrules [2,3] may not preclude evaporative processes, either non-Rayleigh or modified by later equilibration. A predictive model of evaporation has been developed for CaO-MgO-Al_2O_3-SiO_2 (CMAS) liquids, and applied to CAI origins with some success [4,5]. The best model [6] for such liquids is FeO-free, but the only other extant, tested silicate liquid model, MELTS [7], cannot address liquids where molar $SiO_2 < (½ (MgO-Cr_2O_3) + ½ FeO + (CaO-3 P_2O_5) + Na_2O + ½ K_2O)$. To address FeO-rich chondrule liquids, the latter model must be used. For this study, I developed a method for calculating vapor pressures over MELTS liquids, and derived evaporation coefficients consistent with the MELTS activity model from existing experiments, all consistent with the theoretical aproach of [8].

Calculations: For this work, equilibrium partial pressures of gas species over both liquids were calculated using a generalized form of existing techniques [9,4], modified to account for complex oxide components in the MELTS model. Only conditions of fixed hydrogen pressure, $P(H_2)$, were investigated. Extension to systems containing C, N, S, etc. in solar proportions relative to fixed $P(H_2)$ is, however, a simple exercise.

Both liquid models give similar results for at least one condition: that the melt has <5% non-CMAS components so that the Berman activity model applies, and sufficient SiO_2 that the MELTS model applies [10]. Evaporation coefficients were calculated from the experimental results of [8], for CMAS liquids, using both models, for the few data points where this condition is met. The evaporation coefficients derived by [8] for CMAS liquids, using the Berman model, are found to be applicable to calculations using the MELTS model, at least for these experimental conditions, within error.

In the only data set found suitable for evaluation of Fe evaporation parameters [11], only three 2073 K liquid residue compositions are accessible to the MELTS model. Although Mg(g) and SiO(g) account for nearly all Mg and Si evaporation, both Fe(g) and FeO(g) are important species over the liquids of [11]. The average evaporation coefficient is $\alpha(Fe) = 0.185 \pm 0.063$, where $\alpha(Fe)/\alpha(FeO) = (m_{Fe}/m_{FeO})^{0.5}$, and m is mass. This allows first approximations of the relative amounts of Fe, Mg and Si which can be expected to evaporate from particular chondrule liquids, as will be shown. More evaporation data on FeO- and SiO_2-rich liquids is urgently needed.

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