A CHEMICAL MODEL OF MICROMETEORITE IMPACT INTO OLIVINE. A. A. Sheffer and H. J. Melosh, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, abigailw@lpl.arizona.edu, jmelosh@lpl.arizona.edu.

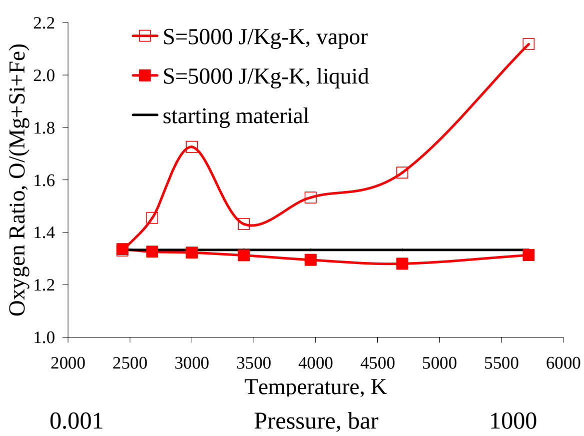
Introduction: Laboratory simulations of space weathering using laser irradiation have been successful in reproducing space weathering characteristics such as the reduction of olivine to form nanophase iron particles [1,2]. However, the chemistry of the reduction of Fe^{2+} in olivine to Fe metal has not been fully explored. We present a thermodynamic model of olivine undergoing post-impact cooling and decompression.

Shock Melting: The cooling path of rocks melted by hypervelocity impact is much different than for rocks melted at a constant pressure [3]. A strong shock causes both the pressure and temperature to jump to very high values. Since the shock compression is irreversible, the rock's entropy also jumps. Decompression is isentropic, thus cooling follows a specific P-T path.

Modeling: The equilibrium module in the HSC Chemistry package [4] was used to model the Gibbs energy minimization. Equilibrium compositions were computed for the pressures 0.001, 0.01, 0.1, 1, 10, 100, 1000, and 10000 bars over the temperature range 1500-6000 K. Entropy calculations were performed in Excel. We used the composition of Fa_{10} similar to the San Carlos olivine used in [1,2] as a starting composition. Only the elements Si, Mg, Fe, and O were included in the model.

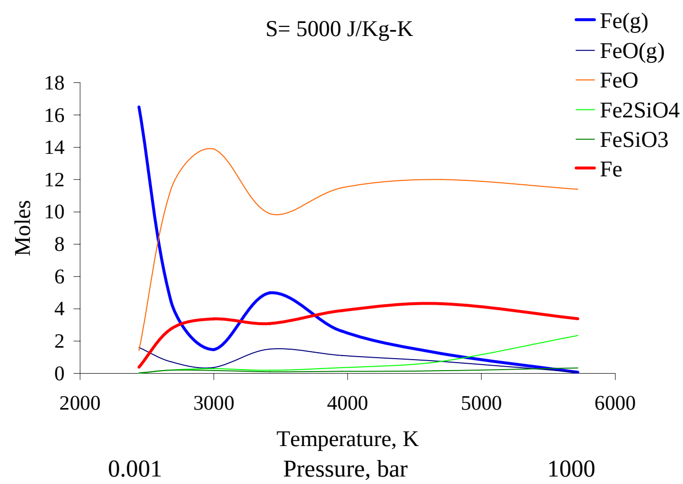
Results: We modeled the isentropic cooling path for S= 5000 J/K-kg. This is an intermediate value in the range (S=3000 to 6000 J/Kg-K) required to vaporize forsterite but allow formation of a liquid upon decompression and cooling.

The ratio of moles of O to moles of Si, Mg, and Fe is an indicator of oxygen enrichment. The higher the number, the more oxygen is available for bonding with the other elements. The starting material value is 1.33.



Except for at the lowest temperature and pressure, the vapor phase at this entropy contains a higher ratio of oxygen to other elements than the liquid phase or the starting material. Therefore, any loss of vapor would leave the liquid reduced compared to the starting material.

The dominant equilibrium species along the correlated P-T path are MgO and $MgSiO_3$. At the lowest temperature and pressure, $Mg_{(g)}$, $O_{(g)}$, and $SiO_{(g)}$ become the most abundant species. The Fe-bearing species are plotted below. Fe metal is present in the liquid phase for the entire cooling path, but $Fe_{(g)}$ is also present for the majority of the cooling path.



Discussion: Since both Fe metal and $Fe_{(g)}$ are present along the cooling path, droplets could form both inside the quenched glass and as a product of vapor deposition. These results support previous work that reducing agents are not necessary [1,2,5], and that micrometeorite impact can produce iron metal.

Future work will include modeling the isentropic cooling path of a bulk chondritic composition.

References: [1] Sasaki, S. et al. (2003) *Adv. Space Res.*, 31, 2527-2542. [2] Sasaki, S. et al. (2002) *Adv. Space Res.*, 29, 783-788. [3] Melosh H. J. and Artemieva N. (2004) *LPS XXXV*, Abstract #1732. . [4] Eriksson G. and Hack K. (1990) *Metall. Trans., 21B*, 1013-1023. [5] Hapke, B. (2001) *JGR*, 106, 10039-10073.

Acknowledgments: This work was supported by NASA grant NAG5-11493.