

EVAPORATION OF CAI LIQUIDS INTO SOLAR GAS. A. V. Fedkin¹, L. Grossman^{1,2} and S. B. Simon¹, ¹Department of the Geophysical Sciences, 5734 S. Ellis Ave., ²Enrico Fermi Institute, The University of Chicago, Chicago, IL 60637. (avf@uchicago.edu)

In [1], a method for calculating the vapor pressure of a CaO-MgO-Al₂O₃-SiO₂ (CMAS) liquid droplet in pure H₂ was used to calculate the evolution of the bulk chemical compositions of hypothetical high-temperature condensate assemblages upon melting and evaporation. We have made a major improvement to this model, allowing us to calculate the composition path of CAI-like liquids evaporating into more general gas compositions.

In this work, we assume that a CAI precursor liquid is immersed in a gas whose composition is solar except for the amounts of CMAS components which condensed above the temperature of forsterite condensation. H, He, C, N, O, Mg, Al, Si, P, S and Ca were assumed present. Using the CMAS activity-composition model of [2], the partial pressures of 49 species in equilibrium with the droplet surface were calculated as a function of temperature from 2000 to 1500K (the solidus) and P(H₂) from 10⁻² to 10⁻¹¹ bar, for liquid compositions α (CMAS wt%: 31.78, 8.30, 40.17, 19.74) and δ (24.37, 15.07, 30.79, 29.77).

For both compositions, the contribution of evaporated material to the total gas in contact with the droplet ranges from 10⁶ to 10² times that of the ambient gas for Si and Mg, and from 10⁵ to 10 times for oxygen with increasing P(H₂) at 2000K. At 1500K, the ratio of evaporated material to that from the ambient gas ranges from 10² to 1 for Si and oxygen, and from 10³ to 1 for Mg with increasing P(H₂) up to ~10⁻⁴ bar. As in [1], partial pressures of H₂O and of most Mg and Si species increase, and P(O) and P(O₂) decrease, with increasing P(H₂) for both α and δ at all investigated temperatures. This is due to passing from a free evaporation regime to a hydrogen-reaction-dominated regime with increasing P(H₂). As a result, log fO₂ ranges from ~IW+1 to IW-3 at 2000K and from ~IW-1 to IW-5 at 1500K with increasing P(H₂) for both liquid compositions. As in [1], evaporation of magnesium and silicon occurs predominantly as Mg_(g) and SiO_(g), respectively, and the P(SiO)/P(Mg) ratio is a function of droplet composition and temperature, and is independent of P(H₂). In some cases at 1500K, the sum of the partial pressures of Si species in equilibrium with the droplet is less than that for the ambient gas, resulting in condensation, rather than evaporation, of SiO₂. This occurs at P(H₂) 5 x 10⁻⁵ and 6 x 10⁻⁴ bar for α and δ , respectively.

When 50% of the Mg evaporates into a solar gas from a totally molten droplet of composition α , 15.7% and 0.9% of the Si evaporate at 2000K and 1500K, respectively, while 35.1% and 6.2% of the Si evaporate from δ . During isothermal evaporation of 60% of the Mg from these compositions, log fO₂ at the droplet surface decreases by ~0.1 at 2000K and ~0.2 at 1500K. Because silicate liquids are unstable relative to evaporation in solar gas at all temperatures above their solidi and for all reasonable nebular pressures, the oxygen fugacity of the gas in contact with all silicate droplets in the solar nebula was higher than that of a solar gas, by up to 6 orders of magnitude depending on temperature and P(H₂).

References: [1] Grossman L. *et al.* (2000) *GCA*, 64, 2879-2894. [2] Berman R.G. (1983) PhD thesis, UBC.