

CHEMICAL CONSTRAINTS ON FORMATION OF THE MOON.

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Introduction: Potassium and zinc isotopic anomalies indicate lunar material formed at high temperatures from ejecta of a giant impact on the early Earth [1,2]. High temperatures and high oxygen fugacity (f_{O_2}) can fractionate e.g., Ce/LREE, Nd/Sm, Lu/Hf, Th/U, W/Hf, Rb/Sr, K/U during condensation of such ejecta. Our chemical equilibrium calculations over a range of P – T conditions for formation of the Moon from a bulk silicate Earth (BSE) melt – vapor system constrain the conditions where lunar elemental ratios occur and where Ce depletions are absent.

Results: Figure 1 shows the stability for bulk silicate Earth (BSE) melt in a P-T plot. Melt is stable on and to the right (i.e., higher P) of the red colored evaporation / condensation curve. Unsaturated BSE vapor is stable to the left of the red curve. The saturated vapor pressure curve for BSE melt is the black curve. BSE melt has variable composition between the red & black curves; and is increasingly Mg,Si-rich toward the black curve. Our calculated curves agree with [3,4] and [4] also found the red & black curves approached each other with increasing temperature. The material forming the Moon occurs on and to the right of the red curve (the critical curve is reached at some unknown higher P and T [5]). High T coupled with high f_{O_2} can produce fractionated elemental ratios in Moon-forming material; in particular for Ce/LREE [6-8] and Th/U [7]. Figure 2 shows large Ce depletions in the 4100 – 3300 K range at 10 bars. Other atomic ratios at 3300 K are 1.00 Nd/Sm, 1.00 Lu/Hf, 1.00 W/Hf, 2.36 Th/U, 10^{-3} Rb/Sr, 0.004 K/U. All ratios are BSE-normalized. We will give a synthesis of the chemical constraints at the meeting.

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