NEBULAR EVOLUTION AND VOLATILE DEPLETION IN THE INNER SOLAR SYSTEM.

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Introduction: Historically, two principal theories have sought to explain volatile depletion: incomplete condensation during cooling of a hot inner disk (e.g. [1-5]); and variants of a two-component model, in which depleted chondrules are mixed with matrix of ~CI composition (e.g. [6-9]). A significant problem for disk evolution models arises from constraints on chondrite formation: achieving a hot disk, 'late', at asteroidal distances [10]. A problem for the two-component model is that many differentiated objects (e.g. the Earth [11]) show depletions greater than those observed in chondrules [12,13]. Hf-W data [14,15] raises another issue: if chondrule formation postdates core formation in planetesimals then chondrules cannot be responsible for volatile depletion of differentiated meteorites.

Previous work: Differentiated objects show a wide range in levels of depletion. Using parameters for a 'canonical' nebula [16], we found depletion levels and trajectories that are a close fit to magmatic iron compositions, and consistent with Hf-W ages [14,15] and dynamical models of formation location [17]). Our work showed that incomplete condensation from a 'hot' disk is a viable explanation for volatile depletion, assuming those bodies accreted early, and in the terrestrial planet region.

Results and Discussion: Recently, we employed a similar approach [16] to explore a variety of additional scenarios, within the parameter space of a 'canonical' nebula. We find that our earlier result - that disk evolution models of this type provide an explanation for volatile depletion in differentiated objects - is robust: all scenarios produce depletion levels and trajectories consistent with magmatic iron compositions. Intriguingly, we also identified some scenarios where compositions approached chondritic depletion levels at asteroidal distances, and timescales of 10^6 after CAI. While understanding chondrite depletion may not be the key to unlocking the mechanism for inner Solar System chemical evolution and volatile depletion (since depletion predates chondrite accretion), it remains an outstanding question. Disk evolution models may provide an answer.

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