HIERARCHICAL ACCRETION: EVIDENCE FROM COMPOSITIONAL DIVERSITY OF CO AND ORDINARY CHONDRITE INCLUSIONS.

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Introduction: Reitmeijer [1] used “hierarchical accretion” to describe the origins of chondritic interplanetary dust particle (IDP) textures and bulk compositions. From the smallest scale to chondritic meteorites, nebular constituents accumulated hierarchically from tiny, to small, to larger objects, yielding chondritic, or solar, major refractory element ratios at small and large scales [e.g., 2]. This paradigm for accretion is consistent with the notion of "complementarity" between not only chondrules and matrix in chondrites [3, 4], but also between chondrules themselves [5], and between Ca-, Al-rich inclusions (CAIs) and other components [6]. Presently, the opposition to these two ideas is largely driven by interpretations of isotopic measurements as supporting a long chondrule formation time span [e.g., 7]. Indeed, [8] finds this objection the single barrier to a one-reservoir model for chondrule and CAI formation and accretion with matrix (i.e., hierarchical accretion and complementarity).

Methods: We measured the bulk chemical compositions of thousands of inclusions (chondrules, CAIs, AOAs) in CO chondrites [9], and hundreds of inclusions in LL3 ordinary chondrites [10], in addition to associated matrix.

Results: Preliminary analysis indicates that the major element diversity of inclusion compositions is significantly smaller in LL3 ordinary chondrites than in CO chondrites. However, the numbers of ordinary chondrite inclusions analyzed to date is not nearly as statistically powerful as the data for CO chondrites.

Discussion: Results support the hypothesis that earlier formed, smaller, more compositionally diverse, chondrules and CAIs are represented by the population in CO chondrites, and that these components accreted and were melted to form the ~10x larger inclusions that are represented in the CAI-free ordinary chondrites. The bulk flat REE compositions of both CO and ordinary chondrites, and the presence of relict CAIs in ordinary chondrite chondrules [11] support this interpretation.

Conclusion: Preliminary analysis of large numbers of inclusions in CO and ordinary chondrites supports both the complementarity of all components, and the hypothesis of hierarchical accretion of smaller components into larger bodies. These parent bodies collectively retain near-solar bulk compositions because their matrix and inclusions all formed from single, discrete, solar composition reservoirs in time and space. A recurrent, focused heating process must operate on such reservoirs [12].

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