Mixing of solid precursors during formation of FeO-poor chondrules in CR3 chondrites

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In CR3 chondrites, FeO-poor chondrules measured by SIMS [1] have $\delta^{18,17}O$ values on the slope ~1 primitive chondrule mineral (PCM) line [2]. They are ^{16}O-poor relative to the bulk Solar System estimate [3], but ^{16}O-rich relative to O associated with H_2O [4] and organics [5] in CR chondrites. $\Delta^{17}O$ values systematically increase from –6 to ~–1 ‰ as chondrule Mg# decreases from 99.2 to ~96. The Mg# range implies fO_2 varied by 1.1 log units in the chondrule-forming environment (IW –3.6 to IW –2.5, respectively; e.g. [6]), suggesting addition of oxidizing ^{16}O-poor H_2O to the highest Mg# chondrule precursors as a mechanism to form lower Mg# chondrules [7]. Using existing equilibrium condensation models and an O-isotope mass balance we examine if the CR3 chondrule Mg#-$\Delta^{17}O$ trend can be explained by precursors variably mixed in Solar gas and a CI chondrite composition split into silicate, organic, and H_2O components. In the model, ratios of atomic H, O, and C, in assemblages, dependent on the degree of enrichment in dust, H_2O, and organics, determine fO_2 during chondrule-formation [e.g. 6]. We assigned O-isotope ratios of precursor components, based on measurements/estimates [1,3,5], allowing for quantifying model parameters that match the observed CR3 chondrule trend. Our model predicts FeO-poor CR3 chondrules formed at dust enrichments of 100-200×, from dusts with 0 to 0.8 times the amount of H_2O in CI chondrites

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