

THE OXYGEN ISOTOPE SYSTEMATICS OF THE UNEQUILIBRATED ORDINARY CHONDRITES.

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Introduction: Unequilibrated Ordinary Chondrites (UOCs) have undergone only minor thermal processing on their parent bodies, and, therefore, provide unaltered isotopic records from early solar system processes, as most of their minerals retain nebular composition. Olivine and pyroxenes in UOC chondrules represent equilibrium condensation phases. High precision oxygen isotope analyses by micro laser-fluorination, combined with mineralogical and petrological data are a powerful tool to investigate early solar system processes affecting the oxygen isotope distribution and evolution. UOC oxygen isotope distributions are commonly modeled incorporating two reservoirs: solid and gas [1-4]. The “solid” endmember is represented by type I chondrule olivines and pyroxenes, and secondary aqueous alteration phases represent the “gas” endmember [2, 5].

Results: UOCs of low petrologic types (3.00) display large ranges in their bulk oxygen isotope composition ($\delta^{18}\text{O}$) that span the entire $\delta^{18}\text{O}$ range of the three subgroups (H, L, LL) of the Ordinary Chondrites (OCs) (~-3.5 to 5.5‰), and even extend the range up to 7 ‰ [6]. The $\delta^{17}\text{O}$ values of these bulk samples have similarly large ranges, but are lower than those of the OCs by several 10th of and up to 1‰ [6]. This suggests that isotopic heterogeneity of early Solar System components is preserved in UOCs even when analyzing bulk material [6]. The oxygen isotopically very positive matrix oxygen isotope data of NWA 7731 [6] might represent the composition of H₂O ice at the time of accretion; this value and bulk matrix $\delta^{18}\text{O}$ values of Semarkona [4] are the most positive UOC values from each respective dataset.

Discussion: Calculated oxygen isotopic averages of the previously studied type 3.00 UOCs [1, 2] do not fall into the respective oxygen isotope field of their “assigned” OC subgroup, but, instead, have somewhat lower $\delta^{17}\text{O}/\Delta^{17}\text{O}$ values. This raises two questions: (1) are bulk UOCs truly in the same oxygen isotope fields as OCs, or do they occupy their own, distinct oxygen isotope field, and (2) when equilibrated and metamorphosed, would UOC material oxygen isotopically “turn into” OC material?

We are obtaining high-resolution spatial and high-resolution analytical micro oxygen isotope analyses of low type UOC (e.g., NWA 7731, NWA 8276, and Semarkona) components in order to more accurately understand the degree and nature of solid-gas mixing in the UOCs: (1) chondrule minerals (olivines and pyroxenes), (2) secondary alteration minerals (phyllosilicates and other hydrated phases), and (3) matrices and chondrules. We are also studying low petrographic type equilibrated OCs (H, L, LL) in order to establish possible similarities or differences between those rocks and UOCs. Further, we are conducting experiments to “equilibrate”/“metamorphize” [7] UOC material in order to test whether such processes transform UOC material into OC material, and whether UOCs and OCs might possibly share the same parent body. We will present our first results.

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