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Correlation between mass independent oxygen isotope fractionation and Mg# among type I chondrules in pristine CO chondrite DOM 08006

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Chondrules are considered to have formed by transient heating events in the dust-rich protoplanetary disk, where O-isotopes in ambient gas were derived mainly from solid precursors and might have efficiently exchanged with chondrule melt [1]. A series of studies have been conducted to examine O 3-isotopes in individual chondrules $\Delta^{17}O$ (= $\delta^{17}O - 0.52 \times \delta^{18}O$) and their relationship to Mg#'s (= [Mg]/[Mg+Fe] molar %) of olivine and pyroxene phenocrysts, which are good indicators of oxygen fugacity during chondrule formation [e.g., 2-5]. In CR chondrites, individual chondrules show a negative correlation between $\Delta^{17}O$ (from –6‰ to –1‰) and Mg# (from 99 to 96), suggesting variable amounts of ^{16}O-depleted water ice existed among precursors and controlled both $\Delta^{17}O$ and oxygen fugacity in the chondrule forming environments [2]. In other CCs, such as CO, CM, and CV chondrites, $\Delta^{17}O$ and Mg# show bimodal distributions; $\Delta^{17}O$ from –6‰ to –4‰ for high Mg# chondrules (>98) and nearly constant $\Delta^{17}O$ ~–2.5‰ for a wide range of Mg# (100-30) [1, 3-5].

In this study, we present new analyses of Mg# and $\Delta^{17}O$ in 16 high Mg# (>98) chondrules from the least metamorphosed CO chondrite DOM 08006 (CO3.01), some of which were reported in [6]. The $\Delta^{17}O$ values range from –6‰ to –4‰, and negatively correlate with Mg#'s that range from 99.2 to 98.5. These data suggest chondrules with the highest Mg#'s (~99) in CO formed in the presence of ^{16}O-depleted water ice. Similar results have been observed in CM and CV chondrites [4-5]. Therefore, our results do not support a bimodality of $\Delta^{17}O$ among high Mg# (99-100) chondrules that was recently proposed by [7], which was based on limited olivine analyses exhibiting cathodoluminscence in chondrules from Y-81020 (CO3.05).

Reference: [1] Ushikubo et al. (2012), GCA 90, 242-264. [2] Tenner et al. (2015), GCA 148, 228-250. [3] Tenner et al. (2013), GCA 102, 226-245. [4] Chaumard et al. (2018), GCA 228, 220-242. [5] Hertwig et al. (2018), GCA 224, 116-131 [6] Fukuda et al. (2022), GCA in press. [7] Libourel et al. (2022), GCA 319, 73-93.