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Newly identified hibonite-bearing FUN inclusions with low Al/Mg ratios

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It has been recognized that a minor group of CAIs named FUN (*F*ractionation and *U*nknown *N*uclear effects) and some types of hibonite ($CaAl_{12}O_{19}$) inclusions show isotopic anomalies in ^{48}Ca, ^{50}Ti, and no or small excesses in ^{26}Mg from the decay of ^{26}Al. The existence of isotopic anomalies in Ca and Ti suggests that these inclusions formed at the earliest stage of the solar system evolution, when isotopic heterogeneity still existed. The lack of ^{26}Al may also be interpreted as their formation before the homogenization of ^{26}Al distribution in the early solar system. Hence, FUN inclusions and hibonite-bearing inclusions may have significant importance in studying the earliest stage of the solar system evolution.

In order to better understand the isotopic homogenization process(es) in the early solar system, I have conducted multiple isotopic analyses of three hibonite-bearing inclusions from the Murchison (CM2) meteorite using two ion microprobes (Cameca ims-1270 & NanoSIMS 50). I identified three new hibonite-bearing FUN inclusions (MC037, MC040, and MC003), which exhibit extremely large mass-dependent fractionation in Mg (up to ∼55 ‰/amu) but almost no excess in ^{26}Mg, and have resolvable isotopic anomalies in ^{48}Ca and ^{50}Ti. The results suggest that these inclusions formed during the isotopic homogenization process(es). The results of Mg isotopic compositions (extremely large isotopic fractionation) and elemental abundances (rather low Al/Mg ratios of 20-150) indicate that the precursors of these inclusions might have more Mg-rich (less refractory) compositions than the previously reported hibonite-bearing F(UN) inclusions (Al/Mg ratios from ∼500 up to ∼60000). In addition, their oxygen isotopic compositions are plotted on a mass-dependent fractionation line with Δ^{17}O values of ∼-23 ‰, similar to the value for the majority of typical CAIs. This suggests that oxygen isotopic compositions of their precursors are also ^{16}O-rich ($\delta^{17,18}$O ∼-50 ‰), identical to those of typical CAIs. Furthermore, the textual signatures suggests that a molten precursor of MC040 may have been quenched. Although the origin of FUN inclusions is still not known, the present results and previous works show that there are further variations in their precursor compositions, isotopic anomalies, and thermal processes.

Keywords: FUN inclusion, hibonite, ion microprobe, Mg isotopes, Ca and Ti isotopes, oxygen isotopes