Carbonate stardust from the Murchison meteorite

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The formation of carbonates in meteorites is generally attributed to secondary aqueous alteration in "planetary environments" (such as Earth, Mars and asteroids), and carbonates are considered to be a good indicator of the past presence of liquid water. However, we report the first discovery of unique calcite grains embedded in the interior of a large calcium-aluminum-rich inclusion (CAI) from the Murchison CM2 carbonaceous chondrite. The individual calcite grains in the CAI are agglomerated submicron (<1 μm) crystals and coexist with high-temperature condensates such as spinel and diopside. The oxygen isotope ratios of the calcite grains have an extreme $^{17}O/^{16}O$ and $^{18}O/^{16}O$ anomaly and are clearly different from that of the secondary carbonates in the matrix. The calcite crystals have large negative anomalies with relatively heterogeneous oxygen isotope compositions ranging from −120 to +5‰ for $\delta^{17}O_{SMOW}$ and from −50 to +100‰ for $\delta^{18}O_{SMOW}$, which are extremely depleted in ^{17}O and enriched in ^{18}O relative to spinel and diopside (−45 to −40‰ for $\delta^{17}O_{SMOW}$ and −50 to −45‰ for $\delta^{18}O_{SMOW}$). Although the oxygen isotope compositions of the secondary carbonates are distributed along the TF line, those of the calcite grains in the CAI are heterogeneous and linearly distribute neither on the TF line nor near the TF line in the three oxygen isotope diagram. Therefore, our results suggest that the primitive carbonate grains may form in the proto-solar "nebular environment" without liquid water.

キーワード：酸素同位体、CAI、分子雲、原始太陽、原始太陽系星雲、二次イオン質量分析計
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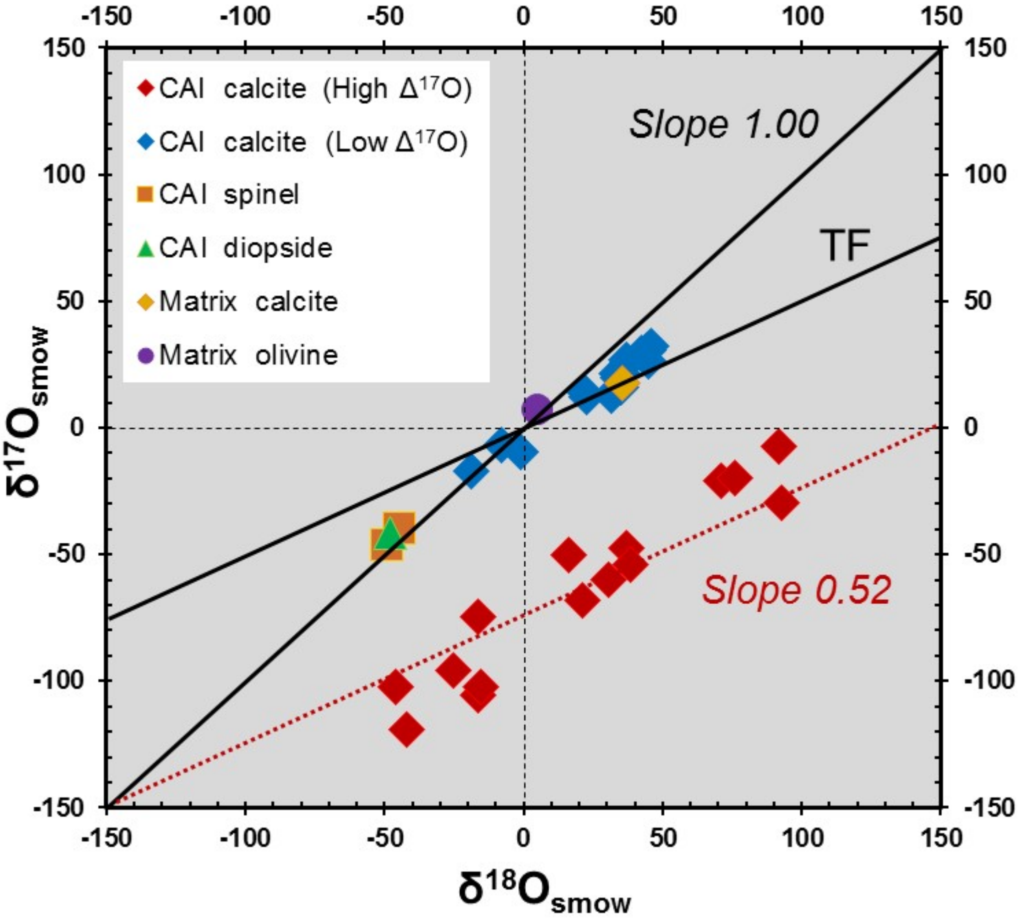

CAI calcite (High Δ17O)
CAI calcite (Low Δ17O)
CAI spinel
CAI diopside
Matrix calcite
Matrix olivine
Slope 1.00
TF
Slope 0.52
δ17Osmow
δ18Osmow

