Nature of oxygen-isotope exchange in Ca,Al-rich inclusions

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Oxygen isotopic composition of the Sun inferred from the solar wind returned by *Genesis* is ^{16}O-rich (Δ^{17}O ~ –28±2‰) [1]. The majority of Ca,Al-rich inclusions (CAIs) studied in CO, CR, CH, and CM chondrites of petrologic types ≤ 3.0 are uniformly ^{16}O-rich (Δ^{17}O ~ –24‰), suggesting formation in a gas of approximately solar composition [2,3]. Among the rare exceptions are CAIs incompletely melted during chondrule formation. Wark-Lovering rims around these CAIs are partly or completely destroyed, the melted minerals are ^{16}O-depleted to various degrees (Δ^{17}O up to –5‰), and the Al-Mg systematics of the CAIs are reset or disturbed [4,5].

Most CAIs in CB chondrites are igneous and are surrounded by igneous rims of Ca-rich forsterite. They are isotopically uniform, but show a range of Δ^{17}O, from –15‰ to –5‰ [6]. It is suggested that these CAIs experienced complete melting and gas-melt interaction in an impact generated plume ~4562.5 Ma [6,7]. If correct, these observations and O-isotope composition of the plume gas inferred from Δ^{17}O of the CB cryptocrystalline chondrules condensed from the plume (~ –3‰) [6] suggest that CB CAIs experienced incomplete (40–90%) O-isotope exchange during this process, assuming the CAI precursors had Δ^{17}O of –24‰.

Many CAIs in CV≥3.1 and CO≥3.1 chondrites experienced O-isotope exchange with ^{16}O-poor (Δ^{17}O ~ –2 to 0‰) hydrothermal fluids on their parent bodies [8–10]. The Δ^{17}O of the fluids is inferred from O-isotope compositions of aqueously formed magnetite and fayalite in CVs and COs [11]. CAI minerals affected by this exchange include anorthite, melilite, grossite, perovskite, and, possibly, several ultrarefractory minerals (davisite, eringaite, kangite, and warkite). Although hydrothermal alteration of the CV and CO chondrites occurred ~3–4 Ma after formation of CAIs [11], the Al-Mg systematics of the CAIs appear to have been largely unaffected by the parent body O-isotope exchange [9].

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