^{16}O-RICH MELILITE MANTLE OF A COARSE GRAINED COMPOUND COMPACT TYPE A INCLUSION FROM ALLENDE

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Introduction: Oxygen isotopic heterogeneity in a Ca-Al-rich inclusion (CAI) has been widely observed. The heterogeneity may correspond with change of oxygen isotopic composition in the solar nebula or alteration in the parental asteroid [1]. A self-shielding model predicts that oxygen isotopic composition of solar nebular gas evolves from ^{16}O-rich to ^{16}O-poor [2]. Change of oxygen isotopic distribution from CAIs to chondrules seems to support the evolution, but the O isotopic heterogeneity in a CAI suggests that the trend of O isotope evolution experienced local complexity in the nebula. Here we report a compound compact type A CAI formed in a nebular region changing O isotopic compositions from ^{16}O-poor to ^{16}O-rich.

Experimental: A polished thin section of ON01 CAI was examined with a petrographic microscope and by X-ray analysis using SEM-EDS system (JEOL JSM-7000F). In situ oxygen isotopic analyses were conducted with a Cameca ims-1270 [3].

Results: ON01 is a ~6.5 x 5.5 mm sized, round-shaped inclusion, which is classified into coarse-grained compact Type A CAIs (CTAs), but has complex petrography. It is predominated by melilite with small amount of spinel, perovskite and fassaite. X-ray elemental maps show that ON01 inclusion consists of three regions; spinel-rich inner core, spinel-poor outer core, and gehlenite mantle. The gehlenite mantle is enclosed by Wark-Lovering (W-L) rim. Melilite grains in the inner core are irregularly shaped, relatively small (< ~500 μm), and aluminous (median $Åk_{27}$). They generally show reverse zonation with Åk-rich core to Åk-poor rim. In contrast, magnesian (median $Åk_{35}$) and coarser melilite laths (up to 1.2 mm) consist of the outer core. The melilite laths appear to be oriented from the rim with increase of Åk contents to the interior. The gehlenite mantle ($Åk_{<\sim10}$) completely encloses the cores, and contains spinel, perovskite, and high Ti-hibonite (6~8 wt% of TiO_2). The mantle minerals corrode the outer core melilite. Oxygen isotopic compositions of ON01 plot along the CCAM line. Spinel grains are always enriched in ^{16}O (δ^{18}O=-45‰). Melilite of the inner and outer cores is uniformly poor in ^{16}O (δ^{18}O=0‰). In contrast, gehlenite in the mantle is generally enriched in ^{16}O as plotted towards spinel.

Discussion: The petrography and compositions of the inner core resembles the features of fluffy Type A CAIs (FTAs) [4] indicating condensation origin. The outer core resembles the normal CTAs experienced melting. From the aspect of melilite composition, the melting of the outer core is not inconsistent with the petrography of inner core that has never been totally melted. This texture indicates that ON01 is a compound CAI composed of FTA and CTA. The O isotopic composition of the core melilite indicates that the core was formed in ^{16}O-poor nebular gas. The ^{16}O-rich composition of the gehlenite mantle, and corroded texture of the core-mantle boundary require a discrete condensation event of solid or melt. Therefore, O isotopic composition of nebula surrounding ON01 changed from ^{16}O-poor to ^{16}O-rich.

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