Oxygen isotopic compositions of a compound CAI in Allende

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Ca-Al-rich inclusions (CAIs) and chondrules are considered to be formed at different locations and times and by different processes in the solar nebula [1]. However, recent observations of the compound CAI-chondrule objects [2, 3] suggest that CAIs and chondrules are contemporaneously formed by the same heating mechanism or that CAIs and chondrules are re-melted together after mixing of these two objects. Thermal history of compound objects are expected to give constraints on the relationship between CAI and chondrule forming processes, although there are few such studies. We report oxygen isotopic compositions of a compound CAI (*CAI 025*) from Allende (CV3) which consists of Al-rich interior and chondrule-like igneous rim.

Oxygen isotopic compositions were analysed in situ by SIMS (Cameca ims-1270) using Cs+ primary ion beam focused to 2-10 µm. Repeatability of the standard analysis was about ± 2 ‰ on both $\delta^{17}O$ and $\delta^{18}O$.

The oxygen isotopic compositions of *CAI 025* constituent minerals are correlated with the inferred crystallization sequence. Subhedral spinel in the interior is enriched in ^{16}O ($\Delta^{17}O$ = -24.7 to -15.2) and clustered into three subgroups. Olivine and low-Ca pyroxene in both interior and rim have intermediate $\Delta^{17}O$ values range from -12.6 to -2.9. Anorthite in the interior is depleted in ^{16}O ($\Delta^{17}O$ = -2.7 to +0.8). The range in the oxygen isotopic compositions of spinel indicates that each spinel grain had crystallized from a liquid with different oxygen isotopic compositions. Oxygen isotopic compositions of olivine and low-Ca pyroxene indicate that both portions of interior and rim of the CAI were melted in relatively ^{16}O-poor environment. Presence of poikilitic olivine surrounded by anorthite in the interior suggests mixing of a Si-rich chondrule-like component to a precursor CAI. These observations suggest that *CAI 025* is formed by repeated incomplete melting of a CAI precursor with the presence of chondrule-like material.

[1] Wood (1996) in *Chondrules and the Protoplanetary Disk* 55-69. [2] Itoh & Yurimoto (2003) *Nature* **423**, 728-731. [3] Krot ***et al.*** (2005) *Nature* **434**, 998-1001.

Highly siderophile elements in the mantles of the terrestrial planets

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The highly siderophile elements (HSE) pose a challenge for studies of planetary geochemistry. HSE are normally strongly partitioned into metal relative to silicate melt, yet the abundances of these elements estimated for Earth's primitive upper mantle (PUM) and the martian mantle are only about 200× lower than in chondrites. In contrast, HSE abundances in the lunar mantle may be more than 20× lower than in the terrestrial PUM. HSE abundances in diogenites, some of which may sample the mantle of the asteroid Vesta, are highly variable and span the range estimated for the Earth, Moon and Mars. The generally chondritic Os isotopic compositions of the terrestrial, lunar and martian mantles require that their long-term Re/Os ratios were also within the range of chondritic meteorites. Further, most HSE in the terrestrial PUM appear to be present in chondritic relative abundances, although Ru/Ir and Pd/Ir ratios are slightly suprachondritic. Similarly suprachondritic Ru/Ir and Pd/Ir ratios have also been reported for some lunar impact melt breccias that were created via large basin forming events. Numerous hypotheses have been proposed to account for the HSE present in Earth's mantle including inefficient core formation, lowered metal-silicate D values resulting from metal segregation at elevated temperatures and pressures, and late accretion of materials with chondritic bulk compositions after the cessation of core segregation. Synthesis of the large database now available for HSE in the mantles of rocky bodies reveals that each of the main hypotheses has flaws, and that more complex, hybrid models may ultimately be necessary to account for the observed HSE characteristics of the terrestrial planets.