# Melting of an Allende Type B1 CAI in $^{16}$O-rich nebular gas

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Oxygen isotopes in coarse-grained CAIs are disturbed heterogeneously among the constituent minerals along a slope-1 line on an O three-isotope diagram [1]. The origin of the heterogeneous O isotope distributions in Type B CAIs still remains controversial. Here we propose O isotope evolution of CAI melt during crystallization to explain the O isotopic distributions in an Allende Type B1 CAI TS34, based on the petrographic observations and in-situ O isotope measurements; we also conducted an investigation of $^{26}$Al–$^{26}$Mg chronology of the CAI. The O and Al–Mg isotopes have been measured by using a SIMS instrument, Cameca ims-1280HR, installed in Hokkaido University.

The TS34 CAI mainly consists of melilite, fassaite, and spinel, in an igneous texture. Spinel is uniformly $^{16}$O-rich ($\Delta^{17}$O = −22.7 ± 1.7‰, 2SD), while melilite is uniformly $^{16}$O-poor ($\Delta^{17}$O = −2.8 ± 1.8‰). Chemical zoning of Ti in fassaite crystals in TS34 CAI corresponds to the direction of crystal growth: they grew from Ti-rich to Ti-poor compositions [2]. The fassaite crystals show continuous variations in $\Delta^{17}$O along the inferred directions of crystal growth, from $^{16}$O-poor ($\Delta^{17}$O ~ −4‰) to $^{16}$O-rich ($\Delta^{17}$O ~ −23‰). The $^{16}$O-poor side of the fassaite is equilibrated with the melilite. The O isotopic distribution in fassaite likely correlates with the O isotopic evolution of the melt during fassaite crystallization, from $^{16}$O-poor to $^{16}$O-rich, which may have been originated by O isotope exchange with $^{16}$O-rich surrounding nebular gas. The melilite may have crystallized from the $^{16}$O-poor melt at the earliest stage of crystallization, equilibrated with the most $^{16}$O-poor fassaite. The $^{16}$O-rich spinel is a relict at the melting and crystallization event. These melting and crystallization relationships are consistent with phase diagram [3]. Internal $^{26}$Al–$^{26}$Mg isochron of the melilite and fassaite in TS34 CAI shows an initial value of $(^{26}\mathrm{Al}/^{27}\mathrm{Al})_0$ = (5.003 ± 0.075) × $10^{-5}$, which corresponds to relative age of 0.05 ± 0.02 Myr, from the canonical [4]. Our data demonstrate that both $^{16}$O-rich and $^{16}$O-poor reservoirs had been existed in the solar nebula at least ~0.05 Myr after the birth of the Solar System.

[1] Clayton et al. (1977) *EPSL* 34, 209–224. [2] Simon et al. (1991) *GCA* 55, 2635–2655. [3] Stolper (1982) *GCA* 46 2159–2180. [4] Larsen et al. (2011) *ApJL* 735 L37–L43.