Variations in initial $^{26}Al/^{27}Al$ ratios among fine-grained CAIs in the reduced CV chondrites

*Noriyuki Kawasaki[1], Changkun Park[2], Naoya Sakamoto[1], Hisayoshi Yurimoto[1,3]

1. Hokkaido University, 2. KOPRI, 3. ISAS/JAXA

Ca-Al-rich inclusions (CAIs) are oldest solids formed in the Solar System [1] and composed of high-temperature condensates from a solar-composition gas [2]. Most of CAIs are thought to have contained detectable amounts of live ^{26}Al, a short-lived radionuclide with a half-life of ~0.7 Myr, at their formation [3]. Recent high-precision ^{26}Al–^{26}Mg mineral isochron studies using secondary ion mass spectrometry (SIMS) revealed detailed distributions of initial $^{26}Al/^{27}Al$ values, $(^{26}Al/^{27}Al)_0$, for individual CAIs in the reduced CV chondrites [e.g., 4–9]; coarse-grained, igneous CAIs and fluffy Type A CAIs show similar variations in $(^{26}Al/^{27}Al)_0$ respectively, which range from ~5.2 to ~4.2 $\times 10^{-5}$. In this study, we obtained new ^{26}Al–^{26}Mg mineral isochrons of five fine-grained, spinel-rich CAIs (FGIs) from the reduced CV chondrites Efremovka, Vigarano and TIL 07007 by *in situ* measurements using a SIMS instrument (CAMECA ims-1280HR installed at Hokkaido University). Since FGIs are likely to be condensates from a solar nebular gas, ^{26}Al–^{26}Mg mineral isochrons of them enable a more systematic comparison of $(^{26}Al/^{27}Al)_0$ between CAIs formed by condensation and by melt crystallization than has previously been achieved. The obtained ^{26}Al–^{26}Mg mineral isochrons for five FGIs give $(^{26}Al/^{27}Al)_0$ of (5.19 ±0.17) $\times 10^{-5}$, (5.00 ± 0.17) $\times 10^{-5}$, (4.53 ±0.18) $\times 10^{-5}$, (4.43 ±0.31) $\times 10^{-5}$, and (3.35 ±0.21) $\times 10^{-5}$. The $(^{26}Al/^{27}Al)_0$ for two FGIs are essentially identical to the whole-rock CAI value of $(^{26}Al/^{27}Al)_0$ ~ 5.2 $\times 10^{-5}$ [10, 11], while those for other three FGIs are clearly lower than the whole-rock CAI value. The range of $(^{26}Al/^{27}Al)_0$ values for the FGIs, from (5.19 ±0.17) to (3.35 ±0.21) $\times 10^{-5}$, corresponds to a formation age spread of 0.44 ±0.07 Myr. These variations are slightly larger than those for igneous CAIs ranging from ~5.2 to ~4.2 $\times 10^{-5}$ [5, 6]. Our data imply that CAI condensation events continued for, at least, ~0.4 Myr at the very beginning of our Solar System, if ^{26}Al was distributed homogeneously in the forming region. Alternatively, the observed variations would also raise a possibility of heterogeneous distributions of ^{26}Al in the forming region, corresponding to a range over, at least, $3.4 \times 10^{-5} < (^{26}Al/^{27}Al)_0 < 5.2 \times 10^{-5}$.

[1] Connelly et al. (2012) *Science* 338, 651–655. [2] Grossman (1972) *GCA* 86, 597–619. [3] MacPherson et al. (1995) *Meteoritics* 30, 365–386. [4] MacPherson et al. (2010) *ApJL* 711, L117–L121. [5] MacPherson et al. (2012) *EPSL* 331–332, 43–54. [6] MacPherson et al. (2017) *GCA* 201, 65–82. [7] Kawasaki et al. (2017) *GCA* 201, 83–102. [8] Kawasaki et al. (2018) *GCA* 221, 318–341. [9] Kawasaki et al. (2019) *EPSL* 511, 25–35. [10] Jacobsen et al. (2008) *EPSL* 272, 353–364. [11] Larsen et al. (2011) *ApJL* 735, L37–L43.