VARIATIONS IN INITIAL $^{26}$AL ABUNDANCES AMONG FINE-GRAINED CA-AL-RICH INCLUSIONS IN THE REDUCED CV CHONDrites.

N. Kawasaki$^{1}$, C. Park$^{2}$, N. Sakamoto$^{3}$, and H. Yurimoto$^{1, 4}$

$^{1}$Natural History Sciences, Hokkaido University (kawasaki@ep.sci.hokudai.ac.jp), $^{2}$Division of Earth-System Sciences, KOPRI, $^{3}$Isotope Imaging Laboratory, Hokkaido University, $^{4}$ISAS/JAXA.

Introduction: Ca-Al-rich inclusions (CAIs) are composed of high-temperature condensates from a solar-composition gas [1] and the oldest objects formed in our Solar System, as determined by U-corrected Pb–Pb chronology [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 CV chondrites [4–10]. The data show that coarse-grained, igneous CAIs and fluffy Type A CAIs show similar variations in ($^{26}$Al/$^{27}$Al)$_{0}$, which range from ~5.2 to ~4.2 × 10$^{-5}$ [10]. However, few studies have obtained such high-precision $^{26}$Al–$^{26}$Mg mineral isochrons of fine-grained inclusions (FGIs); only two FGIs have been examined [4, 10]. Volatility-fractionated trace-element patterns [11, 12] and complex multi-layered structures [13, 14] of FGIs in CV chondrites are indicative of condensates formed directly from the solar nebular gas. In this study, we obtained new $^{26}$Al–$^{26}$Mg mineral isochrons of five FGIs from the reduced CV chondrites, Efremovka, Vigarano, and Thiel Mountains (TIL 07007), by in situ measurements using SIMS. 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.

Experimental: $^{26}$Al–$^{26}$Mg isotopic compositions of minerals in FGIs were measured using a Cameca ims-1280HR SIMS instrument at Hokkaido University. An $^{16}$O$^+$ primary beam accelerated to 23 keV was employed in the experiment. We used both the peak-jumping mode and the multicollection mode, depending on the secondary ion intensities of Mg-isotopes from the minerals. The full analytical procedures are reported in [8, 10].

Results and Discussion: FGIs HKE02 and HKE03 from Efremovka, HKV03 from Vigarano, and TIL01 from TIL 07007 are fine-grained, spinel-rich inclusions. They have irregular shapes and complex multi-layered textures composed mainly of spinel, melilite, and diopside. The CAI TIL02 from TIL 07007 is a compound object consisting of fine-grained, anorthite-pyroxene-rich core enclosed by fluffy Type A CAI-like melilit-rich mantle. The entire inclusion of TIL02 is surrounded by Wark-Lovering rim [13]. We measured Al–Mg isotopic compositions of melilite and spinel in each FGI and defined $^{26}$Al–$^{26}$Mg mineral isochrons. The obtained $^{26}$Al–$^{26}$Mg mineral isochrons give ($^{26}$Al/$^{27}$Al)$_{0}$ of (5.19 ± 0.17) × 10$^{-5}$ for HKE02, (5.00 ± 0.17) × 10$^{-5}$ for HKV03, (4.53 ± 0.18) × 10$^{-5}$ for TIL02, (4.43 ± 0.31) × 10$^{-5}$ for TIL01, and (3.35 ± 0.21) × 10$^{-5}$ for HKE03. The ($^{26}$Al/$^{27}$Al)$_{0}$ values for the FGIs HKE02 and HKV03 are essentially identical to the whole-rock CAI value of ($^{26}$Al/$^{27}$Al)$_{0}$ ~ 5.2 × 10$^{-5}$ [15, 16], while those for the other three FGIs are clearly lower than the whole-rock CAI value. The observed significant variation in ($^{26}$Al/$^{27}$Al)$_{0}$ for the FGIs, from (5.19 ± 0.17) to (3.35 ± 0.21) × 10$^{-5}$, corresponds to a formation age spread of 0.44 ± 0.07 Myr. These variations are similar to, but slightly larger than those for igneous CAIs ranging from ~5.2 to ~4.2 × 10$^{-5}$ [5, 7]. 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 variation in ($^{26}$Al/$^{27}$Al)$_{0}$ would also raise a possibility of heterogeneous distributions of $^{26}$Al in the forming region, corresponding to a range over, at least, 3.4 × 10$^{-5}$ < ($^{26}$Al/$^{27}$Al)$_{0}$ < 5.2 × 10$^{-5}$.