

Variations in initial $^{26}\text{Al}/^{27}\text{Al}$ ratios among condensate CAIs from CV chondrites

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Fine-grained Ca-Al-rich inclusions (FGIs) and fluffy Type A CAIs (FTAs) in CV chondrites are suggested to be condensates formed directly from the solar nebular gas (e.g., MacPherson and Grossman, 1984; Krot et al., 2004). Al-Mg mineral isochrons of seven FGIs and two FTAs from reduced CV chondrites Efremovka, Vigarano, Thiel Mountains 07007, and Northwest Africa 8613 were obtained via in situ Al-Mg isotope measurements using secondary ion mass spectrometry (Cameca ims-1280HR at Hokkaido University). The slopes of the mineral isochrons for seven FGIs and two FTAs exhibit statistically significant variations in initial $^{26}\text{Al}/^{27}\text{Al}$ ratios, $(^{26}\text{Al}/^{27}\text{Al})_0$, ranging from (5.19 ± 0.17) to $(3.35 \pm 0.21) \times 10^{-5}$, which correspond to a relative age spread of 0.44 ± 0.07 Myr. Inferred upper limit of $(^{26}\text{Al}/^{27}\text{Al})_0$ for them is identical to the Solar System $(^{26}\text{Al}/^{27}\text{Al})_0$ of $\sim 5.2 \times 10^{-5}$ as determined by whole-rock Al-Mg isochron studies for CAIs in CV chondrites. The intercepts of the mineral isochrons, the initial $^{26}\text{Mg}/^{24}\text{Mg}$ ratios, are consistent with Mg-isotope evolution path of a solar-composition nebular gas. The observed variations in $(^{26}\text{Al}/^{27}\text{Al})_0$ for condensate CAIs are essentially similar to those (~ 5.2 to $\sim 4.2 \times 10^{-5}$) for coarse-grained, igneous CAIs of CV chondrites that are formed by melting and solidification (MacPherson et al., 2012, 2017). If ^{26}Al was distributed homogeneously in the forming region, then our data indicate that thermal processes of condensation and melting for CAI formation occurred contemporaneously and continued for at least ~ 0.4 Myr at the very beginning of the Solar System. Alternatively, the observed variations in $(^{26}\text{Al}/^{27}\text{Al})_0$ also indicate the possibility of heterogeneous distributions of ^{26}Al in the forming region, corresponding to a range of over at least $3.4 \times 10^{-5} < (^{26}\text{Al}/^{27}\text{Al})_0 < 5.2 \times 10^{-5}$.

Fig. 1. Variations in initial $^{26}\text{Al}/^{27}\text{Al}$ ratios among CAIs in CV chondrites (after Kawasaki et al., 2020). Colored symbols indicate data from this study. Other data are from Jacobsen et al. (2008), Larsen et al. (2011), MacPherson et al. (2010, 2012, 2017), Kita et al. (2012), and Kawasaki et al. (2018).

