BULK CHONDRITE VARIABILITY IN MASS-INDEPENDENT MAGNESIUM ISOTOPE COMPOSITION – IMPLICATIONS FOR INITIAL SOLAR SYSTEM ^{26}AL/^{27}AL.

T.-H. Luu, R. C. Hin, C. D. Coath and T. Elliott,
Bristol Isotope Group, School of Earth Sciences, University of Bristol, Bristol BS8 1RJ, UK (tutu.luu@bristol.ac.uk)

Introduction: The ^{26}Al-^{26}Mg short-lived chronometer (half life of 0.72 Myr) has been extensively used to date objects formed in the solar protoplanetary disk, SPD (e.g. [1-2]). However, the use of the Al-Mg systematics as a chronometer relies on the assumption that (^{26}Al/^{27}Al)$_0$ was initially homogeneously distributed in the different formation regions of the objects being dated. Improvements in bulk analytical techniques over the past decades now allows differences of a few parts per million (ppm) in mass-independent Mg isotopic compositions, $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$, to be distinguished. This capability provides a valuable perspective on possible (^{26}Al/^{27}Al)$_0$ heterogeneity in solar system bodies.

So far, variability in $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ among solar system objects has been interpretated as reflecting either (i) variability in Al/Mg, based on the observation that the $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ of bulk chondrites correlate with their Al/Mg, suggesting a common, canonical (^{26}Al/^{27}Al)$_0$ in the parent bodies of these samples [3-4], or (ii) variability linked to a heterogeneous initial distribution of (^{26}Al/^{27}Al)$_0$ within the SPD, based on the covariation of $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ and ε^{54}Cr between bulk chondrites [5-6], or (iii) nucleosynthetic Mg-isotope heterogeneity across the SPD, as is evident on a small scale by the different intercepts of Al-Mg isochrons of some unusual CAIs [7]. Thus, to date, the bulk chondrite $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ data have not clearly resolved the question of whether or not (^{26}Al/^{27}Al)$_0$ in the SPD was homogenous.

Here we consider new data of our own together with the most recent data of the literature [8-9] to reassess the problem. We have also focused on better characterizing the composition of enstatite chondrites, in order to expand the existing dataset of single values reported by [3] and [5]. As well as their bearing on the cause of bulk chondrite $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ variability, enstatite chondrites provide a likely protolith composition for the Earth [e.g., 10].

Results and Discussion: Bulk carbonaceous (CV, CI, CM, CO, CK) and ordinary (H, LL) chondrites define a primordial Al-Mg isochron whose slope and intercept yield (^{26}Al/^{27}Al)$_0$ ~ $(4.7\pm0.8)\times10^{-5}$ and ($\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$)$_0$ = -31.6 ± 5.7 ppm, within uncertainty of the canonical value of (^{26}Al/^{27}Al)$_0$ ≈ 5.2×10^{-5} and ($\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$)$_0$ ≈ -34 ppm previously defined by the oldest, dated solar system objects, namely calcium-, aluminium-rich inlusions (CAIs) from CV chondrites [e.g., 11]. This is indicative of a near homogenous initial (^{26}Al/^{27}Al)$_0$ during formation of normal CAIs and precursor grains of most bulk chondrite groups, and strongly supports the use of the Al-Mg systematics as a short-lived chronometer.

The $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ of enstatite chondrites are slightly more radiogenic (~ 3 ppm) at similar Al/Mg to the ordinary chondrites. This is an entirely new observation. We speculate that the higher $\Delta'^{26}\mathrm{Mg}_{\mathrm{DSM\text{-}3}}$ of enstatite chondrites is explained by ~ 0.5 Ma delay in condensation and removal of a refractory component from the source reservoirs of EH and EL enstatite chondrites.

References: [1] Schiller M. et al. (2015). *Earth and Planetary Science Letters* 420:45-54. [2] Luu T.-H. et al. (2015). *Proceedings of the National Academy of Sciences* 112:1298-1303. [3] Schiller M. et al. (2010). *Earth and Planetary Science Letters* 297:165-173. [4] Kita N.T. et al. (2013). *Meteoritics & Planetary Science* 48:1383-1400. [5] Larsen K.K. et al. (2011). *Astrophysical Journal* 735:L37-L43. [6] Van Kooten E.M.M.E. et al. (2016). *Proceedings of the National Academy of Sciences* 113:2011-2016. [7]Wasserburg G.J. et al. (2012). *Meteoritics & Planetary Science* 47:1980-1997. [8] Olsen M.B. et al. (2016). *Geochimica et Cosmochimica Acta* 191:118-138. [9] Larsen K.K. et al. (2016). *Geochimica et Cosmochimica Acta* 176:295-315. [10] Javoy M. et al. (1986). *Chemical Geology* 57:41-62. [11] Jacobsen B. et al. (2008). *Earth and Planetary Science Letters* 272:353-364.