HETEROGENEOUS DISTRIBUTION OF ^{26}AL IN THE SOLAR PROTOPLANETARY DISK.

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Use of ^{26}Al-^{26}Mg system as a relative chronometer to date early solar system (SS) processes is based on the assumption that ^{26}Al was homogeneously distributed, at least in the inner part of the solar protoplanetary disk. To date, the evidence for ^{26}Al homogeneity has been based on either high-precision Mg-isotope measurements of the inner SS solids – CAIs, chondrules, and asteroids [1–3], and concordancy between ^{26}Al-^{26}Mg and Pb-Pb ages obtained on the same chondritic components [4]. We note, however, that the resolution required to unequivocally rule-out ^{26}Al heterogeneity is beyond the current state-of-the-art in Mg-isotope measurements: e.g., the amount of ^{26}Mg resulting from the *in situ* decay of ^{26}Al [μ^{26}Mg*, the per 10^6 deviation from the terrestrial ^{26}Mg/^{24}Mg value] in a reservoir with solar Al/Mg ratio is only 38 ppm assuming an initial ^{26}Al/^{27}Al ratio of ~5×10^{-5}. Thus, an uncertainty of 10 ppm in the μ^{26}Mg* value can translate into a potential heterogeneity of up to 50% in the initial abundance of ^{26}Al in material with solar Al/Mg ratio.

To test the assumption of ^{26}Al homogeneity – and hence the chronological significance of the ^{26}Al-^{26}Mg system – we have developed novel protocols allowing for measurement of the μ^{26}Mg* value and Al/Mg ratios in silicate materials by HR MC-ICPMS to higher precision than previously possible, namely with an external reproducibility of 2.5 ppm and 0.2%, respectively. Five AOAs and four CAIs from the reduced CV chondrite Efremovka define a statistically significant Al-Mg isochron (MSWD=1.6) with a slope corresponding to a ^{26}Al/^{27}Al value of $(5.26\pm0.01)\times10^{-5}$ and an initial μ^{26}Mg* of -16.0 ± 1.5 ppm. The error on this slope corresponds to an age uncertainty of ~2,000 years, supporting a very short duration of CAI- and AOA-forming epoch [1,2]. The CAI-AOA regression intercepts the solar ^{27}Al/^{24}Mg ratio of 0.1 at a μ^{26}Mg* of 21.0 ± 1.5 ppm, that is, significantly higher than the terrestrial value. We have also analyzed a number of primitive meteorites and a martian shergottite (NWA856). Apart from E-chondrites, an R-chondrite (NWA753) and NWA856, which have a μ^{26}Mg* value identical to Earth, all samples analyzed in this study show small but resolvable excesses and deficits in μ^{26}Mg* compared to the terrestrial value.

The observed variations in μ^{26}Mg* are not correlated to the ^{27}Al/^{24}Mg ratios, but do correlate with the ^{54}Cr abundance determined here by TIMS for the same sample digestions. Thus, these results are most easily understood if they represent initial heterogeneity in the abundance of ^{26}Al among various SS reservoirs. If this interpretation is correct, our data suggest that large-scale heterogeneity of up to 75% may have existed in the initial ^{26}Al/^{27}Al ratios of various SS reservoirs at the time of CAI formation, thereby compromising the chronological significance of ^{26}Al-^{26}Mg data. The canonical ^{26}Al/^{27}Al ratio of ~5×10^{-5}, which has been a fiducial marker for the beginning of the SS, may not represent the initial abundance of ^{26}Al for the SS as a whole.

References: [1] Thrane et al. (2006) *ApJ* **646**, L159. [2] Jacobsen et al. (2008) *EPSL* **272**, 353. [3] Villeneuve et al. (2009) *Science* **325**, 985. [4] Amelin et al. (2002) *Science* **297**, 1678.