Homogeneity of ^{26}Al and Mg isotopes in the proto-planetary disc in the young Solar System

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The precise Mg isotope composition of chondrites is important for two reasons. Firstly, it can identify the precursor material and processes involved in the accretion of Earth and whether Earth contains chondritic [1] or non-chondritic Mg [2]. Secondly, variations or otherwise in the mass-independent abundance of ^{26}Mg ($\delta^{26}Mg^*$) can constrain the homogeneity of the initial distribution of ^{26}Al in the early Solar System. This is important as the short-lived ^{26}Al-^{26}Mg chronometer ($t_{1/2}$ = 0.73 Myr) is used to date the relative timing of solid and planetesimal formation in the early Solar System and its validity depends on the assumption that ^{26}Al was homogeneously distributed in the proto-planetary disc. Evidence for Mg or ^{26}Al isotopic heterogeneity in chondrites needs to carefully evaluated given the recent discovery of significant heterogeneities in the distribution of other neutron-rich isotopes of some elements (e.g., ^{50}Ti, ^{54}Cr; [3,4]).

To this end, we have measured the Mg isotopic composition of a wide range of chondrites by pseudo-high resolution multiple collector inductively coupled plasma mass spectrometry with an accuracy and precision of < ±0.006‰ on $\delta^{26}Mg^*$ (2 se). Novel chemical separation techniques for Mg were developed to minimise the presence of contaminant elements (e.g., Mn, Ni), which are not readily separated by conventional cation exchange techniques traditionally utilised for Mg isotopic studies.

Nineteen ordinary, enstatite and carbonaceous chondrites have a mean $\delta^{25}Mg$ = -0.16 ± 0.10‰ (2 sd), which is indistinguishable from the $\delta^{25}Mg$ of Earth's mantle ($\delta^{25}Mg$ = -0.14 ± 0.07‰; [5]), suggesting that there is no resolvable difference between the range of chondrites analysed and Earth. $\delta^{26}Mg^*$ variations are more than an order of magnitude smaller than, and do not correlate with, ^{50}Ti or ^{54}Cr anomalies in the same chondrite groups. Small variations in $\delta^{26}Mg^*$ amongst the chondrites correlate with $^{27}Al/^{24}Mg$ ratios and are principally controlled by the presence of refractory inclusions in some carbonaceous chondrites.

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Cosmogenic ^{36}Cl production rates from Ca and K spallation

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Published cosmogenic ^{36}Cl production rates from Ca and K spallation differ by almost 50% (e.g. c.f. Gosse and Phillips [1]). The main difficulty in calibrating ^{36}Cl production rates is to constrain the relative contribution of the various production pathways, which depend on the rock composition. In particular, the production via the $^{35}Cl(n,\gamma)^{36}Cl$ pathway, which depends on the Cl content, is difficult to parameterize due to the complex distribution of low-energy neutrons at the land/atmosphere interface. To overcome this difficulty, separated Ca- and K-rich minerals with particularly low Cl concentrations were used to calibrate the production rates from Ca and K.

Ca-rich plagioclases and K-feldspars were separated from samples collected on the surfaces of four basaltic lava flows from Mt. Etna (38°N, Italy) and of a trachyte lava flow from volcano Payun Matru (36°S, Argentina), respectively. Their ages were determined by non-cosmogenic methods and range between 0.4 and 33 ka. Sample sites range between 500 and 2500 m in elevation. Scaling factors were calculated using five different published scaling models. Four of these models account for geomagnetic field variations integrated over the respective exposure durations. Each of the five resulting calibration data sets was then statistically evaluated using a nonlinear mixed model in a Bayesian framework. The Bayesian approach allows the major inherent uncertainties to be included in a consistent way. First results suggest that the Ca and K spallation production rates determined with this approach are in agreement with the lowest values published so far.

[1] Gosse & Phillips (2001), *Quat. Sci. Rev.* **20** 1475-1560