High-precision ^{26}Al-^{26}Mg dating of early planetesimal magmatism

MARTIN SCHILLER[1]*, JOEL A. BAKER[1] AND MARTIN BIZZARRO[2]

[1]School of Geography, Environment and Earth Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand (*correspondence: martin.schiller@vuw.ac.nz)
[2]Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350, Denmark

Since the demonstration of the former presence of ^{26}Al ($t_{1/2}$ = 0.73 Myr) in calcium-aluminium-rich inclusions (CAIs) [1], the ^{26}Al-^{26}Mg chronometer has been used to date the relative timing of CAIs and chondrules as well as the formation of some basaltic meteorites (e.g. [2, 3]). Improved levels of precision that can be attained by MC-ICP-MS make it possible to resolve very small excesses in ^{26}Mg ($\delta^{26}Mg^*$) that result from an increase in the Al/Mg ratio associated with the formation of basaltic magmas, if the magma formed in the first 5 Myr of the Solar System [4]. However, the $\delta^{26}Mg^*$ excesses resulting from this are < 0.050‰ and require an accuracy and precision of < ±0.005‰ to fully utilize the new potential of the ^{26}Al-^{26}Mg dating system.

We have measured the Mg isotopic composition of basaltic meteorites from different planetary bodies by pseudo-high resolution multi-collector inductively coupled plasma mass spectrometry. A range of tests have been conducted to ensure that $\delta^{26}Mg^*$ can be determined with an accuracy and precision of < ±0.005‰ and, in particular, developed improved chemical separation techniques to minimise the presence of contaminant elements (e.g., Mn) in purified Mg, which are not readily separated by conventional nitric-acid-based cation exchange techniques.

Our new data confirms the presence of widespread $\delta^{26}Mg^*$ excesses [4] in samples of basaltic meteorites and date planetary melting and magmatism to the first 5 Myr of the Solar System: *Mesosiderite parent body* (1991.305 $\Delta t_{CAIs} = 2.87^{+0.11}_{-0.10}$ Myr); *Eucrite parent body* (Juvinas $\Delta t_{CAIs} = 3.14^{+0.12}_{-0.11}$ Myr); *Angrite parent body* (SAH99555 $\Delta t_{CAIs} = 4.81^{+0.17}_{-0.15}$ Myr); *NWA011/2976 parent body* (NWA2976 $\Delta t_{CAIs} = 3.52^{+0.14}_{-0.12}$ Myr). Two angrite samples (LEW86010, Angra dos Reis) have no resolvable $\Delta^{26}Mg^*$ excess, which is consistent with their young Pb-Pb ages [5].

[1] Lee *et al.* (1976) *GRL* **3**, 41-44. [2] Kita N. T. *et al.* (2000) *GCA* **64**, 3913-3922. [3] Srinivasan *et al.* (1999) *Science* **284**, 1348-1350. [4] Bizzarro *et al.* (2005) *ApJ* **632**, L41-44. [5] Amelin *et al.* (2008) *GCA* **72**, 221-232.

In situ cosmogenic ^{36}Cl production rate calibration from Ca and K in lava flows

I. SCHIMMELPFENNIG[1], L. BENEDETTI[1], R. PIK[2], P. BURNARD[2], P.H. BLARD[3], T. DUNAI[4] AND D. BOURLÈS[1]

[1]CEREGE, Aix en Provence, France (schimmel@cerege.fr)
[2]CRPG, Vandoeuvre-lès-Nancy, France
[3]CALTECH, Pasadena, CA, USA
[4]University of Edinburgh, UK

We performed sequential ^{36}Cl extraction experiments on whole rock grains and Ca-rich plagioclase from the same lava sample taken at Mt. Etna (Sicily, 38°N). This sample has a K-Ar fossil exposure time of (10±3)kyr and a ^{3}He exposure age of (9.4±0.9)kyr [1]. High Cl concentrations (~450ppm) were removed from the plagioclase sample by a 20% preliminary dissolution step. ^{36}Cl concentrations from successive dissolution steps of this Cl-free plagioclase sample yield an exposure age which agrees with K-Ar and ^{3}He dating within uncertainties. This good agreement was obtained using Stone *et al.* (1996) [2] and Evans *et al.* (1997) [3] ^{36}Cl production rates for the target elements Ca and K, respectively,. Stepwise dissolution of the whole rock grains, on the contrary, does not completely remove the high Cl concentrations of the bulk rock. More than 330ppm Cl still remain after 85% dissolution, resulting in a considerable ^{36}Cl production from capture of low-energy neutrons by ^{35}Cl, an additional and still not well-constrained ^{36}Cl production mechanism. The resulting ^{36}Cl exposure ages from the whole rock are systematically 30-40% higher than the independent exposure ages.

Consequently, we used separated feldspars (of different Ca/K ratios) instead of bulk rock for all calibration samples to obtain an accurate ^{36}Cl production rate calibration. We will present results from various Mt. Etna and Payun-Matru (Argentina, 36°S) samples of different elevations and independently determined ages between 0.4kyr and 33kyr. First results imply that the respective ^{36}Cl production rates from Ca and K range between those of Stone *et al.* [2], Evans *et al.* [3] and Phillips *et al.* [4].

[1] Blard *et al.* (2008, in press) *Quat. Geochronol.* [2] Stone *et al.* (1996) *Geochim. Cosmochim. Acta* **60,** 679-692. [3] Evans *et al.* (1997) *Nucl. Instr. & Meth. in Phys. Res. B* **123,** 334-340. [4] Phillips *et al.* (2001) *Chem. Geol.* **175,** 689-701.