HIGH PRECISION MEASUREMENT OF METEORITIC K BY TIMS

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High precision three-isotope measurements of K have interesting potential applications in the field of cosmochemistry, where they may resolve mass-independent ^{41}K anomalies in meteoritic materials, attributable to the former presence or isolation from decay of the shortlived ^{41}Ca radionuclide ($t_{½} \approx$ 100 ky) in the early solar system. Such measurements may form the basis for tracing and dating based on this shortlived decay system. Because of the very short halflife of ^{41}Ca, the level of ^{41}Ca in the solar systems first (T_0) solids is highly sensitive to the timing of its nucleosynthesis relative to solid formation; therefore, it may help date and constrain the location and process of nucleosynthesis. For the same reasons, viable ^{41}Ca-^{41}K chronometry may reach high chronometric precisions.

The study of the ^{41}Ca-^{41}K system has until now been carried out by SIMS analyses of refractory inclusions [1-3], where microscopic domains with very high Ca/K-ratios of 10^5 to 10^8 contain large ^{41}K excesses of up to ≈ 1000%, correlated with Ca/K ratios, and consistent with the presence of ^{41}Ca at a level of ^{41}Ca/^{40}Ca $\approx 1.4*10^{-8}$ at T_0. This relationship could also, in principle, reflect irradiation and spallogenic overprint, if the main target nuclei are isotopes of calcium. However, it is possible to evaluate the irradiation history of refractory inclusions by measuring ^{40}K, as this nuclide is highly sensitive to irradiation processes given its low abundance. A shortcoming of the SIMS-based method is that it cannot reliably measure ^{40}K.

Given this caveat, we have developed novel analytical protocols, allowing for the high-precision measurement of all isotopes of potassium using a Triton TIMS with customized amplifier setup. This approach can resolve anomalies in the abundance of ^{40}K that may be related to spallogenic overprint, thereby potentially discriminating between the two scenarios. Using these protocols, we have measured the K-isotope composition of metal standards, terrestrial basalts, and two refractory inclusions from the Efremovka CV3 chondrite. The Al-Mg systematics of the two Efremovka inclusions have been analyzed in a companion study [4], and are consistent with the canonical abundance of ^{26}Al.

The reproducibility of our approach has been determined through repeated analyses of metal and rock standards. For sample sizes of 150 ng, the reproducibility of the mass fractionation corrected ^{41}K/^{39}K ratio is 100 ppm (2sd), whereas the reproducibility of analyses of 10 ng K-samples is 200 ppm (2sd). These reproducibilities are sufficient to resolve any expected radiogenic anomalies in refractory inclusions. The analyses of the two Efremovka inclusions, however, show large and near identical positive anomalies in ^{40}K, consistent with a spallogenic overprint. Although these results do not rule out the presence of live ^{41}Ca at T_0, they stress the need to evaluate alternative spallogenic explanations for the Ca-K systematics. We are currently expanding our dataset to include more samples, and developing methods to measure internal isochrons to better understand the nature of Ca-K systematics in refractory inclusions.

References: [1] Srinivasan, G. et al, 1996. *GCA* 60:1823–1835. [2] Sahijpal, S. et al. 1998. *Nature* 391:559-561. [3] Sahijpal, S. et al. 2000. *GCA* 64:1989–2005. [4] Larsen, K. et al. 2010. *GCA* , this meeting.