

PPS004-09

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CALCICUM-41 REVISITED: DEVELOPMENT OF POTASSIUM ISOTOPE MASS SPECTROMETRY ON CAMECA 1280HR2 CALCICUM-41 REVISITED: DEVELOPMENT OF POTASSIUM ISOTOPE MASS SPECTROMETRY ON CAMECA 1280HR2

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Introduction: Amongst the short-lived radionuclides whose prior existence has been inferred in meteoritic components, ⁴¹Ca plays a crucial role in understanding the timescale between its nucleosynthesis and incorporation into the oldest Solar System solids because of its extremely short half-life (0.1 Myr). The initial abundance of ⁴¹Ca relative to ⁴⁰Ca in the solar nebula was found to be 1.4×10^{-8} , as first demonstrated by [1-2] through the detection of large excesses of radiogenic ⁴¹K in Efremovka CAIs. Combined with nucleosynthesis models, such a low abundance implies that the timescale for the transit from the nucleosynthetic site of ⁴¹Ca to the solar nebula should be less than 2 Myr. Soon after the initial discovery, ⁴¹Ca was also found to be correlated with the presence or absence of another short-lived radionuclide ²⁶Al in CM hibonite grains, implying that ⁴¹Ca and ²⁶Al have a common stellar origin [3-5]. However, neither the initial ⁴¹Ca/⁴⁰Ca ratio nor the correlation between ⁴¹Ca and ²⁶Al has been independently confirmed by other laboratories. Several attempts made by [6-8] failed to provide a conclusive answer for the level of ⁴¹Ca/⁴⁰Ca, primarily due to large systematic uncertainties in the mass spectrometry (corrections for doubly ionized species and for peak tailing). In this study, we propose to use the latest generation of large geometry ion microprobe CAMECA 1280HR2, newly installed at CRPG, Nancy, to reinvestigate the initial abundance and distribution of ⁴¹Ca in meteoritic refractory inclusions.

Mass Spectrometry: The mass spectrometry for potassium isotope measurements with the CRPG 1280HR2 is still under development. We have characterized several important factors of the instrument that have crucial impacts on the accuracy of ⁴¹Ca/⁴⁰Ca determination. The tailing effect of ⁴⁰Ca at mass 41 (scattered ⁴⁰Ca ions on ⁴¹K) was found to be about a few tenth of ppb under the mass resolution of 7500. The contribution of the ⁴⁰CaH⁺ tail at mass 41 was estimated to be $\sim 2 \times 10^{-5} \times ^{40}\text{CaH}^+$ by obtaining the count rate at mass 41.95 and assuming the following relationship:

$$(^{40}\text{CaH})_{\text{tail}} = [41.95]/[^{42}\text{Ca}^+] \times [^{40}\text{CaH}^+]$$

The dynamic background of the counting system was also measured overnight when analyses were not performed, and is within the range of 0.003 to 0.009 counts per second. One parameter, which requires special attentions in every measurement, is the (⁴⁰Ca⁴³Ca)⁺⁺/⁴³Ca⁺ ratio. It is used to assess the magnitude of the unresolvable interference (⁴⁰Ca⁴²Ca)⁺⁺ at mass 41. In the phases where ⁴¹Ca/⁴⁰Ca was inferred (i.e., fassaite), the high ⁴⁰Ca/³⁹K ratio ($> 1 \times 10^6$) would result in that $> 80\%$ of the signal measured at mass 41 is derived from (⁴⁰Ca⁴²Ca)⁺⁺. Therefore, having an accurate assessment of (⁴⁰Ca⁴²Ca)⁺⁺ is critical for accurate determinations of ⁴¹Ca/⁴⁰Ca. We will report some preliminary results of the K isotopic compositions in CAIs by the time of the conference.

References: [1] Srinivasan et al. (1994) ApJL, 431, 67-70 [2] Srinivasan et al. (1996) GCA, 60, 1823-1835 [3] Sahijpal et al. (1998) Nature, 391, 559-562 [4] Sahijpal et al. (1998) ApJL, 509 137-140 [5] Sahijpal et al. (2000) GCA, 64, 1989-2005 [6] Ireland et al. (1999) MAPS, 34, A57 [7] Ito et al. (2006) MAPS, 1871-1882 [8] Liu et al. (2008) LPS, 39, #1895 (abstract)

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