Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS004-09 Room:101 Time:May 27 16:30-16:45

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

Ming-Chang Liu[1*], Marc Chaussidon[1]

[1]CRPG-CNRS, [2]ASIAA

Introduction: Amongst the short-lived radionuclides whose prior existence has been inferred in meteoritic components, ^{41}Ca 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 ^{41}Ca relative to ^{40}Ca in the solar nebula was found to be 1.4x10^{-8}, as first demonstrated by [1-2] through the detection of large excesses of radiogenic ^{41}K in Efremovka CAIs. Combined with nucleosynthesis models, such a low abundance implies that the timescale for the transit from the nucleosynthetic site of ^{41}Ca to the solar nebula should be less than 2 Myr. Soon after the initial discovery, ^{41}Ca was also found to be correlated with the presence or absence of another short-lived radionuclide ^{26}Al in CM hibonite grains, implying that ^{41}Ca and ^{26}Al have a common stellar origin [3-5]. However, neither the initial ^{41}Ca/^{40}Ca ratio nor the correlation between ^{41}Ca and ^{26}Al has been independently confirmed by other laboratories. Several attempts made by [6-8] failed to provide a conclusive answer for the level of ^{41}Ca/^{40}Ca, 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 ^{41}Ca 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 ^{41}Ca/^{40}Ca determination. The tailing effect of ^{40}Ca at mass 41 (scattered ^{40}Ca ions on ^{41}K) was found to be about a few tenth of ppb under the mass resolution of 7500. The contribution of the ^{40}CaH^{+} tail at mass 41 was estimated to be ~2x10^{-5}x^{40}CaH^{+} by obtaining the count rate at mass 41.95 and assuming the following relationship:

$(^{40}\text{CaH})_{tail}$ = [41.95]/[(^{42}Ca)$^{+}$] x [(^{40}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 (^{40}Ca^{43}Ca)$^{++}$/^{43}Ca^{+} ratio. It is used to assess the magnitude of the unresolvable interference (^{40}Ca^{42}Ca)$^{++}$ at mass 41. In the phases where ^{41}Ca/^{40}Ca was inferred (i.e., fassaite), the high ^{40}Ca/^{39}K ratio ($>$ 1x10^{6}) would result in that >80% of the signal measured at mass 41 is derived from (^{40}Ca^{42}Ca)$^{++}$. Therefore, having an accurate assessment of (^{40}Ca^{42}Ca)$^{++}$ is critical for accurate determinations of ^{41}Ca/^{40}Ca. 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] Srinivasasn 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)

Keywords: short-lived radionuclide, secondary ion mass spectrometry