LI-BE-B AND AL-MG ISOTOPIC COMPOSITIONS IN CH AND CH/CB CAIS: IMPLICATION FOR THE ORIGIN OF $^{10}$Be IN THE EARLY SOLAR SYSTEM.

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Introduction: Beryllium-10, which decays to $^{10}$B with a half-life of 1.4 Myr [1], is considered as a key indicator of irradiation processes in the early solar system (ESS). However, recent numerical studies [2,3] have demonstrated that $^{10}$Be can be produced by stellar processes with neutrino reactions, which rendered reconsideration of the origin of $^{10}$Be in the ESS. The stable isotopes of Li, Be, and B are also made by irradiation processes [e.g., 4,5]. Thus, the quantitative understanding of initial $^{10}$Be abundances and stable Li-Be isotopic compositions would provide important constraints on the origin of $^{10}$Be in the ESS. Previous studies have provided hints for in-situ irradiation signatures of $^{6}$Li/$^{7}$Li, initial $^{10}$Be/$^{11}$B and initial $^{10}$Be abundances in Calcium, Aluminum-rich Inclusions (CAIs) [e.g., 4-8]. However, most of Li-Be-B data come from CAIs in CV and CM chondrites that have experienced thermal and/or aqueous alteration processes. Therefore, it is possible that some of the observed isotopic compositions might be disturbed by secondary processes. In the present study, we have conducted Li-Be-B and Al-Mg measurements on CAIs in least-altered CH and CH/CB chondrites.

Samples and Analytical Methods: Seven melilite-rich CAIs and one gossite-rich CAI were selected from the Sayh al Uhaymir 290 (CH) and the Isheyevo (CH/CB) meteorites. Petrographic observations and major element concentrations of these CAIs were obtained with FE-EPMA at The Univ. of Tokyo. Lithium, Be, and Al-Mg measurements were performed using a NanoSIMS 50 at Atmosphere and Ocean Research Institute (AORI), The Univ. of Tokyo. The instrumental mass fractionation was determined from measurements of NIST SRM610, 612 glasses and a Madagascar hibonite. The Be/B and Al/Mg relative sensitivity factors were determined from measurements of synthetic melilitic glasses [9] and a Madagascar hibonite.

Results and Discussion: All CAIs studied here do not show resolvable excesses in $^{26}$Mg, which is in agreement with previous studies [e.g., 10]. In contrast to Al-Mg systematics, five out of 8 CAIs show highly variable initial $^{10}$Be/$^{9}$Be ratios ranging from 6.9 to $33 \times 10^{-4}$. The observed variations in initial $^{10}$Be/$^{9}$Be ratios were produced by in-situ cosmic ray irradiation. $^{7}$Li/$^{6}$Li ratios would be affected by spallation products. However, all CAIs with resolvable $^{10}$Be excesses show the chondritic isotopic ratio ($^{7}$Li/$^{6}$Li = $12.06$ [11]) within uncertainties. In order to understand the observed relationship between initial $^{10}$Be/$^{9}$Be and $^{7}$Li/$^{6}$Li, we estimated irradiation effects on $^{7}$Li/$^{6}$Li in CAIs using the observed initial $^{10}$Be/$^{9}$Be ratios and spallation production ratios [12]. Considering low Li concentrations in observed CAIs (26 to 63 ppb), this simple calculation suggests that the observed $^{7}$Li/$^{6}$Li ratios are inconsistent with in-situ irradiation of refractory solids. This could be attributed to: (1) isotopic fractionation from spallogenic $^{7}$Li/$^{6}$Li ratios, (2) condensation from an irradiated chondritic gas, or (3) partial loss of spallogenic Li and isotopic exchange with a chondritic gas, (4) $^{10}$Be was not produced by solar cosmic ray irradiation, but by stellar processes [2,3]. (1) is unlikely because Mg and B isotopes do not show mass dependent fractionations. (2) is a simple interpretation because the observed $^{7}$Li/$^{6}$Li ratios are nearly chondritic. (3) is possible because petrographic observations suggest that some of the CAIs were probably once molten. (4) is also possible because neutrino-induced nucleosynthesis [2,3] predominantly produces $^{7}$Li, which is in sharp contrast to the case for cosmic ray irradiation. [3] has pointed out that low-mass supernovae provided ~8% of $^{7}$Li in the solar system but a negligible amount of $^{10}$Li. If the stellar products were introduced during or after the solar system formation, $^{7}$Li/$^{6}$Li ratios would have been shifted to $^{7}$Li-rich compositions from the chondritic value. Unfortunately, our analytical precision does not resolve excesses in $^{7}$Li from the chondritic value. High precision Li isotope measurements are required to check this scenario.