Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS02-11 会場:203 時間:5 月 20 日 12:30-12:45

角礫岩 LL コンドライトに含まれるアルカリに富む岩片の K-Ca 同位体年代学
K-Ca systematics of alkali-rich fragments in LL-chondritic breccias

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Introduction: Alkali-rich fragments in LL-chondritic breccias, Kraehenberg, Bhola and Y-74442 are very similar in mineralogy and petrography, suggesting that they could have come from related precursor materials [1,2]. Recently we reported Rb-Sr isotopic systematics of alkali-rich igneous rock fragments in Y-74442 [2]. The extremely high Rb/Sr value (2.58 at 4.429 Ga ago) of this source can be explained by mixing of a chondritic component with an alkali-rich component formed in the early solar nebula. Since alkali-rich fragments in the LL-chondritic breccias are highly enriched in K, we can expect enhancements of radiogenic ^{40}Ca. The decay of ^{40}K to ^{40}Ca has not been widely used for dating due to the high abundance of ^{40}Ca along with the fractionation of Ca isotopes during analysis in the mass spectrometer. Here, we report preliminary results of K-Ca isotopic systematics of alkali-rich fragments in Y-74442.

Results and Discussion: The Ca abundances in samples were calculated from their ^{48}Ca/^{44}Ca ratios, normalized to ^{42}Ca/^{44}Ca = 0.31221 [3]. While the Ca abundances in alkali-rich fragments of Y-74442 are almost constant and chondritic (1.3-1.8 x CI), the fragments show enrichments of K (5-15 x CI) [2]. Over time, the enrichment of K in alkali-rich fragments of Y-74442 result in large epsilon ^{40}Ca values (epsilon ^{40}Ca = 2-7) relative to other planetary materials [4,5]. The data of Y-74442 fragments yield a K-Ca age of 4.51 +/- 0.23 Ga (2 sigma, MSWD = 3.5, n = 6) for lambda (^{40}K) = 0.5543 Ga^{-1} [6,7] with an initial ^{40}Ca/^{44}Ca = 47.1587 +/- 0.0032 (2 sigma) using the Isoplot/Ex program [8]. Since K-Ca data for one fragment of Y-74442 deviates from the isochron, we exclude the data from the calculation. This age is within error of the previously reported Rb-Sr age of 4.429 +/- 0.054 Ga [2]. We could obtain a mean initial ^{40}Ca/^{44}Ca ratio of 47.1597 at 4.429 Ga (the more reliable Rb-Sr age). Then, using the initial ^{40}Ca/^{44}Ca value of bulk silicate earth at 4.568 Ga, the source ^{40}K/^{44}Ca ratio of 0.00162 for the fragments is obtained. This source for alkali-rich fragments is about 4.5 times higher than that of the LL-chondrite parent body (^{40}K/^{44}Ca = 0.00035) [9]. It is consistent with the Rb-Sr systematics of Y-74442 fragments [2] and suggesting that the K enrichment may have also occurred by vapor/solid (or liquid) fractionations in the early solar system. A mixture of the alkali component (early nebular condensates) and the ferromagnesian component could reflect flash heating induced by impact on an LL chondritic parent body at least 4.429 Ga ago, and further enrichments of K and Rb relative to Ca and Sr, respectively, could have occurred during this event. The resulting impact-melt rocks could have been fragmented by later impact event(s) and finally incorporated into the Y-74442 parent body.

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キーワード: コンドライト, アルカリ元素, 年代学
Keywords: chondrite, alkaline elements, chronology