Barium isotopic compositions of ordinary chondrites. K. Misawa[1,2], Tatsunori Yokoyama[3], and S. Yoneda[3], [1]National Institute of Polar Research, 10-3 Midoricho, Tachikawa, 190-8518, Japan (misawa@nipr.ac.jp), [2]SOKENDAI, [3]Department of Science and Engineering, National Museum of Nature and Science, 4-1-1 Amakubo, Tsukuba, 305-0005, Japan.

Introduction: Relative to the Sun's photosphere, moderately volatile elements are depleted in the Earth, Moon, Mars, Vesta and all meteorites except CI-chondrites. In relatively few cases, very alkali-rich materials have been observed in chondritic breccias. Previous studies revealed that alkali elements in Krähenberg (LL5), Bhola (LL3–6), Y-74442 (LL4), and Acfer 111 (H3–6) fragments are enriched and fractionated relative to CI-chondrites (Fig. 1) with heavier alkalis being more enriched ($Cs_{CI\text{-}norm}>Rb_{CI\text{-}norm}>K_{CI\text{-}norm}$) [1–4]. Cesium-135 ($t_{1/2}$ = 2.3 Myr) is a short-lived nuclide that can date early solar system events [5–9]. If ^{135}Cs was present in the early solar system, we can detect a ^{135}Ba excess in a reservoir having a high Cs/Ba ratio. In this study, we focus on the ^{135}Cs-^{135}Ba system of rock fragments in chondritic breccias to better understand the extent and timing of the heavy alkali enrichments in the early solar system.

Experimental: The Ba isotopic data were obtained on a TIMS at NMNS by a static multidynamic mode utilizing the zoom lens capability. Instrumental mass fractionation was corrected using the exponential law with ^{134}Ba/^{136}Ba = 0.3078 as the normalizing ratio. A single Ba isotopic analysis usually consisted of 540 cycles that were averaged. Possible isobaric interferences of ^{138}La and ^{136,138}Ce were monitored and corrected using ^{139}La and ^{140}Ce assumed natural ^{138}La/^{139}La and ^{136,138}Ce/^{140}Ce ratios, which was always negligible. Two Ba standards (SPEX ICP-MS standard and JM Alfa Aesar, Suprapur) as well as whole-rock samples of the Leedey (L6) chondrite were analyzed. All data are presented as μ^{13x}Ba values, which are the parts per million deviations from the standard:
$\mu^{13x}Ba = [(^{13x}Ba/^{136}Ba)_{sam}/(^{13x}Ba/^{136}Ba)_{std} - 1] \times 10^6$.

Results and Discussion: The Ba isotopic data are shown in Fig. 2. External precisions of ^{135}Ba/^{136}Ba and ^{137}Ba/^{136}Ba ratios of the standards (50 ng of Ba) are ~20 ppm (2σ) (solid squares). The ^{135}Ba/^{136}Ba and ^{137}Ba/^{136}Ba ratios of whole-rock samples of Leedey (L6) are normal within the errors (Fig. 2, solid circles). The result is consistent with the previous studies: the nucleosynthetic isotopic effects, *r*-process contributions to the ^{135,137}Ba excesses, are smaller in ordinary chondrites than in several CM chondrites [5–9].

The Ba isotopic composition of the spiked sample (composite ^{40}K-^{48}Ca and ^{87}Rb-^{84}Sr spikes) of Leedey (L6) was clearly different from those of standard, indicating a contribution of Ba in the spikes becomes too large to ignore. The Y-74442 and Bhola samples used for the K-Ca and Rb-Sr isotopic studies [3,4] also showed scattered Ba isotopic signatures as expected.

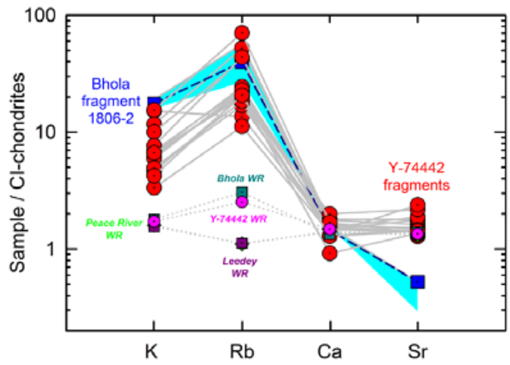

Fig. 1. CI-normalized alkali and alkaline earth abundances of lithic fragments in the LL-chondritic breccias, Y-74442 and Bhola [4]. Shaded area represents ranges of Krähenberg and Bhola fragments [1].

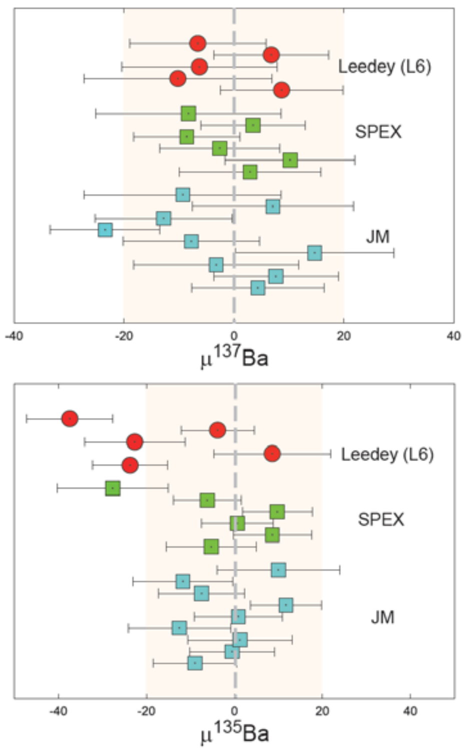

Fig. 2. ^{137}Ba/^{136}Ba (upper) and ^{135}Ba/^{136}Ba (lower) results, normalized to ^{134}Ba/^{136}Ba = 0.3078 for standards (squares) and whole-rock samples of Leedey (circles). Error bars are $2\sigma_m$.

References: [1] Wlotzka F. *et al.* (1983) *GCA* **47**, 743–757. [2] Wlotzka F. *et al.* (1992) *Meteorit.* **27**, 308. [3] Yokoyama Tatsunori *et al.* (2013) *EPSL* **366**, 38–48. [4] Yokoyama Tatsunori *et al.* (2015) *LPSC* **46**, #1695. [5] Hidaka H. *et al.* (2001) *EPSL* **103**, 459–466. [6] Hidaka H. *et al.* (2003) *EPSL* **214**, 455–466. [7] Qin L. *et al.* (2011) *GCA* **75**, 7806–7828. [8] Hidaka H. & Yoneda S. (2013) *Sci. Rep.* **3**, 1330. [9] Bermingham K.R. *et al.* (2014) *GCA* **133**, 463–478.