

Rb–Sr ISOTOPIC SYSTEMATICS OF ALKALI-RICH FRAGMENTS IN YAMATO-74442 AND BHOLA.

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Introduction: Alkali-rich igneous fragments were identified in the brecciated LL-chondrites, Krähenberg (LL5) [1], Bhola (LL3–6) [2], and Yamato (Y)-74442 (LL4) [3–5], and show characteristic fractionation patterns of alkaline elements [6]. The K-Rb-Cs-rich fragments in Krähenberg, Bhola, and Y-74442 are very similar in mineralogy and petrography (olivine + pyroxene + glass), suggesting that they could have come from related precursor materials [5]. We have undertaken Rb–Sr isotopic studies on alkali-rich fragments in Bhola and Y-74442 to precisely determine their crystallization ages and isotopic signatures of their precursor material(s).

Results and Discussion: Rubidium in alkali-rich fragments from Y-74442 is highly enriched: 20–180 times those of ordinary chondrites (OC). Alkali-rich fragments from Y-74442 yield a Rb–Sr age of 4.429 ± 0.054 Ga ($n = 9$, error = 2σ) with an initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio $I_{\text{Sr}} = 0.7144 \pm 0.0094$ (2σ), indicating a young crystallization age with a high I_{Sr} compared with those of LL-chondrite whole-rocks ($T_{\text{LL}} = 4.542 \pm 0.015$ Ga, $I_{\text{SrLL}} = 0.69901 \pm 0.00011$; recalculated with $\lambda(^{87}\text{Rb}) = 1.402 \times 10^{-11} \text{a}^{-1}$) [7].

Assuming that the precursor material enriched in Rb was formed at $T_0 = 4.568$ Ga with an $^{87}\text{Sr}/^{86}\text{Sr}$ ratio = 0.69888 (i.e., identical to the Allende initial $^{87}\text{Sr}/^{86}\text{Sr}$, I_{SrALL} [8]) and the fragments crystallized from the melt at $T = 4.429$ Ga, a time-averaged Rb/Sr ratio is calculated to be ~ 2.5 , which is much higher than the Rb/Sr ratios of the solar nebula or CI-chondrites ($\text{Rb}/\text{Sr}_{\text{SOLAR}} = 0.65$ [8]; $\text{Rb}/\text{Sr}_{\text{CI}} = 0.32$ [9]). Any solid/liquid fractionation processes could be ruled out for K, Rb, and (Cs) enrichments since these alkali-rich fragments show flat REE patterns [6]. We suggest that a condensate from the nebular gas was a carrier of alkaline elements. It was formed from the residual nebular gas after removal of a refractory lithophile component (i.e. Sr). The temperature at which the moderately volatile component (i.e. enriched in K, Rb, and Cs) was removed from the gas was relatively high (≥ 970 K, the 50% condensation temperature of Na [10]). This component was isolated from other lithophiles and might have been isolated from the nebular gas without any interaction with high/low temperature components. At 4.43 Ga the condensate was incorporated into ferromagnesian components (i.e., olivine+pyroxene) possibly during an impact melting event. They suffered further fragmentations due to impacts and then were incorporated into the LL-chondritic breccia.

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