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Rb-Sr Systematics of Erg Chech 002 Constrain the Volatile Element Accretion History of Early Planetesimals

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The Rb-Sr isotopic system is notable for the difference in volatility between its parent element (Rb, T_c = 800°C) and its daughter element (Sr, T_c = 1464°C) [1] leading to strong Rb/Sr fractionation in meteorites. Therefore, initial $^{87}Sr/^{86}Sr$ ratios of achondrite groups can be used to constrain the condensation of moderately volatile elements in early planetesimals by comparison with a nebular evolution line [2]. Erg Chech 002 is an unusual andesitic achondrite that formed as a crustal lava on a differentiated body [3] and has been recently established to be the oldest crustal rock yet identified in the Solar System at 4565.56 ± 0.12 Ma [4]. Twenty-two fractions of Erg Chech 002 were analyzed for their Rb-Sr isotopic systematics: six hand-picked fractions, six magnetically separated fine-grained fractions, and five residues and five leachates of leaching in 0.5 N HNO_3. All of the unleached fractions yield an errorchron with an age of 5708 ± 2035 Ma and a $(^{87}Sr/^{86}Sr)_i$ = 0.6933 ± 0.0142 (MSWD = 61, n =12), while leachates and residues scatter more widely likely due to parent-daughter fractionation during the leaching procedure. The least radiogenic $(^{87}Sr/^{86}Sr)_i$ of any unleached fraction and the isochron $(^{87}Sr/^{86}Sr)_i$ both overlap with a nebular Sr-evolution line constructed using the average CAI $(^{87}Sr/^{86}Sr)_i$ [5] and a CI-chondrite Rb/Sr [6]. All but one of the achondrite groups overlap with this nebular evolution line demonstrating largely homogenous $^{87}Sr/^{86}Sr$ and Rb/Sr in the Solar Nebula. Comparison of Rb-depletion ages with Pb-Pb crystallization ages for EC 002 and other achondrite groups demonstrate that all but one of the groups lost their Rb almost simultaneously with protolith melting, suggesting that present-day Solar System Rb/Sr variations were established by parent-body processes and not incomplete condensation of moderately volatile elements.

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