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No Evidence for Alkali Enrichment in Protoliths of Si-rich Ungrouped Achondrites

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Earth is unique in that it contains a bimodal crust: a younger, mafic oceanic crust and an older, felsic continental crust, while other planets are dominated by basaltic crust. The asteroidal achondrite record is likewise dominated by basaltic materials such as eucrites and angrites. However, in recent years, an increasing number of andesitic to felsic achondrites have been recognized in the meteorite record including the oldest identified achondrite, Erg Chech (EC) 002[1], the brachinite-associated Graves Nunatak (GRA) 06128/9[2] and the 4459 Ma albite-rich Erg Atouila (EA) 001[3]. Experimental studies demonstrate that low-degree melting of diverse chondritic materials produces andesitic and not basaltic melts[4]. The albite and orthoclase dominated mineralogy of EA 001 make it a strongly alkali-element enriched rock (bulk rock 8.27 wt.% Na_2O)[3] that plots outside the Si-alkali range of experimental chondritic melts[4]. Therefore, this unique meteorite may have been enriched in alkali elements by volatility processes on the parent body of its protolith.

To test whether this scenario is tenable, Rb-Sr isotope systematics of both hand-picked separates and *in situ* minerals of EA 001 were measured. As simple magnetic separation and hand-picking yielded a spuriously young age (2423 ± 421 Ma), leaching with dilute acetic and hydrochloric acid was performed. Measurement of a variety of leachates and residues clearly demonstrates mixing between a terrestrial desert component with $^{87}Sr/^{86}Sr$ ~0.711 and a pristine EA 001 component with $^{87}Sr/^{86}Sr$ of ~0.7145. When this pristine EA 001 component is age-corrected to the U-Pb apatite age of 4459 Ma [3], it overlaps with a CI-chondritic Sr isotope evolution curve. This strongly suggests that alkali element enrichment in EA 001 does not result from volatility processes. Future work using an innovative *in situ* Sr isotope method (LA-MC-ICP-MS/MS) will offer more precise constraints on the initial $^{87}Sr/^{86}Sr$ of pristine EA 001.

[1] Barrat J.-A. et al. (2021) *PNAS* **118**(11) [2] Day J. M. D. et al. (2009) *Nature* **457** [3] Wu Y. et al. (2025) *JGR: Planets* **130** [4] Collinet M., Grove T. L. (2020) *GCA* **277**