Initial $^{87}Sr/^{86}Sr$ chronology of Allende fine-grained CAIs from step leaching experiments

B.L.A. CHARLIER*[1], F.L.H. TISSOT[2], N. DAUPHAS[3], H. VOLLSTAEDT[4] AND C.J.N. WILSON[1]

[1]SGEES, Victoria University of Wellington, 6140, New Zealand (*correspondence: bruce.charlier@vuw.ac.nz)
[2]The Isotoparium, Division of Geological and Planetary Science, Caltech, CA, USA
[3]Origins Lab, The University of Chicago, IL, USA
[4]Thermo Fisher Scientific, Bremen, Germany

An important application of the Rb-Sr chronometer lies in establishing the timing of volatile depletion in Solar System planetary materials [1, 2]. This requires that the initial Solar System $^{87}Sr/^{86}Sr$ ratio be precisely and accurately known, the determination of which has proven a challenging task. In theory, Calcium-Aluminum-rich Inclusions (CAIs), which are the oldest materials formed in the Solar System (~4.567 Ga), should provide a straightfoward means to assess the solar system $^{87}Sr/^{86}Sr$ initial. In practice, however, CAIs were subjected to variable degrees of alteration by fluids rich in Ca, alkalis, H_2O, CO_2, halogens and Fe, which can affect their Rb-Sr systematics.

To circumvent these complications, we conducted sequential step leaching experiments on nine fine-grained CAIs (i.e., non-molten, preserving their condensate textures) from Allende. To achieve high-precision on Sr load sizes as small as ~150 pg, sample analysis leveraged new developments in TIMS methods, particularly 10^{13} Ω feedback resistors.

Leachate Rb-Sr data show great diversity. First leachates have high $^{87}Rb/^{86}Sr$ ratios (up to 3.8) and radiogenic $^{87}Sr/^{86}Sr$ (up to 0.94) and yield an age within error of 4.567 Ga. Samples from the fourth leach step have low $^{87}Rb/^{86}Sr$ (<0.04), low $^{87}Sr/^{86}Sr$ and yield a concordant age and precise initial $^{87}Sr/^{86}Sr$=0.698784±76, in agreement with leach step 1 and the lowest published values [1]. Complete digestions of final residues scatter to higher $^{87}Sr/^{86}Sr$, uncorrelated with $^{87}Rb/^{86}Sr$, indicating a nucleosynthetic variability in the most refractory component(s). Results suggest that the timing of formation (e.g., leach 4) and alteration (e.g., leach 1) of Allende CAIs was within error of each other and the accepted 4.567 Ga figure. Final residues represent isotopically exotic components that contain unsupported radiogenic Sr, indicative of a possible independent pre-4.567 Ga history.

[1] Papanastassiou & Wasserburg (1978) *GRL,* **5**, 595–598.
[2] Gray *et al.* (1973) *Icarus,* **20**, 213-239.