

**COMPLEX Pb ISOTOPIC CONTAMINATION IN CAIS FROM NORTHWEST AFRICA 4502.**

Y. Di<sup>1</sup>, M. S. Sapah<sup>1,2</sup>, and Y. Amelin<sup>1</sup>, <sup>1</sup>Research School of Earth Sciences, Australian National University, Canberra, Australia ([yankun.di@anu.edu.au](mailto:yankun.di@anu.edu.au); [yuri.amelin@anu.edu.au](mailto:yuri.amelin@anu.edu.au)), <sup>2</sup>Present address: University of Ghana.

**Introduction:** Most CAIs studied for U–Pb chronology so far are from the CV chondrites Allende and Efremovka [1-4]. Allende CAIs, however, experienced extensive thermal/fluid alteration and disturbance of Rb–Sr isotope systems [5-7]. Efremovka also experienced thermal metamorphism and is moderately shocked [8]. Nonetheless, Pb isotope systems of CAIs from these meteorites yield consistent ages and are deemed undisturbed. During progressive acid leaching, Pb released from these CAIs exhibit either binary mixing of radiogenic Pb with either initial Pb or modern terrestrial Pb, or ternary mixing of these components that is reduced to binary mixing for certain leaching steps, allowing reliable extrapolation of radiogenic <sup>207</sup>Pb/<sup>206</sup>Pb and precise determination of ages [9]. In this study, we perform multi-step acid leaching and Pb isotope analyses for two CAIs from the CV chondrite Northwest Africa (NWA) 4502, together with desert soil recovered from the meteorite surfaces, to examine the nature of non-radiogenic Pb components in these CAIs and the prospect of their reliable Pb-isotopic dating.

**Materials and methods:** CAI #1 and #6 from NWA 4502 have been previously described by [10], and their U–Pb chronology was studied in [11, 12]. Yellow–orange desert soil composed mainly by quartz and feldspars was collected from the surface of two pieces of NWA 4502 meteorite. Seven 20–30 mg fractions of CAI #1, eight ~10 mg fractions of CAI #6, and six ~2 mg fractions of desert material were cleaned using acetone and leached following the procedures listed in the table. Pb was separated using HBr-based anion exchange chemistry. Pb isotope compositions were measured using a Triton or MAT 261 TIMS, with instrumental fractionation corrected using a <sup>202</sup>Pb–<sup>205</sup>Pb spike [13]. The analytical accuracy and reproducibility, as well as the consistency between instruments were monitored using the SRM 981 standard and the EarlyTime synthetic solutions [14].

| Leaching strength | Very weak             | Weak                       |                            |                          | Moderate                          |                   | Strong                                | Dissolution                     |
|-------------------|-----------------------|----------------------------|----------------------------|--------------------------|-----------------------------------|-------------------|---------------------------------------|---------------------------------|
| CAI #6            | L0 = H <sub>2</sub> O | L1 = 0.5M HNO <sub>3</sub> |                            |                          | L2 = 7M HNO <sub>3</sub> + 6M HCl |                   | L3 = 1M HF                            | R = conc. HF + HNO <sub>3</sub> |
| CAI #1            |                       | L1 = 0.3M HBr              | L2 = 0.5M HNO <sub>3</sub> | L3 = 2M HCl              | L4 = 6M HCl (cold)                | L5 = 6M HCl (hot) | L6 = 1M HF (cold)<br>L7 = 1M HF (hot) | R = conc. HF + HNO <sub>3</sub> |
| Desert materials  | L0 = H <sub>2</sub> O | L1 = 0.5M HNO <sub>3</sub> | L2 = 2M HCl                | L3 = 7M HNO <sub>3</sub> | L4 = 6M HCl                       | L5 = aqua regia   | L6 = 1M HF                            | R = conc. HF + HNO <sub>3</sub> |

**Results:** None of the analysed fractions from CAI #1 and CAI #6 yielded a statistically significant <sup>204</sup>Pb/<sup>206</sup>Pb–<sup>207</sup>Pb/<sup>206</sup>Pb isochron. For each CAI, the Pb isotopic compositions of all leachates and residues plot in a triangular area on the <sup>204</sup>Pb/<sup>206</sup>Pb–<sup>207</sup>Pb/<sup>206</sup>Pb diagram, indicating the presence of three or more Pb isotope endmembers. For CAI #6, L1s are mixtures between an unradiogenic Pb endmember (represented by the least radiogenic L1, <sup>206</sup>Pb/<sup>204</sup>Pb = 24.84; <sup>207</sup>Pb/<sup>204</sup>Pb = 17.76) and small amounts of radiogenic Pb. The isotopic composition of this unradiogenic endmember is far away from the average modern terrestrial Pb [15]. L0s are mixtures between this unradiogenic Pb and the average modern terrestrial Pb. All L2s, L3s, and residues, including the highly radiogenic analyses (<sup>206</sup>Pb/<sup>204</sup>Pb up to 1650), exhibit mixing between radiogenic Pb, initial Pb and unradiogenic Pb (defined by L1). CAI #1 shows a similar leaching pattern. An unradiogenic Pb endmember can be defined using the least radiogenic L3 (<sup>206</sup>Pb/<sup>204</sup>Pb = 21.48; <sup>207</sup>Pb/<sup>204</sup>Pb = 16.45). This unradiogenic endmember is different from the average modern terrestrial Pb and the unradiogenic Pb in CAI #6. All L1–L5s are mixtures of this unradiogenic Pb, average modern terrestrial Pb, radiogenic Pb, and initial Pb. The highly radiogenic L6s, L7s, and residues (<sup>206</sup>Pb/<sup>204</sup>Pb up to 970) are mixtures of the unradiogenic Pb, radiogenic Pb, and initial Pb. The Pb isotope compositions of the leachates and residues of the desert materials form a linear array (<sup>207</sup>Pb/<sup>206</sup>Pb = 12.98 × <sup>204</sup>Pb/<sup>206</sup>Pb + 0.140) which represents the simple binary mixing of lattice Pb in the minerals (represented by the least radiogenic L6, <sup>206</sup>Pb/<sup>204</sup>Pb = 15.32; <sup>207</sup>Pb/<sup>204</sup>Pb = 15.12) with a more radiogenic endmember (<sup>206</sup>Pb/<sup>204</sup>Pb ≥ 27.23) that is preferentially released in leachates. The unradiogenic Pb endmembers in the two CAIs plot on the linear array defined by desert materials, suggesting that they formed by mixing of the lattice Pb and labile Pb in the desert materials.

**Discussion and conclusions:** The unique unradiogenic Pb endmembers concentrated in the early leachates of CAIs were not reported in previous U–Pb chronology studies of meteorites. They likely represent terrestrial contamination rather than Pb acquired on parent body or from meteorite matrix. This terrestrial Pb contamination penetrated deeply into CAI minerals, and even the highly radiogenic HF leachates and residues are affected. It cannot be completely removed by our acid leaching sequence, preventing reliable U–Pb age determination unless a more effective cleaning procedure for removal of terrestrial Pb is developed. Our results also demonstrate that the isotopic composition of terrestrial Pb contamination in meteorites can be quite different from the average modern terrestrial composition [15], and can be dependent on the local geochemical background.

**References:** [1] Amelin Y. et al. (2002) *Science*, 297, 1678. [2] Jacobsen B. et al. (2008) *EPSL*, 272, 353. [3] Amelin Y. et al. (2010) *EPSL*, 300, 343. [4] Connelly J.N. et al. (2012) *Science*, 338, 651. [5] Podosek F.A. et al. (1991) *GCA*, 55, 1083. [6] Gray C.M. et al. (1973) *Icarus*, 20, 213. [7] Meeker G.P. et al. (1983) *GCA*, 47, 707. [8] Scott E.R.D. et al. (1992) *GCA*, 56, 4281. [9] Connelly J.N. et al. (2017) *GCA*, 201, 345. [10] Sapah M.S. et al., (2013) *44th LPSC*, 1036. [11] Amelin Y. et al., (2013) *44th LPSC*, 2690. [12] Sapah M.S. et al., (2015) *46th LPSC*, 1859. [13] Amelin Y. and Davis W.J. (2006) *JAAS*, 21, 1053. [14] Connelly J. and Condon D.J., (2014) *Goldschmidt Conference*, 448. [15] Stacey J.S. and Kramers J.D. (1975) *EPSL*, 26, 207.