RARE EARTH ELEMENT ABUNDANCES AND OXYGEN ISOTOPE COMPOSITIONS IN CV3 CAIS: CLUES TO THEIR HISTORY. S. S. Russell[1], T. E. Jeffries[1], R. D. Ash[1,2], M. Gounelle[1] and E. D. Young[2,3], [1]The Natural History Museum, Cromwell Road, London SW7 5BD, UK (sarr@nhm.ac.uk) [2]Dept. Earth Sciences, Parks Road, Oxford OX1 3PR, UK [3]Earth and Space Sciences, UCLA, Los Angeles CA 90095 USA.

Introduction: We report rare earth element (REE) data for a CAI (144A) from Leoville (CV3-reduced), previously measured for oxygen isotopes [1]. The aim was to combine oxygen isotope data and REE data gathered from exactly the same CAI regions, to constrain (i) the conditions of rim formation (ii) the causes of the oxygen isotope variations in CAIs.

Sample description: Leoville 144A is a compact, oval 10mm x 6mm CAI composed of fine grained intergrown melilite, and high Ti, Al-diopside enclosing abundant micron-sized perovskite grains. Mg-rich spinel is abundant throughout the inclusion. The CAI has a hibonite-spinel inner rim surrounded by diopside. The CAI exhibits internal oxygen isotope variations that scatter around the CCAM line [1]. The inclusion rim shows a lack of oxygen isotope fractionation, exhibiting indistinguishable O systematics to the interior.

Techniques: The section was analysed for REEs using a 213nm LA-ICP-MS [2]. Pit sizes are ~50μm, slightly larger than typical grain size and comparable to the pits made during oxygen analysis.

Results:

CAI interior: The REE abundances in the CAI interior are 8-20xCI, with a very slight enrichment in the LREE (Fig. 1). Melilite and diopside exhibit complementary Eu anomalies. REE abundances appear uncorrelated to the oxygen isotope composition.

CAI Rim: The rim analyses are enriched in REEs, up to 100xCI. There is an enrichment in LREEs, and the rim analyses have a strong negative Eu anomaly (Eu=20-30xCI). Some analyses also show a slight negative Yb anomaly.

Discussion:

The similarity in oxygen isotopes of the rim and interior suggest that the rim formed from CAI material [1], as has been suggested for formation of other CAI rims [3]. To produce the observed rim enrichments from interior CAI material would require ~80% evaporation. The Eu anomaly suggests Eu was volatile during rim formation, which requires temperatures close to the hibonite condensation temperature (~1727K), followed by fast quenching before Eu could recondense [4]. Furthermore, the Eu and slight Yb anomaly imply evaporation under reducing (solar) conditions. It is notable that the evaporation has been achieved without associated mass fractionation of oxygen isotopes, perhaps because the surrounding gas pressure was high.

The lack of correlation between REE patterns and oxygen isotope compositions suggests that the intra-CAI oxygen isotopes variations were established after its crystallisation, rather than being a primary effect.

Implications: The rim-forming event occurred in a high gas pressure of solar fO_2, and the CAI was then quickly removed from the high temperature/high pressure region. The constraint of high temperatures and fast cooling make the x-wind model appealing for formation of this CAI [5, 6]. The CAI rim signatures provide quantitative constraints on the environments it experienced, and thus can provide a test of the x-wind and other models. For example, rim formation could plausibly have occurred at the x-point, where the solar gas meets the reconnection ring in which CAIs formed [6], immediately prior to its flight within the x-wind, or rims could have formed within the x-wind itself. Quantitative modelling on the expected pressure and temperature conditions in these regions are required.

The oxygen isotope exchange occurred in a different, lower temperature, longer-duration event.

References: [1] Young E.D. et al. (2000) *Lunar Plan. Sci. Conf.* ***XXXI*** 1837. [2] Jeffries, T.E., 2001, in Alfassi, Z.B. (Ed) Non-destructive Elemental Analysis. [3] Boynton W. and Wark D. (1985) *Meteoritics* **20** 613 [4] Ekambaram V. et al., (1984) *GCA* **48** 2089 [5] Shu F. H. et al., (1997) *Science* **277** 1475 [6] Shu F. H. et al., (2001) *Astrophys. J.* **548** 1029.

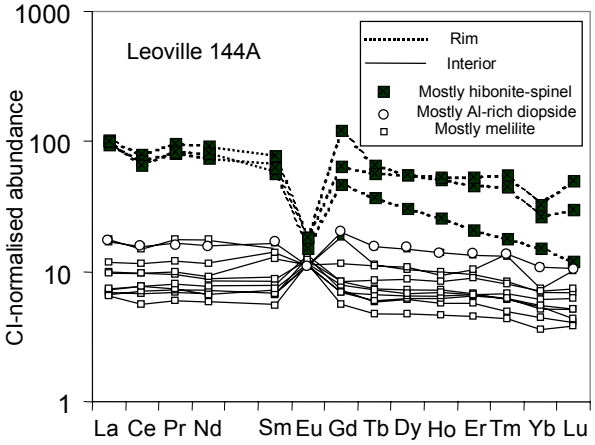

Figure 1. REE abundances from the Leoville 144A CAI.