

## The Solar System's violent beginning recorded in refractory inclusions

MEENAKSHI WADHWA<sup>1</sup>

<sup>1</sup>Center for Meteorite Studies, School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287 (wadhwa@asu.edu)

The refractory calcium-aluminum-rich inclusions (CAIs) in primitive chondritic meteorites represent the first solids to form in the solar protoplanetary disk [1]. Most of these inclusions contain evidence of live  $^{26}\text{Al}$  (half-life  $\sim 0.7$  Ma) in a near-canonical abundance ( $^{26}\text{Al}/^{27}\text{Al} \sim 5 \times 10^{-5}$ ) [2,3]. Recent determinations of well-defined  $^{26}\text{Al}$ - $^{26}\text{Mg}$  internal isochrones for refractory inclusions by high-precision MC-ICPMS and MC-SIMS demonstrate that, following their initial formation, these first solids were thermally processed in the solar nebula over a short time period of  $<100,000$  years [4-10]. The presence of live  $^{26}\text{Al}$  in near-canonical abundance in CAIs has been used to infer injection of freshly synthesized material into the solar nebula from a stellar source, most likely a supernova, just prior to the formation of these inclusions [2].

However, some recent studies suggest that this and other short-lived radionuclides may have been inherited from the parent giant molecular cloud that was enriched in these radionuclides by previous generations of massive stars [11,12]. In either scenario, the Solar System likely originated in a dense stellar nursery. We recently reported the isotope compositions of elements spanning a wide mass range (including Sr, Mo, Ba, Nd, Sm, Gd and Dy) from a suite of selected CAIs from the Allende CV3 carbonaceous chondrite [13,14]. These data suggest at least two distinct sources for r-process nucleosynthetic signatures in Solar System materials, and require supernova material to be mixed into the protoplanetary disk shortly following CAI formation. Taken together, the isotopic systematics in refractory inclusions indicate that the birth environment of the Solar System was an active, high-mass star-forming region of the galaxy.

[1] MacPherson G. J. (2014) *Treatise on Geochem.* 2<sup>nd</sup> Ed., 1, 139-179. [2] Davis A. M. and McKeegan K. D. (2014) *Treatise on Geochem.* 2<sup>nd</sup> Ed., 1, 361-395. [3] MacPherson G.J. *et al* (2014) 45<sup>th</sup> LPSC, #2698. [4] Jacobsen B. *et al* (2008) *EPSL*, **272**, 353-364. [5] Bouvier A. and Wadhwa M. (2010) *Nature Geosci.*, **3**, 637-641. [6] MacPherson G. J. *et al* (2010) *ApJ*, **711**, L117-L121. [7] Kita N. T. *et al* (2012) *GCA*, **86**, 37-51. [8] MacPherson G. J. *et al* (2012) *EPSL*, 331-332, 43-54. [9] Kita N. T. *et al* (2013) *MAPS*, **48**, 1383-1400. [10] Wadhwa M. *et al* (2014) 45<sup>th</sup> LPSC, #2698. [11] Vasileiadis A. *et al* (2013) *ApJL*, 769, L8 (6pp). [12] Gaidos E. *et al* (2009) *ApJ*, **696**, 1854-1863. [13] Brennecka G. A. *et al* (2013) *PNAS*, **110**, 17241-17246. [14] Brennecka G. A. *et al* (2014) 45<sup>th</sup> LPSC, #2280.