Aluminium-26 systematics of CV3 chondrules: Evidence for a multi-stage thermal history

SARA S. RUSSELL1, JENNIFER CLAYDON2, CHRISTOPHER D. COATH3, YI-JEN LAI23 AND TIM ELLIOTT2

1Department of Earth Sciences, Natural History Museum, Cromwell Road, London SW7 5BD, UK
2Bristol Isotope Group, School of Earth Sciences, University of Bristol, Bristol, UK
3Institute of Geochemistry and Petrology, ETH Zurich

Despite several studies of high precision Al-Mg systematics in chondrules, no clear consensus about the formation time of chondrules in relation to CAIs has emerged [1-3]. Following from previous work [1] we have analysed 21 chondrules from the CV3 meteorites Allende, Mokoia and Vigarano for their Mg isotopes and $^{27}\text{Al}/^{26}\text{Al}$ in order to characterise their initial $^{26}\text{Al}/^{27}\text{Al}$. Chondrules were physically separated from their host meteorite and divided into two portions, one of which was dissolved for Al-Mg isotopic analysis. Mg isotopes were measured using a Thermo Finnigan Neptune MC-ICP-MS; samples were bracketed with the DSM-3 isotopic reference standard for Mg [4]. The other portion was characterised by Zeiss EVO 15LS SEM. The chondrules exhibit a range of textural types and compositions.

A recent study of Allende chondrules [2] reported that most chondrule data fall on a simple isochron indicating they were separated from a nebular reservoir when $^{26}\text{Al}/^{27}\text{Al} = \sim 1.2 \times 10^{-5}$. In contrast, our data show a more complex story. Around half of the chondrules appear to have been separated from a nebular environment when $^{27}\text{Al}/^{26}\text{Al} = 1.8 \times 10^{-5}$. The others show variable initial $^{26}\text{Al}/^{27}\text{Al}$ ratios and some have unmeasurably low amounts of initial $^{26}\text{Al}$. There is no clear trend with chemistry or degree of alteration, but all fully melted chondrules had lower initial $^{26}\text{Al}/^{27}\text{Al}$.

We conclude that many chondrules are likely to have experienced more than one stage of fractionation and melting in order to explain their Al-Mg systematics. Models of chondrule formation involving processing through more than one parent body may be required to achieve this.