

# HIGH SPATIAL RESOLUTION ISOTOPE ANALYSES OF PRESOLAR SiC GRAINS FROM THE COLD BOKKEVELD (CM2) CARBONACEOUS CHONDRITE.

I.C.Lyon<sup>1</sup>

<sup>1</sup>School of Earth and Environmental Sciences, The University of Manchester, M13 9PL UK.

Ian.Lyon@manchester.ac.uk

**Introduction:** Measurements of  $^{12}\text{C}/^{13}\text{C}$ ,  $^{14}\text{N}/^{15}\text{N}$  and  $\delta^{29,30}\text{Si}$  as well as the isotope systems of other elements have been obtained from ~17,000 presolar SiC grains cumulatively from many laboratories over a period of >25 years [1]. 14,731 (~85%) of these reported analyses are of SiC grains extracted from the Murchison (CM2) meteorite. The wide spread of  $^{12}\text{C}/^{13}\text{C}$ ,  $^{14}\text{N}/^{15}\text{N}$  and  $\delta^{29,30}\text{Si}$  values measured from these grains [2] lead to models of diverse astrophysical environments where the grains formed. There are however instrumental artefacts associated with high spatial resolution SIMS analyses that can potentially distort measured isotope ratios of grains [3-5] and this work continues the effort to quantify and understand these effects in order that more accurate analyses may be obtained.

In this study, SiC grains separated from the CM2 carbonaceous chondrite Cold Bokkeveld were analyzed by NanoSIMS for  $^{12}\text{C}/^{13}\text{C}$ ,  $^{14}\text{N}/^{15}\text{N}$ ,  $\delta^{26}\text{Mg}$  and  $\delta^{29,30}\text{Si}$ . An aim was to test whether the grain types and distribution of isotope ratios found from the Murchison meteorite were matched by another CM2 meteorite. A further aim was to obtain high spatial resolution (~100nm) analyses with depth profiling through grains to build up 3 dimensional reconstructions of the distribution of  $^{12}\text{C}/^{13}\text{C}$ ,  $^{14}\text{N}/^{15}\text{N}$  and  $\delta^{29,30}\text{Si}$  in the grains to test for isotopic heterogeneity in the grains. Systematic high spatial resolution (< 100nm) analyses of SiC grains have, in general, not previously been obtained. A particular target of study was to obtain  $^{14}\text{N}/^{15}\text{N}$  distributions with high spatial resolution. The determined  $^{14}\text{N}/^{15}\text{N}$  range of 8000 to 290 (the terrestrial value) for mainstream grains and 8000 to 50 for A+B SiC grains is difficult to understand from nucleosynthetic models [6] and detailed modelling of molecular ion transmission artefacts in the NanoSIMS suggest that some isotopic fractionation may be related to instrumental fractionation processes [3]. An aim of this study was to establish to what degree this range would be reproduced when cognizant of instrumental fractionation effects.

**Experimental Methods:** SiC grains isolated from the Cold Bokkeveld meteorite were produced by J. Arden nearly 30 years ago using the methods of [7]. A NanoSIMS 50L installed at the University of Manchester was used for analyses, simultaneously detecting  $^{12,13}\text{C}^-$ ,  $^{12}\text{C}^{14}\text{N}^-$ ,  $^{12}\text{C}^{15}\text{N}^-$  and  $^{28,29,30}\text{Si}^-$  on 7 multiplier detectors. A primary  $\text{Cs}^+$  current of ~0.5pA (D1-5 aperture setting) and spatial resolution ~100nm was used. A Hyperion source for high spatial resolution  $\text{O}^-$  analysis of the grains was subsequently used to acquire ~100spatial resolution analyses of  $\delta^{26}\text{Mg}$ , Al/Mg and  $\delta^{29,30}\text{Si}$  using positive secondary ions. The residue containing presolar SiC was spread over gold foil and imaged using secondary ions, in particular C and Si to establish the presence of SiC grains.

**Experimental Results:** As in Murchison, the average size of SiC grains was found to be >1  $\mu\text{m}$  and A+B grains ( $^{12}\text{C}/^{13}\text{C} < 10$ ) were found to be more prevalent (~17%) than in Murchison (4-5%). The  $\text{CN}^-$  distribution could be complex within and around the grains and  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  was measured to be heterogeneous within some grains. Detailed analytical data for analyses of 93 SiC grains from Cold Bokkeveld will be presented and implications discussed.

**Acknowledgements:** I thank K Moore for advice and assistance with the NanoSIMS analyses.

## References:

- [1] Hynes K. M. and Gyngard F., (2009), *LPS XL*, Abstract #1198
- [2] Davis A., (2011) *Proceedings National Academy Sciences*, 48, 19142-19146
- [3] Lyon I.C., Clarke A., Henkel T., Moore K.L., McMahon G., (2016) *Meteoritical Society abstract #6464*
- [4] Yang W. et al., (2015) *Science China Earth Sciences*, 58, 1758-1767
- [5] Tang G-Q. et al., (2015) *Journal Analytical Atomic Spectroscopy* 30, 950-956
- [6] Hedrosa et al., *arXiv:1303.6418v1*.
- [7] Amari et al., (1989) *Geochimica et Cosmochimica Acta*, 58, 459-470.