

AN ION PROBE STUDY OF THE SULPHUR ISOTOPIC COMPOSITION OF FE-NI SULPHIDES IN CM CARBONACEOUS CHONDRITES. E. S. Bullock¹, K. D. McKeegan², M. Gounelle^{1,3}, M. M. Grady¹, S. S. Russell¹, ¹Department of Mineralogy, The Natural History Museum, Cromwell Road, London, SW7 5BD UK; ²Department of Earth and Space Sciences, UCLA, Los Angeles, CA 90095; ³CSNSM, Université Paris 11, Bâtiment 104, 91 405 Orsay Campus, France. Email E.Bullock@nhm.ac.uk.

Introduction: The CM chondrites have endured variable degrees of aqueous alteration [1] which has changed their original mineralogy. A detailed study of the petrology and mineralogy of the sulphides in a suite of increasingly aqueously altered CMs, combined with sulphur isotope data measured *in situ*, can provide clues as to whether differences in the CM group are a result of different degrees of aqueous alteration, or whether they are the result of nebular heterogeneity.

Previous studies: A previous study of the sulphur isotopic values of chemically extracted Fe-Ni sulphides in 3 CM chondrites yielded values with up to 10‰ variation in $\delta^{34}\text{S}_{\text{CDT}}$, and 5‰ variation in $\delta^{33}\text{S}_{\text{CDT}}$ [2]. Sulphur isotopes in Fe-Ni sulphides have been studied in two CM1 samples: an ion probe study of sulphides in the CM1 lithology in Kaidun [3,4] showed a range of $\delta^{34}\text{S}_{\text{CDT}}$ values from -5.7‰ to +1.1‰, and an ion probe study of sulphides in the Antarctic CM1 ALH88045 [5], which gave $\delta^{34}\text{S}_{\text{CDT}}$ values ranging from -1.7‰ to +1.8‰ and $\delta^{33}\text{S}_{\text{CDT}}$ values of -0.8‰ to +1.0‰.

Method: One section from each of the following CM2s (listed in order of increasing alteration according to [1]) was studied: Bells, Murray, Mighei and Cold Bokkeveld. One section of the CM1 chondrite ALH88045 was also analysed. The isotopes ^{32}S , ^{33}S and ^{34}S were measured with the UCLA Cameca IMS 1270 in multicollector mode following the method outlined in [6]. Chemical compositional data for the sulphides were collected using the Cameca SX50 EMP at the Natural History Museum.

Results and Discussion: All of the grains studied in the CM chondrites were pyrrhotite or pentlandite, or a mixture of these two phases. All of the data points lie on the terrestrial mass-dependent fractionation line. The $\delta^{34}\text{S}_{\text{CDT}}$ values for the CM2 chondrites range between -7.0‰ to +6.1‰, whilst $\delta^{33}\text{S}_{\text{CDT}}$ vary between -3.5‰ to +3.4‰. The results obtained for the CM1 ALH88045 overlap those obtained previously by [5], with $\delta^{34}\text{S}_{\text{CDT}}$ values from -2.9‰ to -0.4‰ and $\delta^{33}\text{S}_{\text{CDT}}$ values between -1.4‰ and -0.2‰. There are no isotopic differences apparent between sulphide grains occurring in the matrix, and those that form chondrule rims. There was no progressive increase in the proportion of heavier isotopes with increasing alteration, as might be expected if sulphates were forming by alteration of sulphides and preferentially removing the lighter isotopes. This suggests that the S isotopic composition of the sulphides was not defined by progressive alteration on the parent body.

References: [1] Browning L. B. et al *Geochimica et Cosmochimica Acta* 60: 2621-2633. [2] Gao X. and Thiemans M. H. (1993) *Geochimica et Cosmochimica Acta* 57: 3159-3169 [3] McSween H. Y. et al (1996) *27th Lunar and Planetary Science Conference*: 855-856. [4] McSween H. Y. et al (1997) *Meteoritics and Planetary Science* 32: 51-54. [5] Bullock E. S. et al (2003) *Meteoritics and Planetary Science* 38: A143 [6] Farquhar J. et al (2002) *Science* 298, 2369-2372.