

### CONTINUING INVESTIGATION OF THE NAKHLITE MAGMA PILE

M. M. Grady<sup>1,2</sup>, M. Anand<sup>1,2</sup>, M. A. Gilmour<sup>1</sup>, J. Watson<sup>1</sup> and I. P. Wright<sup>1</sup>. <sup>1</sup>PSSRI, The Open University, Milton Keynes MK7 6AA, UK. E-mail: m.m.grady@open.ac.uk. <sup>2</sup>Dept. Mineralogy, The Natural History Museum, London SW7 5BD, UK.

**Introduction:** the nakhlites are a group of 1300 million year old mafic cumulates that appear to emanate from a single magma body, as either a single flow or series of related flows [1]. On the basis of variations in olivine composition, it has been suggested that the individual nakhlites might derive from different depths within a cumulate pile [2, 3]. The most recent find, MIL 03346, is thought to be from the outermost edge, and might be a chill margin [4]. Chassigny, which has the same crystallization age as the nakhlites, might come from a related, deeper, magma body. The nakhlites have been altered by water, leading to two populations of martian weathering products: (i) clay minerals produced by alteration of the primary silicate minerals, and (ii) evaporates (carbonates and sulphates) deposited from the fluid. When there were only three nakhlites for study, it was inferred that the secondary minerals were a sequence formed by progressive deposition from an evaporating brine [5]. Now that there are more than double that number of nakhlites, we are re-visiting this theory, first by re-analysing the carbonates.

**Method:** Whole rock powders were dissolved in 100% H<sub>3</sub>PO<sub>4</sub> at 72°C, the product gases were passed through a GC to separate CO<sub>2</sub> from other species. The minimum amount of CO<sub>2</sub> analysed was ~ 20 nmole; at this level, errors on δ<sup>13</sup>C ~ ±1‰. Yields were calculated from calibration using NIST19.

#### Results:

Sample	wt (mg)	[C] (ppm)	δ <sup>13</sup> C (‰)
GV	26.9	102.0	28.2
GV	30.6	53.3	25.3
Lafayette	13.3	24.8	25.4
Lafayette	36.1	87.4	23.5
MIL 03346	44.3	1.9	9.0
MIL 03346	35.6	26.5	38.2
MIL 03346	30.8	23.7	38.3
Nakhla	27.1	51.3	51.3
Nakhla	49.5	53.1	52.2
Nakhla	54.6	95.0	48.6
Nakhla	73.1	74.3	47.7
Y593	37.2	117.1	42.3
Y593	48.3	221.1	42.2
Y593	72.0	116.9	42.3
Chassigny	68.2	3.2	-8.6
Chassigny	103.7	4.2	-7.6

**Conclusions:** carbonates in nakhlites are <sup>13</sup>C-enriched, those in Chassigny are not, confirming previous findings [6]. Carbonate abundances are very variable, indicating great heterogeneity in their distribution. Carbonates in MIL 03346 are intermediate in composition between (Nakhla and Y 000593) and (Lafayette and Governador Valadares). This does not necessarily support locating MIL 03346 at the upper margin of a lava flow.

**References:** [1] Lentz R. et al. (1999) *Meteoritics & Planet. Sci.*, 34, 919-932. [2] Harvey R. P. and McSween H. Y. Jr. (1992) *Earth Planet. Sci. Lett.*, 111, 467-482. [3] Mikouchi T. et al. (2003) *Ant. Met. Res.*, 16, 34-57. [4] Day J. M. D. et al. (2006) *Meteoritics & Planet. Sci.*, 41, 581-608. [5] Bridges J. C. and Grady M. M. (2000) *Earth Planet. Sci. Lett.*, 176, 267-279. [6] Wright I. P. et al. (1992) *GCA*, 56, 817-826.