

A SEARCH FOR CARBONATE MINERALS IN CHASSIGNY; I.P.Wright, M.M.Grady and C.T.Pillinger, Planetary Sciences Unit, Department of Earth Sciences, Open University, Walton Hall, Milton Keynes MK7 6AA, England.

With the presence of carbonates firmly established in the nakhlite, Nakhla, [1,2] and the shergottite, EETA 79001, [3,4,5] it seemed appropriate to assess the likelihood that such minerals may be present in the only known chassignite (Chassigny). At the outset, it was anticipated that significant quantities of carbonates would probably not be detected in Chassigny, as a previously undertaken detailed petrographic study [6] had not produced a positive identification. However, carbonates in the other SNC meteorites were detected by gas release experiments (*i.e.* stepped heating, acid-dissolution *etc.*) prior to petrographic recognition. Stepped heating analyses on Chassigny have been made twice previously [7,8], but in neither case was there any evidence to suggest the presence of carbonates.

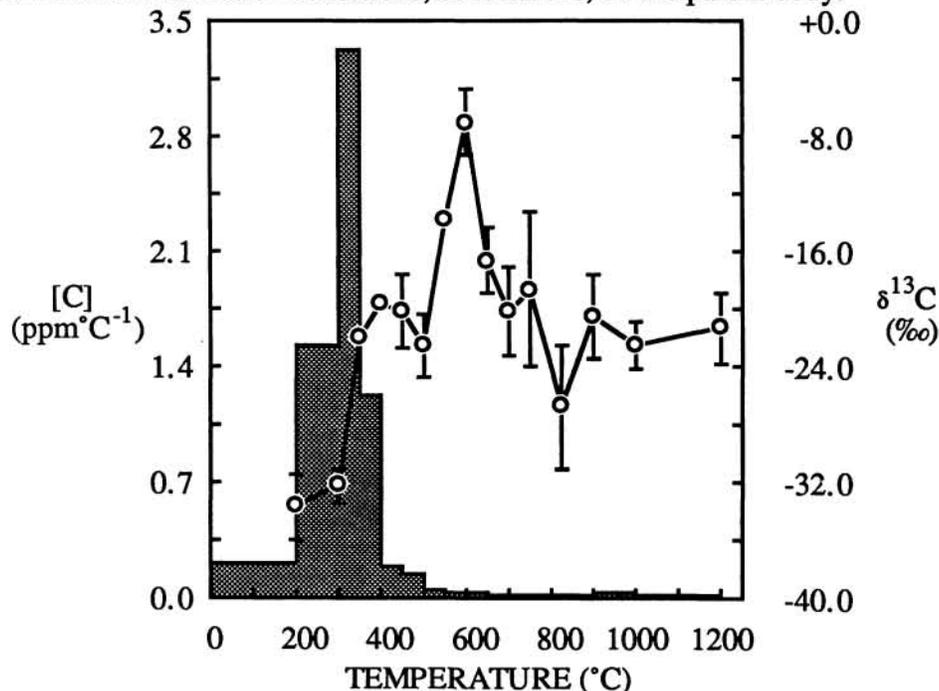
Notwithstanding these results, a large sample (130.383 mg) of Chassigny whole rock material was subjected to orthophosphoric acid-dissolution (30 minutes @ 25°C - a procedure known to convert carbon in the form of carbonate minerals, such as calcite, to CO<sub>2</sub> gas). Somewhat surprisingly, 327 ng of carbon as CO<sub>2</sub> was released during the dissolution, corresponding to 2.5 ppm C, with  $\delta^{13}\text{C}_{\text{PDB}}$  of -4.7‰ and  $\delta^{18}\text{O}_{\text{SMOW}}$  of +39.6‰. If it is assumed that the CO<sub>2</sub> arises from the dissolution of calcite then the  $\delta^{18}\text{O}_{\text{SMOW}}$  of the mineral phase is +29.1‰. The oxygen isotope datum is similar, albeit slightly <sup>18</sup>O-enriched, to values acquired from acid-dissolutions of the other SNC meteorites (+21 to +26‰). However, the carbon in the Chassigny carbonate is somewhat less <sup>13</sup>C-enriched than the equivalent minerals in either Nakhla ( $\delta^{13}\text{C} > +15‰$ ) or EETA 79001 ( $\delta^{13}\text{C} = +7$  to +10‰). Nevertheless, the  $\delta^{13}\text{C}$  value of -4.7‰ is distinctly different from that of the whole rock, known from previous studies to be -25.7 to -22.7‰.

In order to pursue further the possibility that carbonates are present in Chassigny, two whole rock samples were analysed by stepped combustion. The first sample was measured using the standard extraction procedure - the results are shown in the figure. The second sample was treated with dichloromethane, a technique shown to be effective in the removal of surficial terrestrial organic contamination from basaltic glass fragments [9]. The results from this second extraction ( $\Sigma\text{C} = 450$  ppm,  $\Sigma\delta^{13}\text{C} = -24.9‰$ ) are very similar to the first ( $\Sigma\text{C} = 442$  ppm,  $\Sigma\delta^{13}\text{C} = -26.2‰$ ) indicating that, for Chassigny at least, dichloromethane has little effect on the carbon components present. In common with previous analyses the first step in both stepped combustions (*i.e.* room temperature to 200°C) yielded isotopically light CO<sub>2</sub> ( $\delta^{13}\text{C} = -34, -36‰$ ). From 200-400°C the isotopic composition was observed to rise to -20, -18‰, as in previous experiments [7]. Between 400 and 500°C the  $\delta^{13}\text{C}$  values become slightly more negative by about 2‰. It seems that 50-60% of the carbon released below 500°C in Chassigny (corresponding to about 250 ppm of C) probably has a  $\delta^{13}\text{C}$  of *ca.* -18‰. A carbon isotopic composition of this nature is unusual for terrestrial organic contamination and so it is considered that this might be an indigenous component. On the other hand, the isotopically light carbon released at the lowest temperature may be related to that component observed in other SNC meteorites, which again is not obviously a terrestrial contaminant [8]. It is noteworthy that dichloromethane was not effective in removing any

of the low-temperature carbon. Clearly the carbon must be different to that which is easily removed from basaltic glasses and assumed to be organic contamination acquired during laboratory handling of the samples or as a result of exposure in the environment [9].

Returning to the figure, it can be seen that from 500 to 700°C there is evidence for an isotopically heavy component. As this is the temperature range over which carbonates decrepitate it seems safe to conclude that Chassigny does indeed contain such minerals. 5 ppm carbon with  $\delta^{13}\text{C}$  of  $-14.1\text{‰}$  is released between 500 and 700°C; assuming two components of carbon contribute to the measured values then 1.5 – 2.0 ppm carbon with  $\delta^{13}\text{C}$  of  $-4.7\text{‰}$  are present in this sample (the range in carbon concentration corresponding to whether the second component is assumed to have  $\delta^{13}\text{C}$  of  $-18$  or  $-20\text{‰}$ ). This agrees well with the result from the acid-dissolution experiment which gave a value for the carbon content of 2.5 ppm.

During a survey of carbon in HED samples, no evidence was found for carbonates in any sample other than Kapoeta, which is a regolith breccia containing clasts of carbonaceous chondrite materials. Furthermore, carbonates have never been found in any lunar rocks, or lunar meteorites. Thus, it seems that the presence of carbonates in SNC meteorites is a function of the geological complexity of the parent body (Mars). The carbonates found in Chassigny ( $\delta^{13}\text{C} = -4.7\text{‰}$ ) appear to have a different carbon isotopic composition to those in either Nakhla ( $>+15\text{‰}$ ) or EETA 79001 ( $+7$  to  $+10\text{‰}$ ). The spread in  $\delta^{13}\text{C}$  between carbonates of the three SNC meteorites may well document different formation conditions, or locations, on the parent body.



References: [1] Carr *et al.* (1985), *Nature*, **314**, 248-50; [2] Wentworth and Gooding (1989), *LPS*, **XX**, 1193-4; [3] Wright *et al.* (1988), *GCA*, **52**, 917-24; [4] Clayton and Mayeda (1988), *GCA*, **52**, 925-7; [5] Gooding *et al.* (1988), *GCA*, **52**, 909-15; [6] Floran *et al.* (1978), *GCA*, **42**, 1213-29; [7] Fallick *et al.* (1983), *LPS*, **XIV**, 183-4; [8] Wright *et al.* (in prep.); [9] Matthey *et al.* (1989), *GCA*, **53**, 2377-86.