NO UNUSUAL COMPOSITIONS OF THE STABLE ISOTOPES OF NITROGEN, CARBON AND HYDROGEN IN SNC METEORITES. A.E. Fallick*, R.W. Hinton, D.P. Mattey, S.J. Norris, C.T. Pillinger, P.K. Swart and I.P. Wright. Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, U.K. and *S.U.R.R.C., East Kilbride, Glasgow G75 OQU.

Traditionally, the achondrite meteorites, Shergotty, Nakhla and Chassigny have been classified as "type specimens" of three unusual groups - Shergottites (4 members), Nakhlites (3 members) and Chassignites (2 members). More recently, these three groups have been loosely amalgamated as the SNC meteorites on the basis of similar chemistry and inferred history. The meteorites are highly differentiated igneous rocks displaying cumulate textures and are very similar to terrestrial dolerites (Shergottites), dunites (Chassignites) and pyroxenites (Nakhlites). The most remarkable feature of the SNC meteorites is their apparently young crystallisation ages which average at 1.31 Gy (1,2).

In order to explain these, Weinke (3) suggested that Nakhla might have formed near the surface of an object which was at least as large as the planet Mars. Subsequently, it has been postulated that Mars itself might be a suitable candidate for the parent body of Shergotty (4,5). At present, the idea of a Martian origin for SNC meteorites is well established by various lines of evidence although dynamic problems remain to be resolved.

The possibility that SNC's do originate from Mars opens up some interesting opportunities for stable isotope analyses, especially if the ejection mechanism (unknown) caused these meteorites to retain any memory of the Martian atmosphere. Thus, nitrogen, carbon and hydrogen isotopic data could relate to any or all of the observations outlined below: (i) Nier et al (6) and Owen et al (7) have reported that the nitrogen isotopic composition of the Martian atmosphere, as measured by the Viking mission, is considerably enriched in $^{15}N$ by as much as 75% ($^{14}N/^{15}N$=156/1). Any nitrogen retained from passage through such an atmosphere could be expected to have an anomalous isotopic composition. (ii) Although only one hundredth of the Earth's atmosphere in pressure, the Martian atmosphere is 95% carbon dioxide and hence carbon might appear as one of the most abundant constituents if atmospheric sampling occurred. (iii) Rather unusually, some SNC meteorites have hydrous minerals present. Chassigny contains the amphibole kaersutite (8) whilst Nakhla hosts iddingsite (9,10), an alteration product of olivine which could be preterrestrial in origin.

To investigate the above possibilities, four SNC meteorites, Shergotty, Nakhla, Chassigny and Zagami, have been analysed for nitrogen, carbon and hydrogen content and stable isotopic composition. Techniques employed involved stepped heating in oxygen for carbon, stepped pyrolysis for nitrogen and bulk combustion for hydrogen. The results are shown in the Figures.

Nitrogen All four meteorites show a very similar nitrogen release pattern with a maximum in the 700-800°C temperature increment. The same step invariably affords the highest $\delta^{15}N$ value, with subsequent higher temperature fractions becoming lighter by as much as 40°/oo. The total nitrogen abundance in all cases is very small, only 3-7ppm, and the $\Sigma\delta^{15}N$ values above 600°C are close to 0°/oo with the exception of Zagami which is somewhat heavier.

Carbon Virtually all the carbon in SNC meteorites is combustible below 500°C, this observation taken together with the $\delta^{13}C$ values (-25 to -35°/oo) for these low temperature fractions indicate a large proportion of the carbon to be contamination. Some carbon is released above 600°C and this seems likely to be indigenous. Its isotopic composition is difficult to measure but its $\delta^{13}C$ value seems likely to be -30°/oo or lighter. Two unusual features of the carbon measurements are the peaks in (i) the $\delta^{13}C$ profile for Nakhla at 500°C and (ii) the carbon release pattern for Shergotty at 700°C. Unfortunately, sample availability precludes us from investigating these further.

Hydrogen To ensure that indigenous hydrogen was not contaminated by the element from terrestrial organics, each sample studied was precombusted at 350°C (440°C in the case of Shergotty). The D/H values of water liberated by combustion over the entire temperature range up to 1000°C are very tightly grouped with $\delta D=-32°/oo$ for Chassigny, $-37°/oo$ for Nakhla and $-47°/oo$ for Shergotty. The amounts of water recovered were 0.9, 1.1 and 1.3 μmoles/g respectively.

Discussion The conspicuous fact concerning the stable isotope composition of nitrogen, carbon and hydrogen from SNC's is that unlike most other meteorites, they are not unusual from a terrestrial standpoint. This in itself, may point to an origin in a planetary sized object. Unfortunately, the results are difficult to compare with terrestrial samples since no data is available for analogous specimens. Most certainly there is no evidence for a heavy nitrogen component from atmospheric sampling and the indigenous carbon content is low. No D/H measurements of the Martian atmosphere have been obtained but studies for Venus have afforded 200ppm water with a D/H ratio of $1.6\times10^{-2}$ (11) in keeping with an extensive fractionation by proton loss. Mars might have been expected to be similarly outgassed but no evidence of such a process is available from our data.

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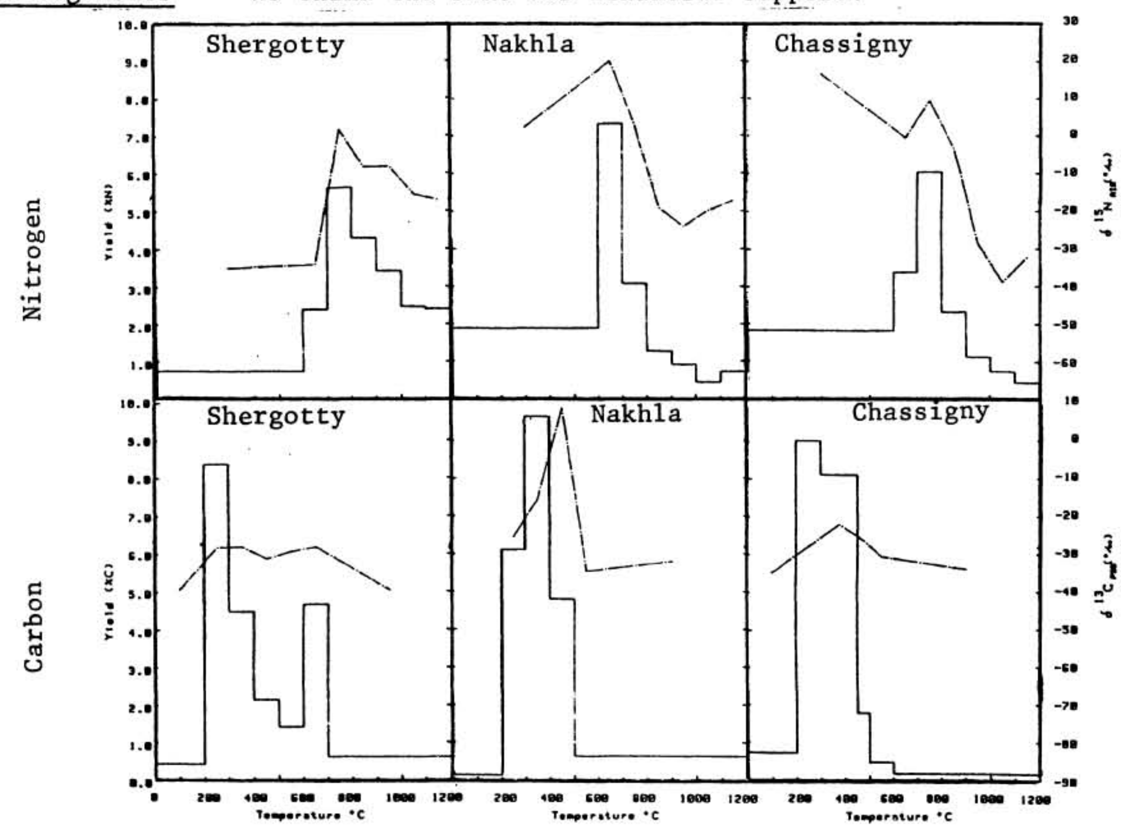


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