CARBON-14 AND STABLE-ISOTOPIC COMPOSITION OF ORGANIC MATERIAL AND CARBONATES FROM SOME SNC METEORITES. A. J. T. Jull[1,2], S. Cloudt[1] C. Courtney[1], and C. J. Eastoe[2], [1] NSF Arizona AMS Facility, University of Arizona, Tucson AZ 85721, USA, [2] Department of Geosciences, University of Arizona, Tucson AZ 85721, USA.

Among the many interesting properties of the SNC meteorites [1] is that they contain minerals such as carbonates that result from aqueous alteration [2]. Additionally, McKay et al [3] have reported on evidence of possible biological fossils associated with carbonates from Allan Hills 84001. The isotopic composition of C and O is important not only to understanding the origin of the carbonates, but potentially can give information about martian H_2O and CO_2 isotopic compositions, as well as indications of biological activity. We use ^{14}C as a label to identify extraterrestrial carbonate phases, as they will have a low $^{14}C/^{12}C$ ratio <~4% modern terrestrial carbon [see refs 4,5 for discussion], compared to higher values from terrestrial sources. We can make similar arguments for organic materials if the meteorites were irradiated as small objects in space. Terrestrial weathering products or organic materials introduced after the meteorite fall would lead to higher levels of ^{14}C. Carbon and o-isotope abundances may also be affected by later isotopic exchange and the values that arise from weathering of meteorites are known [2,6].

We have previously reported measurements of the $\delta^{13}C$, $\delta^{18}O$ and ^{14}C composition of CO_2 released from acid-etching experiments of the SNC meteorites, Allan Hills 84001 [4,5], Nakhla [4,5,7], Zagami [7] and Lafayette [8]. Measurements for ALH 84001 and Nakhla showed high ^{13}C values up to +45‰ which correlate inversely with low ^{14}C indicating an extraterrestrial carbonate; low values of $\delta^{13}C$ (<+5‰) show approximately modern terrestrial ^{14}C and imply a terrestrial source. We assigned the high $\delta^{13}C$ values of carbonate observed in Allan Hills 84001 and other SNC meteorites to a fractionated source compared with the originally light carbon. A likely origin for this ^{13}C-enriched component is an isotopically heavy martian atmosphere, however, given the possibility of biological activity involving Allan Hills carbonates, we cannot exclude this as a source of the isotopic fractionation. In contrast, Zagami carbonates show CO_2 released with the lowest values of ^{14}C having the lowest $\delta^{13}C$ of -20‰. We suggest Zagami carbonate samples a different carbon reservoir such as a magmatic source.

Previous isotopic results on carbonate from EETA 79001 (9) showed a large amount of ^{14}C in carbonates of $\delta^{13}C$ of +3 to +8‰, indicating some exchange with terrestrial CO_2. Organic phases present in SNC meteorites form part of the debate on the question of whether there is evidence for life in these rocks. Wright et al (10) studied stepped combustions of EETA 79001. We have begun some preliminary studies of $\delta^{13}C$ and ^{14}C measurements on CO_2 released by combustion in oxygen. Results are shown in the table. These results suggest that the organic phases combusting at temperatures of 200°–400°C are light with $\delta^{13}C$ of -27.7‰, typical of terrestrial organics and contain ~58% modern C. This is equivalent to a radiocarbon age of about 4300 yr. The second step (400°–600°C) contained carbon which presumably is a mixture of the +3–8‰ carbonate and -27.7‰ per mil organics, but similar ^{14}C. The higher-temperature fraction up to 830°C had some spallogenic ^{14}C (from the silicate) released in this step. We will report further studies on SNC meteorite step-combustions and the implications of these results at the Conference.

References: [1] H. McSween (1994) *Meteoritics, 29*, 757–779. [2] J. L. Gooding et al. (1988) *GCA, 52*, 909–915 S; J. Wentworth and J. L. Gooding, *LPS XXI*, 1321–1322. [3] D. S. McKay et al (1996) *Science, 273*, 924. [4] A. J. T. Jull et al. (1995) Meteoritics, 30, 311–318. [5] A. J. T. Jull et al (1997) *JGR Planets, 102*, 1663. [6] M. M. Grady et al. (1988) *GCA, 52*, 2855–2866. [7] C. S. Romanek et al. (1994) *Nature, 372*, 655–657. [8] A. J. T. Jull et al, *LPS XXVIII*, 685. [9] A. J. T. Jull et al, *LPS XXIII*, 641. [10] I. P. Wright et al (1989) *Nature, 340*, 220.

TABLE 1. Isotopic composition of combustion of EETA 79001 in oxygen at various temperatures.

Temp. range	C (μg)	C (ppm)	$\delta^{13}C$	Fm ^{14}C	^{14}C age (yr BP)
200°–400°C	79	197	–27.77 ± 0.01	0.583 ± 0.031	4335 ± 430
400°–600 °C	15	37	–2.96 ± 0.03	0.444 ± 0.074	6525 ± 1340
600°–830 °C	30	74	–17.62 ± 0.08	1.66 ± 0.13	----a

a - contains spallogenic ^{14}C released >750 °C