^{41}Ca IN THE NORTON COUNTY AUBRITE; D. Fink[1], J. Klein[2], B. Dezfouly-Arjomandy[2], R. Middleton[2], G.F. Herzog[3] and A. Albrecht[3]; 1) App. Nuclear Physics, ANSTO, Australia, 2034; 2) Dept. Physics, Univ. Penn., Philadelphia, PA 19104; 3) Dept. Chemistry, Rutgers Univ., New Brunswick, NJ 08903.

Calcium-41 production occurs predominantly through two channels - spallation on iron (P_{41}(sp)) and neutron capture on ^{40}Ca (P_{41}(n)). Fink et al. [1] found the average ^{41}Ca activity in small iron falls to be 24±1 dpm/kg Fe and noted that P_{41}(sp) appears to vary only modestly with shielding. In contrast, P_{41}(n) is highly shielding dependent, a reflection of the acute sensitivity of neutron flux intensities to the depth, composition, and effective radius of the irradiated body. Nishiizumi et al. report maximum values of P_{41}(n) of 1100 dpm/kg-Ca in the large C3 chondrite, Allende [2], and of 1000 dpm/kg-Ca at a depth of 150 g/cm^2 in the Apollo 15 drill core [3]; Klein et al. [4] find P_{41}(n) of 1880 dpm/kg Ca in Jilin (H5) and inferred a pre-atmospheric radius between 54 and 135 cm by using the model calculations of Spergel et al. [5] for ^{59}Ni in L-chondrites.

We report here on ^{41}Ca activities in the Norton County aubrite. Norton County is of interest because of its unusually large size, because extensive track measurements have been made on it [6], and because of its composition. Considered as a group, the aubrites contain especially low levels of certain elements that absorb thermal neutrons (i.e., the REEs and Fe). As a result, they have effective macroscopic capture cross sections (Σ_{eff}) that are a factor 4-5 smaller than those calculated for, say, ordinary chondrites. Accordingly, in aubrites, a much larger proportion of the thermal neutron fluence survives to react with ^{40}Ca, thereby increasing P_{41}(n). The calculations of Spergel et al. [5] for P_{59}(n), a good analog for P_{41}(n), suggest that at the center of a 300 g/cm^2 aubrite, P_{41}(n) should exceed by a factor of four that at the center of a similar sized L-chondrite. We set out to test this prediction and then to see whether the approach taken by [4] could be extended to Norton County so as to obtain new constraints on its preatmospheric radius.

Dr. E. Scott generously provided specimens from the strewn field fragments (N23.5 and N102) and from the surface of the main mass. The latter were taken from documented locations close to the sites of material sampled for track and/or radionuclide studies. We analyzed six samples for ^{41}Ca by accelerator mass spectrometry [7] and for selected major elements by direct coupled plasma emission spectrometry [8]. Measured ^{41}Ca/^{40}Ca ratios (1σ errors of ±7-10%) were corrected for background (1-3%) and normalized to our ^{41}Ca standard. The native Ca contents ranged from 0.3-0.5% except in NC-102 for which a value is not yet available.

The ^{41}Ca contents in the six Norton County specimens are given in Table 1. The maximum value, 5360 dpm/kg-Ca, is the largest reported to date for any extraterrestrial sample and confirms the anticipated effect of composition on P_{41}(n). As implied above, the quantity Σ_{eff} is useful in correcting for the effect of bulk composition on expected production rates. Table 1 includes values of Σ_{eff} calculated from our DCP results and published data. The total contribution from Gd, Sm and Eu to Σ_{eff} was estimated to be <1% [9]. Column 4 of Table 1, labeled ^{41}Ca$_{L\text{-}Ch}$, presents ^{41}Ca activities for Norton County normalized to L-chondrite composition by using a value of Σ_{eff}(L-chond.) of 0.078 cm^2/g.

Published profiles of ^{59}Ni in L-chondrites of different radii [5] have been scaled to predict ^{41}Ca profiles (see [7], Fig. 3). The maximum normalized ^{41}Ca content in Norton County (NC-3c) indicates a minimum radius of ~130-150 g/cm^2 (~40-50 cm for a density of 3.2 g/cm^3), consistent with a minimum radius of ~40 cm inferred from the recovered mass and from the track densities [6,10] assuming an exposure age of 100 My. Table 1 also shows the depths for each sample estimated from (a) the track density and (b) the ^{41}Ca activity assuming a radius of 50 cm. We consider the agreement satisfactory. For larger radii, 50-80 cm, the track data give depths that are at most 1 cm smaller than those in Table 1 while the ^{41}Ca results give appreciably smaller depths.

Table 1: ^{41}Ca contents and other properties of Norton County samples.

Sample	^{41}Ca (dpm/kg-Ca)	Σ_{eff} (cm^2/g)	^{41}Ca$_{L\text{-}Ch}$ (dpm/kg-Ca)	Track Dens. (10^5/cm^2 pyx)	Depth (cm) (a)	(b)
NC-3c	5360	0.0022	1510	0.279	27	34
NC-3e	3850	0.0019	940	1.02	21	19
NC-5	2730	0.0019	665	5.00	15	13
NC-6	2280	0.0016	470	17.6	11	9
NC-7	1600	0.0022	450	23.5	10	8
NC-102	16.8*	0.0018		33.0		

Notes: *dpm/kg bulk; a) from track data; b) from ^{41}Ca$_{L\text{-}Ch}$.

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