DEPTH VARIATION IN COSMOGENIC RADIONUCLIDE PRODUCTION IN VERY LARGE METEORITES: ALLENDE AND DRP78002-9; K. Nishiizumi, D. Elmore*, P. W. Kubik*, and J. R. Arnold; Dept. of Chemistry, B-017, Univ. of Calif., San Diego, La Jolla, CA 92093 (USA); *Nuclear Structure Research Lab., Univ. of Rochester, NY 14627 (USA).

Meteorites which are large compared to the mean interaction length of cosmic rays (~150 g/cm^2) show depth variations which are qualitatively different from those seen in smaller bodies. The moon is a limiting case [1]. The most extensively studied object in this class is Jilin [2,3]. We report here new and unpublished data on two very large objects which fell as showers: Allende and the Antarctic iron group DRP78002-78009.

Allende. We have measured ^{36}Cl ($t_{1/2}$ = 3.0x10^5 years) by AMS using the University of Rochester MP tandem van de Graaff accelerator in a series of samples of Allende, from a number of collected stones, whose preatmospheric depth was determined by Pellas [4] on the basis of cosmic-ray track data. Our samples weighed about 100 mg, and were taken in close proximity to those used by Pellas for the track studies. Near the surface the track method is capable of high precision; this is less true at greater depth. We have of course no information on preatmospheric shape. The preatmospheric mass has been estimated at >2 tons, corresponding to a sphere radius of >55 cm.

In any meteorite containing Cl the production of ^{36}Cl takes place by two mechanisms: spallation of heavier targets (especially Fe and if present Ca), and thermal neutron capture in ^{35}Cl. It is well known that these should have different depth variations in large objects. Spallation production must decrease with depth, while neutron capture is low at the surface, increasing with depth at least for some distance [5].

The preliminary data are given in Table 1, along with literature data on ^{60}Co (a pure neutron capture product), ^{10}Be and ^{26}Al (spallation products) and earlier counting data by Mabuchi et al., and Nakamura [6,7]. The two production mechanisms seem clearly displayed. The first three samples show mainly spallation production, while ^{36}Cl in the deepest samples, with high ^{60}Co, is mainly due to neutron capture. If we assume that the Cl content of these samples is constant, at 290 ppm Cl [7], and that calculated spallation production of ^{36}Cl (especially from Fe) in Allende is 8$\pm$1 dpm/kg meteorite, we obtain the profile of neutron capture production shown in Fig. 1-a. The correlation with ^{60}Co, shown in Fig. 1-b, is excellent. One sample USNM 3512 C3A, falls far off the depth curve; possibly this is due to inhomogeneity in Cl content. The agreement between our data and those determined by counting [6,7] is very good. The ratio of production rates, normalized for composition is in the range 1.5-2, perhaps tending to a lower value at the highest concentrations [6]. Since neutron capture in Co has a major resonance contribution, such a variation is not unexpected.

DRP78002-9. This group of irons has long been known to be a single shower, a Group IIB iron. We present here data on ^{36}Cl measured by AMS, and ^{53}Mn determined by neutron activation. It is obvious that this meteorite was very large indeed, with a range of ^{53}Mn activity on the order of 80. Even though ^{53}Mn and ^{36}Cl are produced by different nuclear reactions, the ratios of ^{53}Mn/^{36}Cl activities observed in iron meteorites of various sizes vary only over a limited range, are 22$\pm$6. The high activity ratio ^{53}Mn/^{36}Cl observed in the Derrick Peak meteorite must be explained by decay of ^{36}Cl due to long terrestrial age. The terrestrial age, calculated from the equation

$$T = \frac{1}{\lambda_{Cl} - \lambda_{Mn}} \ln \frac{[^{53}Mn/^{36}Cl]}{22}$$

where λ_{Cl} and λ_{Mn} are decay constant of ^{36}Cl and ^{53}Mn, is 1.3×10^6 years.

The preatmospheric size of Derrick Peak meteorite was at least 3.5 m (diameter) or 170 tons (weight).

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TABLE 1. Cosmogenic Radionuclides in Allende

	DEPTH (cm)	^{36}Cl	^{60}Co (dpm/kg meteorite)	^{10}Be[8]	^{26}Al
MPI-I6	0.4-0.8	10.1 ± 0.5			
MPI-IF	2.6-3.2	12.4 ± 2.1	9 ± 3[9]	19.2 ± 2.9	52 ± 4[9]
USNM3512 A1b2	3.5	14.6 ± 2.1	14 ± 3[10]	18.5 ± 3.0	51 ± 2[10]
USNM3515 G4	5	17.3 ± 0.8	41 ± 2[10]	20.2 ± 3.5	57 ± 2[10]
USNM3512 C3A	10	13.5 ± 0.8		20.5 ± 3.0	
USNM3531 D1	15	38.8 ± 7.8	90 ± 2[11]	19.0 ± 2.7	52 ± 2[11]
USNM3529 D2	24	47.4 ± 4.2	166-185[11]	19.3 ± 2.7	56 ± 6[11]
USNM3529		54 ± 2[6]	129 ± 7[6]		52 ± 3[6]
USNM3702		36 ± 6[7]	122 ±13[7]		65 ±13[7]
USNM3807		25 ± 6[7]	68 ±15[7]		32 ±13[7]
USNM3882		30 ± 6[7]	89 ±14[7]		58 ±13[7]

TABLE 2. ^{53}Mn and ^{36}Cl in Derrick Peak

	^{53}Mn dpm/kg Fe	^{36}Cl dpm/kg metal	$^{53}Mn/^{36}Cl$
DRP 78002,2	9.5 ±0.6	0.0269 ±0.0033	353 ± 49
DRP 78004,1	64 ±3	0.193 ±0.016	332 ± 31
DRP 78005,1	30 ±2	0.086 ±0.008	348 ± 40
DRP 78006,1	167 ±7	0.535 ±0.036	312 ± 25
DRP 78007,91	144 ±6	0.486 ±0.026	296 ± 20
DRP 78008,5	2.1 ±0.3	0.0102 ±0.0016	206 ± 44
DRP 78008,6	2.1 ±0.2	0.0126 ±0.0022	167 ± 33
DRP 78008,7	2.1 ±0.2	0.0165 ±0.0049	127 ± 40
DRP 78009,6	70 ±3	0.208 ±0.015	337 ± 28
DRP 78009,7	60 ±3	0.161 ±0.013	372 ± 35
			av. 315 ± 64

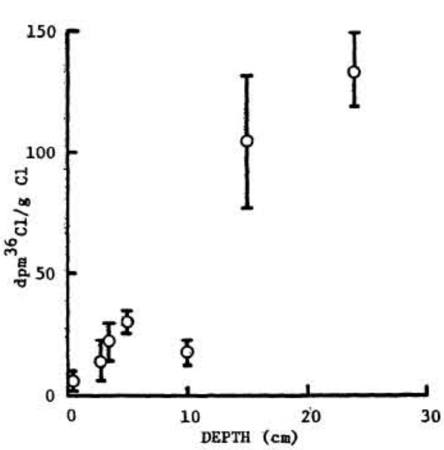

Fig. 1-a

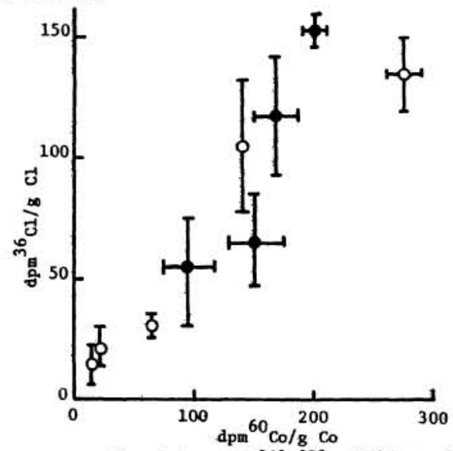

Fig. 1-b ●[6],[7], ○This work