MEASUREMENTS OF ^{53}MN IN DEEP SEA STONY SPHERULES, K. Nishiizumi and J. R. Arnold, Dept. of Chemistry, B-017, Univ. of Calif., San Diego, La Jolla, CA 92093.

Cosmic-ray produced ^{53}Mn ($t_{1/2} = 3.7 \times 10^6$ y) was measured in one individual and several groups of deep sea stony spherules by highly sensitive neutron activation analysis.

One giant stony particle (KK-2) was provided by D. Brownlee for this experiment. He polished one corner of the particle. The outside of the sample was etched by sea water but the inside was unetched. Before dissolution, the polished surface was examined by electron microprobe analysis. Five different positions were analyzed with a 20 μm beam spot. The chemical compositions of all five positions were quite similar to chondritic compositions, suggesting a homogeneous melt. The weight of the polished spherule is 1.077 mg. The other three groups of stony spherules were selected from the Millard collection, described by Murrell et al [1]. These spherules were collected from Pacific Ocean red clay at 4280 m depth. After an SEM study of about 500 stony spherules, three groups were selected. The first group includes 22 spherules whose individual weights were more than 30 μg and whose densities were more than 2.8 g/cm^3. The total weight was 967 μg and average density was 3.55 g/cm^3. The second group includes 23 spherules whose individual weights were more than 30 μg and densities were between 2.0 and 2.8 g/cm^3. The total weight was 911 μg and average density was 2.49 g/cm^3. The last group includes spherules whose individual weights were less than 20 μg. The total weight was 877 μg. The chemical compositions, preliminary ^{53}Mn data as well as ^{53}Mn data previously reported for the same Millard stony spherules [2] are presented in Table 1.

The positive ^{53}Mn results make it clear that these deep sea stony spherules are of extraterrestrial origin. The most surprising thing is that all samples have 200-300 dpm ^{53}Mn/kg Fe, even though the samples are different in size and density. The ^{53}Mn activity levels are slightly lower than chondritic values and are shown in Table 1.

Bodies in the submillimeter size range entering the earth's atmosphere exhibit a wide range of velocities and orbits. Some orbits must have been circularized by Poynting-Robertson and related effects, while others (most shower meteors for example) have highly elliptical orbits. The ^{53}Mn production rate experienced by an object in near-circular orbits is much greater than 300 atoms/kg min (mainly due to SCR), while for a highly elliptical orbit it must be much less (no secondary particles and low SCR flux). The lifetimes in space must also vary. Hence we would predict a wide range of ^{53}Mn values in spherules originating in bodies of comparable mass.

If spherules originate mainly from large bodies, probably much or most of the mass is in a size range of 1-100 kg, the socalled "small meteorite" class [3,4]. Most of these objects do not reach the earth's surface at all, and even those which do lose most of their mass in ablation. Hence, the spherules must constitute a fairly representative sample of these bodies. Meteorites typically show 300-500 dpm ^{53}Mn/kg Fe. Lower ^{53}Mn contents should be found in samples of larger bodies (because of shielding) or smaller bodies (lack of secondaries, possibly shorter exposure times). There may be other explanations as well.

In any case, the approximate constancy observed, if confirmed, may lead to useful insights and applications. This result strongly supports Blanchard et al's work [5]. They concluded that silicate spherules are derived from ablation of stony meteorites based surface morphology, elemental compositions and internal textures.

The measurements of cosmic-ray produced ^{10}Be ($t_{1/2}$ = 1.6x10^6 y) is the same stony spherules are now in progress.

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Table 1 ^{53}Mn in Deep Sea Spherules

	Wt. (μg)	Mn (%)	Fe (%)	Ni (%)	dpm^{53}Mn /sample (10^{-5})	dpm^{53}Mn /kgFe
Brownlee KK-2	1077	0.31	23.5	0.62	5.1±1.1	202±44
L.J. >30 μg, ρ >2.8	967	0.18	31.9	0.70	6.9±1.1	225±36
L.J. >30 μg, 2.8>ρ>2.0	911	0.16	31.0	0.83	7.4±1.2	262±36
L.J. <20 μg	877	0.20	35.7	0.97	6.6±1.2	210±37
L.J. stony spherules(1)	4477	0.21	27.2	0.62	30±2	243±18
Chondrite		0.2-0.3	20-30	1.1-1.9		∿300-560

(1) Nishiizumi et al (1980)