COSMIC RAY EXPOSURE AGES AND TRAPPED NOBLE GASES IN TWO ACAPULCOITES AND TWO LODRANITES: A COMMON ORIGIN? D. H. Garrison (Lockheed Martin) and D. D. Bogard (code SN4), NASA Johnson Space Center, Houston, TX 77058.

Introduction: Acapulcoites and lodranites are believed to have originated on a common, chondrite-like parent body that reached metamorphic temperatures of ~950-1050°C. Compared to acapulcoites, lodranites represent a greater degree of phase separation and removal (1), and thus have somewhat different compositions. More than a dozen of these two classes of meteorites are known to exist. From noble gas data, it has been suggested that eight lodranites have a common cosmic ray exposure age of 5±1 Ma (2), and four acapulcoites suggest similar exposure ages of ~5.5-6.5 Ma (3). All but one of these meteorites show relatively low $^{21}Ne/^{22}Ne$ ratios, suggesting space irradiation under low shielding of only several cm. The evidence for irradiation under low shielding and the possibility that most or all acapulcoites and lodranites have a common exposure age suggests that a single impact event on the parent body may have launched many small meteoroids into space. If this scenario is true, then the observed chemical and petrologic differences among acapulcoites and lodranites indicate short-scale heterogenefities of the parent, and the identical ^{39}Ar-^{40}Ar ages of 4.52 Ga for five acapulcoites (4) may represent the time of metamorphism for a limited portion of the parent body.

New Data and Exposure Ages: We measured noble gases in ~50 mg samples of two acapulcoites, ALH81187 and EET84302 (classified by some as a lodranite, but by (1) as an acapulcoite), and in two lodranites, LEW88280 and MAC88177 (Table 1). Concentrations of cosmogenic noble gases in all but ALH81187 also were reported recently by (2). Relatively large $^{21}Ne/^{22}Ne$ ratios suggest the presence of SCR Ne in analyses of Y-74357 and possibly Y-74063 and ALH81187 (5). The low $^{3}He/^{21}Ne$ ratios for MAC88177 (this work and 2) suggest diffusive loss of He. However, neither individual cosmogenic abundances nor $^{3}He/^{21}Ne$ production ratios show a correlation with $^{21}Ne/^{22}Ne$ for available acapulcoite and lodranite data. This apparent lack of shielding dependence is ascribed to variations in concentrations of target elements, primarily Mg.

The chemical composition of acapulcoites/lodranites is generally similar to chondrites, but individual analyses show considerable variations. These variations, along with small shielding, can produce significant differences in production rates used to calculate cosmic ray exposure ages from Ne and Ar. To calculate cosmic ray exposure ages for our four meteorites (Table 1), we used measured concentrations of cosmogenic ^{3}He, ^{21}Ne, and ^{38}Ar and production rates for L-chondrites given by (6). These production rates were adjusted for compositional differences and were normalized to average shielding based on the $^{22}Ne/^{21}Ne$. For elements Mg, Si, Al, and Na, the main targets for ^{21}Ne production, we used average literature data for acapulcoites and lodranites. For Ca, and Fe, targets for ^{38}Ar production, we used determinations in aliquots of the samples analyzed for noble gases (1). We calculated K from the measured ^{40}Ar of each sample and a K-Ar age of 4.5 Ga measured on Gibson and several acapulcoites (1).

Our average of three ages for ALH81187 is 5.0 Ma (range 4.4-5.7 Ma). No previous data have been reported for ALH81187. Our ^{3}He and ^{21}Ne ages for LEW88280 average 5.5 Ma, which is generally consistent with previously reported ^{3}He and ^{21}Ne ages of 5.62 and 3.35 Ma (2). Our ^{21}Ne age of 5.1 Ma for MAC88177 is identical to the ^{21}Ne age reported by (2); the low ^{3}He age in both studies is due to diffusive loss. However, LEW88280, MAC88177, and EET84302 all show much higher ^{38}Ar exposure ages, and EET84302 also shows a low ^{21}Ne age. Even so, the average of three ages for EET84302 is 5.1 Ma. Our sample of EET84302 contained considerable metal (we estimate ~40% in the sample analyzed for noble gases), much more we believe than the sample analyzed for chemistry (1). Thus, we ascribe the high ^{38}Ar and low ^{21}Ne ages for EET84302 to a much higher metal/Mg-silicate ratio for our sample. The higher ^{38}Ar ages for LEW88280 and MAC88177 are more difficult to explain, and we have no comparison as (2) did not report ^{38}Ar data. The ^{38}Ar concentrations for these two meteorites had the largest correction factors (2-2.5) applied for shielding and composition, and the uncorrected ^{38}Ar data would give ages of 4-5.5 Ma. Thus we conclude that the applied compositional corrections to ^{38}Ar are suspect.

Ignoring the high ^{38}Ar ages, these two acapulcoites and two lodranites could easily have cosmic ray exposure ages of 5±1 Ma. We caution, however, that the large correction factors that have to be applied for shielding and compositional differences must be precisely determined before it can be concluded that most acapulcoites and lodranites have a common exposure age.

Trapped Gases and ^{129}Xe: Abundances of trapped ^{36}Ar, ^{84}Kr, and ^{132}Xe in our four samples are shown in Table 1. Our measured ^{132}Xe concentrations of ~0.25-21 x10^{-10} cm^3/g are similar to concentrations of ~3-15 x10^{-10} cm^3/g previously reported for Acapulco, ALH77081, and Lodran, but are considerably lower than the bulk sample value of ~5 x10^{-8} cm^3/g reported for Y-74063 (7, 8). The relative isotopic compositions of Xe in three of our samples are normalized to the atmospheric composition and compared to the composition of trapped chondritic Xe in Fig. 1. This Xe closely resembles that previously reported for several lodranites (9), but differs in detail from atmospheric, solar, and chondritic Xe. Data for MAC88177 are not shown because the low Xe abundance resulted in large relative isotopic uncertainties.

Also interesting is the unusually high $^{129}Xe/^{132}Xe$ ratio of 5.7 for ALH81187, which is considerably above values of ~1.09-1.4 measured for the other three meteorites. Previously reported values of $^{129}Xe/^{132}Xe$ are 1.060 and 1.067 for Acapulco and EET84302, respectively, ~1.2 for ALH77081, and ~1.09 for bulk samples of Y-74063 (8, 10, 11). Concentrations of radiogenic ^{129}Xe (from ^{129}I decay) for several lodranites and acapulcoites are ~10^{-10} cm^3/g or less (Table 1; 8). In contrast, ALH81187 and Y-74063 contain ~20 and ~30 x10^{-8} cm^3/g of radiogenic ^{129}Xe, respectively (Table 1; 8). The higher $^{129}Xe/^{132}Xe$ ratio for ALH81187 may have two explanations. This material may have inherited a larger relative abundance of iodine compared to Xe. Alternatively, compared to other acapulcoites and lodranites, ALH81187 may have lost its trapped Xe by diffusion at an earlier time, before most of the live ^{129}I had decayed. This second explanation would permit us to use the $^{129}Xe/^{132}Xe$ ratio and the ^{129}I half-life to estimate the time difference in Xe loss between ALH81187 and the other meteorites. The relatively low $^{129}Xe/^{132}Xe$ for several acapulcoites/lodranites indicates that the inherited $Xe/^{129}I$ ratio was relatively high. If we also apply this constraint to ALH81187, then the time interval between diffusive loss of Xe from ALH81187 and the other acapulcoites/lodranites would have to be several half-lives of ^{129}I. Such a condition would be inconsistent with similar $^{129}I/^{129}Xe$ formation intervals between Acapulco and the Bjurbole chondrite (12) and with ^{39}Ar-^{40}Ar ages of 4.52 Ga for several acapulcoites, including ALH81187 (4). Thus, we conclude that ALH81187 probably inherited greater amounts of live ^{129}I.

Meteorite	^{3}He	^{21}Ne	^{38}Ar	22/21	^{36}Ar	^{84}Kr	^{132}Xe	129/132	Exposure Age Ma		
	cosmogenic x10^{-8} cc/g				trapped x10^{-10} cc/g				He	Ne	Ar
ALH81187	6.70	1.040	0.127	1.320	385	0.89	4.16	5.688	4.40	5.68	4.92
EET84302	6.91	0.693	0.393	1.164	788	5.02	20.5	1.087	4.34	2.60	8.41
LEW88280	8.18	1.479	0.255	1.245	549	1.57	4.93	1.114	5.26	5.71	11.0
MAC88177	0.64	1.301	0.181	1.287	9.3	0.19	0.25	1.450	0.42	5.10	10.5

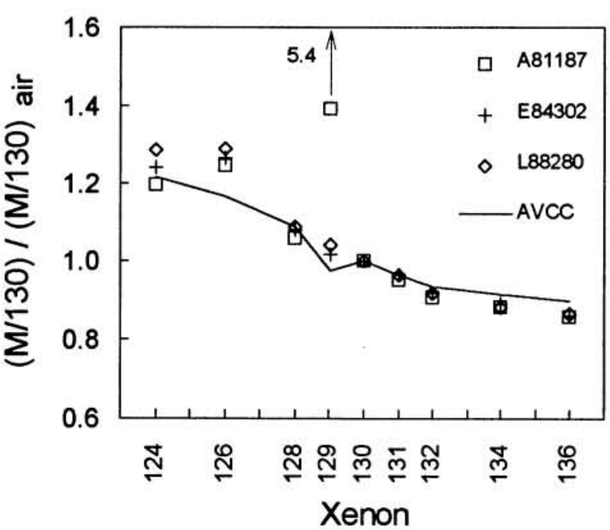

Figure 1. Measured Xe isotopic ratios relative to air. Uncertainties are within the symbol size for masses 128 through 136 and approximately twice the symbol size for 124 and 126.

References: (1) Mittlefehldt et al., GCA, in press, 1996; (2) Weigel et al., Meteoritics 29, 548, 1994; (3) McCoy et al, GCA, in press, 1995; (4) Bogard and Garrison, this volume; (5) Garrison et al., Meteoritics 30, 738, 1995; (6) Eugster, GCA 52, 1649, 1988; (7) Palme et al., GCA 45, 727, 1982; (8) Takaoka and Yoshida, NIPR Symp. Ant. Met. 4, 178, 1991; (9) Weigel and Eugster, LPSC XXV, 1479, 1994; (10) Kim and Marti, Meteoritics 29, 482, 1994; (11) Schultz et al., EPSL 61, 23, 1981; (12) Nichols et al., GCA 58, 2553, 1994.