THE NATURAL TL SURVEY OF THE 1987/1988 ANTARCTIC METEORITE COLLECTIONS: PAIRING, AN UNUSUAL CARBONACEOUS CHONDRITE GROUP AND THE LUNAR METEORITES. Derek W. G. Sears, Hazel Sears and Benjamin M. Myers, Cosmochemistry Group, Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR 72701.

We have been measuring the natural thermoluminescence levels of Antarctic meteorites as the data provide a semi-quantitative indication of terrestrial age and help identify meteorites with unusual thermal and radiation histories [1-4]. Our data for some of the 1987/1988 collections appeared in the last Antarctic Meteorite Newsletter[4], in which we also made suggestions concerning pairing. In the present paper, we describe our pairing procedures, and we discuss TL data for two unusual meteorite types in the collection, a group of carbonaceous chondrites and the lunar meteorites.

Pairing. Our procedures are summarised in Table 1, which concerns four suggested pairings. Natural TL levels for Antarctic meteorites range over 3 orders of magnitude, with about 80% falling in the range 20-80 krad. These four L6 chondrites from Elephant Moraine have similar and unusually low natural TL, consistent with an extremely large terrestrial age (on the order of 0.4 ± 0.2 My [5]) or mild reheating within the last 10^5 y. Except for EET87541, no thin section descriptions are available (they were classified for the Newsletter by the refractive index of separated grains), but JSC descriptions and the descriptions we make during sample preparation are not inconsistent with the pairing we suggest (notwithstanding heterogeneously distributed metal and consequent hardness differences). The sigmas on the induced TL data are about $\leq 10\%$ for TL sensitivity, peak temperature and width. The heterogeneity in these parameters for a single Antarctic meteorite may be assessed from the data for the 110kg H5 chondrite LEW85320 (Table 2). Two 5cm cores were removed 27.5cm apart from the base of this approximately conical mass, and 5 samples were removed from each core. There were no systematic trends in any TL property, the standard deviations for the data for both cores being 6%, 40%, 3% and 5% of the mean for natural TL, TL sensitivity, TL peak temperature and width, respectively. Other meteorites have shown cosmogenic natural TL gradients, a factor of 2 variation over 30cm being the maximum observed case [6], so our pairings are probably conservative. Nevertheless, we suggest that the 121 meteorites from the 1987 collection that we measured may actually represent only 85 discrete finds. Details are given in ref. 4.

Unusual Carbonaceous Chondrites. Murray and 14 Antarctic C2 chondrites we have previously measured had no detectable natural or induced TL, while MAC87300/301, which Mason suggests are paired C2 chondrites [2], and MAC88107, which we suggest is paired with MAC87300/301, have natural TL values of 17 ± 6, 17 ± 2 and 14 ± 1 krad, respectively, and induced curves resembling LEW85332, Colony and ALHA77307 (Fig. 1). These 6 meteorites have fairly low TL sensitivity and, most notably, an additional peak at 330-400°C. In their TL properties at least, these 6 carbonacous chondrites constitute a discrete group. The classification of Colony and ALHA77307 has proved controversial [7,8,9], but in many senses they appear to lie at the least-metamorphosed end of the CO chondrite metamorphic spectrum [10,11]. Mason suggested that LEW85332 was also a CO chondrite, but further mineralogic and compositional data are not those of a normal CO chondrite (Ed Scott and Alan Rubin, per. comm.). As Rubin et al. argued for Colony and ALHA77307, it might be that these 6 meteorites extend the range of properties of the CO class. Alternatively, they could represent a new class, or, most importantly, it could be that the hiatuses in the properties of some of the small related CI, CM, CO classes are a sampling artifact.

The Lunar Meteorites. Like the other lunar meteorites, MAC88104/105 have low natural TL (2.4 ± 0.3 and 2.9 ± 0.3 krad at 250°C, compared with 0.75, 1.7 and 0.5 krad for ALHA81005, Y 791197 and Y 82192, respectively, [12-14]). Like ALHA81005 and Y 791197, MAC88104/105 show appreciable anomalous fading (20% and 40% in 15 days, respectively) which accounts, at least in part, for their low natural TL values. The high temperature (350°C) natural TL of MAC88104/105 is similar to ALHA81005 (around 10 krad), much higher than Y 82192 and much lower than Y 791197. If the shock associated with ejection from the lunar surface removed all the low temperature TL, and we assume, following Sutton [12,13], a dose rate of 10 rad/y and a power-law dependency in the rate of anomalous fading, then the observed natural TL levels at high glow curve temperatures are consistent with the same short transit time for MAC88104/105 as for ALHA81005, <2,500y. It may also imply comparable burial depths on the lunar surface to ALHA81005, in the order of meters deeper than

Y 791197 yet shallower than Y 82192 [15]. The induced TL curves of MAC88104/105 are very similar to the other lunar meteorites (we have not yet measured the mare-rich lunar meteorite EET87521 [17,18]) and to lunar sample 60010,188 [13], and unlike several Apollo nonhighland samples. The amount of feldspar present would not produce the observed differences in glow curve shape between highland and mare-rich material, and we suspect that the differences in thermal processing are involved. The peak temperature for the induced TL is comparable to that observed for disordered feldspars and appreciably higher than observed for ordered feldspars [16,17], which implies annealing $>800^{\circ}$C by regolith processing, shock during ejection from the lunar surface, parent body metamorphism, or rapid cooling since crystallization of the feldspar.

1. Sears & Hasan, 1986, LPI Tech Rpt 86-01, 83; 2. Antarctic Meteorite Newsletter (AMN), Aug. 1988; 3. AMN, March 1989; 4. AMN, Sept. 1989; 5. Hasan et al., 1987, PLPSC 17th, E703; 6. Lalou et al., 1970, C.R. Ser. D, 270, 2401; 7. Scott et al., 1981, Meteoritics, 16, 385; 8. Ross & Sears, 1982, Meteoritics, 18, 1; 9. Biswas et al., 1982, Proc. 6th NIPR Symp. Ant. Met., 221; 10. Rubin et al., 1985, Meteoritics, 20, 175; 11. Keck & Sears, 1987, GCA, 51, 3013; 12. Sutton & Crozaz, 1983, GRL, 10, 809; 13. Sutton, 1986, Proc. 10th NIPR Symp. Ant. Met., 133; 14. Sutton, 1986, Meteoritics, 21, 520; 15. Hoyt et al., 1971, Proc. 2nd Lunar Sci. Conf., 2245; 16. Guimon et al., 1985, GCA, 52, 119; 17. Hartmetz & Sears, 1986, LPS XVIII, 395. 17. Warren & Kallemeyn, 1990, GCA, 53, 3317; 18. Delaney, 1990, Nature, in press.

Table 1. Pairing information on four L6 chondrites

	Nat TL (krad)	Sample Descriptions JSC*	UAF	TL sens (Dhaj = 1)	Peak Temp (°C)	Peak Width (°C)
EET87556	8.5±0.2	A, pale grey oxid rind minor weathering	grey, white incl/ orange spots, veins/ metal, hard	1.6±0.1	183±5	141±2
EET87568	8.9±0.4	A, pale grey oxid rind minor weathering	white/grey veins, orange spots, soft, much magnetic	2.2±0.2	171±4	127±2
EET87584	9.5±0.1	A, pale grey white clast/incl soft, minor oxid	v. weathered soft	1.0±0.1	162±4	128±4
EET87541	6.6±0.1	A, lt/med grey abund lt incl unweath inter	grey, white flakes, no mag	0.98±0.04	181±3	152±2

*'A' refers to weathering category.

Table 2.
Thermoluminescence data for two cores from LEW85320

Core	Depth (cm)	Nat TL (krad)	TL sens (Dhaj = 1)	Peak Temp (°C)	Peak Width (°C)
11	<1	22.8±0.3*	0.6±0.1	186±9	163±6
	3	31.6±0.9	0.9±0.1	189±13	144±12
	3.5	36.8±1.7	0.9±0.1	184±4	144±7
	3.5	47.7±7+	0.7±0.1	199±8	148±5
	5	34.5±0.4	1.0±0.2	185±11	145±2
12	1.5	34.9±1.5	1.9±0.3	183±3	147±8
	1.5	38.4±0.7	0.7±0.1	187±3	158±7
	3.5	34.4±1.0	1.0±0.1	186±6	152±7
	3.5	33.1±0.4	0.7±0.1	183±4	145±1
	4.5	42.6±6+	1.6±0.2	188±7	160±11

*Data discounted, sample too close to fusion crust.
+Data discounted, large uncertainties.

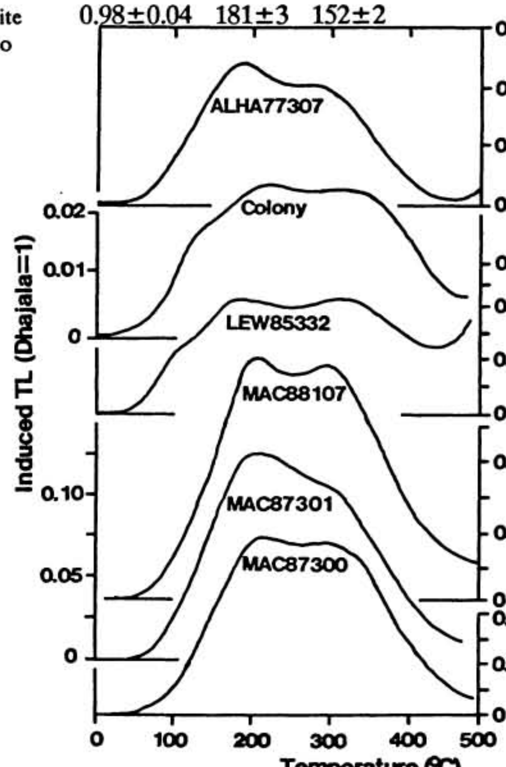

Fig. 1. Glow curves for 6 carbonaceous chondrites.

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