THERMOLUMINESCENCE SENSITIVITY OF SIXTEEN TYPE 3 ORDINARY CHONDRITES. D.W.G. Sears and K.S. Weeks, Department of Chemistry, University of Arkansas, Fayetteville, Arkansas 72701.

In ordinary chondrites, thermoluminescence (TL) sensitivity varies systematically with petrologic type, being a factor of 10 higher in types 5 and 6 than in type 4 and a factor of up to 1000 higher in type 4 than in type 3. Furthermore it displays a very large (1000-fold) variation in type 3 which is associated with changes in many petrographic properties which are thought to be the result of metamorphic alteration. We report here TL sensitivity data on 14 previously unstudied type 3 ordinary chondrites and on fresh samples of the particularly heterogeneous Bremervörde and Parnallee meteorites which were studied earlier. The new Parnallee datum agrees well with the previous value (0.42, ref. 1). Bremervörde is discussed below. The new data further demonstrate our previous findings of a close association between metamorphism and TL sensitivity and provide some additional observations which may help in determining the mechanism behind the TL variation.

Table 1. Thermoluminescence and other data on 16 type 3 ordinary chondrites in order of decreasing TL.

Sample	Source†	Mass* (mg)	TL Sensitivity†† (Dhajala = 1) Duplicates	Mean	Petrologic Type
Allan Hills A77216	MWG (38)	46	2.4	1.6	3.8
	MWG (39)	398	0.74		
Allan Hills A79022	MWG (16)	211		0.96	3.7
Reckling Peak A79008	MWG (9)	226	1.3	0.89	3.7
	MWG (10)	199	0.48		
Bremervörde	BM (33910) via UNM-B1	108		0.60	3.7
Allan Hills A77304	MWG (40)	524	0.62	0.60	3.7
	MWG (44)	271	0.58		
Reckling Peak A80205	MWG (7)	54	0.51	0.55	3.7
	MWG (8)	70	0.58		
Outpost Nunatak A80301	MWG (9)	65	0.47	0.52	3.7
	MWG (8)	43	0.56		
Allan Hills A77197	UNM	95		0.38	3.6
Reckling Peak A80256	MWG (8)	137		0.38	3.6
Parnallee	BM (34792)	~50		0.37	3.6
Suwahib (Buwah)	BM (1931,428) via UNM (SB2)	195		0.25	3.6
Allan Hills A77013	UNM	145		0.14	3.5
Allan Hills A76004	MWG (12)	63	0.012	0.034	3.3
	MWG (14)	126	0.055		
Inman	UNM(C71-12,D)			0.031	3.3
Reckling Peak A80207	MWG (6)	70	0.016	0.016	3.2
	MWG (7)	165	<0.031		
Allan Hills A77176	UNM	120		0.010	3.2

†MWG, Antarctic Meteorite Working Group of NASA/NSF. UNM, E. Scott, Univ. of New Mexico. BM, R. Hutchison, British Museum, Natural History. (Catalog or fragment numbers in parenthesis.)
*Refers to mass homogenized for sampling. Measurements were made on 4 mg.
††1 σ uncertainties are 40% (50 mg samples) to 20% (200 mg samples)

Sears, D.W.G. and Weeks, K.S.

Relevant data on our samples and the TL results are listed in the Table. (Samples of Dhajala, which were used for normalization, and Krymka and Chainpur, which were used to check new procedures and apparatus, were taken from previous studies; 1.) The present samples span more than two orders of magnitude in their TL sensitivity. The highest are comparable to the highest in earlier studies, but none have TL sensitivities comparable to the lowest observed in earlier studies. However two meteorites, Reckling Peak A80207 and Allan Hills A77176, fill the hiatus which previously existed between Bishunpur (0.0054) and St. Mary's County (0.034).

Petrologic types are also indicated in the Table. Except as noted below, they should be considered tentative pending petrographic and other data. However where comparisons are available, there is good agreement between the TL assignments and petrographic data. The present Bremervörde sample has the silicate heterogeneity equivalent to a type 3.7 (C.V.(Fa)* = 26%; 3) and the TL is in perfect agreement with this. Our previous Bremervörde sample has a TL sensitivity comparable with Allan Hills A78084 (2.6 c/f 2.3), and both have the silicate heterogeneity equivalent to type 4 (C.V.(Fa) = 1.5% c/f 0.32%; 3,4). Allan Hills A77216 and A79022 are breccias containing material of various petrologic types. However both appear from silicate heterogeneity data to be fairly equilibrated (A77216, Fa_{23-26}, 5; A79022, C.V.(Fa) = 1%, 4), consistent with their high TL sensitivities; parts of both may be type 4. There are literature data for two of the present samples which lie at the low end of the TL range. The Inman meteorite contains much petrographic evidence indicating that it belongs to a low petrologic type (6): much fine-grained opaque matrix, 0.35 wt%C and a C.V.(Fa) = 40% (calculated from fig. 5 of ref. 6). The last two parameters are consistent with type 3.3 and 3.5 assignments, respectively, while the TL data suggest type 3.3. Allan Hills A76004 also has highly inhomogenous silicates (C.V.(Fa) = 65% from ref. 7, empirically converted from 50 PMD wt FeO), equivalent to type L3.4. Like many other type 3 chondrites, it is a breccia, although particularly heterogeneous (8), and this is reflected in a particularly large deviation between our duplicates.

The existence of a relationship between TL sensitivity and metamorphism seems well-established, but the cause of the spread is presently unclear. The discovery of two meteorites in the previous hiatus between Bishunpur and St. Mary's County does, however, probably make theories which involve changes of a steady gradational nature more plausible.

Acknowledgements. We are grateful to the meteorite donors listed in the Table and to the Research Corporation and NASA (NAGW-296) for grant support.

(1) Sears, D.W., et al. (1980) Nature 287, 791-795.
(2) Sears, D.W., et al. (1982) Geochim. Cosmochim. Acta 46, in press.
(3) Scott, E., University of New Mexico, personal communication.
(4) Scott, E.R.D., et al. (1982) Meteoritics 17, 65-75.
(5) Score, R., et al. (1981) Antarctic Meteorite Newsletter 4, 144 pp.
(6) Keil, K., et al. (1978) Meteoritics 13, 11-22.
(7) Olsen, E., Field Museum of Natural History, personal communication.
(8) Olsen, E.J., et al. (1978) Meteoritics 13, 209-225.

*Coefficient of variation, (standard deviation/mean) x 100, of the mole Fa in the olivine. See ref. 2 for a discussion of this parameter.