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A THERMOLUMINESCENCE STUDY OF THE SHERGOTTITES.

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The shergottite achondrites are intensively shocked assemblages of pyroxene, maskelynite, and sometimes olivine, with minor magnetite, pyrrhotite and whitlockite, which were probably ejected from Mars.(1) Since thermoluminescence (TL) has proved of value in exploring the shock history of ordinary chondrites(2,3), a TL study of the shergottites was undertaken.

Two fragments of each meteorite were ground and a 5 mg aliquot removed for TL measurements. After removal of the natural TL by heating to 500°C, the TL sensitivity was measured by exposing the samples to a 250 mCi Sr-90 beta source and determining the induced TL. Details of the apparatus and procedures can be found in (4). The intensity of the TL at the maximum emission (normalized to the Dhajala meteorite), the temperature at which the TL emission is maximum (T), and the full width at half maximum (FWHM) were measured from the glow curves (Table 1).

Table 1: Thermoluminescence data on shergottite meteorites.+

Meteorite	Source*	Maskelynite** (vol.%)	Mass (mg)	TL sensitivity (Dhjala=1000)	T (C)	FWHM (C)
Shergotty,7	GSI	23.3	152	1.2 +/-0.4	158+/-5	108+/-8
Shergotty,20	GSI		172	1.8 +/-0.5	146+/-6	140+/-26
ALHA77005,67	MWG	8	81	0.6 +/-0.2	169+/-9	128+/-20
ALHA77005,68	MWG		57	0.73+/-0.1	236+/-8	126+/-20
Zagami	BM	21.8	70	0.42+/-0.08	156+/-11	120+/-28
Zagami	BM		120	0.35+/-0.08	158+/-2	88 +/-12
EETA79001$,171	MWG	17	32	0.25+/-0.07	182+/-4	118+/-10
EETA79001$,170	MWG		30	0.15+/-0.02	181+/-7	100+/-6

\+ Errors quoted are 1 sigma
* MWG:Meteorite working group
GSI:Geological Survey of India, Calcutta.(Fragment # indicated).
BM:British Museum (R. Hutchison;Catalog Number BM1966,54)
$ Lithology A (see ref. 5)
**From refs. 5 and 6

The TL sensitivity values for the shergottites are extremely low and display a ten-fold range (for comparison the lowest TL sensitivity for an ordinary chondrite is 2.7, where Dhjala=1000). The peak temperature and width show some variation, and there is an indication of systematic variation with TL sensitivity.

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TL OF SHERGOTTITES

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We suspect that the TL phosphor in the shergottites is the feldspathic material. The extremely low sensitivities presumably reflect the thorough maskelynization of feldspar during the shock event. The range in TL sensitivities is not due to sample heterogeneity because we have good agreement between duplicates. Neither does the amount of maskelynite in the meteorite appear to be responsible for the TL range, since the percentage of the maskelynite is only 8 for 77005, but 23.3 for Shergotty and 21.8 for Zagami, while Shergotty and Zagami have very dissimilar TL sensitivities. We suggest that the range in TL sensitivity observed for the shegottites reflects differing amounts of crystalline material now present in the maskelynite. Either (1) some of these meteorites were shocked more than others, so that the TL is measuring tiny amounts residual feldspar, or (2) maskelynization during shock was complete, but the glass underwent post-shock recrystallization. Dodd has suggested that the zoning in pyroxenes infers a slower cooling rate for Shergotty than Zagami(6), and McSween and Jarosewich(5) report zoning in the pyroxenes 79001 (lithology A) similar to that of Zagami. These inferred cooling rates are consistent with the TL sensitivity range being associated with the extent of post-shock recrystallization.

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