The thermal history of Lunar rocks, regolith and Lunar meteorites: Secondary processing as viewed by thermoluminescence. S. Symes, P. H. Benoit, J. D. Batchelor and D. W. G. Sears. Cosmochemistry Group, Dept. Chemistry and Biochemistry, University of Arkansas, Fayetteville, Arkansas 72701, USA.

The Moon has served as a petrogenic testing ground since the inception of the Apollo program. Thermoluminescence (TL) measurements on returned lunar material were fairly common during the earliest days of the program (*e.g.*, Hoyt *et al.*, 1972) but virtually ceased after the first few missions. Since that time, much has been learned about TL properties and their value in deciphering the history of extraterrestrial samples (Sears, 1988). Here we report new TL data for a suite of lunar samples covering virtually all the major lunar rock types present in the Apollo and lunar meteorite collections. Both highland and mare material were examined and data for highland core 60009/10 were also obtained. We have previously discussed natural TL of lunar meteorites (Sears *et al.*, 1991); our present discussion is confined to induced TL measurements.

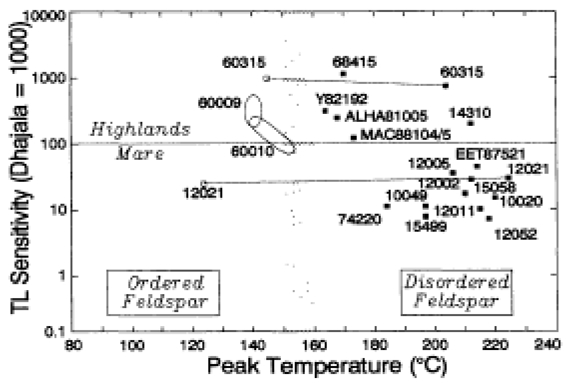

FIG. 1. Induced TL sensitivities *vs.* peak temperatures for lunar samples and lunar meteorites. Envelopes for lunar core 60009/10 include a total of 10 samples. Open symbols indicate non-dominant peaks.

In lunar and meteoritic samples, three induced TL parameters are measured: the intensity of the signal (TL sensitivity) reflects the amount and composition of feldspar, while the TL peak temperature and peak width reflect its structural state which is, in turn, determined by thermal/metamorphic history (Fig. 1). There is fairly clear distinction between highland and mare samples in TL sensitivity, with the mare samples having lower values. This presumably reflects the greater abundance of feldspar in highland samples, although the TL sensitivities even for highland samples are unusually low in view of their high feldspar contents. The high TL peak temperatures suggest that the feldspar of both highland and mare samples is predominantly disordered. Only two rock samples have minor amounts of ordered feldspar and this form of feldspar is dominant only in lunar core 60009/10. For mare samples this is not surprising, since many of these are known to have cooled very rapidly.

The lack of ordered feldspar in highlands samples (including lunar meteorites) reflects the lack of pervasive metamorphism similar to that experienced by the eucrites (Batchelor and Sears, 1991). However, in lunar core 60009/10, we see a trend of increasing induced TL peak temperature and decreasing TL sensitivity as a function of regolith maturity. We interpret this as indicative of disordering of pre-existing ordered feldspar and destruction of feldspar through impact processes. This is presumably the reason for the low TL sensitivities of highland samples relative to eucrites. Three of the lunar meteorites (Y82192, ALHA81005, and MAC88104/5) seem to represent intermediate steps in this process, although the impact which sent them to Earth may have affected their TL data. The presence of weak peaks due to low temperature feldspar in at least one highland sample (60315) suggests that at least some rocks may contain relatively pristine feldspar which has not been affected by impact processes. Whether this feldspar is intimately intermixed or separated in clasts has yet to be determined.

In summary, our TL data emphasize the importance of cooling rate (mare samples) and pervasive impact processes (highland samples) on the thermal history of lunar samples. TL should be useful in studying rocks and clasts of suspected unusual histories.

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