THERMOLUMINESCENCE OF PLAGIOCLASE FELDSPARS AND IMPLICATIONS FOR METEORITE STUDIES. J. David Batchelor and Derek W.G. Sears. Cosmochemistry Group, University of Arkansas, Fayetteville, AR 72701.

Introduction. Thermoluminescence (TL) properties of meteoritic feldspar have provided many new insights into meteorite history, but a greater knowledge of the details of the TL mechanism in feldspar, and in particular its compositional dependence, would greatly enhance these applications. We have examined a suite of terrestrial feldspars in order to better understand this compositional dependence. It is established that feldspar is the predominant TL phosphor in meteorites and that the TL sensitivity of the ordinary chondrites is proportional to the amount of feldspar present. For example, major increases in TL sensitivity result from the production of feldspar by devitrification of feldspathic glass by metamorphism, and serve as an indicator of chondrite petrologic type(1). In addition, the TL peak temperature and width shift to larger values following annealing above a certain critical temperature. This effect has been attributed to disordering of the crystal lattice, and its use has been suggested as a threshold paleothermometer(2).

Meteorites contain a variety of plagioclase feldspars. In equilibrated ordinary chondrites, the feldspar is essentially oligoclase, but a variety of compositions, including anorthite, are observed in unequilibrated ordinary chondrites. In the CAI's and most achondrites, the feldspar is often anorthositic, while the shergottites contain maskelynite of labradorite composition(3).

Experimental. Each feldspar was ground and seived, and the fraction from 140 to 200 mesh was taken for TL analysis using the apparatus and techniques of Ref. 2. The photomultiplier was fitted with a standard blue filter, 60 nm bandpass centered at 410 nm.

Results. Fig. 1 shows that the TL sensitivity of plagioclase decreases logarithmically with increasing Ca. The regression line shown in Fig. 1 has a correlation coefficient of 0.94. Fig. 2 shows peak temperature and width against composition. Four of the 6 samples have peak temperatures and widths of 90 - 130C; there is possibly a suggestion that the peak temperature for anorthite may be higher than the others. Three samples of albite were measured, and while one produced TL curves similar to the other feldspars, two produced glow curves with three peaks, one of which also seems to be in the 90 -130C range. Data for the strongest peaks are plotted in Fig. 2; interference between peaks prevented width measurement for these samples. The oligoclase sample is noteworthy for its higher values for peak temperature and width.

Discussion. Our work confirms earlier suggestions(4,5,6) that high sodium plagioclases have higher TL sensitivity; in fact, TL sensitivity decreases logarithmically with increasing An. Since Na^+ and Ca^{2+} are almost identical in size, this trend may be due to the increased charge density of the divalent calcium, which may prevent de-excitation and result in phonon emission. Alternatively, de-excitation may take place through a different site, resulting in wavelengths outside the blue region. Spectra by Akber and Prescott and by Huntley et al. indicate that this is not happening in the visible or near infrared.

Peak temperatures and widths in the ranges of 120 - 160C and 80 - 140C, respectively, are observed for type 3.2 - 3.5 ordinary chondrites and terrestrial feldspars in the low form, so we suggest that our andesine, labradorite, bytownite, and anorthite are in the ordered form. On the other hand, the present oligoclase data resemble those for samples known to be in the high (disordered) form. The oligoclase sample is from Mitchell Co., North Carolina, an area of heavy metamorphism.

The complexity of the albite peaks could be structurally related. Albites of < 3% An have a "low albite" structure, while those with higher Ca content show a structure of peristeritic intergrowths. The exact composition of these albites has not yet been determined.

Conclusion. This study has illuminated several aspects of feldspar behavior in meteorites. For example, the low TL sensitivity of achondrites can be understood, despite their high abundance of feldspar, in view of their high anorthite content. Within the equilibrated OC's, compositional differences in feldspar represent a significant source of scatter in the correlation of TL sensitivity with petrologic type - especially so since feldspar compositions of most equilibrated ordinary chondrites fall on the steep portion of the logarithmic curve. The incorporation of compositional data may allow further refinement of the petrologic types.

References. 1) Sears et al. (1980) Nature, 287, 791-795. 2) Guimon et al. (1985) GCA, 49, 1515. 3) Dodd (1985) Meteorites, Cambridge U.P. 4) Akber & Prescott (1985) Nucl. Tracks Rad. Meas., 10, 575. 5) Hasan et al. (1986) J. Lumin., 34, 327-335. 6) Huntley et al. (1988) J. Lumin., 39, 123-126.

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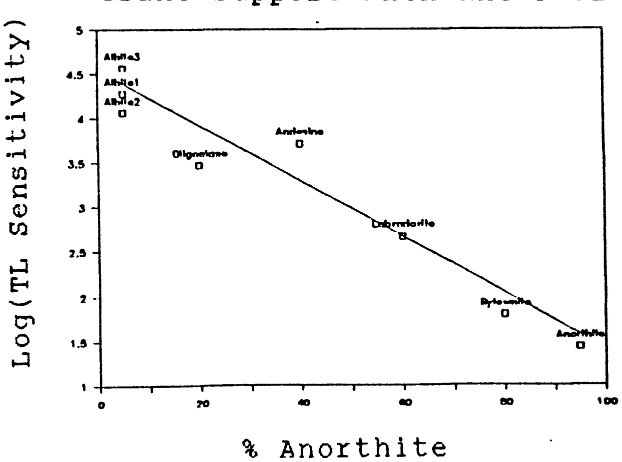

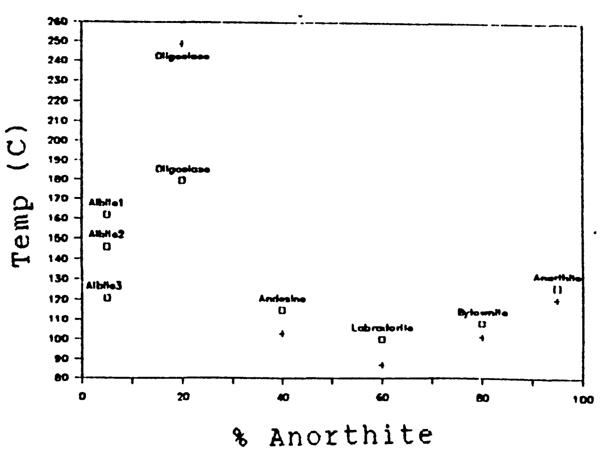

Fig. 1 (left) Log TL sensitivity vs mole % anorthite and Fig. 2 (right) TL peak temperature (squares) and width (plus signs) vs mole % anorthite. In both figures, the feldspars are albite, oligoclase, labradorite, bytownite, and anorthite. Typical 1 sigma uncertainties are as follows; TL sensitivity 5%, peak temperature and width, 10 C.