A STUDY OF THE EFFECT OF DEVITRIFICATION ON THERMOLUMINESCENCE IN TYPE 3.4 ORDINARY CHONDRITES. R. Kyle Guimon[1], Gary E. Lofgren[2], Derek W.G. Sears[1]; [1]Dept. Chemistry, Univ. Arkansas, Fayetteville, AR 72701. [2]NASA Johnson Space Center, Houston, TX 77058.

Metamorphism is an important process in ordinary chondrites which must be understood before the primary formational processes of these meterorites can be unraveled. Thermoluminescence (TL) is a good techinque for determining the extent of metamorphism. There is a 10^5 range of TL sensitivity in the ordinary chondrites, types 3-6, and a 10^3 range in the types 3.1-3.9 (1,2). The crystallization of primary igneous glass to feldspar primarily during devitrification is believed to be the mechanism by which the 10^5 range in TL sensitivity is achieved (2-5).

X-ray diffraction studies on mineral separates from types 4-6 ordinary chondrites have shown that the TL phosphor is feldspar in the high temperature, disordered form (3). The peak temperature of the type 4-6 chondrites is 190 +/-30°C with a peak width of 160 +/-20°C (6). ALHA 77214.55, which is paired with ALHA 77011 (7), is a type 3.4 ordinary chondrite (6) and was chosen for this experimental study because it has a low peak temperature (126 +/-5°C) and peak width (92 +/-5°C) which suggest that feldspar is the phosphor and it is in the low temperature form. By annealing the starting material we hope to transform the feldspar to the high temperature form and increase the TL sensitivity transforming the material from one with type 3.4 TL characteristics to one with type 3.6 or higher. While the transformation of the feldspar to the high form can be accomplished by simple thermal annealing (8), an increase in TL sensitivity has been accomplished only at elevated pressure with a sodium disilicate solution present (5).

Aliquots of a non-magnetic fraction (30 μg) of 77214.55 were sealed together with water (10 wt %) and sodium disilicate (approx. 2 molal) in gold capusles. The capsules were annealed for 10, 20, 100, 200, and 500 hours at either 500 or 850°C and approximately 1 kb hydrostatic pressure in externally heated pressure vessels (9). Duplicate samples were run at each temperature. The TL was measured using the techniques described in 10.

The results are shown in figure 1. At 500°C the TL sensitivity decreases with increasing run duration by over an order of magnitude. There is a modest increase in the peak temperature up to 200 hrs and a significant increase after 500 hrs. At 850°C the TL sensitivity initially decreases to almost zero in the 10 hr run, but after 20 hrs has increased to within an order of magnitude of the initial value with a peak temperature of 190°C. Continued annealing (200 hrs) results in a modest increase in sensitivity, but no further change in peak position.

The data show the effects of several processes. Some associated primarily with the experimental technique and some with the luminescence phenomena. The initial decrease in the TL sensitivity with the annealing indicates that the phosphor is being destroyed. The subsequent increase in sensitivity, especially at 850°C, suggests that the phosphor is reappearing primarily as function of time. The initial decrease in TL sensitivity is probably related to the addition of sodium disilicate to the water which is then added to the meteoritic material in the charge. This added material will change the compositon of the meteorite, with the residual glass being the first and most drastically affected. This change in composition of the residual glass could render any phases in the immediate glass unstable. If

any of these phases are responsible for the luminescence, it will be severly reduced or eliminated. Subsequent crystallization of feldspar phases stable in the new glass or melt composition given sufficient time to grow will recreate the luminescence of the bulk material, but the feldspar will be the high temperature form as reflected by the increased peak temperature. The subsequent increase in TL sensitivity is then a process similar to those occuring naturally while the initial decrease is related primarily to the particulars of the technique used to accelerate the devitrification process. Experiments are in progress to confirm this interpretation of the observed data.

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Figure 1. TL sensitivity vs. peak temperature for duplicate ALHA 77214.55 annealed for different times at approximately 1 kb with 10 wt. % of a 2 molal solution of sodium disilicate. Unannealed value is indicated.