

MECHANISM FOR METAMORPHISM-INDUCED TL CHANGES IN UOC: EVIDENCE FROM SEPARATED DHAJALA CHONDRULES. M. H. Sparks and D. W. G. Sears, Department of Chemistry, University of Arkansas, Fayetteville, Arkansas 72701, USA.

The unequilibrated ordinary chondrites (UOC) have experienced a diverse range of metamorphic intensities. This is evidenced by their silicate and metal heterogeneity, matrix recrystallization and chemistry, and abundance of C and inert gases (1,2). Thermoluminescence (TL) sensitivity shows a 10^3 fold increase with increasing metamorphism throughout the UOC. Furthermore, in the temperature range 100-240°C, the band of TL emission widens and moves to higher temperatures as the metamorphic intensity increases. Sears *et al.* (2,3) suggest that these TL properties are consistent with the formation of the TL phosphor (feldspar) by devitrification of glass to produce an ordered structure in type 3.3-3.5 chondrites and a disordered structure in types ≥ 3.6 . However, Huss *et al.* (1) observed that feldspar is formed through metamorphism-induced reactions in the fine-grained matrix; this provides an alternate explanation for the observed TL increase. Devitrified glass is seldom if ever observed in the fine-grained matrix of UOC, in contrast to the chondrules (1,4,5,6). The aim of the present work is to determine whether the major TL carrier in a fairly well metamorphosed UOC is in the chondrules or is in the matrix. We have extracted 58 chondrules from the Dhajala H3.8 chondrite and studied them by EDX/SEM, TL, and petrographic techniques. Here we present the TL data. The morphological, chemical, and petrologic data will be reported elsewhere.

The TL sensitivities of the individual Dhajala chondrules (expressed as a ratio to the TL sensitivity of Dhajala powder) varied from 0.002 to 0.12. The distribution of TL values appears to be bi-modal (see figures): 17% of the chondrules have values between 0.06-0.12 with the remainder concentrated between 0.002 and 0.01. The chondrules varied in mass by a factor of ≥ 100 (5.3 μg to 1.6 mg, a mean of 0.26 mg), with no correlation between mass and TL; the three chondrules with a mass of >1 mg have normalized TL of 0.10-0.004 and the five chondrules with masses of < 0.02 mg have normalized TL sensitivities of 0.067-0.003. Assuming a chondrule TL of 0.06 and mass of 0.26 mg, then such chondrules need to be only $\sim 6.5\%$ of the bulk powder to produce its observed TL. Since 17% of the chondrules are the high TL variety and 50-75% of the meteorite is chondrules, most of the TL emission from bulk powder can be ascribed to high TL chondrules. In fact, the low TL chondrules are five times as numerous as the high TL chondrules, but only make a small contribution to the total TL emission because they are a factor of 10 lower in TL sensitivity.

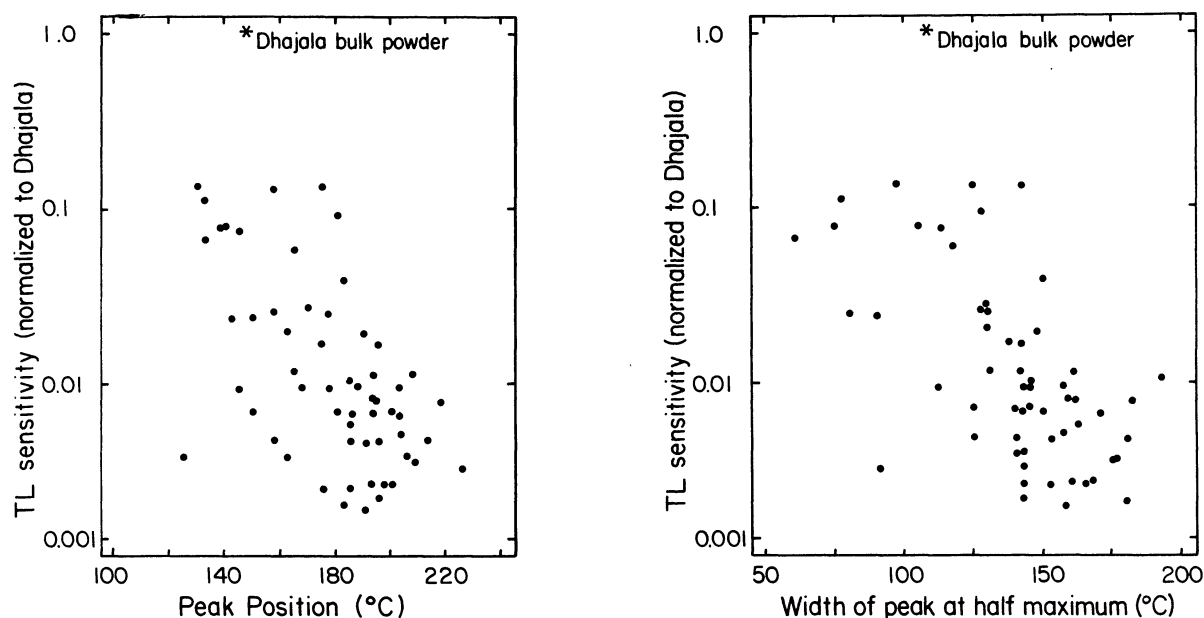
Possible causes for the observed variations in TL sensitivity, peak width, and temperature are difficult to define unambiguously without further data. Some conclusions can be drawn from further consideration of the present range of TL sensitivities observed in the separate chondrules. Due to varying metamorphic histories, like the bulk UOC, one might expect chondrules with the higher TL to have TL peaks which are broader and at higher temperatures in the glow curve. The opposite is observed (see figures). Therefore, we conclude that the range of TL sensitivities of individual chondrules is associated with indigenous physical and chemical differences rather than the metamorphism experienced. The width and temperature of the TL peak for the bulk powder is similar to those observed with high TL chondrules; this is consistent with our conclusion that high TL chondrules are the major TL

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carrier. Although nearly half the present chondrules have microcraters on their surface, these are distributed randomly. We conclude that impact-induced effects cannot be responsible for the TL differences. Chemical differences are a plausible explanation for the range of TL sensitivities in Dhajala chondrules. Within the Tieschitz H3.6 chondrite, Al and Mn vary over a factor of 5 and Na by more than a factor of 10 in individual chondrules, while Ca shows only a factor of ~ 20% variability (7,8). The proportion of low TL chondrules is similar to the proportion of porphyritic chondrules in Dhajala (77% according to ref. 6). So perhaps the high TL chondrules are one or more of the non-porphyritic varieties.

In summary, we conclude that TL sensitivity in the Dhajala meteorite is largely concentrated in a small portion of the chondrules; work in progress will enable us to identify which of several mechanisms is responsible for the TL differences between chondrules. It is clear from the present data that the high TL of certain chondrules is not due simply to a high feldspar content, as this would not produce a change in peak width and temperature.



Thermoluminescence vs. temperature (left) and peak width (right) for 58 Dhajala chondrules. The asterick refers to bulk powder.

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