THERMOLUMINESCENCE AND THE THERMAL HISTORY METEORITES. D. W. G. Sears, P. H. Benoit and D. G. Akridge. [1]Cosmochemistry Group, Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, Arkansas 72701. cosmo@uafsysb.uark.edu.

Introduction: Arguably the most successful technique for evaluating the thermal history of meteorites, especially primitive chondrites, utilizes their induced thermoluminescence (TL) properties.

Unequilibrated ordinary chondrites: The ordinary chondrites display a 10^5-fold range in TL sensitivity which clearly correlates with petrographic type and thus metamorphic history. The type 3 chondrites alone display a 10^3-fold range which correlates with a variety of much less precise indicators of metamorphic alteration such as mineral heterogeniety, volatile contents, and abundance of presolar grains. TL sensitivity is the basis of the widely-used subdivision of type 3 ordinary chondrites into types 3.0-3.9 [1]. Laboratory experiments and cathodoluminescence (CL) studies indicate that the TL sensitivity increases during metamorphism as glass crystallizes to feldspar [2].

The temperature and width of the induced TL peak are also related to thermal history, because UOC of type 3.3-3.5 have sharp low-temperature peaks that can be changed by laboratory heating to ~800 ^{o}C to broad high-temperature peaks like those of type 3.6-3.9 UOC [3]. The details are complex, but X-ray diffraction experiments with terrestrial feldspar suggests that the order to disorder transition is involved in this behavior. Thus peak temperature and width can be used for palaeothermometry.

CO and CV chondrites: The TL sensitivity of these classes also provides a sensitive indicator of metamorphic alteration and they have also been divided into type 3.0-3.9 [4,5]. However, TL peak temperatures and widths indicate metamorphic temperatures for all petrologic types below ~800 ^{o}C. Thus the CV and CO chondrites spent longer at lower temperatures than UOC.

H chondrites: The equilibrated H chondrites with ~8 Ma cosmic ray exposure (CRE) ages have higher induced TL peak temperatures (>195 ^{o}C) when found in Allan Hills than non-Antarctic meteorites (<195 ^{o}C) [7]. Metallographic cooling rates for the >195 ^{o}C samples are ~100 ^{o}C/Ma, and for <195 ^{o}C samples are ~10 ^{o}C/Ma, indicating that peak shape is related to cooling rate. For the other Antarctic sites, the proportion of meteorites with the higher peak temperature decreases as terrestrial age decreases. There is thus a secular variation in the nature of H chondrites produced by the ~8 Ma event. Thermal calculations, assuming a regolith and megaregolith on a 100 km H chondrite parent body, suggest that these cooling rates could be produced near the surface and could easily be sampled by a impact [8].

Regolith breccias: The TL sensitivity of the comminuted matrix is lower than that of the clasts due to the destruction of crystalline feldspar. Thus the matrix-to-clast TL sensitivity ratio provides a measure of regolith maturity [9]. A similar trend is observed in lunar breccias and lunar soils [10].

HED and mesosiderite meteorites: The HEDs, especially the eucrites, can be subdivided into petrographic types 1-6 using TL sensitivity and the types agree with thosed based on mineralogy [11]. The peak temperature of the metamorphism-sensitive peak reflects metamorphism <800 ^{o}C. Thermal modelling indicates that metamorphism of eucrites was assocated with the event that produced the 3.5 Ga Ar-Ar ages of most eucrites [12]. TL data indicate that the anomalous paired LEW 85300 eucrite was shock-heated to ~1000 ^{o}C [10]. Its TL properties closely resemble those of lunar samples.

Conclusion: TL sensitivity measurements on a variety of materials provide a quantitive indicator metamorphic alteration while TL peak temperature and width often enable palaoethermometry. Laboratory heating and CL studies provide reasonable explanations for the mechanisms.

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