THE FINE-SCALE COSMOGENIC HISTORY OF THE SEMARKONA UNEQUILIBRATED ORDINARY CHONDRITE.

J. Craig and D. W. G. Sears. Arkansas Center for Space and Planetary Sciences and Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, Arkansas 72701.

Introduction: As part of a project to hone our skills at handling and measuring the thermoluminescence properties of small particles, we have now measures the TL properties of sixty-four 10-15 μm fragments of the Semarkona type 3.00 ordinary chondrite, mostly matrix [1]. Semarkona is one of the most primitive meteorites known and it serves as a proxy for IDPs and Stardust particles. Natural TL provides an indication of the thermal and radiation history and therefore could provide insights into the surface and subsurface processes on comets [2]. In the resent case we were essentially running control samples – samples with a common radiation and thermal history - and expected to see uniform TL properties.

Methods: Samples are handled in a class 100 clean room, characterized, and run on a modified Daybreak Nuclear and Medical systems TL rig. The natural TL is measured and then the induced TL is measured three times, a 140 mCi ^{90}Sr source being used for irradiations. Before and after each sample, a background curve (shutter closed) and a black body curve (shutter open, drained sample) are run to monitor and remove these signals. Data handling is explained in [2].

Results: Contrary to expectations we saw a large range in the natural TL properties of these tiny Semarkona fragments [1]. Variations in the onset of the natural TL (as the samples are heated in the lab) suggest that the particles have experienced a wide range of temperatures. The intensity of the normalized high-temperature TL signal suggests a range of absorbed radiation doses. Variations are not random, but dose absorbed decreases abruptly as temperature experienced decreases more gradually.

Discussion: All but four particles show behavior consistent with exposure to a number of point sources of heat and radiation in which gradients in radiation dose are steeper than gradients in temperature. This is consistent with data on radiation attenuation and thermal conduction through silicates. In view of the known heterogeneities of Semarkona and the nature of cosmic ray interactions with meteorites, we suggest that neutron-capture reactions on Ca in Ca-rich phases (such as chondrule mesostasis) might be responsible. The four anomalous particles are unexplained, but a mineralogical explanation is possible (such as the presence of Ca-rich phosphates).

Conclusion; We think this is the first instance of heterogeneities in cosmic ray interaction on the 10 μm scale being observed in meteorites. Aside from new insights into the nature of cosmic ray interactions in an ordinary chondrite, these results bode well for using TL to investigate the history of cometary particles.

References:

[1] Craig J. P. and Sears D. W. G. 2010. Abstract #1401. 41st Lunar & Planetary Science Conference. [1] Sears D. W. G. and Craig J. P. 2010. Abstract #1404. 41st Lunar & Planetary Science Conference.