X-RAY COMPUTED TOMOGRAPHY AND THE RADIATION HISTORY OF METEORITES.

D. W. G. Sears[1], D. S. Ebel[2], S. Wallace[2], and J. M. Friedrich[2,3]. [1]NASA Ames Research Center/BAER Institute, Mountain View, CA 95035. [2]American Museum of Natural History, New York, NY 10024. [3]Department of Chemistry, Fordham University, New York, NY 10458. [1]E-mail: Derek.Sears@NASA.gov.

Introduction: X-ray computed tomography (CT) is an exciting way of examining the interiors of meteorites and other geological samples and it has taken the field by storm. Several review articles have been published [e.g. 1,2], an issue of GCA has been dedicated to the technique [3], and many papers have been published which involve the CT scanning of meteorites [4-5]. Here we report experiments that indicate that CT tomography deposits a considerable radiation dose in the meteorite and seriously compromises its natural radiation record.

Method: Ten aliquots of the Bruderheim L6 chondrite were drained of their natural thermoluminescence (TL) by heating to 500 ^{o}C in the TL apparatus at Ames Research Center. They were then placed in labelled vials and sent to the AMNH where half were scanned on a GE Phoenix VtomeX S240 CT scanner, exposing the samples to radiation typical of that used for meteorite studies, and half were retained as controls. They were then returned to Ames with no indication as to which had been irradiated. The TL apparatus used is a modified Daybreak Nuclear and Medical Inc. system frequently described in the literature [6].

Results: Five of the samples had TL data unaltered from the state they left Ames while five had a very strong signal consisting of a TL peak at ~250^{o}C in the glow curve (plot of TL emitted verses heating temperature) resembling that of ordinary chondrites in their natural state. It was very clear which samples had been in the CT scanner and which had not. The typical signal for the CT samples was 20,000 cps, while for the others the signal strength was ~40 cps.

Discussion: It is clear that a typical exposure in the CT scanner deposits a radiation dose to the meteorite many orders of magnitude above background and possibly comparable to the dose received by the meteorite over a typical cosmic exposure period. The natural TL signal from Antarctic meteorites, for example, is ~5000-50,000 cps. Furthermore, if the methods for data reduction developed for Antarctic meteorites were mistakenly applied to the present data (the researcher being unaware of the CT scan exposure), the apparent dose absorbed by the scanned samples would be ~100 krad, comparable with freshly fallen meteorites.

This is not to say that CT scans should never be performed, but that it should only be performed with knowledge of the changes being induced in the sample. This is particularly critical when irreplaceable main masses, or sole masses, of a given meteorite are placed in a CT scanner. Current techniques are easily capable of detecting the absorbed radiation; future techniques will be even more susceptible.

References: [1] Cnudde V. et al., 2006. Applied Geochemistry 21, 826-832, [2] Ketcham R.A., 2001. Computers and Geosciences 27, 381-400. [3] GCA 116, September issue. [4] Ebel D.S. et al., 2008. MAPS 43, 1725-1740. [5] Tsuchiyama A. et al., 2002. Geochemical Journal 36, 369-390. [6] Gnos E. et al., 2002. MAPS 37, 835-854. [7] Sears D.W.G. et al., 2013. Chemie der Erde-Geochemistry 73, 1-37. Supported by the FINESSE and RIS^{4}E projects in NASA's SSERVI.