SUPPLEMENTARY INFORMATION

A Response to LeCompte *et al.* (2012)

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To provide an independent test for reproducibility of the magnetic microsphere results and to verify the hypothesis (in part with the encouragement of some of the leading YDIH proponents), Surovell *et al.* (2010) sampled seven sites, including two reported by Firestone *et al.* (2007). The results of the study by Surovell *et al*. show low levels of magnetic microspheres or none, but no evidence for high concentrations at or around ~12.9k cal a BP.

LeCompte *et al.* (2012) report an evaluation of these conflicting results. They conclude that "the analytical protocol employed by Surovell *et al*. deviated significantly from Firestone *et al*. (P. 2960). LeCompte *et al*. (2012) suggested there were five methodological "deficiencies" in Surovell *et al*.'s (2009) work , but in doing so grossly mischaracterize the protocols used by Firestone *et al*. (2007), use novel protocols in their own study, and have some of the same "deficiencies" in their own work. Most troubling, impact proponents have made *post hoc* modifications to laboratory methods and then criticized prior researchers for not using them.

For example, Firestone (2009) and LeCompte *et al.* (2012) criticized Surovell *et al*. (2009) for using sample intervals that were too thick. In the online open access journal *The Journal of Cosmology*, Firestone (2009) wrote: "Tedious microstratigraphy is required to find the YDB impact layer which was often <2-3 mm wide. Broad sampling intervals near the YD layer used by Surovell *et al*. (2009) have diluted their results considerably." However, two years earlier Firestone *et al*. (2007:Supplementary Information) reported YDB layer thicknesses an order of magnitude thicker, ranging from <2 cm to 15 cm. Firestone *et al*. (2007) and Firestone, West, and Warwick-Smith (2006) examined samples 2.5 to 20 cm in thickness, and regularly found peaks in microspherules and magnetic grains. Except for samples from Shawnee-Minisink, Surovell *et al*.'s (2009) samples were 5 to 10 cm thick. The difference between Surovell *et al*.'s mean sample thickness (9.9 cm) and that of LeCompte *et al*. (8.7 cm) is negligible, and if Shawnee-Minisink is excluded, Surovell *et al*.'s mean interval (8.5 cm) is smaller. Other sampling thicknesses used by YDIH proponents vary widely even within a site

(Table 1).

Another major criticism of Surovell *et al*. (2009) relates to sieving of magnetic grains prior to the counting of spherules. LeCompte *et al*. (2012) argue that coarse fractions must be first removed to concentrate magnetic spherules for counting, and they used a 53 μm sieve to remove the large particles. This supposedly critical step was not used by Firestone *et al*. (2007), and sieving was never even mentioned in the 2007 paper nor the supplementary information. Notably, the microspherules illustrated by Firestone *et al*. (2007) range in diameter from 90 to 150 μm, so they would have been removed by sieving in LeCompte *et al*.'s (2012) work. Therefore, LeCompte *et al*.'s (2012) spherule counts cannot be comparable to those of Firestone *et al*. (2007).

Issues of spherule identification raise major concerns. Replication of spherule counts is simply impossible if different studies use different criteria for identifying microspherules. Consider the inherent difficulty of the task of counting microspherules in a replicable way. One is faced with literally thousands of silt-sized magnetic particles that vary with respect to roundness, sphericity, and surface texture. Deciding which of those should or should not be counted is a highly subjective process. Faced with this challenge and to the need to ensure replication of Firestone *et al*.'s (2007) methods, Surovell sent a letter and 254 images of possible spherules to Allen West, the coauthor of Firestone *et al*.' (2007) who performed the spherule counting. Surovell *et al*. (2009) based their identification criteria on West's reply.

In response, LeCompte *et al*. (2012:2966) argued that because cosmic spherules can be non-spherical, Surovell *et al*. (2009) used inappropriate criteria for spherule identification. However, the identification of cosmic spherules was not Surovell *et al*.'s (2009) primary concern, but instead they designed their study to follow the protocols used by Firestone *et al*. (2007). By including nonspherical "spherules" and those with rough surface texture, LeCompte *et al*. (2012) failed to follow Firestone *et al*.'s (2007) methods. Even more problematic, following the publication of Surovell *et al*.'s study, Allen West dramatically revised his protocols for spherule identification. In an unpublished methods document titled "Separation of YD Event Markers (8/10/2007)" provided by Allen West, "typical magnetic spherules" were illustrated with the same microspherule images published in Firestone *et al*. (2007:fig. 2) (Figure S1a). In January of 2010, after the publication of Surovell's study, West provided an updated and unpublished version of the protocols titled "YOUNGER DRYAS BOUNDARY (YDB)

MARKERS (Version 1-1-2010)" in which "Typical magnetic 'spherules'" were illustrated as having dramatically different morphologies including particles that have rough surfaces and are nonspherical, even including teardrop-shaped sedimentary grains (Figure S1b)

Regardless of methodological details, Surovell *et al*. (2009) were able to recover both microspherules and magnetic grains, two of the most reliable markers from the Firestone *et al.* (2007) study. Surovell *et al*. (2009) found that microspherules were regularly found in non-YDB samples and occasionally in YDB samples as well, but in zero of seven sites was a strong peak in spherules uniquely associated with the YDB. In other words, the presence, absence, and relative abundance of magnetic microspherules appears to have little to do with extraterrestrial impact. The same was true for magnetic mineral grains, which were ubiquitous. Although Firestone *et al*. (2007) *et al*. found YDB magnetic grain peaks in ten of ten Clovis sites, Surovell *et al*. (2009) again found no peaks unique to the YDB. This is especially puzzling because there is no disagreement about the protocols use in magnetic grain extraction. Further, and contrary to statements by LeCompte *et al.* (2012), the point of the study by Surovell *et al.* was not to date any sites or to confirm or dispute any dating. It was simply to reproduce laboratory results.

REFERENCES CITED

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Figure S1
Two figures provided to Todd Surovell by Allen West to aid in spherule identification. A) Figure 13 from an unpublished methodological document titled "Separation of YD Event Markers (8/10/2007)." B) Figure 9 from an unpublished methodological document titled "YOUNGER DRYAS BOUNDARY (YDB) MARKERS (version 1-1-2010)." (Published with permission).