SUPPORTING INFORMATION APPENDIX to:

Chronological evidence fails to support claim of an isochronous widespread layer of cosmic impact indicators dated to 12,800 years ago

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Site specific discussions

List of Tables (Tables 1-16 are included in the site specific discussions; Tables 17-19 follow the last site entry, beginning on page 59)

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List of figures (all figures are included in the site specific discussions)

INTRODUCTION AND NOTES

Site-by-site details are provided in this document. We do not discuss individual site contexts or finds in detail, save as relevant to the analysis of the chronology. Sites are listed in alphabetical order and identified by group, as per Figure 1 of the main text.

Tables S1 to S16 provide the radiocarbon and OSL data for the individual sites, both the ages used and relevant ages omitted from analyses by YDIH proponents. All radiocarbon dates are listed as ^{14}C years before present. Tables S17 to S19 provide the data we used in replicating the original regression-based age/depth models of YDIH proponents (Table S17), the regression coefficients from our replicated age/depth models as given by GraphPad Prism (Table S18), and r^2 values for the regression models and p values for the regression coefficients as given by GraphPad Prism (Table S19).

Figures S1-S2, S4-S5, and S8-S15 are regression graphs for the sites in Groups 3a and 3b, based on the dates in Table S17. These were produced in GraphPad Prism; regression model equations are provided in the discussion as necessary. In the age/depth model graphs, regressions of depth on age are shown on the left, and regressions of age on depth are shown on the right; error bars represent 1 SD dating error terms, dotted lines represent unweighted regressions, and solid lines represent weighted regressions (which are only possible for the regressions of age on depth shown on the right because the variable whose standard deviation is used for weighting should be the Dependent Variable [DV]). Figures S3, S6-S7 provide the MCAge Depth plots for the Arlington Canyon and Big Eddy sites. See the main text for discussion of the methods used to generate these plots.

1. ABU HUREYRA – GROUP 3A

Abu Hureyra (Syria) is a large and complex Late Pleistocene/Early Holocene archaeological tell located in the Euphrates Valley, which has yielded a rich record of early plant and animal domestication along with evidence of the transition from foraging to farming and early village life in the Middle East. Occupied virtually continuously for more than 4000 years, the site was drowned behind a dam in 1974 and is currently beneath >25 m of water (1, 2). Analysis for impact indicators was conducted by Bunch et al. (1) using archived sediment samples from arbitrarily numbered excavation levels in Trench E at the site, in which there were multiple pit houses, structures and discontinuous zones of archaeological occupation (ref. 1, its SI Figure S3).

In order to develop a chronology for the supposed YDB layer, Bunch et al. (1) used “Linear interpolation … to develop an age-depth model based on 13 accelerator mass spectrometry (AMS) radiocarbon dates from (2).”All of the ages come from Abu Hureyra 1 Trench E, which has three phases of occupation that span the terminal Pleistocene from 11,500-10,000 ^{14}C yrs BP (2). The primary source on the radiocarbon ages from the site (2) lists 38 radiocarbon ages for Abu Hureya 1 but used only 16 of those to ascertain the ages of the three Abu Hureyra 1 subphases as discussed in Moore et al. (2; the full list of radiocarbon ages from the site is in ref. 2, its Appendix 1). Only 15 of those ages are listed here (Table S1) (BM-1121 is not included as it is a composite sample from multiple levels). Also listed here is an additional radiocarbon age provided in Bunch et al. (ref. 1, its Table S2).

Table S1. Radiocarbon ages for Abu Hureyra from Moore et al. (ref. 2, its Table A.1). Dates are in stratigraphic order, as per the Harris Matrix in Moore et al. (ref. 2, its Figure 5.28). Ages omitted without explanation by Bunch et al. (1) and Wittke et al. (3) are highlighted in gray. Radiocarbon ages on charcoal obtained from multiple levels are not included here.

Lab no.	**Level**[1]	**Depth (masl)**	**^{14}C**	**±**	**Comments**
OxA-170	405	285.33	10600	200	Carbonized grain
OxA-8718	418	285.13	11140	100	Carbonized grain; omitted
OxA-407	419	285.13	10050	180	Charred bone
OxA-8719	419	285.13	10610	100	Charred bone; omitted
OxA-386	420	285.12	10800	160	Carbonized grain
OxA-473	425	284.95	10000	170	Charred bone
OxA-397	430	284.91	10420	140	Carbonized grain
OxA-434	430	284.91	10490	150	Charred bone
UCIAMS-105429	445	284.70	11070	40	Charcoal; Bunch et al. identify this as **YDB layer** (ref. 2, its SI Table 2)
BM-1718R	447	284.67	11140	140	Charcoal; among “dates closest to the YDB layer” Bunch et al. (ref. 2, its SI Table 2)
OxA-171	457	284.72	10600	200	Carbonized grain
OxA-6685	455	284.72	10930	120	Carbonized grain; omitted
OxA-430	460	284.56	11020	150	Charred bone; among “dates closest to the YDB layer” Bunch et al. (ref. 2, its SI Table 2)
OxA-172	470	284.29	10900	200	Carbonized grain; among “dates closest to the YDB layer” Bunch et al. (ref. 2, its SI Table 2); Wittke et al. (ref. 3 its SI Table S.1) identify this as **YDB layer**
OxA-468	470	284.29	11090	150	Charred bone; among “dates closest to the YDB layer” Bunch et al. (ref. 2, its SI Table 2)
OxA-883	470	284.29	11450	300	Carbonized grain from same layer as OxA-172 and OxA-468, but Bunch et al. (ref. 2, its SI Table 2) do not identify as among “dates closest to the YDB layer”

[1] Absolute depth of Levels 418-421 is the same; absolute depth of Levels 450, 455 and 457 is the same as per Moore et al. (ref. 2, its Figure 5.10)

For reasons unspecified, 3 of these 16 ages are excluded from the regression analyses of Bunch et al. (1) and Wittke et al. (3), although both claim to have "adopted the chronology of Moore et al. 2000" (ref. 2, its SI p. 2; ref. 3, its SI p.2). The sample of radiocarbon ages they selected includes dates from all three phases of the occupation. There is a discrepancy as to the position of the supposed YDB layer. Bunch et al. (1) identify Layer 445 (depth 284.7 masl) in Phase 1 deposits as containing impact indicators and therefore "consistent with the YDB layer," with a radiocarbon age of 11,070 ± 40 ^{14}C yrs BP (UCIAMS-105429). They identify four other radiocarbon ages as "dates closest to the YDB layer," though it appears this is based on the ages themselves and not the stratigraphic position of the sample relative to that layer (1). In contrast, Wittke et al. (ref. 3, its SI Table S1) identify an age from Layer 470 (depth 284.29 masl) in overlying Phase 2 as the YDB layer, associated with a radiocarbon age of 10,900 ± 200 ^{14}C yrs BP (OxA-172). There are two additional and older radiocarbon ages available from Layer 470 (Table S1), yet neither of these is identified in (3) as bearing on the YDB layer.

The Abu Hureyra radiocarbon samples were collected from non-contiguous archaeological levels in Trench E "from various locations across 1.66 m of sediment ranging from about 284.24 to 285.90 m asl" (ref. 1, its SI p. 2). The relative position of the levels is provided in a Harris Matrix illustration (ref. 2, its Fig 5.10, Fig. 5.28), which in turn is linked in an unspecified manner to absolute elevation (in masl). Our attempt to replicate the "linear interpolation" age/depth model discussed by Bunch et al. (1) and Wittke et al. (3) used the same 13 dates employed by those authors and used linear regression models (DV = BO + B1*IV). Graphs of these models are shown in Figure S1.

Our result for the predicted depth of YDB-age deposits at this site is 284.63 masl, which varies somewhat from each of the 284.29 masl and 284.7 masl values, discussed above, identified as the supposed YDB layer by the different authors. A weighted regression analysis is statistically significant (see Table S19) and produces a predicted age of 13,044 cal BP for the 284.29 masl layer and a predicted age of 12,763 cal BP for the 284.7 masl layer; each of these ages falls slightly outside of the IntCal04 12,900 ± 100 YDB interval, one in either direction.

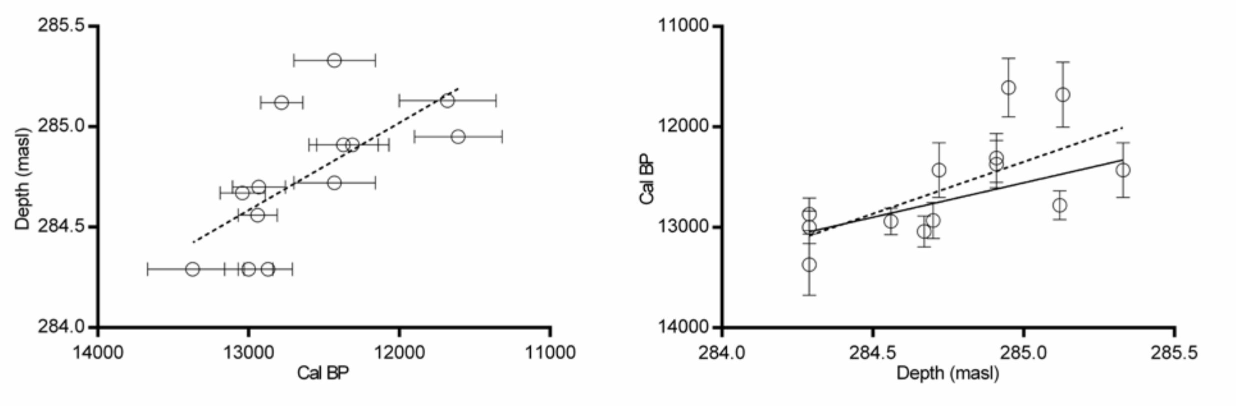

Figure S1. Graphs of replicated regression-based age/depth models for Abu Hureyra. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

It can be seen in the graph of the weighted regression (Figure S1 right, solid line) that the influence of two relatively young dates with relatively large standard deviations is reduced in comparison to the unweighted age/depth model, leading to a lower regression slope (i.e. the weighted model leads to somewhat older ages at higher depths, though the difference is small in the vicinity of the two reported YDB layer depths).

2. ARLINGTON CANYON – GROUP 3A

The Arlington Canyon locality is on Santa Rosa Island, one of the California Channel Islands. It is a 5 m thick geological section located ~1.2 km upstream from the Clovis-age Arlington Springs site which yielded human skeletal remains of terminal Pleistocene age (ref. 4, pp. 2534-2535). The section was selected after preliminary work suggested that deposits spanning the Younger Dryas interval might occur here (4). Of particular interest were two dark layers. The lower was a 44 cm thick “distinctive, organic carbon rich” mud that occurred at the base of the section above a basal gravel, a layer that appeared “similar in character” to a black mat, and subsequently was found to yield apparent evidence of burning and impact indicators of the sort that “occur widely in the YDB layer” (ref. 4, pp. 2536, 2538; ref. 5, pp. 12624-12625). A second dark silt layer, 20 cm thick, was observed higher in the section, with a ~60 cm cobble layer between the two. It too was reported to be carbon rich and contain charcoal and apparent impact indicators.

Sixteen radiocarbon ages were obtained on the Arlington Canyon section from depths of ~1 to 5 m below surface (Table S2), of which six were rejected by Kennett et al. (4): five were deemed “slightly older,” possibly as a result of an “old wood effect,” and a sixth was rejected as being “out of stratigraphic sequence” (ref. 4, its Table 4). Based on the remaining radiocarbon ages, they concluded that the supposed YDB layers (they lumped the two lower carbon rich layers) “accumulated rapidly at ~13.0–12.9 ka” (ref. 4, p. 2538).

Table S2. Radiocarbon ages for Arlington Canyon as originally reported by Kennett et al. (4, and not Kennett et al. 5, as erroneously noted in Wittke et al. ref. 3, its SI Table S1). Radiocarbon ages rejected by Kennett et al. (4) as subject to ‘Old wood’ effect included here if included in the analysis by Wittke et al. (3). Ages omitted without explanation by Wittke et al. (3) are highlighted in gray.

Lab no.	Depth (cmbs)	^{14}C	±	Comments
UCIAMS-47235	95-99	11040	30	Charcoal; omitted
UCIAMS-47236	179-183	12095	40	Charcoal; rejected by Kennett et al. 2008 (4)
UCIAMS-47237	215-217	10895	35	Charcoal; omitted
UCIAMS-47238	267-270	11105	30	Charcoal; omitted
UCIAMS-47239	392-396	11105	30	Charcoal; sample depth at 394 in Wittke et al. (3)
UCIAMS-42816	403-406	11095	25	Wood; sample depth at 404.5 in Wittke et al. (3)
UCIAMS-36308	464-469	11095	25	Wood; sample depth at 461.5 in Wittke et al. (3)
UCIAMS-36307	469-475	11070	25	Wood; sample depth at 471 in Wittke et al. (3)
UCIAMS-36959	480-485	11075	30	Charcoal; sample depth at 487 in Wittke et al. (3)
UCIAMS-36960	480-485	11185	30	Glassy Carbon; rejected by Kennett et al. (4), used by Wittke et al. (3) who put sample depth at 487
UCIAMS-36961	480-485	11440	90	Carbon Sphere; rejected by Kennett et al. (4), used by Wittke et al. (3) who put sample depth at 487
UCIAMS-36962	480-485	11110	35	Carbon Elongate; rejected by Kennett et al. (4), used by Wittke et al. (3) who put sample depth at 487
BETA-161032	480-485	10860	70	Wood; omitted
UCIAMS-36306	485-491	11375	25	Wood; rejected by Kennett et al. (4), used by Wittke et al. (3) who put sample depth at 495
UCIAMS-36305	493-498	11235	25	Wood; rejected by Kennett et al. (4), used by Wittke et al. (3) who put sample depth at 495.5
UCIAMS-36304	498-503	11020	25	Wood; **YDB Layer** according to Wittke et al. (3) who put sample depth at 500.5

In their analysis and discussion of Arlington Canyon, Wittke et al. (3) **“**adopted the chronology of Kennett et al. (4) who obtained accelerator mass spectrometry (AMS) ^{14}C dates on charcoal, wood, carbon spherules, and glassy carbon,” which yielded “12 [sic] accelerator mass spectrometry (AMS) ^{14}C dates." Eleven of the Arlington Canyon ages are provided in Wittke et al. (ref. 3, its SI Table S1), on the basis of which, evidently, they concluded that the supposed YDB layer "dates close to 12.8 ka by linear interpolation" (ref. 3, its SI p. 2). Although Wittke et al. (3) also explicitly state that the YDB encompasses both dark layers, they highlight the radiocarbon sample obtained from a depth of 500.5 cm below surface (UCIAMS-36304) – the *deepest* in the section, the *youngest* of the eleven ages they tally, and perhaps not coincidentally, the one closest to 12,800 ± 150 cal BP – as the age of the supposed YDB layer (ref. 3, its SI Table S1).

That conclusion cannot be supported. When the radiocarbon ages from Arlington Canyon utilized by Wittke et al. (3) are reanalyzed, the predicted depth of YDB-age sediments falls at a depth of 441.1 cm below surface, not at 500.5 cm below surface, the depth that Wittke et al. (3) identify as being associated with a YDB-age radiocarbon date. Moreover, a weighted linear regression analysis designed to estimate the age of the 500.5 cmbs layer places the age of this layer at 13,108 cal BP, over a century and a half prior to the earliest calibrated age range for the YD onset (using the IntCal09 dates for the YDB interval). Of even greater concern is that the weighted regression is not statistically significant (*p* value of slope coefficient = 0.257) and, as can be seen in Figure S2, any relationship that does exist between age and depth for these dates is driven almost entirely by the two dates from highest in the section, which are separated from the rest of the dates by a depth of over 50 cm.

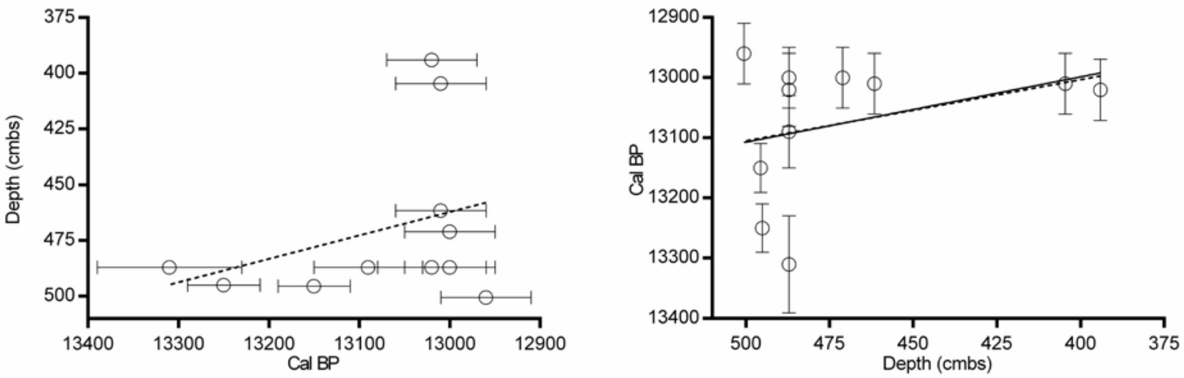

Figure S2. Graphs of replicated regression-based age/depth models for Arlington Canyon. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

We return below to this issue of the relationship, or lack thereof, between age and depth among the Arlington Canyon dates. We also note that the center points of the dates that Wittke et al. (3) use for Arlington Canyon all predate 12,900 cal BP; thus, predicting the depth of the 12,800 cal BP layer requires extrapolation beyond these data on the age scale, not actually interpolation as they state.

There is, further, an unaccountable contradiction regarding the chronology of the supposed YDB layer. In response to criticisms by van Hoesel et al. (6) – who, incidentally, said nothing of Arlington Canyon – Wittke et al. (7) insist "The radiocarbon dates from Arlington Canyon *were never used to date the YDB*" (ref. 7, p. E3897, emphasis ours). That is either a gross misstatement or their "linear interpolation" is based on some other unspecified chronological data. It is difficult to imagine what those data might be. Their posthoc rationalization for not having used the Arlington Canyon radiocarbon ages is that they "are systematically older," possibly the result of an "old wood effect." Here too they contradict their own claims. For while Kennett et al. (4) identified a possible old wood effect, they did so only in regard to five of the ages from the site. Inexplicably, Wittke et al. (3) *include* those five ages in their tally of dates for the site, making no mention of possible old wood concerns (ref. 3, its SI Table S1).

As is apparent from the suite of radiocarbon ages from Arlington Canyon (Table S2) – excluding those rejected by Kennett et al. (4) – the "dates from upper and lower parts of the sequence are statistically similar suggesting rapid accumulation of fluvial deposits shortly after ~12.95 ± 0.05 ka" (ref. 5, pp. 12624-12625; also ref. 3, its SI pp. 2-3). That is certainly the case: although separated by 4 meters, the radiocarbon ages at the top (11,040 ± 30 ^{14}C years BP at 95-99 cm below surface) and bottom (11,020 ± 25 ^{14}C years BP at 498-503 cm below surface) of the section are statistically indistinguishable, as shown by chi-square analysis (8). Indeed, all but two (UCIAMS-47237, BETA-161032) of the ages deemed acceptable by Kennett et al. (4) are statistically part of the same population, and average to 11,070 ± 10 ^{14}C years BP.

This virtual uniformity in age across a 4 m vertical section is problematic in terms of resolving a precise age for the supposed YDB layer. MCAge Depth analysis, which excludes only those ages rejected by Kennett et al. (4, a more reliable listing than in ref. 3), indicates that *all* layers from 92-97 cm below surface, 203-263 cm below surface, and 472-500+ cm below surface fall within the temporal span of 12,800 ± 150 cal BP. When upper and lower 99% confidence intervals are included, the YD onset encompasses all layers from 196-350 cm below surface, and 378-500+ cm below surface. The age/depth curve at Arlington Springs is essentially a flat-line in which terminal Pleistocene ages apply to much of the section from about 200 to 500 cm below surface (Figure S3).

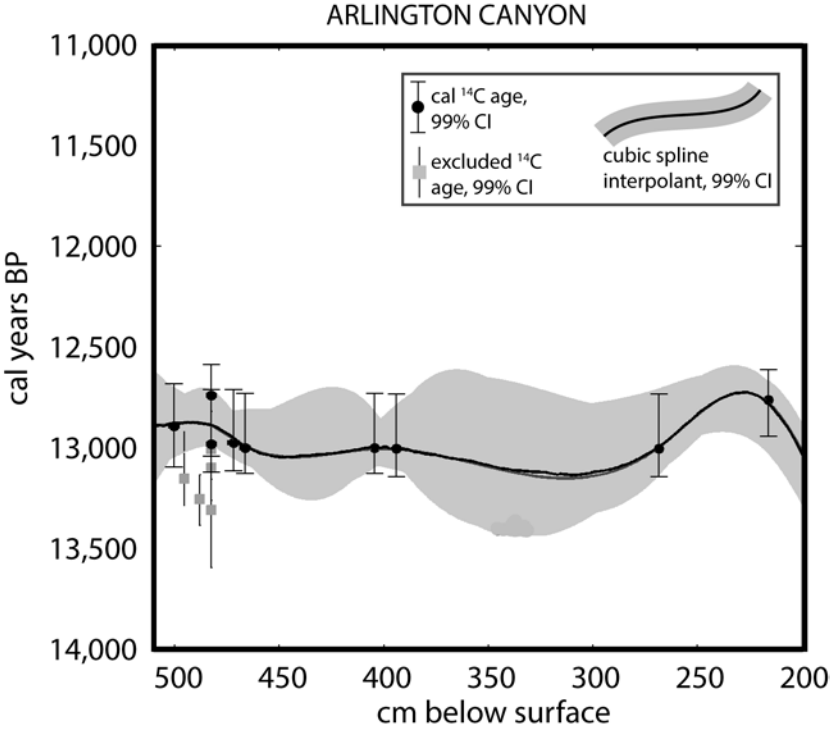

Figure S3. MCAge-depth model for Arlington Canyon on all dates in Table S5 accepted by Kennett et al. (4), with confidence interval derived from 1000 bootstrapped chronologies.

Although both the lower and upper of the supposed YDB layers fall within the proper temporal range, it raises the question of why apparent impact indicators were only found in those two layers, given that there are several meters of sediment of the same age in that section. In order to better resolve the precise level and age of any supposed impact indicators at Arlington Springs, it will be necessary to examine a more precisely dated section, and one without so much overlap in time.

3. BARBER CREEK – GROUP 3A

Barber Creek is located in the Tar River basin on the North Carolina coastal plain (9, 10). The site has yielded Early Archaic through Early Woodland period cultural materials, found relatively well stratified in a relict aeolian sand-sheet (with minor contributions from fluvial deposition) paralleling Barber Creek, a tributary of the Tar River. Site investigators place the beginning of aeolian sand-sheet deposition at "just before or during the Younger Dryas stadial event (ca. 12,900-11,500 CALYBP)" (ref. 10, p. 26). Wittke et al. (3) report there is no black mat at the site, although at a depth of ~100 cm below surface "the sediments abruptly change from alluvial to eolian deposition, producing a clear lithologic break and color change. The age-depth model indicates that this shift corresponds to the onset of Younger Dryas cooling" (ref. 3, its SI p. 4). They collected three 2.5-cm-thick sediment samples across the interval from 97.5 to 105 cm below surface, and determined that the supposed YDB layer was at 100 cm below surface. Their age/depth model is reportedly based on the chronology of Moore and Daniel (10); however, Wittke et al. (3) do not make full use of that chronology, omitting four additional OSL ages (Table S3) as well as six radiocarbon ages available from the site (Table S4; see ref. 9, its Table 1; ref. 10, its Table 1-1).

Table S3. OSL ages for Barber Creek from Moore and Daniel (ref. 10, its Tables 1-1 and 1-2). Ages omitted without explanation by Wittke et al. (3) are highlighted in gray.

Lab no.	**Depth (cmbs)**	**OSL**	**±**	**Comments**
FS2476	60	9740	590	Single aliquot – omitted by Wittke et al. (3)
FS2797	77	12800	710	Single aliquot – same sample as UW1963; Moore & Daniel reject mean age in favor of minimum age model result (10390 ± 620) for this sample; omitted by Wittke et al. (3)
UW1963	77	9100	700	Single grain – same sample as FS2797; omitted by Wittke et al. (3)
UW1907	80	9200	700	Single grain
UW1908	100	12100	700	Single grain – identified as the YDB layer
UW1909	140	14500	1000	Single grain
FS2511	315	16800	1900	Single aliquot – omitted by Wittke et al. (3)

Their "Interpolation by second-order polynomial regression … [is] based on three optically stimulated luminescence (OSL) dates," which they assert puts the age of the supposed YDB layer at "12.1 ± 0.7 ka (range of 11.4 to 12.8 ka)" and thus is "determined to be close to 12.8 ka" (ref. 3, its SI p. 4). However, it seems apparent that the age they give for the supposed YDB layer is merely the OSL age of sample UW1908, which comes from 100 cmbs. As such, it has a wide uncertainty (1400 calendar years), only a fraction of which overlaps with the target time span of 12,800 ± 150 cal BP. That this estimate is not actually the result of interpolation by second-order polynomial regression is readily evident in a visual inspection of their age/depth plot (ref. 3, its SI Figure 2d); although presumably based on that interpolation, it is obvious in this plot that YD onset-age sediments lie closer to a depth of ~110 cm, some 10 cm below their supposed YDB layer.

Table S4. Radiocarbon ages for Barber Creek from Daniel et al. (ref. 9, its Table 1). Ages are reported from 10 cm excavation levels (measured below surface). Absolute depths are not provided; depths listed here are midpoint of the level. Ages omitted without explanation by Wittke et al. (3) are highlighted in gray.

Lab no.	**Depth (cmbs)**	**^{14}C**	**±**	**Comments**
Beta-188955	55	8950	40	wood charcoal, Level 6 – omitted by Wittke et al. (3)
Beta-166239	65	8440	50	wood charcoal, Level 7 – omitted by Wittke et al. (3)
Beta-150188	75	8940	70	wood charcoal, Level 8 – omitted by Wittke et al. (3)
Beta-166237	75	9280	60	wood charcoal, Level 8 – omitted by Wittke et al. (3)
Beta-166238	95	9860	60	wood charcoal, Level 10 – omitted by Wittke et al. (3)
Beta-188956	105	10500	50	wood charcoal, Level 11 – omitted by Wittke et al. (3)

Our re-analysis using those same three OSL ages confirms this (employing a 2nd order polynomial equation in the form of $DV = BO + B1*IV + B2*IV^2$), as the predicted depth of deposits that date to the onset of the Younger Dryas is ~109.5 cm below surface (Figure S4).

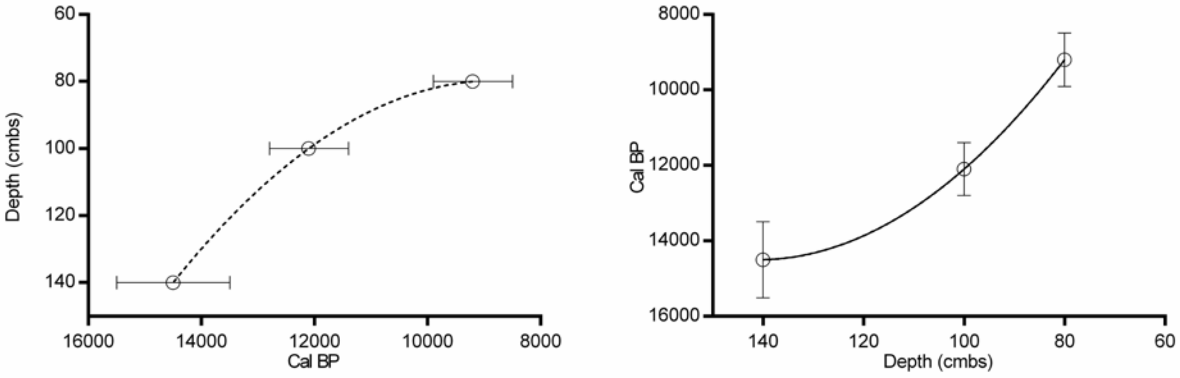

Figure S4. Graphs of replicated regression-based age/depth models for Barber Creek. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

In estimating the age of the 100 cmbs depth Wittke et al. (3) identify as the YDB layer, both weighted and unweighted regressions give identical and not especially interesting results due to the fact there are only three data points involved: both return the 12,100 cal BP age derived directly from the 100 cmbs layer as the age of this layer. Regression significance cannot be calculated in this re-analysis because the regression line is a perfect fit to the data, as will generally be the case when a 2nd order polynomial equation is fit to only three points.

As a check on the results of regression analyses described above, which as noted were based only on three of the OSL dates from the site, we examined the available radiocarbon ages from Barber Creek (Table S4) using MCAge Depth analysis. There is warrant to do so, for as Moore and Daniel state, "Both OSL age estimates from the upper meter at the Barber Creek Site are in close agreement with the previously established radiocarbon dating sequence" (ref. 10, p. 24). The results are shown in Table S5.

Table S5. Age/Depth chronology for Barber Creek site generated by MCAge Depth. Ages calibrated with IntCal09. Levels shaded and in bold have median ages within span of 12,800 ± 150. Supposed YDB layer is at 100 cm below surface (bold, outlined).

Depth (cmbs)	**median cal age**	**cal age – upper confidence interval**	**cal age – lower confidence interval**
98.00	11679	11802	11528
99.00	11769	11882	11607
100.00	**11862**	**11963**	**11688**
101.00	11956	12051	11770
102.00	12051	12146	11846
103.00	12146	12243	11923
104.00	12243	12340	12000
105.00	12339	12438	12078
106.00	12436	12537	12155
107.00	12532	12641	12232
108.00	12627	12744	12309
109.00	**12722**	**12847**	**12386**
110.00	**12816**	**12948**	**12462**
111.00	**12909**	**13048**	**12538**
112.00	13000	13147	12612
113.00	13089	13243	12686
114.00	13175	13338	12759
115.00	13260	13432	12830
116.00	13342	13523	12900
117.00	13421	13611	12969

These results reveals that layers from 109-111 cm below surface have median ages that fall within the span of 12,800 ± 150 cal BP; if upper and lower confidence intervals are considered, that vertical range expands to all layers from 108-116 cm below surface. In contrast, the supposed YDB layer at 100 cm is 1000 years younger, with a chronological range from 11,963-11,688 cal BP.

4. BIG EDDY – GROUP 3B

Big Eddy is a rich, multi-component archaeological site in southwest Missouri that has yielded a stratified sequence of cultural materials that range from the Paleoindian through the Late Prehistoric periods (11-13). Testing for spherules was done by Wittke et al. (3) on five samples at depths of 311-318, 319-326, 327-335, 336-343 and 344-351 cm below surface. Only two of those samples yielded supposed impact markers: one from 319-326 cmbs (15 spherules/kg) and one from 327-335 cmbs (100 spherules / kg). Accordingly, Wittke place the “proxy-rich YDB layer from 327 to 335 cmbs” (ref. 3, its SI p. 5).

To determine the age of that layer, Wittke et al. (3) “adopted the chronology of Lopinot et al. who acquired 30 AMS radiocarbon dates based on charcoal from this sequence” from which an age-depth model was generated using logarithmic interpolation that put its age “close to 12.8 ka” (ref. 3, its SI p. 5). Although a scatter plot of those ages with depth is provided, the full list of ages is not (ref. 3, its SI Fig. 3d; Table S1). Instead, only seven “key dates” are listed and, inexplicably, their depth data is omitted (sample depth data is provided for virtually all other sites in that table, and that information is readily available for Big Eddy). The seven key dates are listed in order of increasing age (ref. 3, its SI Table S1), though when depth data is included it is apparent that ages are not in chronological order with depth.

The 30 radiocarbon ages used in the Big Eddy scatter plot in Wittke et al. (ref. 3, its SI Fig. 3d) is provided in Table S6. There are several points to make in regard to the data. First, although there are three radiocarbon ages available from the proposed YDB layer they span ~1700 ^{14}C years (thus, are not statistically part of the same population and cannot be averaged). Second, only one of those three ages (10,710 ± 85 ^{14}C years BP) is within of 12,800 ± 150 cal years BP, but only at 2 standard deviations. Finally, the layers above and below the supposed YDB layer all yielded YD onset ages (Table S6).

Table S6. Radiocarbon ages from Big Eddy, from Hajic et al. (11); Lopinot et al. (12-13), as provided by Lopinot. The solid lines enclose the five layers sampled for impact indicators.

Lab no.	Depth (cmbs)	^{14}C	±	Comments
AA-35462	283	9835	70	bark charcoal
AA-72611	285	9751	64	unspecified
AA-72609	286	9924	50	unspecified
AA-72610	294	10440	160	unspecified
AA-26653	298	10185	75	indeterminate charcoal
AA-75719	303	10506	53	unspecified
AA-27487	306	10400	75	indeterminate charcoal
AA-27480	308	10340	100	wood charcoal
AA-29022	313	10430	70	wood charcoal
AA-75720	315	10896	54	**overlaps YD onset at 1 SD**; material unspecified
AA-72607	317	9960	920	unspecified
AA-27488	321	10470	80	wood charcoal
AA-27485	322	11280	75	wood charcoal
BETA-230984	322	10940	60	**overlaps YD onset at 1 SD**; material unspecified
AA-72612	322	10959	54	**overlaps YD onset at 1 SD**; material unspecified
AA-27481	326	11160	75	**overlaps YD onset at 1 SD**; Bark or wood charcoal;
AA-25778	328	10260	85	**Supposed YDB layer, does *not* overlap YD onset**; wood charcoal
AA-27486	331	11900	80	**Supposed YDB layer, does *not* overlap YD onset;** bark or wood charcoal;
AA-26654	333	10710	85	**Supposed YDB layer, overlaps YD onset at 2 SD**; Indeterminate charcoal
AA-27482	338	11190	75	**overlaps YD onset at 2 SD**; Wood charcoal
AA-26655	347	10940	80	**overlaps YD onset at 1 SD**; indeterminate
AA-72608	347	12450	300	unspecified
AA-34586	358	12320	130	conifer wood charcoal
AA-34587	364	11930	110	Alder(?) wood charcoal
AA-72613	373	11960	270	unspecified
AA-34588	375	12250	100	Conifer wood charcoal
AA-34589	383	11375	80	Conifer wood charcoal
AA-27483	384	11910	440	indeterminate charcoal
AA-34590	386	12590	85	conifer wood charcoal
AA-27484	396	12700	180	indeterminate charcoal

Wittke et al. suggest there is a problem with “Accurately dating individual layers … because some charcoal fragments have clearly moved up and down within the sequence, and some older charcoal may have been introduced by flood-induced redeposition from sources upstream” (ref. 3, its SI p. 5). But if that is so, why is the 327-335 cm layer considered to date to the YD onset as it has but a single date that overlaps the YD onset (at 2SD), while layers above and below have multiple ages that overlap at 1 SD, and in the case of the layer above a tighter temporal range? Or is there relatively little age difference in the five layers sampled for spherules? If that is the case and all roughly overlap in time, then why was there a spike in spherules in only one of the layers? Or, is the dating of the entire section is problematic?

Wittke et al. (ref. 3, its SI p.5) put the age of the supposed YDB layer at “close to 12.8 ka,” and as we found in our replication of their statistical analyses, they appear to be correct in their general point. In our replication (Figure S5), we used the 30 dates in Table S6.

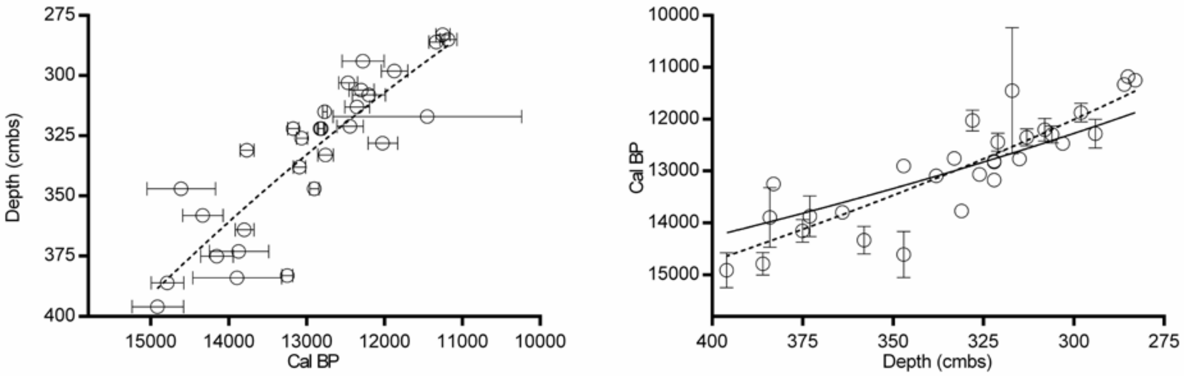

Figure S5. Graphs of replicated regression-based age/depth models for Big Eddy. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

However, because those dates were appropriately reported with calibrated 2 SD ranges, rather than with symmetrical calibrated ± SD error terms comparable to the ones reported by Wittke et al. (ref. 3, its SI Table S1), we recalibrated the dates to obtain the calibrated ± SD terms necessary for weighted regression. Recalibration was done with OxCal version 4.2 (//c14.arch.ox.ac.uk/oxcal/OxCal.html), which can provide 1 SD error terms for calibrated dates, and the IntCal04 calibration curve, following the original calibration used for this site. We used the median calibrated ages from IntCal04, along with the recalibrated 1 SD error terms that we obtained from OxCal. Even though the calibrated 1 SD error terms that we obtained may not precisely correspond to those that generated the plot in Wittke et al. (3), these error terms – the only ones available – should provide an accurate relative-scale measure of the uncertainty associated with individual dates and thus be suitable for use in weighted regression. Our replication uses logarithmic regression, with the log of the depth variable used (i.e., $\text{Log}_{10}(\text{DV}) = \text{BO} +$

B1*IV, when depth is the DV, and DV = BO + B1* Log_{10}(IV), when depth is the IV) because this produces the best match with the age/depth model shown in Wittke et al. (ref. 3, its SI Fig. 3).

The regressions produced in our reanalysis are highly statistically significant and result in a predicted depth for YDB-age deposits of 330.2 cmbs, which falls squarely within the 327-335 cmbs zone identified by Wittke et al. (3) as the YDB layer, as well as a weighted regression-predicted age of 12,952 cal BP for this layer. Though this age differs from the 12.8 ka date that Wittke et al. (3) state the layer's age is close to, it falls within the YDB interval for sites where IntCal04 was used (12,900 ± 100 cal BP).

The chronology generated by the MCAge Depth analysis (Table S7) reveals that all layers from 322.5-332.5 cm below surface have median ages that fall within the span of 12,900 ± 100 cal BP; if upper and lower confidence intervals are considered, that range expands to all layers from 318.5-342 cm below surface. The resulting age/depth curve also reveals there are multiple outliers (that is, ages outside the 99% confidence interval of the age/depth spline) and, of course, ages with wide uncertainties (Figure S6).

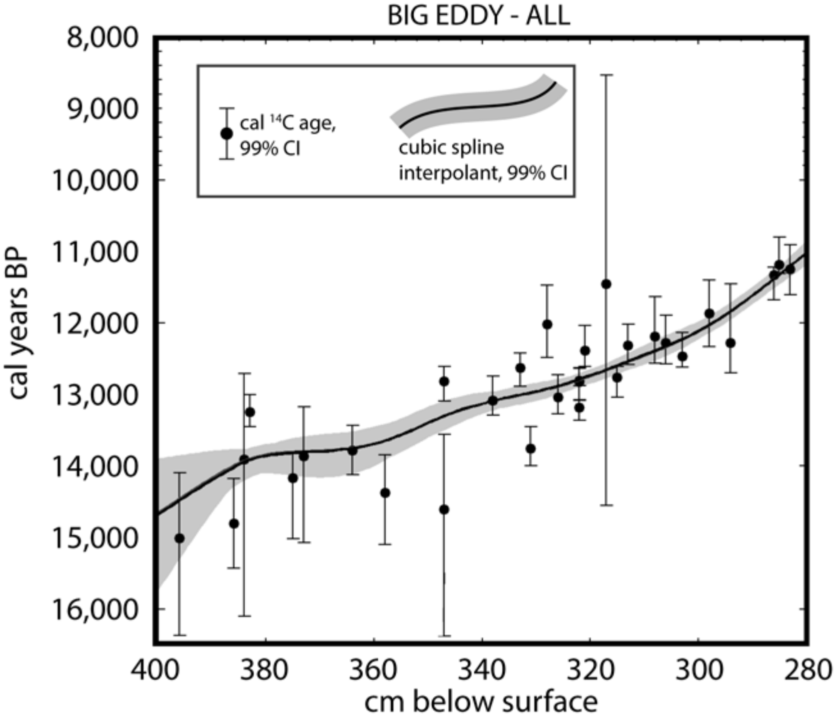

Figure S6. MCAge-depth model for Big Eddy based on all dates in Table S9, with 95% confidence interval derived from 1000 bootstrapped chronologies.

These outliers contribute little to the resolution of the age/depth curve, and indeed potentially bias the result. Removing the problematic outliers (the ^{14}C ages at depths of 321, 328, 331, 347 [12,450 ± 300] and 383 cm below surface), as well as the ages with a SD >100 years, as per the suggestion of YDIH proponents (14) (^{14}C ages at depths of 294, 317, 358, 364, 373, 384, 396 cm below surface), changes the age/depth curve, most notably in revealing there was a sharp increase in the sedimentation rate that peaked ~12,900 cal BP, but which began several centuries earlier and lasted several centuries later (Figure S7). That essentially flattened the age/depth curve on either side of the YD onset, indicating that *all* layers from depths of 320-348 cm below surface have median ages that fall within the span of 12,900 ± 100 cal BP, with upper and lower confidence intervals within that window that encompass all layers from >316 to 355 cm below surface (Table S7).

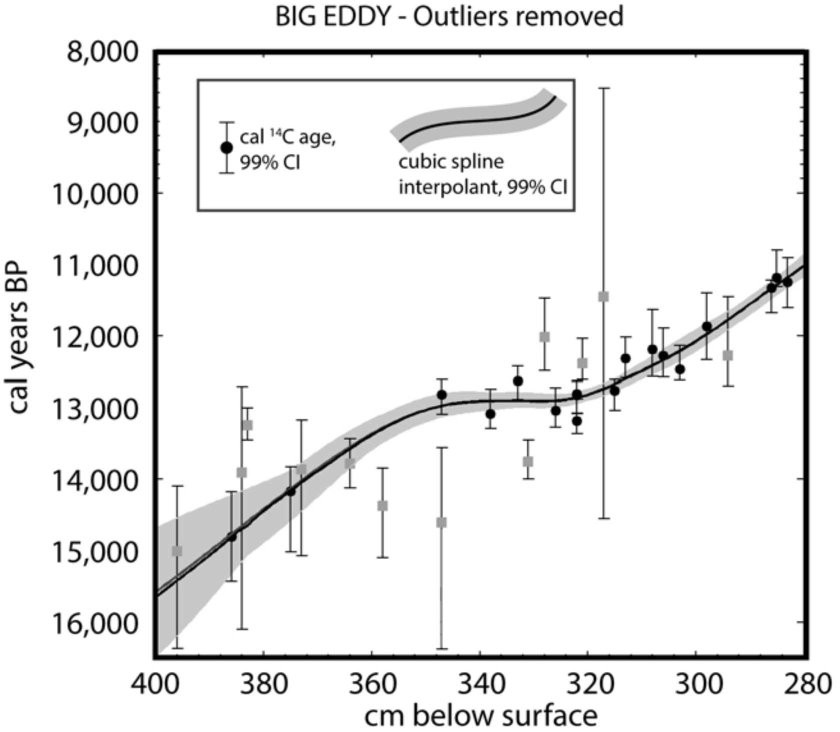

Figure S7. MCAge-depth model for Big Eddy after the elimination of outliers in Figure S6 (ages outside the 95% confidence interval) and ages with standard deviations >100 ^{14}C years (shown in gray). The 95% confidence interval derived from 1000 bootstrapped chronologies.

Table S7. Age/Depth cal BP chronology for Big Eddy site generated by MCAge Depth analysis, as calculated after removal of outliers (ages outside 99% confidence intervals) and ages with SD > 100 radiocarbon years. Levels shaded and in bold have median ages within span of 12,900 ± 100. Supposed YDB layer is at 327-335 cm below surface (outlined).

Depth (cmbs)	median cal age	cal age – upper confidence interval	cal age – lower confidence interval
316	12700	12798	12626
317	12731	12826	12656
318	12761	12852	12685
319	12788	12874	12712
320	**12812**	**12894**	**12737**
321	**12834**	**12916**	**12760**
322	**12853**	**12938**	**12780**
323	**12868**	**12956**	**12797**
324	**12880**	**12970**	**12808**
325	**12889**	**12980**	**12811**
326	**12895**	**12987**	**12812**
327	**12899**	**12992**	**12810**
328	**12901**	**12994**	**12807**
329	**12901**	**12994**	**12803**
330	**12900**	**12993**	**12798**
331	**12899**	**12991**	**12793**
332	**12897**	**12991**	**12790**
333	**12896**	**12992**	**12787**
334	**12896**	**12994**	**12786**
335	**12896**	**13001**	**12787**
336	**12897**	**13008**	**12790**
337	**12899**	**13015**	**12794**
338	**12901**	**13023**	**12795**
339	**12904**	**13031**	**12787**
340	**12907**	**13040**	**12782**
341	**12911**	**13049**	**12778**
342	**12916**	**13058**	**12776**
343	**12923**	**13069**	**12776**
344	**12931**	**13081**	**12779**
345	**12941**	**13094**	**12784**
346	**12953**	**13108**	**12792**
347	**12968**	**13124**	**12803**
348	**12985**	**13144**	**12817**
349	13004	13169	12834
350	13026	13196	12854
351	13050	13224	12877
352	13076	13253	12902
353	13105	13287	12930
354	13135	13322	12961
355	13168	13360	12992

In effect, then, although the supposed YDB layer at 327-335 cm below surface falls within the proper temporal range, that is also true of *all* the layers sampled for impact indicators at the Big Eddy site. In order to better resolve the precise level and age of any supposed impact indicators at Big Eddy it will be necessary to examine a continuous and directly dated sedimentary section, rather than obtain a sample of supposed indicators from one location on the site which is then dated by a conglomeration of ages from several other locations on site, all of which were deposited at more or less the same time.

5. BLACKVILLE – GROUP 3A

The Blackville locality (South Carolina) is a site on a sand rim of one of the Carolina Bays. According to Bunch et al. (1), samples for analysis were cored by hand auger[5] from a section of aeolian and alluvial sediments ~2 m thick, which lay unconformably atop an apparent Miocene marine clay (ref. 1, p. E1905). A 15-cm thick peak in apparent impact indicators was reported to occur from 175-190 cm below surface; the supposed YDB layer was placed at 183 cm below surface (ref. 1, its SI p. 4).

It was not possible to obtain radiocarbon ages "because of sediment mixing by deep-rooted plants" (ref. 1, its SI p. 4). Instead, three OSL dates (Table S8) were obtained at depths of 107, 152 and 183 cm below surface (ref. 1, its SI Table S2), and the age of the supposed YDB layer was subsequently based on "linear interpolation" of the upper and lower of the OSL ages. The OSL age in between at a depth of 152 cm below surface (18,540 ± 1680 years BP) was rejected because of the "large magnitude of [its] age reversal" which was argued to be the result of older sediments lying stratigraphically higher than younger sediments (ref. 1, its SI p. 5). But given the problem of sediment mixing, there is no way to know which date or dates in the section should be rejected. No explanation is given as to why the lowest OSL age at 183 cm below surface was not rejected as being the result of younger sediments mixed into older strata. Presumably it was kept for reasons other than its coincidence with the presumed age of the supposed YDB layer.

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[5] Strictly speaking, hand augers do not bring up 'cores' per se, but rather 10-20 cm of sediment (the amount depending on the size of the auger and the resistance of the sediment), which is invariably churned by the twisting and cutting motion of the auger bit. Nor is it clear how OSL ages were retrieved from a bucket auger.

Table S8. OSL ages from Blackville, from Bunch et al. (ref. 1, its Table S2).

Lab no.	Depth (cmbs)	OSL	±	Comments
LB862	107	11500	1030	
LB861	152	18540	1680	Rejected by Bunch et al. (1)
LB859	183	12960	1190	YDB layer identified by Bunch et al. (1)

Given that an OSL age was available directly on the supposed YDB layer, the necessity of a linear interpolation is unclear. Nor is it obvious that the date for the supposed YDB layer is actually based on a linear interpolation: first, the interpolated date on the supposed YDB layer is reported to be 12.96 ka, coincidentally the same age as the OSL date itself from that depth (which was accompanied, of course, by an 1190 year uncertainty). Second, when an attempt to replicate the linear interpolation is made (Figure S8), the predicted depth of YDB-age deposits is 174.67 cm below surface, slightly *above* the depth of the supposed YDB layer. Further, the age of the 183 cmbs layer that is predicted by weighted regression is 12,960 cal BP, and given that OSL ages are comparable to calibrated radiocarbon ages and that the calibrated age of the YD onset is put at 12,800 ± 150 cal BP, the modelled date for the Blackville supposed YDB layer predates the YD onset.

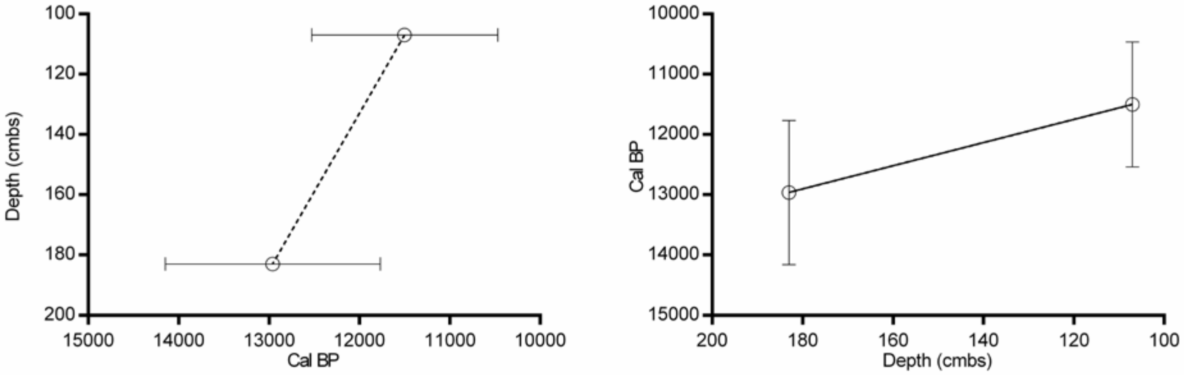

Figure S8. Graphs of replicated regression-based age/depth models for Blackville. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

In deriving these re-analysis results, we exclude the same date that Bunch et al. (1) reject. We also note that, based as they are on only two data points, it is not possible to calculate significance for the regressions that use the data of Bunch et al. (1). We observe, however, that the great deal of overlap in the error terms of the two unrejected dates (see Figure S8) indicates that in fact there is not a strong relationship between age and depth even for these two dates.

Regardless, given that the supposed YDB layer and the OSL sampling was from a zone 15cm thick in a section known to be subject to mixing, and given the wide uncertainty in the actual OSL age from this layer of 12,960 ± 1190 – which could pre- or post-date the YD onset (with an OSL age range of 14,150-11,770 years BP) – there is little precision in the dating of the supposed YDB layer at Blackville.

6. BLACKWATER DRAW – GROUP 3A

Blackwater Draw (also known as the Clovis site, but more correctly, Blackwater Locality 1) is the type locality for the Clovis artifact style. The site is situated in a large quarry pit created by long-term gravel mining that has destroyed most of its deposits. Much of the stratigraphic research and radiocarbon dating at the site has focused on the "North Bank" of the quarry (on exposures mostly destroyed in the 1960s) (15-17) and along the margins of the "South Bank" (on exposures still present) (18). These sections are ~360m apart. Two key points about the stratigraphy, archaeology and geochronology at the site, apparently not realized by the YDIH proponents, are that the lithostratigraphy is not isochronous across the site, and Clovis archaeological materials are only dated in the North Bank area of the site.

The key strata are Units B, C and D. Unit B is sand and gravel alluvium deposited by springs around the basin margin; Unit D is diatomite, diatomaceous earth, and organic-rich mud deposited in lacustrine and palustrine environments. Unit C, however is a much more complex unit. It includes alluvium, slopewash, and mudflow deposits that interface with both Units B and D. The stratigraphic position of Clovis archaeological remains on the South Bank was unclear until Haynes re-examined the 1936 work of Cotter (19; see the discussion in 16). Initially, Haynes (ref. 18, p. 370) was uncertain whether the South Bank Clovis material was in Unit B or C. His subsequent re-examination clearly showed that Clovis finds from 1936 were from the upper contact at the top of Unit B (ref. 16, its Fig. 17). Unit B produced two radiocarbon ages (11,810 ± 90 and 11,380 ± 150 ^{14}C years BP), which are in reverse stratigraphic order and considered to be minimum ages (ref. 18, p. 367). On the North Bank all of the Clovis material is in Units B_2 and B_3. Between the two “banks” and ~175m north of the South Bank was an area excavated in 1956 and 1957 (the so-called Jelinek excavations). Both mammoth and bison were found in what appears to be Unit C in this area (ref. 18, p. 370, 19).

According to Firestone et al. (21-23), LeCompte et al. (24), and Wittke et al. (3), supposed impact markers are found on the South Bank at the base of Unit D, just above or resting on Unit C. More specifically, “YDB markers are concentrated in a ~2-cm layer of fine-grained fluvial or lacustrine sediment that lies at the base of the black mat in the uppermost stratigraphic horizon [Unit C] containing *in situ* mammal bones and Clovis artifacts” (ref. 22, its SI p. 18). Wittke et al. 2013 (ref. 3, its SI p. 6) likewise state “The thin contact between Units D and C represents the YDB layer.” As noted, however, there is no Clovis material in Unit C just below Unit D on the South Bank.

In their initial publication on the YDIH, Firestone et al. (21) claim that the South Bank contained a ledge “jammed with spears, tools, and bone” 18 inches above the Clovis level (in upper Unit C) and the supposed YDB extinction zone (contact of Units C and D). They further assert that “Eight radiocarbon dates indicated that no humans had visited Blackwater Draw for more than 1000 years” after the impact “event” (ref. 21, p. 73). Ignoring the fact that radiocarbon dating cannot indicate the presence or absence of humans, no such artifact-laden ledge is reported from the South Bank or anywhere else in the site. More importantly, the eight radiocarbon dates are not identified. Kennett and West (25, p. E110) argue that “Folsom-age materials occur above the Clovis materials but a hiatus of ~500 years is suggested.” These statements indicate a lack of understanding of the site and are contradicted by ample evidence for essentially continuous archaeological occupation from Clovis time into the Holocene (15-18). Likewise, the assertion in Wittke et al. (ref. 3, its SI p. 6) that “Haynes (1995) demonstrated that the Clovis-aged C stratum and YD-aged D stratum occurs across ≈50% of the area” is flawed by the fact that Haynes’ cited work was not at the Clovis site proper but instead in the outlet channel between the site and Blackwater Draw proper, as Haynes makes clear.

In their discussion of the South Bank, Firestone et al. (22) focus on three radiocarbon ages for the Late Pleistocene strata (B,C and D) at the site (18). No rationale was provided to explain the selection of these three dates among the many available from this site on those strata. We note that two of the three cited ^{14}C ages, including a critical age of ~12.98 ka, were collected and dated in the 1960s from the site's *North* Bank ~360m distant (26). The original radiocarbon age of that ~12.98 ka cal age, moreover, has a standard deviation of 500 years (11,040 ± 500 ^{14}C years BP), and therefore provides little precision beyond placing it in the Late Pleistocene. Moreover, destruction by quarrying makes it impossible to precisely correlate the two distant areas of the site. Further, radiocarbon dates on the lower diatomite are available from just ~13m west of the sample section of Firestone et al. (22) and Wittke et al. (3) but they make no mention of these (10,740 ± 100 [AA-1362] and 10,470 ± 580 [A-4701] ^{14}C years BP).

Although apparently aware that there are many radiocarbon ages available from the site, Wittke et al. (3) estimate the age of the supposed YDB layer at their spherule sample section, the same section on the South Bank sampled by Firestone et al. (21) and Surovell et al. (27), using just five radiocarbon ages on Units B, C, D and E at the site (Table S9). For inexplicable reasons, they include only one age each for Units C and D – the units that incorporate their supposed YDB layer. There are many more available from those strata, as shown in Table S9 – which is itself not intended to be comprehensive (a fuller listing is available in 16-18, among other sources). Nonetheless, it highlights the availability of other ages from the strata at the site specific to the supposed YDB layer (units E-B), and more importantly emphasizes the variation in the age of those units across the site. Such should suffice to show that the data provided by Firestone et al. (22) and Wittke et al. (3) are inadequate to determine the age of their supposed YDB layer.

By Wittke et al.'s own admission four of the five radiocarbon ages they utilize are from "~60 m east" of where they sampled for spherules, and the fifth from "~175 m northeast" of their sample location (ref. 3, its SI, pp. 6-7). The four ages from ~60 m distant are from a stratigraphic section studied by Haynes (18); an additional 16 radiocarbon ages are available from that same study on the same stratigraphic units, yet those were ignored by Wittke et al. (3), who provided no explanation or rationale for the selection of just the four dates they used.

Table S9. Radiocarbon ages from Blackwater Draw, from Wittke et al. (ref. 3, its Table S.1), also Haynes (18) and Haynes and Warnica ref. 16, its Table 4). Ages omitted without explanation by Wittke et al. (3) are highlighted in gray. Note: this table does not include all ages from all those stratigraphic units or the site, only those deemed "most reliable" for their stratigraphic position, as specified by Haynes and Warnica (16)

Lab no.	**Level**	**Depth (masl)**	**^{14}C**	**±**	**Comments**
A-4703	E_3	1237.97	10000	910	South Bank, measured depth from Haynes 1995
A-4705	E_1	1237.86	9260	320	South Bank, measured depth from Haynes 1995
AA-87338	E		9889	50	North Bank; omitted
AA-87337	E		9820	110	North Bank; omitted
A-1372	E/D		10250	200	South Bank; omitted
AA-86575	D_{2a}		10281	58	North Bank; omitted
AA-87335	D_{2a}		10376	50	North Bank; omitted
AA-2261	D_2	1237.76	9950	100	South Bank, measured depth from Haynes 1995
AA-1370	D_{2z}		10260	230	South Bank; omitted
AA-1364	D_{1g}		10210	110	South Bank; omitted
AA-1363	D_{1g}		10160	120	South Bank; omitted
AA-1362	D_{1e}		10740	100	South Bank; omitted
A-4701	D_{1e}		10470	580	South Bank; omitted
AA-39843	D_{1b}		10526	70	North Bank; omitted
AA-89168	C_1		10884	67	North Bank; omitted
SMU-1880	C	~1237.56	10780	110	~175m north of the South Bank, arbitrary depth from Wittke et al. 2013 using unspecified method
AA-1360	C		10580	100	South Bank; omitted
AA-30454	B_3		10914	72	North Bank; omitted
AA-87917	B_3		10933	56	North Bank; omitted
AA-2262	B_{1b2}	1237.48	11810	90	South Bank, measured depth from Haynes 1995
AA-1375	B_{1a}		11380	150	South Bank; omitted

Wittke et al. (3) also failed to note that Haynes (ref. 18, p. 367) considered AA-2262 as possibly contaminated and an age reversal (ref. 18, its Fig. 8E). The fifth radiocarbon date they used (SMU-1880), reported by Johnson and Holliday (20), came from a sample recovered in a jacketed section of possible Unit C material recovered during excavations in 1956. This is an area of the site long ago separated from the South Bank by extensive quarrying, precluding any microstratigraphic correlation (especially given the Stratum C complexities). The absolute elevation of this sample cannot be estimated, let alone with the centimeter-scale precision given in Wittke et al. (ref. 3, its SI Table S1).

For that matter, they provide no explanation of the means by which they “integrated the three locations” – that is, their sample section, and the two locations ~60 m and ~175 m distant from which the radiocarbon ages were obtained – on to a common depth scale in order “to produce a generalized composite age-depth model” (ref. 3, its SI p. 7). Their depth profile is arbitrary both internally and especially with respect to their sampling section on the South Bank (where the supposed YDB layer is “centered at an elevation of 1,238.32 meters above sea level (masl)” identified as the D/C interface (ref. 24, p. E2961). As a result, the “logarithmic interpolation” that is said to date their supposed YDB layer in Unit C to ~12.8 ka (ref. 3, its SI p. 7) is based on a meaningless depth scale, and hence lacks statistical and stratigraphic merit.

The logarithmic regression-based age/depth model of Wittke et al. (3) is indeed reproducible, which may help to explain why these particular dates were chosen and/or assigned to the depths that they were. Using the same five dates as Wittke et al. (3) and those authors’ depths for those dates, we estimate the depth of YDB-age deposits to be within 3 cm of their reported depth for the YDB layer, and a statistically significant weighted regression provides an estimated age of 12,866 cal BP for this depth, well within the YDB interval (Figure S9; the log of the age variable is used in our regressions because this results in the best match with the age/depth model shown in ref. 3, its SI Fig. 4).

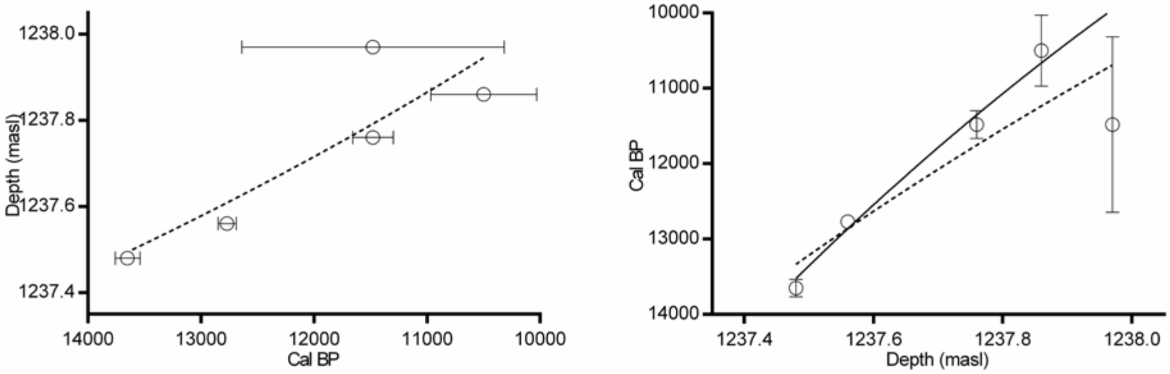

Figure S9. Graphs of replicated regression-based age/depth models for Blackwater Draw. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

The weighted regression for this site also illustrates the value of taking dating uncertainty into account in age/depth modeling, which YDIH proponents do not do, as the one date in this dataset with a very large error term exerts less influence on the weighted regression than on the unweighted regression (see Figure S9). Nonetheless, because of the errors in stratigraphic interpretation, the highly problematic and selective use of available dates, and the arbitrariness of the depths used, there is little reason to accept the results of the age/depth model of Wittke et al. (3).

7. BULL CREEK – GROUP 3C

Bull Creek, in the Oklahoma Panhandle, is one of the three sites first reported with high levels of nanodiamonds (NDs) at the YDB (ref. 28, its SI Fig. 1b). The original source identifies an associated date of ~13,000 ± 100 cal BP but provides no stratigraphic context; this appears to be the date of 11,070 ± 60 ^{14}C years BP reported by Bement et al. (29). The date has little accuracy as a moment in time, however, because the sample was 9 cm thick collected from the middle of the A horizon of a buried soil (29), and A-horizons represent the mixing of organic carbon through the duration of soil formation. In a subsequent paper, based in part on re-sampling of the section (30), the supposed ND peak is from a sample 5cm thick collected below the zone that yielded the radiocarbon date. The supposed ND zone, therefore, pre-dates the YDB. But then Bull Creek also has a ND spike in Late Holocene to modern sediments as well (30), making it evident that nanodiamonds are not restricted to the YD onset.

8. CAROLINA BAYS – GROUP 2A

The Carolina Bays on the Atlantic Coastal Plain are "are a group of ~500,000 highly elliptical and often overlapping depressions scattered throughout the Atlantic Coastal Plain from New Jersey to Alabama …. All of the Bay rims examined were found to have, throughout their entire 1.5-5-m sandy rims, a typical assemblage of YDB markers" (ref. 23, pp. 40-42). The age and origins of these surficial depressions have been debated and discussed for decades (31-32), including the proposal they formed from impacts (33).

Firestone et al. (21) present data from the Carolina Bays as supporting the YDIH, arguing that they date to ~12.9k cal years: "All of the evidence fits our theory that the rims and bays formed all at the same instant" around 12,900 cal BP; they also attribute to Ivester and colleagues ages on two bay rims of 11,300 and 12,630 years ago using OSL (ref. 21, p. 127). Firestone et al. also report an OSL date of 11,400 ± 6100 years BP as close to the age of Clovis and therefore use it to date the YDB (ref. 21, p. 127). Yet, OSL ages are *calendar* years, and ages of ~11,300 and ~12,630 are too young for Clovis and by themselves *postdate* the onset of the Younger Dryas. To be sure, the OSL age of 11,400 ± 6100 years BP overlaps the onset of the Younger Dryas, but then it also includes much of the first half of the Holocene. Given this span of time, it cannot usefully determine the age of supposed impacts indicators at these sites. Moreover, the OSL ages on bay rims reported by Ivester et al. (34) do not pertain to the initial formation of any bay. Extensive OSL dating has shown that these bays formed at different times in the past, though generally between 140,000-120,000, 80,000-60,000 and 50,000-12,000 years ago (35).

Firestone et al. (22) subsequently realized the ages of the Carolina Bays vary, and sought to assert that the supposed YDB layer found in 15 of the bays dated to 12,900 years BP. They based this assertion on the fact that the markers found therein were identical to those found elsewhere dated to 12,900 years BP (ref. 22, p. 16019). That circular argument cannot be used as chronological evidence, as it assumes what it ought to demonstrate.

9. CHOBOT – GROUP 1A

The Chobot site is in lake sediments on the Canadian prairie near Edmonton. Little is reported for the site. Both Firestone et al. (ref. 22, its SI Section C) and Wittke et al. (ref. 3, its SI p. 7 and its SI Fig. 5) report an increase in "impact spherules" immediately above a Clovis occupation zone. Firestone et al. (ref. 22, its SI Section C) state that "the Clovis level is capped by the YDB layer" (also ref. 23, p. 38). Wittke et al. (ref. 3, its SI Fig. 5) likewise refer to "observed Clovis artifacts located at the base of the black layer," but admit they "were unable to date the site radiometrically because of bioturbation by plant roots. However, the stratigraphic position of the spherule layer is immediately above the uppermost level containing abundant Clovis points and artifacts" (ref. 3, its SI p. 7). Yet, neither publication presents or cites data based on archaeological excavations. Ives and Froese (36), archaeologists familiar with the site, report that Clovis artifacts from the site are neither abundant (only three are known) nor found in place (the three points were recovered from the surface).

Wittke et al. (37) in response agreed "with Ives and Froese that the Chobot site is challenging because it is undated. We also agree that some lithics at the site are non-Clovis, but Chobot has three acknowledged Clovis points, which are more than at many Clovis sites." Of course, the relevant issue is not the absolute number of Clovis points, but their numbers relative to the entire lithic assemblage at the site, which is overwhelmingly of much younger age, and the irrefutable fact that no Clovis points have been found *in situ* or in a manner that can be related to the site stratigraphy. Wittke et al. nonetheless assert that while "The evidence from Chobot may seem unpersuasive as a single site … [it] is highly consistent with the multicontinental YDB record. Similar coeval marker peaks occur at ~30 dated YDB sites in 10 countries on four continents. Thus, the best explanation is that Chobot contains the YDB layer where indicated" (37).[6] The logic here is flawed: each of these localities must be dated independently of one another, and independently of a proposed layer of supposed impact markers, else (as with the Carolina Bays) the reasoning is circular. In addition, the assertion that Clovis points were found in place or in great abundance or can be used to date the age of the supposed YDB layer at the site is incorrect.

Although Wittke et al. (3) do not report radiometric ages from Chobot, such are in fact available from this site: Firestone (39) reports dates of 3600 and 1520 ^{14}C years BP on material from the site, though asserted these ages were invalid. As Ives and Froese (36) observe, those dates stratigraphically bracket the supposed YDB Layer, although they are more than 9000 years younger than the onset of the Younger Dryas.

10. DAISY CAVE – GROUP 3D

Daisy Cave is a multicomponent archaeological site on the northeast coast of San Miguel Island off the coast of southern California (40). Firestone et al. (22) report the occurrence of impact markers from Stratum I, described as a "dark brown cave soil," from which a radiocarbon age of 11,180 ± 130 ^{14}C years

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[6] In that same response Wittke et al. (37) assert there is a nonalgal black mat present at the Folsom (NM) site. That is neither correct (38), nor relevant.

BP (13,219-12,913 cal BP at 1 sigma [IntCal09]) was obtained on a small carbonized twig fragment by Erlandson et al. (41). Firestone et al. (ref. 23, pp. 38, 40) noted that “several markers were found, but others, including Ir[idium] were not found, possibly because the protected cave shelter prevented accretion.” Although Firestone et al. (ref. 22, its SI Figs. 16 and 17) indicate additional samples other than the one from Stratum I were obtained, no information is provided on the stratum (strata) in which those occur, or their ages.

11. GAINEY – GROUP 2A

The Gainey site is the type locality for the Gainey point, considered related to the Clovis style. The site has no black mat, no reliable radiocarbon dates, nor a distinct Paleoindian level. As its investigators observe, Gainey is “a plowed site with few undisturbed deposits” (ref. 42, p. 267). The Paleoindian artifacts are on or just below the surface.

Firestone et al. (ref. 22, its Table B-2) report a thermoluminescence (TL) date of 12,400 ± 1000 for the locality, but the cited source (42) presents no such date, but instead a radiocarbon age of 2880 ± 175 ^{14}C years BP for Feature 7 at the site (ref. 42 p. 266). Wittke et al. (ref. 3, its SI p. 9), likewise erroneously citing Simons et al. (42), report a single OSL (sic) age from the site of 12,360 ± 1,240 years BP obtained at ~30 cm depth, and imply it is the “only” age available for the YDB layer. Presumably this is the same date as reported by Firestone et al. (22).

There is, however, a second TL date of 11,420 ± 400 years BP from the site (ref. 43, p. 110). Both of these TL dates are on burned chert artifacts, and their position is unspecified, save for a published hand-drawn diagram of Feature 37, from which the younger of the two TL dates was obtained (ref. 43, its Fig. 4). Hence, the position of these dated artifacts in what Wittke et al. admit is an “extensively bioturbated” deposit (ref. 3, its SI p. 9) is not known.

Further, that these are TL as opposed to OSL dates makes the ages problematic. They were never formally published with the lab data necessary for independent evaluation and they were determined some time before ~1990 and thus did not employ modern methodologies. At that time, the viability of TL dating of burned chert had not been demonstrated. Regardless, like OSL ages, TL ages are read on the same temporal scale as calibrated radiocarbon ages, and hence the Gainey TL dates are younger than the onset of the Younger Dryas. With the inclusion of their standard deviations they overlap with the onset of the Younger Dryas, but those standard deviations are so large as to essentially lack any precision – certainly none sufficient to date an impact event. For the record, the Gainey site excavators consider the 12,400 age "earlier than expected" for Gainey and believe the site was occupied closer to the younger end of the standard error for that age (ref. 44, p. 28).

Finally, one of the YDIH proponents supplied 16 carbon microspherules said to be from the YDB layer at Gainey to Mark Boslough for AMS radiocarbon dating. One of the microspherules returned an age of 207 ± 87 ^{14}C years BP (ref. 45, p. 23). Firestone (39), aware there were several modern and "future" ages on carbon spherules from Gainey, sought to explain these based on as-yet unverified cosmogenic processes for radiocarbon enrichment. A simpler and more obvious answer is that these supposed YDB impact indicators are instead Late Holocene particles resulting from normal terrestrial processes or the result of contamination during sample preparation by YDIH proponents.

12. KANGERLUSSUAQ – GROUP 2A

In cooperation with PBS in late 2008, Kurbatov and others (46) conducted a pilot field and laboratory experiment to determine if impact indicators were present in the Greenland ice sheet. Samples of sufficient size were not available from the deep ice cores of central Greenland (GISP2, GRIP and NorthGRIP), and so they sampled at a locality on the margin of the ice sheet east of Kangerlussuaq, West Greenland, ~1km inland from the ice margin. Due to deformation and shearing, the ice sheet here is thinner, the Younger Dryas age ice varies "unevenly in thickness," and portions of the stratigraphic record are possibly not preserved (ref. 46, pp. 750-751). Kurbatov et al. (46) are appropriately circumspect about the precise ages of the sampled section, noting that "If the stratigraphic interpretation we have adopted is correct, the continuous sequence of ice samples we collected represents ~6000 years of ice, spanning the YD at a resolution of about every 50-100 years" (ref. 46, p. 751). The section they examined "displayed dust stratigraphy and isotopic values similar to deep ice-core records … suggesting that the YD layer is in the correct stratigraphic position at that site," and was possibly "deposited after the end of the last glacial episode (14.6 ka) and prior to the earliest Holocene (11.6 ka)" (ref. 46, pp. 751, 757). However, as they concluded, the results for both the chronology and the analytical procedures for detecting impact indicators need to be significantly refined (ref. 46, p. 757).

13. KIMBEL BAY – GROUP 3A

Kimbel Bay (North Carolina) is also a Carolina Bay, in this case one incised by a drainage that breached its rim. The site stratigraphy was viewed in an "exploratory trench" (of unspecified size and depth) and a hand auger was used to "extract a 490-cm deep core [sic]" (ref. 3, its SI p. 10 [see the note above regarding augering]). The upper 440 cm of sediment is reported to be a mix of aeolian and colluvial sands with discontinuous silty clay bands, unconformably underlain by a fine-grained marine clay of apparent Cretaceous age. Eight 15-cm thick samples were collected from the 76 cm between 297 and 373 cm below surface, but only the six deepest were examined for impact indicators. Wittke et al. identified an apparent peak of impact indicators centered at 358 cm below surface (ref. 3, its SI p. 10).

In order to determine the age of the supposed YDB layer, "discontinuous samples from different locations in the trench" were collected over a 303-cm thick sediment sequence (ref. 3, its SI p. 10). It is not specified how far apart laterally the samples were located. From those samples, three OSL and three radiocarbon ages were obtained (Table S10). "Logarithmic interpolation" was used to develop an age-depth model for the supposed YDB layer using all OSL and radiocarbon ages – despite the obvious chronological reversal of the OSL age at 436 cm below surface – and is said to show that the supposed YDB layer dates to ~12.8 ka (ref. 3, its SI p. 10).

Table S10. Radiocarbon and OSL ages from Kimbel Bay from Wittke et al. (ref. 3, its Table S.1)

Lab no.	**Depth (cmbs)**	**^{14}C/OSL**	**±**	**Comments**
UCIAMS-52613	147	1195	15	charcoal
LB-863	375	25500	2720	OSL
LB-864	406	26080	2940	OSL
AW-SKB-6	436	21640	2630	OSL
UCIAMS-52622	445	27250	130	charcoal (lab number as in [3])
UCIAMS-52622	450	39690	710	charcoal (lab number as in [3])

It is difficult to account for that conclusion. For one, the supposed YDB layer is in the lower sand, just 10 cm above the youngest OSL age of 25,500 years BP, with no indication of any sort of depositional or weathering hiatus, nor erosion. This obvious time gap is not considered in Wittke et al.'s (3) age estimate nor is this hiatus ever discussed or otherwise considered. Although our re-analysis of the age / depth data puts the predicted depth of YDB-age sediments at 353.56 cm below surface (Table 3 in main text), which is within the vertical span of the 15 cm level that yielded the purported impact indicators, that re-analysis, like the original, was based on single point age estimates. Interpolating an age/depth curve using solely point estimates is highly problematic at Kimbel Bay, where statistical uncertainties on the OSL ages range up to almost 3000 years and those with radiocarbon ages are an order of magnitude lower. Accordingly, it is critical in developing an age/depth model for this site to account for the differential weight of these uncertainties.

Doing so yields results that diverge greatly from the conclusion reached by Wittke et al. (3) about the age of the supposed YDB layer at Kimbel Bay, even using the same data and regression model type as they do (Figure S10; the log of the age variable is used in our regressions for this site because this results in the best match with the age/depth model shown in ref. 3, its SI Fig. 8). A weighted regression model predicts the age of the 358 cmbs depth to be 12,094 cal BP, over 500 years younger than the 12,800 ± 150 interval.

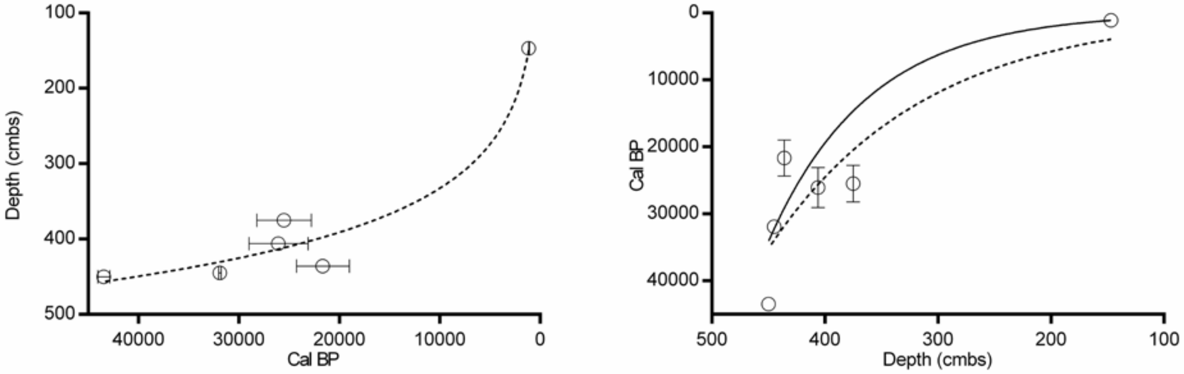

Figure S10. Graphs of replicated regression-based age/depth models for Kimble Bay. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

The weighted regression is significant, giving reason to place statistical confidence in this age estimate, and as can be seen in Figure S10, the weighted regression is far less influenced than the unweighted regression by the three OSL dates with the very large dating error terms in the middle of the age sequence. We also note that while the use of a logarithmic model may be appropriate in this case, additional geoarchaeological evidence is necessary to support its use. The Kimbel Bay age/depth models (Figure S10) are noteworthy for being highly curved. Such curves may well be appropriate for describing the relationship between age and depth at this site, if there is independent reason to suspect variability in depositional rates across the profile such that the distances between ages would be compressed at greater depths in a manner that leads to a logarithmic relationship. However, no such evidence for or discussion of variable depositional rates in the higher levels of this site (i.e. above the sand-clay interface at 440 cmbs) is given by YDIH proponents. As such, the use of a logarithmic model in this case may simply amount to another instance of inductively connecting dots.[7] Under the circumstances, it cannot be claimed that the supposed YDB layer at Kimbel Bay is remotely close in time to the YD onset.

14. LAKE CUITZEO – GROUP 3A

Lake Cuitzeo is a large lake in central Mexico from which a 27 m sediment core was extracted. Found within that core was a "10 cm thick carbon rich layer" occurring at a depth between 2.82 and 2.50 meters below surface, which yielded supposed impact indicators. Sediment samples were examined for indicators at 5 cm intervals between 2.65 and 2.8 meters below surface, and at 10 cm intervals above and below that span between 2.2 and 3.6 meters below surface (ref. 47, p. E739 and its Table 5).

A total of 22 bulk sediment radiocarbon ages are reportedly available from the core (Table S11), although only 21 are provided (ref. 47, p. E739 and its SI Appendix, Table 1). Site investigators developed an age/depth model using a 5th order polynomial regression, but only after rejecting six of the radiocarbon dates because they are "older than the [age/depth] interpolation predicts" (ref. 47, p. E739). However, as Blaauw et al. (48) observed, "the rejected dates were in stratigraphic order" and, more

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[7] This may also be the case for Big Eddy and Blackwater Locality 1, the other two sites where logarithmic age/depth models have been used (3), and it is certainly the case for the sites where 2nd order polynomial models have been used, as noted in the main text.

problematic, the six rejected dates provide the only chronological control from the portion of the core that includes the supposed YDB layer (the ages came from 2.05 to 3.1 meters below surface). The rejection of those ages was subsequently justified by a spike in total organic carbon at 2.75 meters below surface, said to indicate major contamination by “radiocarbon-dead or very old carbon” (ref. 47, p. E739). Curiously, this apparent major contamination of very old or dead carbon occurs amidst a “major rise in charcoal” in the core said to be the result of “a major episode in biomass burning” that marked the onset of the Younger Dryas (ref. 47, p. E741).

Table S11. Radiocarbon ages from Lake Cuitzeo, from Israde-Alcantara et al. (ref. 47, its SI Table 1; also three additional ages reported by Wittke et al. ref. 3, its Table S.1).

Lab no.	Depth (mbs)	^{14}C	±	Material
AA-9351	0.70	930	55	bulk carbon
AA-9352	0.85	1755	115	bulk carbon
AA-9353	1.35	6165	70	bulk carbon; used by Wittke et al. (3)
AA-9354	1.95	8830	215	bulk carbon; used by Wittke et al. (3)
WW-3361	2.05	14270	50	bulk carbon; rejected by Israde-Alcantara et al. (47)
T7-M31	2.25	17605	215	bulk carbon; rejected by Israde-Alcantara et al. (47)
WW-3362	2.45	21730	70	bulk carbon; rejected by Israde-Alcantara et al. (47)
OS-7133C	2.55	21600	100	bulk carbon; rejected by Israde-Alcantara et al. (47)
WW-3363	2.75	27360	130	bulk carbon; rejected by Israde-Alcantara et al. (47)
WW-3375	3.10	32940	190	bulk carbon; rejected by Israde-Alcantara et al. (47)
T11-M47	3.35	15500	130	bulk carbon; used by Wittke et al. (3)
WW-6422	3.65	23870	100	bulk carbon
WW-3576	3.75	28289	120	bulk carbon
WW-6423	3.80	29490	190	bulk carbon
WW-8454	4.00	22780	120	bulk carbon
WW-8455	4.40	21450	100	bulk carbon
AZ-120	4.70	26800	900	tephra
WW-8456	5.35	29890	280	bulk carbon
AA-9359	6.10	32565	2885	bulk carbon
WW-3364	6.65	28600	140	bulk carbon
AA-9770	9.10	42400	1000	bulk carbon

Regardless, it is claimed that the 5th order polynomial regression “predicts that the 12.9-ka YD onset is at a depth of approximately 2.9 to 2.7 m” below surface (ref. 47, p. E739), although the YDB is also illustrated – without regard to the discrepancy – as occurring from 2.82 to 2.5 m below surface (ref. 47, its Fig. 1). Regardless, the conclusion regarding its age is not supported by the regression equation provided in Israde-Alcántara et al. (ref. 47, p. E739 and its SI Table 1: wherein $y = -5\text{E}{-}07x^5 + 6\text{E}{-}05x^4 - 0.0025x^3 + 0.0366x^2 - 0.0108x + 0.512$). Solving for y with that equation if x is 12.9 kcal BP returns a solution that puts the supposed YDB layer at 2.58 m below surface, 12 cm above the top of their reported YD onset zone. When a 5th order polynominal regression line is re-calculated using their same dates[8], the resulting regression equation ($y = \text{-}6\text{E-}20x^5 + 8\text{E-}15x^4 - 3\text{E-}10x^3 + 6\text{E-}06x^2 - 0.0205x + 93.278$ [equation is in units of cm]) puts the predicted depth of sediments dating to 12,900 cal BP at 2.59 m below surface (Figure S11), also above the depth of the onset of the YD as stated by Israde-Alcántara et al. (47). Further, a weighted regression model (again using the same dates, as well as a 5th order polynomial model) predicts that the age of sediments at 2.82 m below surface—the depth that Israde-Alcántara et al. (ref. 47, p. E739) identify as marking the onset of the layer with impact indicators—is 15,916 cal BP, approximately 3,000 years too early. Because this regression is not significant (just as our replication of the depth-prediction regression presented by Israde-Alcántara et al. [47] is not significant), limited stock should be placed in this result.

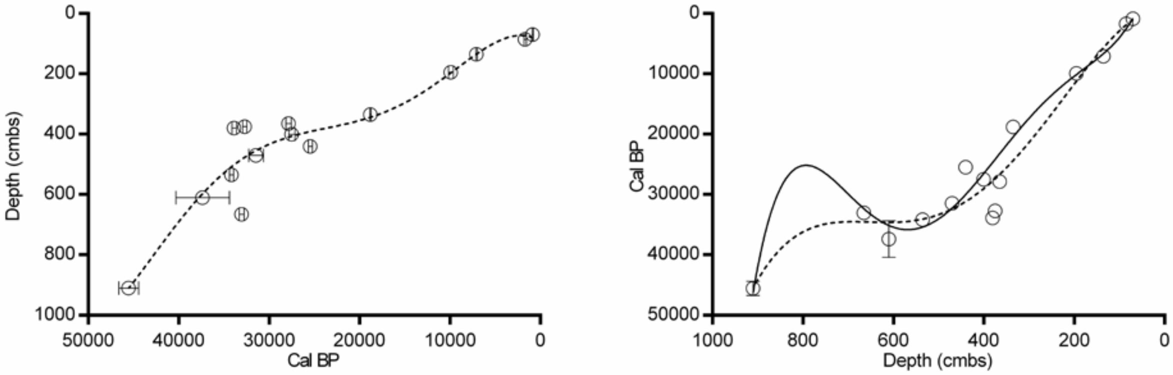

Figure S11. Graphs of replicated regression-based age/depth models for Lake Cuitzeo. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

We observe, however, that our result in roughly consonant with the one independently derived by Blaauw et al. (48). Using an alternative method for age/depth modeling that also takes dating uncertainty

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[8] Specifically, the 15 unrejected dates shown in Israde-Alcántara et al. (ref. 47, its SI Table 1). Wittke et al. (ref. 3, its SI Table 1) show only three of these dates, and they give a calibration result for one (T11-M47) that differs from that given by Israde-Alcántara et al. (ref. 47, its SI Table 1).

into account, and again excluding the six dates rejected by Israde-Alcántara et al. (ref. 47, p. E739), those authors propose an age range of ~21,200-16,000 cal BP for the core depth of 2.8 meters below surface (48). Of course, any attempt to determine a precise age for a supposed YDB layer in a portion of the core for which all dates have been *a priori* rejected is at best problematic. We agree with Blaauw et al. that the layer investigated by Israde-Alcántara et al.“is not demonstrably or securely dated to the start if the YD, and indeed … is most likely several millennia older” (48).

15. LAKE HIND – GROUP 3C

Firestone et al. (22-23) attribute to Boyd et al. (49) the finding that “at ~12.76 ka, the ice dams on the lake failed catastrophically as part of a regional pattern of glacial lake drainages. At the YDB, the failure rapidly transformed the lake from deep to shallow water.” However, Boyd et al. only state that “low water levels were established in the southern glacial Lake Hind basin by at least 10,400 yr B.P.” (ref. 49, p. 601); they had no earlier ages to provide more precise chronological control. Firestone et al. (ref. 22, its SI Table 2) provide a radiocarbon age of 10,610 ± 25 ^{14}C years BP which they calibrate as 12,755 ± 87 cal BP. Although presumably calibrated with IntCal04, that calibration cannot be precisely replicated (IntCal04 returns an age of 12,757-12,661 cal BP at 1 SD). Moreover, even at two standard deviations – calibrated as ranges of 12,791-12,617 (96% area under the curve) and 12,442-12,416 (4% area under the curve) – their YDB layer falls outside the presumed temporal window of the YD impact.

It is perhaps noteworthy that Boyd et al. (ref. 49, p. 602), who are cited by Firestone et al. (22) on the chronology of draining of Lake Hind, observe that Folsom groups were in the region soon after the lake drained, indicating that despite claims to the contrary (22), there was no apparent hiatus in post-Clovis occupations (see also 26).

16. LINGEN – GROUP 2A

Although “abundant charcoal” at Lingen is reported and illustrated from the supposed YDB layer (ref. 3, its SI Fig. 9), evidently none of it was submitted for radiocarbon dating. Instead, as noted in the text, there is only an age available from nine cm below the layer the yielded the supposed impact markers, at a depth of 52.5 cm below surface (the age of 11,310 ± 60 ^{14}C years BP, as noted in the main text). The supposed impact markers were found “at a depth of 43.5-47.5 cmbs in a 3-cm-thick [*sic*] dark, charcoal-rich layer at the top of the Usselo sand,” which according to Wittke et al. correlates with the onset of the YD dated at ≈12.8 ka” (ref. 3, its SI pp. 10-11). According to Wittke et al. (ref. 3, its SI Table S1) this age estimate is derived from an age-depth model, but none is shown or otherwise mentioned. Instead, it is based on the “position of the YDB layer at the top of the Usselo layer,” but as we discuss in the main text that is from a single radiocarbon date at the Usselo type site (50), which cannot be generalized to an otherwise undated specific layer at site in which that horizon occurs, as van Hoesel et al. (51) have shown. We note that Wittke et al. (ref. 3, its SI p. 11) reject the arguments of van Hoesel et al. (51) regarding the variable age of the Usselo layer on the grounds that van Hosel and colleagues neglected to address calibration issues. As van Hoesel et al. (6) state in rejoinder, that “comment is simply not true.”

17. LOMMEL – GROUP 3C

As at Lingen, the age of the supposed YDB at Lommel (Belgium) is in part based on the age of the Usselo soil at the type site. However, at Lommel “One AMS ^{14}C date was acquired on charcoal extracted from the YDB layer at 48.5 cmbs, providing a date of 11.48 ± 0.10 ^{14}C ka BP (13.39 ± 0.12 cal ka BP)” (ref. 3, its SI p. 12). Wittke et al. claim this date is “consistent with an age of ≈12.8 ka” (ref. 3, its SI p. 12). It is impossible to agree that this is so even on their terms since that age of 13,400 cal BP – which we emphasize is directly on the supposed YDB layer – is well outside the chronological range they themselves grant to the onset of the Younger Dryas. Although they add that “Van Geel et al. (50) acquired an AMS ^{14}C date of 10.95 ± 0.05 ^{14}C ka BP (12.86 ± 0.07 cal ka BP) from nearby at the same site,” (ref. 3, its SI p. 12) that fact is questionable and irrelevant. Van Geel et al. (50) worked at the type Usselo section, ~160 km distant from Lommel, and as earlier noted the Usselo soil represents many hundreds of years of accumulation (52-53). The timing of deposition of the impact indicators at Lommel is known, and known not to date to the YD onset.

18. MELROSE – GROUP 3A

The Melrose site consists of colluvium from the surface to 38 cm below surface, which is resting on glacial till that is exposed in a shallow (<50 cm) trench (ref. 1, its SI p. 5). Five contiguous samples were taken from 5-48 cm below surface, with apparent impact indicators found in an 8 cm thick interval from 15-23 cm below surface; that marks the supposed YDB layer (ref. 1, its SI p. 5). If an 8-cm-thick zone represents the YDB, then the upper 15 cm represents the entire Holocene. Yet, no evidence of prolonged weathering is indicated for the surface layer. The stratigraphy therefore indicates that a significant part of the Holocene section is likely missing.

Owing to "a dearth of datable charcoal … and because of sediment mixing by deep-rooted plants," it "was not possible to acquire direct radiometric dating of the sedimentary profile" (ref. 1, its SI p. 6). Accordingly, Bunch et al. (1) acquired a single OSL sample at 28 cm below surface[9] which returned an age of 16,400 ± 1600 years BP. To determine the age of the supposed YDB layer, they used "linear interpolation" to connect the OSL age and the surface, which they assumed to be modern; this reportedly "dates the proxy-rich YDB layer at a depth of 21 cmbs to 12.9 ± 1.6 ka" (ref. 1, p. E1905 and its SI p. 6).

However, their interpolation seemingly involved little more than drawing a straight line between a single point at 16,400 years ago and 0 years ago: moreover, although the surface of the site might be "modern," the sediment comprising that surface might not be, hence using a value of 0 is arbitrary and meaningless. Replicating this "linear interpolation" of two data points through regression (Figure S12) results in a predicted depth for YDB-age sediments of about 22 cmbs. Assuming (after ref. 1, p. E1905 and its SI p. 6) that 21 cmbs is indeed the depth to be used for the proposed YDB layer (and not say, 19 cmbs, which is the midpoint of the 15-23 cmbs zone), this result is about 1 cm lower than that depth, though still within 15-23 cm interval identified as containing impact indicators. More important, an unweighted regression of age on depth[10] predicts an age of 12,300 cal BP for the 21 cmbs depth (Table 3 in main text), which falls well outside the "12.9 ± 1.6 ka" interval that Bunch et al. ascribe to this depth (ref. 1, p. E1905 and its SI p. 6).

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[9] Wittke et al. (ref. 3, SI Table 1) give a depth for the site's OSL date of 30 cm.

[10] A weighted regression model is not possible for Melrose because one of the data points (the ground surface at 0) is not a date with an error term. Regression significance cannot be calculated for this site because there are only two data points, unavoidably resulting in a perfect model fit.

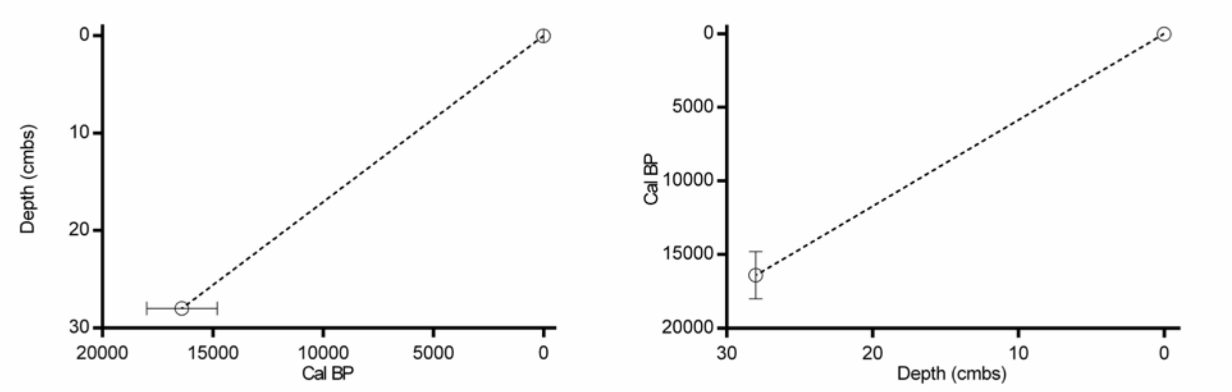

Figure S12. Graphs of replicated regression-based age/depth models for Melrose. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

Beyond the problems with the questionable age/depth interpolation presented for this site, Bunch et al. (ref. 1, its SI p. 6) suggest that the humic colluvium is redeposited glacial till, in addition to being subjected to bioturbation. That plus the lack of precision in the single OSL date available from the site indicates that the age of the zone with supposed YDB indicators is unknown, other than likely being post-glacial in age.

19. MORLEY – GROUP 1A

The Morley site is a drumlin west of Calgary formed by the Cordilleran ice sheet, the age of which is said to be "constrained by the end of local deglaciation to ~13 ka" (ref. 22, its SI Table 2). Dating of the YDB appears to be based primarily on the supposed presence of impact indicators, reported to occur on top of the drumlin. The impact indicators therefore must be younger than ~13,000 cal BP, but there is no age control for this actual locality. The estimate of ~13.ka for the Morely drumlin is based on the fact that "The largest drumlin field near Ontario (5000 km^2) contains 3,000 drumlins that date to shortly after 13 ka, and the age of the Morley drumlin field appears to be similar" (ref. 23, p. 3838). However, no evidence is provided to show in what manner the drumlins are similar or necessarily the same age, which of course must be shown given that the drumlins were deposited by two different continental ice masses – the Cordilleran and Laurentide – and the Ontario drumlin field is ~2600 km southeast of Morley.

20. MUM7B – GROUP 2A

The MUM7B site is a high elevation locality in the northwestern Venezuelan Andes that reportedly "dates to within the range of the proposed [YDB] event" (ref. 54, p. 49). The site section has several radiocarbon dates, yet all predate the Younger Dryas onset (ref. 54, its Table 1). The basis for the claim that the site is within the temporal range of interest rests on the identification of a 3-cm thick black mat found ~20 cm above the youngest dated stratum (at 11,440 ± 100 ^{14}C years BP, or 13,397-13,208 cal BP [IntCal09]). That black mat is not dated. At the time of the original investigation, the black mat was attributed to "an alpine grass fire or groundwater phenomena" (55). It was subsequently offered as a candidate for inclusion among sites showing YD-age impact markers, and although undated its occurrence above sediments dated by AMS to 13,100 cal BP was said to place it "well within the YD window," and to suggest that the MUM7B 'black mat' "sediments are coeval with 'black mat' sites in North America" (ref. 54, p. 53).

That chronological reasoning is problematic, however, since not all black mats are the same age (ref. 26, its Fig 3; 56). As we have previously noted many 'black mats' "have base dates younger than the onset of the YD, and others have base dates older than the onset of the YD" (ref. 26, p. 582). In fact, Quade et al. (57) document their formation throughout the Holocene in the Great Basin (see also 58).

21. MURRAY SPRINGS – GROUP 3A

Murray Springs is a well-known archaeological site along Curry Draw, a tributary of the San Pedro River (59). Clovis-age kills of mammoth and bison were buried by an algal mat, the type locality for the "black mat" used as a marker bed by the YDIH proponents. In the kill area, the black mat (Unit F_2) clearly buries the Clovis-age remains (which are in and resting on Unit F_1 channel sands). Firestone and colleagues (ref. 22, its SI Section C; ref. 23, p. 34) state "a thin layer (<2 cm) that contains YDB markers lies at the base of the black mat and immediately overlies the bones." Wittke et al. also note that "YDB proxies were deposited at the F_1/F_2 contact on top of bones and artifacts but beneath the black mat within a brief temporal window of a few weeks" (ref. 3, its SI page 13).

However, no evidence has been presented by any investigator for supposed YDB markers overlying the bones at Murray Springs. Further, the sampling reported by Firestone et al. (21-22) was along Trench 22 which has never been radiometrically dated (59). The sampling section discussed by Wittke et al. is not specified and has not been dated either (ref. 3, its SI p. 14) so we assume it likewise is from exposures in Trench 22.

Yet, the archaeological features buried by the black mat, the Clovis age-channel deposits (Unit F_1) under the black mat, and the marl (Unit E) are *not present* at the south end of the Trench 22 exposure where the samples for impact indicators were taken. The black mat at that section represents a compressed and mixed facies that covers a disconformity on top of Unit D. The age of the surface of Unit D has not been determined but based on the age of units F_1 and E, it must have been exposed for at least several hundred years if not thousands of years before the Clovis occupation.

As to how the supposed YDB was dated, Firestone et al. (22) cite eight ^{14}C ages averaging 10,980 ± 80 ^{14}C years BP (ref. 22, its SI Table 2); this would appear to be a misstatement of the average of eight ages from F_1 calculated as 10,900 ± 50 ^{14}C years BP (ref. 59, its Table A.1). Wittke et al. (3) recognize that Haynes and Huckell (59) "did not directly date the strata at our sampling location," and in the absence of direct dating they "integrated several locations to produce a generalized composite age-depth model that is consistent with the geochronology of Haynes and Huckell (59) for strata F_2 through strata E. For the 46-cm interval, we utilized the seven dates available on sub-strata that match the stratigraphic designations provided by Haynes and Huckell" (ref. 3, its SI p. 14). They fail to mention, however, there are ~70 radiocarbon ages available that match those stratigraphic designations (for the full listing see ref. 59, its Table A.1).[11]

We grant that not all of those 70 ages are of comparable quality or relevance (and some are different fractions of the same sample), but Wittke et al. (3) do not explain or justify why they selected

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[11] The tally of Murray Springs radiocarbon dates is not intended to be comprehensive (for a full listing see 59), but is intended to highlight the availability of other ages from the relevant stratigraphic units and their variation across the site. Such should suffice to show that the data provided by Firestone et al. (22) and Wittke et al. (3) are inadequate to determine the age of their supposed YDB layer.

the seven they did. When compared with a list of 48 ages from the relevant strata (Table S12), including many identified by the site investigators as reliable, it is obviously not the case that dates were selected by Wittke et al. (3) based on proximity to their sampling locality or to other ages – none are even from the same area of the site – or based on the material dated or the degree of uncertainty accompanying the age.

Table S12. Radiocarbon ages for Murray Springs from Wittke et al. (ref. 3 its Table S.1) and Haynes and Huckell (ref. 59, its Table A.1). The latter lists 70 radiocarbon dates derived from ~50 samples (multiple fractions were dated on some) from unit F_2, basal F_2 contact, F_1 and E. The list below includes single ages as well as average ages from multiple fractions. Ages omitted without explanation by Wittke et al. (ref. 3, its Table S.1) are highlighted in gray.

Lab no.	Level	^{14}C	±	Comments
A-969	F_{2c}	9020	360	Area 1; residue & humates (average); omitted
A-977	F_{2b}	10250	170	Area 1; carbonate
A-989b	F_{2a}	10360	90	Area 1; humates; omitted
TX-1239	F_2	9310	150	Trench 13N; carbonate; omitted
TX-1252/1253	F_2	9600	150	Trench 13N; residue & humates (average); omitted
TX-1238	F_2	9810	150	Trench 13N; carbonate
TX-1237	F_2	9660	150	Trench 13N; carbonate; omitted
TX-1184/1185	F_2	9820	110	Trench 13N; humates (average); omitted
I-4566	F_2	8830	170	Profile B; carbonate; omitted
AA-26210	F_{2a4}	9823	46	Profile B; residue; omitted
AA-26211	F_2	10325	44	Profile B; residue; omitted
AA-26212	F_{2a1}	10628	60	Profile B; residue
SMU-130/133	F_2	9400	30	North of RR; humates (average); omitted
TX-1181-1182	F_2	9370	140	Area B; humates (average); omitted
TX-1460/1461	F_2	9820	110	Area 8; humates (average); omitted
A-1045	F_2/D	10760	100	Area 4; charcoal + F_2
TX-1044	F_2/D	12600	2440	Area 4; charcoal + F_2; omitted
TX-1045	F_2/D	10260	140	Area 4; charcoal + F_2; omitted
SMU-19	F_2/F_1	10740	190	Trench 28; humates; omitted
SMU-29	F_1	10790	150	Trench 28; humates; omitted
TX-1462	F_1	10930	170	Trench 28; charcoal
SMU-1463	F_1	10900	200	Trench 28; humates; omitted
A-805A/805B	F_1	11220	330	Area 1; charcoal (average); omitted
SMU-17	F_1	8770	80	Area 1; charcoal; omitted
TX-1406	F_1	12940	390	Area 1; charcoal; omitted
TX-1413	F_1	11080	180	Area 1; charcoal; omitted
SMU-190	F_1	12820	450	Area 1; snail shell CO_2; omitted
SMU-42	F_1	10840	140	Area 2; charcoal; omitted
SMU-18	$F_1(E_2)$	11190	180	Area 2; charcoal
SMU-41	F_1	10840	70	Area 2; charcoal; omitted
SMU-43	F_1	11160	110	Area 2; humates; omitted
TX-1459	F_1	10710	160	Profile B; charcoal; omitted
SMU-27	F_1	10890	180	Trench 20; charcoal; omitted
SMU-28	F_1	11210	200	Trench 20; humates; omitted

I-4565	E	10430	160	Profile A; carbonate; omitted
I-4563	E	9780	140	Profile A; carbonate; omitted
I-4562	E	12310	170	Profile A; carbonate; omitted
I-4564	E	19620	380	Profile A; carbonate; omitted
A-897	E	21200	500	Profile A; carbonate; omitted
SMU-33	E	11880	250	Profile Y; marl residue
SMU-34	E	13980	190	Profile Y; marl residue; omitted
SMU-35	E	18060	150	Profile Y; marl residue; omitted
SMU-36	E	16180	420	Profile Y; marl residue; omitted
SMU-37	E	27560	2300	Profile Y; marl residue; omitted
SMU-38	E	19650	1400	Profile Y; marl residue; omitted
TX-1234	E	10480	200	Trench 1; carbonate; omitted
TX-1235	E	13310	190	Trench 1; carbonate; omitted
TX-1236	E	10750	170	Trench 1; carbonate; omitted

Just as problematic as the long list of omitted ages is the fact that, Wittke et al. admit, the seven ages they use are from different locations across an “approximately 300×400 m excavation area” (ref. 3, its SI p. 13). This raises the question as to how those ages were “integrated” into a common depth scale for purposes of their “interpolation by second order polynomial regression used to develop an age-depth model,” thereby enabling them to precisely determine the age of the “1-cm-thick YDB layer [that] was found at a depth of about 2.46 m at the contact between strata F_1 and F_2” (ref. 3, its SI p. 13). No explanation is provided, and given that the elevation of these stratigraphic units varies across the site, the only conclusion to be reached is that the depths assigned to those seven widely scattered dates are arbitrary and unreliable. None of those samples actually occur at those depths. Hence, the statistical analysis based on them must be as arbitrary and unreliable well.

Leaving these problems aside for the moment, the age/depth model results that Wittke et al. (ref. 3, its SI Fig. 11) present for Murray Springs are nonetheless reproducible. Using the same seven ages and depths from Wittke et al. (ref. 3, its SI p. 14 and its SI Tables S1 and S3), we estimate the depth of the supposed YDB deposits to be within 1 cm of the 2.46 m depth that they report for the YDB layer (Figure S13; a 2nd order polynomial model is used following Wittke et al. [3]). Further, a weighted regression provides an estimated age of 12,809 cal BP for this depth, which falls within the YDB interval. The weighted regression, however, is not statistically significant.

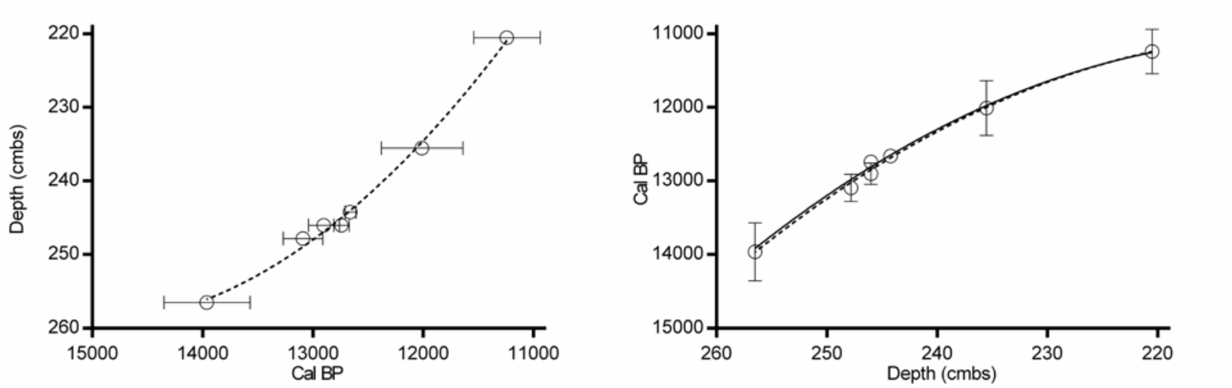

Figure S13. Graphs of replicated regression-based age/depth models for Murray Springs. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

Ultimately, however, and like the case at Blackwater Draw, because of the problematic selection of dates and the arbitrary and unclear depth scale used,[12] there is little reason to accept the age/depth model Wittke et al. (3) present for Murray Springs.

22. NEWTONVILLE – GROUP 2A

The Newtonville (New Jersey) exposure is a sandpit with two layers of loamy sand colluvium (the upper an ashen gray, the lower a yellowish brown) separated by a clear wavy boundary, with the lower of the two atop a Miocene-age sand and gravel, at the top of which a fragipan formed (ref. 60, its SI Fig. S1b). Two 10-cm thick samples were collected for analysis of impact indicators, just above and just below the boundary of the two loamy sand strata. A single OSL age of 16,800 ± 1700 years BP was obtained from matrix in a sand-filled thermokarst involution below the lower loamy sand, indicating that this coversand is Late Wisconsin in age (ref. 60, its SI p. 1). No age control is available for the upper loamy sand. Curiously, Wu et al. (60) report that the underlying, Late Wisconsin age sediment yielded 2000 magnetic microspherules per kilogram, while the upper and younger loamy sand yielded only 1800 microspherules per kilogram.

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[12] Murray Springs is one of several sites in Wittke et al. (ref. 3, its SI Table S1) in which depths are not listed in the depth column. Given that the actual depths for the Murray Springs radiocarbon samples are not on the same vertical scale, that is perhaps not surprising. The depths used in Wittke et al. (3), however, can be derived from information scattered through the text and tables cited.

23. OMMEN – GROUP 3C

As at Lingen and Lommel, the stratigraphic section at Ommen, Netherlands, is tied to the Usselo soil, and with that a presumption of a 12,800 cal BP date. Like those sites, Ommen yielded a charcoal-rich layer at the top of the Usselo sand, at a depth of 117.5 cmbs, which YDIH proponents identify as the supposed YDB layer. But as at Lommel, their radiocarbon results undermine that claim. Charcoal from the supposed YDB layer at Ommen produced an age of 11,440 ± 35 14C years BP (which they calibrate as 13,300 ± 50 cal BP) (ref. 3, its SI Table S1). Wittke et al. (ref. 3, its SI pp. 14-15) admit this date "is somewhat older than typical charcoal in the YDB," and attribute that result to "bioturbation, redeposition, or the 'old wood' effect." The possibility of mixing begs the question of the stratigraphic integrity of the supposed YDB layer. In light of what they deem an older than acceptable age, they suggest that "the stratigraphic position of the YDB in this site at the top of the Usselo sand is consistent with an age of ≈12.8 ka" (ref. 3, its SI p. 15). We have already discussed the flaws in this line of reasoning, and here again observe that a more straightforward conclusion is that this radiocarbon date merely confirms the fact that the Usselo soil represents ~1400 years of surface stability, and that the impact markers could date to any time within that age range.

24. PAW PAW COVE – GROUP 1A

Paw Paw Cove is an exposure situated along the western side of Tilghman Island in the Chesapeake Bay, Maryland. Archaeological investigations conducted by Darrin Lowery resulted in the recovery of Clovis-age artifacts "located at the contact of the 2ABtxb soil horizon and the overlying Btx [loess] soil horizon" (ref. 61, p. 53-54). The underlying 2ABtxb soil horizon has a radiocarbon age of 17,820 ± 170 ^{14}C years BP (ref. 61, p. 54), and the presence of Clovis-age artifacts on top of it suggested to Lowery that "a significant portion of terminal Pleistocene geologic time is missing from the region's upland depositional sequence. It is assumed that the region's upland areas had been eroded and deflated during and slightly after the Clovis occupation" (ref. 61, p. 56). The radiocarbon age on the underlying soil provides a *terminus post quem* for those artifacts.

Surovell et al. (27) sampled the section in the area where the artifacts were found in an effort to look for YDB indicators. LeCompte et al. (ref. 24, p. E2961) obtained a sample from a stratigraphic section estimated to be "within less than a few hundred meters of the site reported in Surovell et al." LeCompte et al. state that "Surovell et al. assumed they were sampling the YDB layer, and we have not questioned that assumption" (ref. 24, p. E29610). But since no ages are available from either section of material from the surface on which the artifacts were found, there is no evidence that either section contains an *in situ* YDB-age zone. Neither study makes reference to the underlying radiocarbon age, or the issue of deflation of the surface on which the Clovis-age artifacts were found.

25. PLAYA BASINS – GROUP 2A

The playa basins of the Great Plains are presented as having been "blown out of the soft earth by flying debris" (ref. 21, p. 217) from the "extraterrestrial event" at 12,900 cal BP. But the chronology fails here, for Firestone et al. (ref. 21, p. 216-217) misstate the results of the playa studies reported by Holliday et al. (62). Firestone et al. (ref. 21, p. 216) state that "Holliday and coworkers (62) took core samples from beneath twelve dry lake beds in the area and found radiocarbon dates ranging from 16,000 to 20,000 years ago. He concluded that because these dates are from the underlying formation, the Salinas [playas] formed more recently." Firestone et al. further state that "the age of the basins is consistent with the date of the Event," that is, the proposed YDB impact (ref. 21, p. 218). In fact, however, no radiocarbon ages 16,000-20,000 were recovered from any underlying formation. Holliday et al. (62) clearly state that some playa basins were present throughout the Late Pleistocene, but others formed between 13,000 and 10,000 ^{14}C yrs BP, and that the basins were formed by erosion. Holliday's more recent data (63) shows that most playas are >14,000 cal BP and thus substantially older than the Younger Dryas and not 'caused' by it. And as noted in the main text, there is a Clovis mammoth bone bed – the Miami site (64-65) – in a pre-YD-age playa basin. Of course, by the YDIH Clovis should not occur in a post-impact feature.

26. SHERIDEN CAVE – GROUP 3D

Sheridan Cave is on the side of a karstic sinkhole. Excavations yielded two bone points, a small Clovis point, and some microdebitage (66). A "1.5 cm thick, charcoal-rich layer at 45.3 cm below the cave floor" was identified as a YDB layer and produced apparent impact indicators (ref. 3, its SI p. 15). That charcoal lens, according to site's original investigators, is in the upper 20 cm of their Stratum 5a (ref. 66, p. 514). Wittke et al. (3) infer the age of the supposed YDB layer from three samples that "returned dates of 10.84 ± 0.08 ^{14}C ka BP (12.80 ± 0.07 cal ka BP), 10.92 ± 0.03 ^{14}C ka BP (12.83 ± 0.05 cal ka BP), and 10.96 ± 0.06 ^{14}C ka BP (12.87 ± 0.08 cal ka BP)." Together these three ages "indicate that the impact proxy-rich YDB layer at 45.3 cm dates to ≈12.8 ka, consistent with the age of the YDB at other sites" (ref. 3, its SI p. 15).

In fact, however, only two of those dates are from the charcoal lens / supposed YDB layer: the third, 10.92 ± 0.03 ^{14}C ka BP (rounded from 10,915 ± 30 ^{14}C BP), was on Bone Point 2, which was recovered 10 cm above the charcoal lens, at the contact between Stratum 5a and overlying Stratum 5b. Wittke et al. (ref. 3, its SI Fig. 13) claim that the "Clovis projectile points made of chert... and bone ... were found in the charcoal-rich YDB layer." That is not the case. As is clearly illustrated by Redmond and Tankersley (ref. 66, Fig. 9) and affirmed by Waters et al. (67), "the charcoal level within Stratum 5a is 10-15 cm below the artifact bearing level" (ref. 67, p. 108).

Moreover, the chronology of the charcoal lens is stratigraphically anomalous. There are 10 radiocarbon ages from Stratum 5a, which range from 10,840 to 12,840 ^{14}C yrs BP (Table S13). The overlying unit, Stratum 5b, has 5 radiocarbon ages, four of which range from 10,470 to 11,710 ^{14}C yrs BP (the fifth, 13,120 ^{14}C yrs BP, is rejected as an outlier by Redmond and Tankersley, ref. 66, p. 514). Leaving aside the two radiocarbon ages that are directly from the charcoal lens, the four youngest ages from upper Stratum 5a in which the lens is located form a statistical population (as determined by chi-square analysis [8]) with an average age of 11,550 ± 30 ^{14}C years BP. The overlying Stratum 5b has several statistically distinct age groups, only two of which (CAMS-10349 and CAMS-33970) can be averaged, which results in an age of 11,100 ± 40 ^{14}C years BP.

In effect, the charcoal lens is significantly *younger* than the stratum in which it occurs, as well as being younger than three of the four ages available from the overlying stratum. The charcoal lens is closest chronologically to Stratum 5c, which is atop Stratum 5b. In fact, had there been no dated samples from the charcoal lens, the chronological sequence at Sheriden would appear in better geochronological order, and the onset of the Younger Dryas would be placed not in Stratum 5a but in Stratum 5c, which has a series of four ages (Beta-117602, CAMS-26783, Beta-117601, Beta-117607) that form a statistical cluster that averages to 10,900 ± 35 ^{14}C years BP or 12,837-12,676 cal BP (IntCal09).

Table S13. Radiocarbon ages from Sheriden Cave, from Redmond and Tankersley (ref. 66, its Table 1 and Figure 9) and Waters et al. (67)

Lab no.	Stratum	^{14}C	±	Comments
Beta-139686	5c	10440	40	bone collagen *Rangifer*
Beta-117604	5c	10550	70	charcoal
Beta-117605	5c	10570	70	charcoal
Beta-117603	5c	10600	60	charcoal
Beta-117606	5c	10620	70	charcoal
AA-21710	5c	10680	80	charcoal
Beta-117602	5c	10850	70	charcoal
CAMS-26783	5c	10850	60	bone collagen *Castoroides*
Beta-117601	5c	10940	70	charcoal
Beta-117607	5c	10970	70	charcoal
AA-21712	5b	10470	70	charcoal
CAMS-10349	5b	11060	60	bone collagen *Platygonus*
CAMS-33970	5b	11130	60	bone collagen *Platygonus*
PITT-892	5b	11710	220	charcoal
UCIAMS-38249	5a/5b	10915	30	Bone Point 2
Beta-127909	5a	10840	80	charcoal from the charcoal lens
Beta-127910	5a	10960	60	charcoal from the charcoal lens
CAMS-12837	5a	11480	60	bone collagen *Arctodus*
CAMS-12839	5a	11570	70	bone collagen *Arctodus*
CAMS-33968	5a	11570	50	bone collagen *Arctodus*
CAMS-12845	5a	11610	90	bone collagen *Arctodus*
Beta-139687	5a	11860	40	bone collagen *Mylohyus*
Beta-127907	5a	12520	170	dentin collagen *Cervalces*
Beta-127908a	5a	12590	450	dentin collagen *Cervalces*
Beta-127908b	5a	12840	100	dentin collagen *Cervalces*

Complicating the matter further, ages that fall within the YDIH proponents' temporal window of 12,800 ± 150 cal BP can be found in the charcoal lens and Stratum 5a (Beta-127909, Beta-127910), at the Stratum 5a/5b contact (UCIAMS-38249), in Stratum 5b (CAMS-10349), and especially in Stratum 5c (Beta-117602, CAMS-26783, Beta-117601, Beta-117607). That being the case, it begs the question of why supposed YD impact indicators are only found in a charcoal lens that dates to 10,920 ± 50 (average of Beta-127909 and Beta-127910) that is in the upper portion of a stratum that dates to 11,550 ± 30 ^{14}C years BP. Clearly, the geochronology of Sheriden Cave is not entirely straightforward.

27. TALEGA – GROUP 3A

Talega is a 21.5 meter deep alluvial section in the Santa Ana Mountains, California. Nine samples, 30 cm thick each, were obtained from between 12.6 and 19.3 meters below surface. These were examined for impact indicators, and on that basis the supposed YDB layer was placed at the base of Stratum 12, at a depth of 14.9-15.2 meters below surface (ref. 3, its SI p. 16). The site stratigraphy as illustrated (ref. 3, its SI Fig. 14B) appears to be complex, with alternate cut and fill and ponding episodes. The 2.4 meter thick Stratum 12 is interpreted as a narrow channel fill of sand and silt "intercalated with black silt loam" inset into underlying Stratum 13 (ref. 3, its SI p. 16).

Although five radiocarbon ages are shown in the generalized stratigraphic profile, and more are alluded to in the text (which is why in the main text we can only estimate the number of omitted ages as ~4), only three radiocarbon ages are provided by Wittke et al. (ref. 3, its SI Table S1). Of the five calibrated ages shown in the generalized stratigraphic profile, only one of those (in Stratum 15) precisely matches a calibrated age provided in the table of dates (compare ref. 3, its SI Fig. 14B and its SI Table S1). These three ages (Table S14), evidently from Stratum 12 (two) and Stratum 15, are used to develop an "age-depth model generated by second-order polynomial regression" which is said to place the age of the supposed YDB layer at ~15 meters below surface to "~12.8 ka" (ref. 3, its SI p. 17).

Table S14. Radiocarbon ages from Talega site, from Wittke et al. (3)

Lab no.	Depth (mbs)	^{14}C	±	Comments
Beta-196150	13	11060	60	13020 ± 145 cal BP; Bulk carbon, Stratum 12
Beta-196151	15	11070	50	13030 ± 145 cal BP; Bulk carbon, Stratum 12
Beta-196153	21	14980	425	17920 ± 425 cal BP; Bulk carbon, Stratum 15

However, the dating of the supposed YDB layer, and indeed of the larger stratigraphic section at Talega, is complicated by contradictory and inconsistent information. Of Stratum 12, the supposed YDB layer, it is reported that "Two samples 1.7-m apart in this 2.4-m-thick section yielded an identical age of

13.02 ± 0.15 cal ka, suggesting that the channel was cut and refilled rapidly, possibly due to debris flows" (ref. 3, its SI p. 16). Although two such ages are not shown in the table of dates, perhaps that statement refers to an *average* of the two ages that are listed at depths of 13 and 15 meters below surface (Table S14): 13,020 ± 145 and 13,030 ± 145 cal BP (ref. 3, its SI Table S1). Regardless, an age of 13,020 ± 150 cal BP does not fall within the temporal target of 12,800 ± 150 cal BP.

Moreover, if as suggested these two dates "indicate that all or most of Stratum 12 is the YDB layer" (ref. 3, its SI p. 16), that seemingly contradicts the evidence from Stratum 10, which is said to have "contained a YD-age soil," and a "soil profile dating to between 11.22 ± 0.05 ^{14}C ka BP to 12.55 ± 0.40 ^{14}C ka BP" (ref. 3, its SI p. 16). When the Stratum 10 ages are calibrated (IntCal09, as per 3), the older of the two ages *predates* the YD onset by nearly 1000 calendar years (2 SD range of 13718-16477 cal BP), while the younger is just at the YD onset (2 SD range of 12930-13273 cal BP), and within the temporal target of 12,800 ± 150 cal BP. Yet, Stratum 10 is 3.1 meters *higher* in the Talega section than Stratum 12, the supposed YDB onset layer, and is not reported to have supposed impact indicators.

Likewise, two ages are shown (top to bottom) for Stratum 13: one of 13.03 ka cal BP (no standard deviation provided) and one of 13.71 ± 37 ka cal BP (ref. 3, its SI Fig. 14). And though the younger of the two ages overlaps with the two ages from Stratum 12, no explanation is provided as to why it or the older age from Stratum 13 were not utilized in the age-depth interpolation.

For that matter, our re-analysis of the Talega age/depth interpolation cannot replicate the original results. Wittke et al. (3) present their age/depth model in their SI Figure 14, stating, as noted above, that it was derived through 2nd order polynomial regression. We are unable to fit a 2nd order polynomial regression to the data that they provide for Talega in their Table S1 that resembles the curve shown in this figure, despite using a variety of software packages including Microsoft Excel, SPSS, and GraphPad Prism. Instead, we find that 2nd order polynomial regressions fit lines to the data as shown in our Figure S14. The graph on the left side of this figure has depth as the DV and shows a function that is obviously problematic as an age/depth model, while the graph on the right side of this figure has age as the DV and shows a function that, though not so obviously problematic, still does not match their curve, even accounting for the reversal of axes. This failure to replicate the curve they show goes beyond the problem with using 2^nd order polynomial functions in age/depth modeling that is discussed in the main text, and it may indicate some more fundamental error.

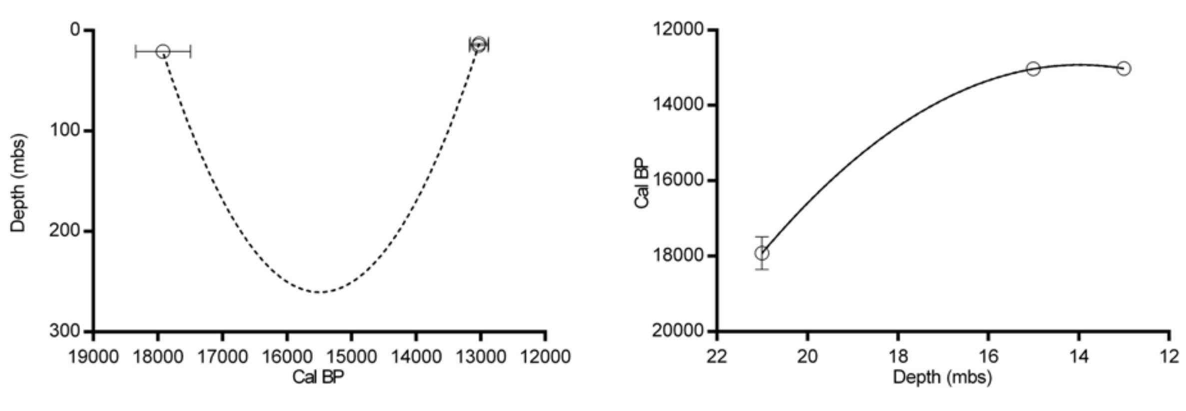

Figure S14. Graphs of replicated regression-based age/depth models for Talega. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

Nonetheless, carrying through with the replication, our re-analysis indicates that a 2^nd order polynomial regression to predict the depth of YDB-age deposits returns the absurd depth of -33 m below surface: that is, deposits of such age occur 33 meters *above* the ground surface. Aside from the problems with the curve just discussed, the reason for this result appears to be that any age-depth model using the Talega data as presented by Wittke et al. (3) involves extrapolation on the age scale beyond the youngest of the ages, which have calibrated point estimates of just over 13,000 cal BP, and hence is not an actual interpolation (as discussed above, this is also the case for Arlington Canyon). Thus, when the 2^nd order polynomial regression curve is projected through these dates at depths of 13 and 15 m below surface to 12,800 cal BP, it results in a point 33 m above the ground surface (see Figure S14, left). Ironically, this result could have been avoided had a younger age from an overlying stratum at the site not been omitted in Wittke et al. (3); however, that same overlying stratum produced an even older age. Our re-analysis indicates further that the predicted age of the 15 mbs level at Talega is 13,030 cal BP, which falls outside of the YDB interval. And finally, due to the small number of data points and the perfect fit to the data that results, regression significance cannot be calculated. We did not use MCAge Depth to analyze the larger suite of dates available for Talega, which might have provided more useful results, because actual depths were not provided for the radiocarbon ages in Stratum 10 or Stratum 13.

In sum, the dates from overlying Stratum 10 are as old or older than those in Strata 12, while the dates from underlying Stratum 13 are as young as those from Stratum 12, and the Stratum 12 dates themselves predate the YDB onset. It cannot be concluded the supposed YDB layer dates to 12,800 ± 150 cal BP or, for that matter, that anything about the geochronology at Talega well controlled.

28. TOPPER – GROUP 3A

The Topper site is located along the Savannah River of South Carolina. The primary focus of excavations at this site has been on an alluvial terrace adjacent to a chute channel of the modern river. This area of the site is well known (albeit minimally published) for its claim to have pre-Clovis artifacts (68). The geoarchaeological context of this area of the site has been summarized by Waters et al. (69), who divided the terrace into three units. Unit 1 consists of an upward fining sequence that reflects a shift from point bar to overbank floodplain deposits and Unit 2 is composed of sandy alluvium that is interspersed with gravels. Unit 3 is described by Waters et al. (69) as colluvium originating from the adjacent hillslope; they subdivided this unit into 3a and 3b with the Clovis artifact assemblage located at the base of Unit 3b. However, the Clovis horizon and the area of sampling for proposed impact indicators was in an upslope sand sheet complex that is located outside of the area examined by Waters et al. (69). The geologic units described by them do not readily translate to this area of the site. Instead, the age of the sediments is almost entirely based on the distribution of temporally diagnostic artifacts (70-71).

Seven five-cm thick discontinuous samples of bulk sediment were collected from a sequence between 0 and 180 cm below surface, of which six were examined for impact indicators. The supposed YDB layer is reported by Wittke et al. (3) to center at a depth of 60 cm below surface at the base of Stratum 3b, and at the 3b/3a contact (ref. 3, its SI p. 17). However, LeCompte et al. (24) identify the supposed YDB layer as “a 4-cm-thick layer that was centered at 79 cm below the surface (cmbs) and previously accepted as the YDB layer by Firestone et al. and Surovell et al” (ref. 24, p. E2961). That 19 cm discrepancy in the depth of the supposed YDB layer is not explained, although it is not obviously for lack of shared knowledge, as the Topper site principal investigator is a co-author on both publications.

The sampling for impact indicators and dating is further confused by incomplete reporting of where the sampling was carried out – either by LeCompte et al. (24) or Wittke et al. (3). It would appear as though samples were collected from at least two excavation blocks where the upslope Clovis occupation zone was found or claimed to be located (by 3, 22, 24, 27). It is also clear that they inexplicably chose not to sample on the alluvial terrace where Waters et al. (69) conducted their dating, despite adopting their chronology and using a sub-sample of their OSL dates to construct their age-depth model.

One of us (DSM) worked at Topper for four field seasons (2005-2008), which allows us to locate some of the sampling areas relative to one another. The samples reported by Firestone et al. (22) were collected in a block ~60m northeast and upslope from the east end (Block G) of the section illustrated by Waters et al. (ref. 69, its Fig. 4). The June 2008 sampling area reported in LeCompte et al. (ref. 24, p. E2961) was farther upslope and ~100m northeast of Block I and ~110m northeast of Block D, both of which were sampled for radiometric dating (ref. 69, its Figs 3-4, 5c, 5d). The location of the samples reported by Wittke et al. (3) is unclear. As noted, they report Block D was "approximately 60m to the west of our sample site." However, if that is correct it literally places their sample site just above a chert outcrop. The nearest excavation area east of Block D is at a distance of ~75m, and is where the samples were collected and reported by Firestone et al. (22). Goodyear (72) reports a date of ~12.8k cal yrs in association with Clovis artifacts, used to support dating of spheres by Wittke et al. (3). However, the area that produced that radiocarbon date is an excavation block ~70m north of and further upslope from the sampling area reported by LeCompte et al. (24), and ~120m north of and upslope from the area investigated by Firestone et al. (22).

Sampling for OSL and radiocarbon dating was reported by Waters et al. (69) and by Wittke et al. (3), who state that they "adopted the chronology of Waters et al. (69), based on 18 OSL dates on quartz grains" (ref. 3, its SI Table S18). However, none of these OSL ages were from the same location sampled for impact indicators; instead, and as just noted, "the closest sample location from Waters et al. (69) was in area D on transect A-G, approximately 60 m to the west of our sample site" (ref. 3, its SI p. 18). Only four of the OSL ages from Area D of the site are said to "span the YDB interval" and are used for the age/depth interpolation. Omitted without explanation are two OSL ages from area D that are within the temporal range of the four utilized ages (Table S15) as well as five OSL ages on units 3b and 2b from Area 1. Wittke et al. (3) also used a single radiocarbon age from a “charred piece of softwood” reported to be “associated with the dense floors of Clovis artifacts on the Hillside” (ref. 72, p. 11), from still another area of the site (discussed below), though they ignored more than a dozen additional available radiocarbon ages (ref. 69, its Table 1). Wittke et al. use the four OSL and one radiocarbon age to produce “a generalized age-depth model using second-order polynomial regression,” the results of which in their view place the age of the supposed YDB layer at “12.8 ka” (ref. 3, its SI p. 18).

Table S15. OSL ages from Area D of the Topper site, from Wittke et al.2013 (ref. 3, its Table S.1), Waters et al. (ref. 69, its Figure 5c and Table 2); radiocarbon age also used by Wittke et al. (3). Supposed YDB layer is at the base of Unit 3b, which in Area D overlays Unit 2B. The two OSL ages from Area D omitted without explanation by Wittke et al. (ref. 3, its Table S.1) are highlighted in gray. Five other OSL ages on units 3b and 2b from Area 1 also omitted by Wittke et al. (3) are not listed.

Lab no.	**Depth (cmbs)**	**OSL/^{14}C**	**±**	**Comments**
UIC-836	72	8000	800	Unit 3b Area D; quartz grains; omitted
UIC-782	89	7300	800	Unit 3b Area D; quartz grains; depth data omitted by Wittke et al. 2013
UIC-835	100	7600	900	Unit 3b Area D; quartz grains; Depth data omitted by Wittke et al. 2013
AA100294	not provided	10958	65	Wood; depth data omitted by Wittke et al. 2013; Goodyear 2013 reports this as 12,841 ± 62 cal BP; Wittke et al. 2013 as 12,835 ± 114 cal BP
UIC-763	119	13200	1300	Unit 3b Area D; quartz grains; Depth data omitted by Wittke et al. 2013
UIC-764	140	14800	1500	Unit 2b Area D; quartz grains; Depth data omitted by Wittke et al. 2013
UIC-837	167	14000	1200	Unit 2b Area D; quartz; omitted

The depths below surface shown in Wittke et al. (ref. 3, its SI Fig. 15) for the five ages (though only four are shown), do not correspond to the depths reported by Waters et al. (69) for those ages. The YDB layer reported by Wittke et al. (3) is at 60 cm below surface, but the highest depth reported by Waters et al. (ref. 69, its Table 2) for the four OSL ages used by Wittke et al. (3) is 89 cm below surface. Wittke et al. (3) do not explain how they obtained their depth data and interpolated their depths from the measured depths provided by Waters et al. (69) from Area D 60 m distant. Hence, it is impossible to check their analysis and results.

The sampling history at Topper raises two key points regarding the search for impact indicators and a supposed YDB layer at the site. First, there are no ages directly associated with the purported impact marker horizon. Second, all of the sampling for YDB markers was along a slope. Considering that the Clovis assemblage is along a slope break (69), downslope redeposition of the assemblage is a distinct possibility. Mixing in stratum 3 is noted by Waters et al. (ref. 69, p. 1308), highlighted by OSL ages older than the Clovis assemblage below the OSL samples. Miller (ref. 70, pp. 38-43) also found evidence for the presence of rills in the Clovis artifact horizon, and more broadly argued that a variety of factors (including tree throws and krotovinas) that could impact preservation vary greatly from one excavation unit to the next on the upslope area of the site where Firestone et al. (22), LeCompte et al. (24), and Wittke et al. (3) chose to sample. Rather than sampling within excavation units that have been analyzed and reported (71, 73-75), they instead sampled where effects of these post-depositional processes have not been assessed.

The location of both LeCompte et al. (24) and Wittke et al. (3)'s samples on a slope is also likely the source of the 19 cm discrepancy between reported depths of the YDB. In other words, Miller (70) argues that the slope of the modern ground surface does not correspond with slope of the Clovis deposit, and the Clovis deposits are found deeper relative to the ground surface with increasing distance east and north of the chert outcrop. This also casts doubt on the validity of incorporating OSL dates and a single radiocarbon date from disparate parts of the site into an age-depth model.[13]

Leaving these serious problems aside for a moment, even using the four OSL dates from the site that Wittke et al. (3) use, a YDB age for the 60 cmbs level is not supported by re-analysis (Figure S15). The re-analysis indicates a predicted depth for YDB-age sediments of 58.63 cmbs, which is within the

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[13] As with other sites, Wittke et al. (ref. 3, its SI Table S1) fail to provide specific depths used in their age-depth analysis; more problematic, the depths they appear to have used – as based on a close examination of their plot and other tables (ref. 3, its SI Fig. 15, Table S3) – do not match those provided by Waters et al. (69), despite the claim in Wittke et al. (3) to have followed that chronology.

zone that Wittke et al. (3) identify as the YDB layer. However, a weighted regression indicates a predicted age for the 60 cmbs level of 11,098 cal BP, well outside of the YDB interval. This regression is not statistically significant, and so this result should be viewed with caution, but it certainly provides no support for a YD onset age of the supposed YDB layer.

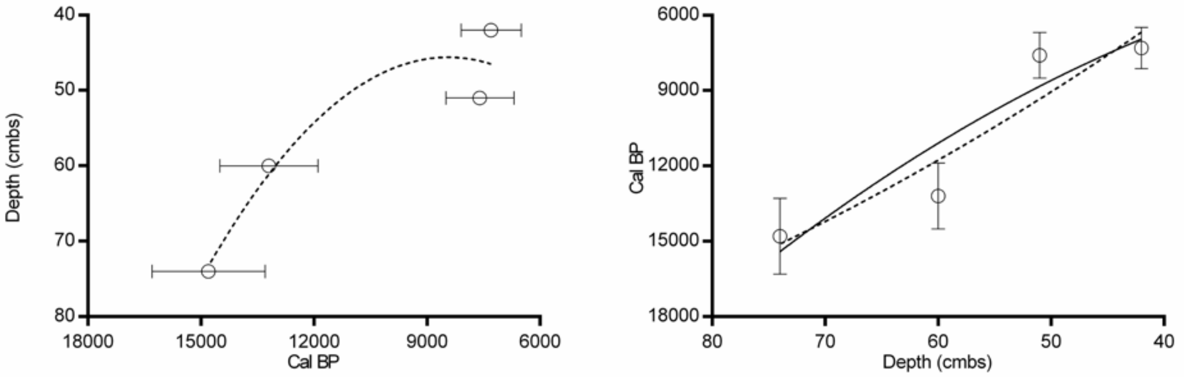

Figure S15. Graphs of replicated regression-based age/depth models for Topper. **L**: regression of depth on age; **R**: regression of age on depth. Error bars represent 1 SD. Dotted lines represent unweighted regressions, and solid lines represent weighted regressions.

In their study of magnetic microspherules at Topper, LeCompte et al. (24) describe spherules occurring essentially atop Clovis lithic debitage with a “shadow” (a significant decline in spherules) below the artifacts, implying that the spherules were draped across artifacts exposed at the surface. The layer of spherules was ~4cm thick and buried by only ~50cm of sand, however. Further, *all* samples collected below and above the highest concentration of spherules yielded measurable amounts of spherules. This strongly suggests that either: 1) all of the sand from just below the Clovis artifacts to or near the surface was deposited with spherules and the amount of spherules depends on the rate of sand deposition (which must have been slow; 50cm in 13,000 years = 1cm/260 yrs) or 2) the spherules were translocated downward and accumulated at the lithologic break created by the artifacts. Downward movement of fine particles is a common characteristic of soil formation, especially in sandy soils, and is well documented in sand mantles in the southeast (76-77). Accumulation of the particulates is also common at lithologic breaks in the soil column. Regardless of the process, the claim that the maximum number of spherules is contemporaneous with the artifacts, which may or may not be in primary context, seems unlikely.

In summary, in the absence of any age control on the section(s) sampled for supposed impact indicators, it is impossible to assert the supposed YDB layer at the Topper site falls within the target time window of 12,800 ± 150 cal BP.

29. WALLY'S BEACH – GROUP 2A

Wally's Beach is an alluvial section exposed along the shores of a modern reservoir. Erosion has revealed a Late Pleistocene vertebrate fauna located just under the surface, some of the bones with associated stone tools as well as Clovis artifacts. However, "None of the Paleoindian points recovered was *in situ* and therefore it is not possible to directly link the points with the [dated] faunal remains" (ref. 78, p. 687). Firestone et al. (22) report impact markers "including Ir at 51 ppb … inside an extinct horse skull" at Wally's Beach (ref. 22, its SI p. 12). They identify an age for that supposed impact signature of 10,980 ± 80 ^{14}C yrs BP – 12.97 cal BP – citing Kooyman et al. (78), the original investigators of the site (ref. 22, its Table 1). However, they do not mention that the cited age is actually on an extinct musk ox and not on an extinct horse, and that Kooyman et al. (78) in fact provide four radiocarbon ages from the site (Table S16), one of which is an extinct horse (but not the extinct horse that yielded the supposed impact markers) but its age significantly precedes the onset of the Younger Dryas.

Table S16. Radiocarbon ages from Wally's Beach, from Kooyman et al. (ref. 78, p. 686)

Lab no.	**Level**	**^{14}C**	**±**	**Comments**
TO-7691	Surface	10980	80	bone collagen, *Bootherium*
TO-7693	Surface	11130	90	bone collagen, *Bison*
TO-7696	Surface	11330	70	bone collagen, *Equus*
TO-8972	Surface	11350	80	bone collagen, *Rangifer*

And, as noted in the main text, the timing of the sediment deposition *within the bone* is altogether unknown, for that process would have depended on when the carcass decomposed and its skeletal cavities opened, and how often the skull cavity was swept clean of sediment and refilled.

Table S17. Radiometric data used in attempts to replicate age/depth models employed by YDIH proponents; data are from Wittke et al. (ref. 3 its Table S1) except as noted in site-by-site discussions.

Site	**Date Type**	**Lab Number**	**Depth**[1]	**^{14}C BP**	**^{14}C SD**	**Cal BP**	**Cal SD**
Abu Hureya	^{14}C	OxA-170	285.33	10600	200	12430	270
Abu Hureya	^{14}C	OxA-407	285.13	10050	180	11680	320
Abu Hureya	^{14}C	OxA-386	285.12	10800	160	12780	140
Abu Hureya	^{14}C	OxA-473	284.95	10000	170	11610	290
Abu Hureya	^{14}C	OxA-397	284.91	10420	140	12310	240
Abu Hureya	^{14}C	OxA-434	284.91	10490	150	12370	230
Abu Hureya	^{14}C	OxA-171	284.72	10600	200	12430	270
Abu Hureya	^{14}C	UCIAMS-105429	284.70	11070	40	12932	176
Abu Hureya	^{14}C	BM-1718R	284.67	11140	140	13040	150
Abu Hureya	^{14}C	OxA-430	284.56	11020	150	12940	130
Abu Hureya	^{14}C	OxA-172	284.29	10900	200	12870	160
Abu Hureya	^{14}C	OxA-468	284.29	11090	150	13000	160
Abu Hureya	^{14}C	OxA-883	284.29	11450	300	13370	300
Arlington Canyon	^{14}C	UCIAMS-47239	394.00	11105	30	13020	50
Arlington Canyon	^{14}C	UCIAMS-42816	404.50	11095	25	13010	50
Arlington Canyon	^{14}C	UCIAMS-36308	461.50	11095	25	13010	50
Arlington Canyon	^{14}C	UCIAMS-36307	471.00	11070	25	13000	50
Arlington Canyon	^{14}C	UCIAMS-36959	487.00	11075	30	13000	50
Arlington Canyon	^{14}C	UCIAMS-36960	487.00	11185	30	13090	60
Arlington Canyon	^{14}C	UCIAMS-36961	487.00	11440	90	13310	80
Arlington Canyon	^{14}C	UCIAMS-36962	487.00	11110	35	13020	60
Arlington Canyon	^{14}C	UCIAMS-36306	495.00	11375	25	13250	40
Arlington Canyon	^{14}C	UCIAMS-36305	495.50	11235	25	13150	40
Arlington Canyon	^{14}C	UCIAMS-36304	500.50	11020	25	12960	50
Barber Creek	OSL	UW 1907	80.00	--	--	9200	700
Barber Creek	OSL	UW 1908	100.00	--	--	12100	700
Barber Creek	OSL	UW 1909	140.00	--	--	14500	1000
Big Eddy	^{14}C	AA-35462	283.00	9835	70	11250	90
Big Eddy	^{14}C	AA-72611	285.00	9751	64	11180	110
Big Eddy	^{14}C	AA-72609	286.00	9924	50	11331	100
Big Eddy	^{14}C	AA-72610	294.00	10440	160	12275	270
Big Eddy	^{14}C	AA-26653	298.00	10185	75	11870	170
Big Eddy	^{14}C	AA-75719	303.00	10506	53	12467	120
Big Eddy	^{14}C	AA-27487	306.00	10400	75	12295	160
Big Eddy	^{14}C	AA-27480	308.00	10340	100	12200	210
Big Eddy	^{14}C	AA-29022	313.00	10430	70	12350	160
Big Eddy	^{14}C	AA-75720	315.00	10896	54	12765	30
Big Eddy	^{14}C	AA-72607	317.00	9960	920	11450	1210
Big Eddy	^{14}C	AA-27488	321.00	10470	80	12440	170
Big Eddy	^{14}C	Beta-230984	322.00	10940	60	12807	40
Big Eddy	^{14}C	AA-72612	322.00	10959	54	12823	40
Big Eddy	^{14}C	AA-27485	322.00	11280	75	13170	70
Big Eddy	^{14}C	AA-27481	326.00	11160	75	13060	70
Big Eddy	^{14}C	AA-25778	328.00	10260	85	12020	190
Big Eddy	^{14}C	AA-27486	331.00	11900	80	13765	90

Big Eddy	^{14}C	AA-26654	333.00	10710	85	12755	100
Big Eddy	^{14}C	AA-27482	338.00	11190	75	13090	80
Big Eddy	^{14}C	AA-26655	347.00	10940	80	12900	60
Big Eddy	^{14}C	AA-72608	347.00	12450	300	14607	440
Big Eddy	^{14}C	AA-34586	358.00	12320	130	14330	260
Big Eddy	^{14}C	AA-34587	364.00	11930	110	13795	120
Big Eddy	^{14}C	AA-72613	373.00	11960	270	13867	380
Big Eddy	^{14}C	AA-34588	375.00	12250	100	14150	210
Big Eddy	^{14}C	AA-34589	383.00	11375	80	13245	70
Big Eddy	^{14}C	AA-27483	384.00	11910	440	13890	570
Big Eddy	^{14}C	AA-34590	386.00	12590	85	14785	210
Big Eddy	^{14}C	AA-27484	396.00	12700	180	14910	330
Blackville	OSL	LB862	107.00	--	--	11500	1030
Blackville	OSL	LB859	183.00	--	--	12960	1190
Blackwater Loc. 1	^{14}C	A-4703	1237.97	10000	910	11480	1160
Blackwater Loc. 1	^{14}C	A-4705	1237.86	9260	320	10500	470
Blackwater Loc. 1	^{14}C	AA-2261	1237.76	9950	100	11480	180
Blackwater Loc. 1	^{14}C	SMU-1880	1237.56	10780	110	12770	80
Blackwater Loc. 1	^{14}C	AA-2262	1237.48	11810	90	13650	110
Kimbel Bay	^{14}C	UCIAMS 52613	147.00	1195	15	1130	40
Kimbel Bay	OSL	LB863	375.00	--	--	25500	2720
Kimbel Bay	OSL	LB864	406.00	--	--	26080	2940
Kimbel Bay	OSL	AW-SKB-6	436.00	--	--	21640	2630
Kimbel Bay	^{14}C	UCIAMS 52622	445.00	27250	130	31900	120
Kimbel Bay	^{14}C	UCIAMS 52622	450.00	39690	710	43460	610
Lake Cuitzeo	^{14}C	A-9351	70.00	930	55	860	60
Lake Cuitzeo	^{14}C	A-9352	85.00	1755	115	1690	130
Lake Cuitzeo	^{14}C	A-9353	135.00	6165	70	7070	90
Lake Cuitzeo	^{14}C	A-9354	195.00	8830	215	9910	260
Lake Cuitzeo	^{14}C	T11-M47	335.00	15500	130	18810	80
Lake Cuitzeo	^{14}C	WW-6422	365.00	23870	100	27850	300
Lake Cuitzeo	^{14}C	WW-3576	375.00	28289	120	32710	240
Lake Cuitzeo	^{14}C	WW-6423	380.00	29490	190	33880	260
Lake Cuitzeo	^{14}C	WW-8454	400.00	22780	120	27490	340
Lake Cuitzeo	^{14}C	WW-8455	440.00	21450	100	25460	220
Lake Cuitzeo	^{14}C	AZ-120*	470.00	26800	900	31450	800
Lake Cuitzeo	^{14}C	WW-8456	535.00	29890	280	34170	240
Lake Cuitzeo	^{14}C	A-9359	610.00	32565	2885	37350	2950
Lake Cuitzeo	^{14}C	WW-3364	665.00	28600	140	33050	260
Lake Cuitzeo	^{14}C	A-9770	910.00	42400	1000	45540	1100
Melrose	Surface	--	0.00	--	--	0	--
Melrose	OSL	LB860a	28.00	--	--	16400	1600
Murray Springs	^{14}C	TX-1238	220.50	9810	150	11240	300
Murray Springs	^{14}C	A-977	235.50	10250	170	12010	370
Murray Springs	^{14}C	AA-26212	244.20	10628	60	12660	50
Murray Springs	^{14}C	A-1045	246.00	10760	100	12740	70
Murray Springs	^{14}C	TX-1462	246.00	10930	170	12900	140
Murray Springs	^{14}C	SMU-18	247.80	11190	180	13090	180
Murray Springs	^{14}C	SMU-33	256.50	11880	250	13960	390
Talega	^{14}C	Beta-196150	13.00	11060	60	13020	145

Talega	^{14}C	Beta-196151	15.00	11070	50	13030	145
Talega	^{14}C	Beta-196153	21.00	14980	425	17920	425
Topper	OSL	UIC-782	42.00	--	--	7300	800
Topper	OSL	UIC-835	51.00	--	--	7600	900
Topper	OSL	UIC-763	60.00	--	--	13200	1300
Topper	OSL	UIC-764	74.00	--	--	14800	1500

1. See Table 2 of the main text for units of measurement, which vary among the sites.

Table S18. Regression coefficients from age/depth model replication analyses of sites in Group 3a. Big Eddy (Group 3b) included here as well.

a. Unweighted regression, depth as DV

Site	B0	B1	B2	B3	B4	B5
Abu Hureyra	290.243	-4.354E-04				
Arlington Canyon	-904.265	0.105				
Barber Creek	221.761	-3.237E-02	1.843E-06			
Big Eddy	2.067	3.506E-05				
Blackville	-491.630	5.205E-02				
Blackwater Draw	1253.856	-3.957				
Kimbel Bay	-442.932	193.925				
Lake Cuitzeo	93.278	-2.046E-02	5.704E-06	-3.312E-10	7.717E-15	-6.121E-20
Melrose	0.000	1.707E-03				
Murray Springs	-327.271	7.763E-02	-2.568E-06			
Talega	-9473.032	1.256742	-4.06E-05			
Topper	94.329	-1.155E-02	6.845E-07			

b. Unweighted regression, age as DV

Site	B0	B1	B2	B3	B4	B5
Abu Hureyra	3.071E+05	-1034.346				
Arlington Canyon	1.260E+04	1.017				
Barber Creek	-1.373E+04	400.000	-1.417			
Big Eddy	-4.201E+04	2.181E+04				
Blackville	9444.474	19.211				
Blackwater Draw	246.381	-0.196				
Kimbel Bay	3.134	3.140E-03				
Lake Cuitzeo	-520.911	-12.330	0.576	-1.193E-03	7.463E-07	-5.312E-11
Melrose	0.000	585.714				
Murray Springs	6.297E+04	-501.316	1.210			
Talega	3.270E+04	-2830.000	101.250			
Topper	-8725.790	425.164	-1.392			

c. Weighted regression, age as DV

Site	B0	B1	B2	B3	B4	B5
Abu Hureyra	2.083E+05	-686.896				
Arlington Canyon	1.256E+04	1.085				
Barber Creek	-1.373E+04	400.000	-1.417			
Big Eddy	-2.706E+04	1.588E+04				
Blackville	9444.474	19.211				
Blackwater Draw	340.231	-0.272				
Kimbel Bay	2.328	4.902E-03				
Lake Cuitzeo	-1.343E+04	302.075	-1.779	5.767E-03	-7.995E-06	3.837E-09
Melrose	--	--				
Murray Springs	6.474E+04	-514.670	1.234			
Talega	3.270E+04	-2830.000	101.250			
Topper	3432.149	-18.771	2.442			

Table S19. r^2 values for age/depth model regressions from replication analyses and *p* values for the regression coefficients given in Table S18 for Group 3a sites. Big Eddy (Group 3b) included here as well.

a. Unweighted regression, depth as DV

Site	**r^2**	***p*: B0**	***p*: B1**	***p*: B2**	***p*: B3**	***p*: B4**	***p*: B5**
Abu Hureyra	0.450	< 0.001	0.012				
Arlington Canyon	0.107	0.512	0.326				
Barber Creek	1.000	n/a	n/a	n/a			
Big Eddy	0.758	< 0.001	< 0.001				
Blackville	1.000	n/a	n/a				
Blackwater Draw	0.745	< 0.001	0.060				
Kimbel Bay	0.954	0.008	0.001				
Lake Cuitzeo	0.912	0.391	0.761	0.587	0.588	0.605	0.636
Melrose	1.000	n/a	n/a				
Murray Springs	0.995	0.014	0.003	0.007			
Talega	1.000	n/a	n/a	n/a			
Topper	0.918	0.517	0.668	0.594			

b. Unweighted regression, age as DV

Site	**r^2**	***p*: B0**	***p*: B1**	***p*: B2**	***p*: B3**	***p*: B4**	***p*: B5**
Abu Hureyra	0.450	0.010	0.012				
Arlington Canyon	0.107	< 0.001	0.326				
Barber Creek	1.000	n/a	n/a	n/a			
Big Eddy	0.767	< 0.001	< 0.001				
Blackville	1.000	n/a	n/a				
Blackwater Draw	0.780	0.045	0.047				
Kimbel Bay	0.784	0.060	0.019				
Lake Cuitzeo	0.944	0.977	0.972	0.794	0.844	0.920	0.987
Melrose	1.000	n/a	n/a				
Murray Springs	0.995	0.006	0.008	0.005			
Talega	1.000	n/a	n/a	n/a			
Topper	0.875	0.839	0.782	0.914			

c. Weighted regression, age as DV

Site	**r^2**	***p*: B0**	***p*: B1**	***p*: B2**	***p*: B3**	***p*: B4**	***p*: B5**
Abu Hureyra	0.330	0.031	0.040				
Arlington Canyon	0.140	< 0.001	0.257				
Barber Creek	1.000	n/a	n/a	n/a			
Big Eddy	0.617	< 0.001	< 0.001				
Blackville	1.000	n/a	n/a				
Blackwater Draw	0.964	0.003	0.003				
Kimbel Bay	0.996	0.032	< 0.001				
Lake Cuitzeo	0.958	0.195	0.193	0.279	0.251	0.230	0.218
Melrose	--	--					
Murray Springs	0.959	0.122	0.140	0.106			
Talega	1.000	n/a	n/a	n/a			
Topper	0.850	0.933	0.990	0.854			

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