



Research Article

The Language of Opposition: A Quantitative Analysis of Four Papers Critical of the Younger Dryas Impact Hypothesis

James Lawrence Powell^{1,*} 

¹Independent Scholar, Los Angeles, USA

*Correspondence to: James Lawrence Powell, E-mail: jpowell@usc.edu

Received: 1 April 2026; Revised: 1 April 2026; Accepted: 1 April 2026; Published online: 23 April 2026

How to cite: Powell J.L., The Language of Opposition: A Quantitative Analysis of Four Papers Critical of the Younger Dryas Impact Hypothesis. *Airbursts and Cratering Impacts*. 2026 | Volume 4 | Issue 1 | Pages: 1–30 | DOI: 10.14293/ACI.2026.0005

ABSTRACT

The Younger Dryas Impact Hypothesis (YDIH), first proposed in 2007, holds that an extraterrestrial body impacted or burst in the air over North America about 12,800–12,900 years ago and contributed to the onset of Younger Dryas cooling, the disappearance of the Clovis Culture, and the Pleistocene megafaunal extinction. This study examines the use of tendentious language and logical fallacies by four papers that oppose the YDIH — Pinter and Ishman (2008), Pinter et al. (2011), Boslough et al. (2012), and Holliday et al. (2023) — through a sentence-by-sentence audit of their narrative content. Across the four papers, rhetoric of this kind appears in nearly four in ten narrative sentences audited — a rate more than four times higher than that found in a comparison sample of evidentiary (data-focused) papers on either side of the debate. When opposition to a hypothesis relies this heavily on rhetoric and logical fallacies rather than evidence and analysis, readers are entitled to ask what, if anything, in the oppositional literature can be taken at face value.

KEYWORDS

Younger Dryas Impact Hypothesis, rhetorical analysis, logical fallacies, peer review, tendentious language

Introduction

The focus of this article is the Younger Dryas Impact Hypothesis (YDIH), first proposed by Firestone et al. (2007) [1]. The hypothesis posits that about 12,900 years ago, a comet struck or burst in the atmosphere over North America, triggering an “impact winter.” The hypothesis immediately became controversial, and the published criticism of it now

forms a substantial literature of its own. The four critical papers total to 128,348 words.

This study does not weigh the evidence for or against the YDIH but instead examines the language in which opposition to the hypothesis has been expressed — specifically, the extent to which that language relies on improper rhetoric and logical fallacies rather than on evidence and analysis.

© 2026 The Author(s).  This work has been published open access under Creative Commons Attribution License CC BY 4.0 <https://creativecommons.org/licenses/by/4.0/>, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited. Conditions, terms of use and publishing policy can be found at www.scienceopen.com.

Methods

The four opposition papers selected for this study share a common character: they are extended critical assessments that argue against the YDIH rather than papers that report new empirical findings. A fifth opposition paper, Surovell et al. (2009), was excluded from this set because it is a data paper — an attempted replication of the YDIH microspherule evidence — not a critical review [2]. Its language is assessed later alongside two other evidentiary papers, on the same terms.

Every narrative sentence in each of the four papers was evaluated for tendentious language and logical fallacies. For this purpose, a narrative sentence is one that advances an argument, reports a finding, characterizes evidence, or makes a claim — in short, a sentence that bears directly on the scientific case being made. Table captions, table headers, footnotes, reference entries, section headings, and procedural statements (“Samples were analyzed by SEM”) were excluded. All quotations were verified against the published text.

Artificial intelligence was used for initial screening, which saved considerable time, reduced the likelihood that relevant passages would be overlooked, and avoided reviewer bias. Every candidate sentence identified in screening was then reviewed, and none was included unless it clearly exhibited improper language. Final decisions were made by the author.

The threshold for evaluating a sentence went beyond ordinary scientific disagreement. Papers that challenge a hypothesis naturally use strong language, and not every pointed phrase qualifies. What crossed the line here were recurrent patterns: skeptical qualifiers applied before evidence is examined (“purported,” “so-called,” “claimed,” “supposed”); labels that pre-judge the outcome (“requiem,” “fatally flawed”); statements attributing motive, bad faith, or incompetence without evidentiary support; ad hominem attacks; and so on.

Note that this study examines words and arguments as they appear in the published text. No inference is drawn about the intentions, competence, or character of the authors; the analysis is confined to what the sentences say and how they say it.

Results

Below are summaries of the analyses of the four critical papers. A full report on each is in the Appendices.

Pinter & Ishman (2008) [3]

Paper: Pinter, N. and Ishman, S.E. (2008) “Impacts, mega-tsunami, and other extraordinary claims.” *GSA Today*, v. 18, no. 1 (Appendix 1).

This is the first and the shortest of the four papers, and the most heavily rhetorical throughout. It has only 51 narrative

sentences, and more than half contain improper language. No section of the paper is free of it and the opening and closing paragraphs are entirely rhetorical Table 1.

Pinter et al. (2011) [4]

Paper: Pinter, N., Scott, A.C., Daulton, T.L., Podoll, A., Koeberl, C., Anderson, R.S., and Ishman, S.E. (2011) “The Younger Dryas impact hypothesis: A requiem.” *Earth-Science Reviews*, v. 106, p. 247–264 (Appendix 2).

This paper contains substantial stretches of clean scientific prose in the technical middle sections where data are reported. The sections that frame the argument — Abstract, Introduction, and Conclusions — carry the weight, and 73% of the sentences in the Conclusions are faulty Table 2.

Table 1: Distribution of sentences containing loaded language and logical fallacies across paragraphs in Pinter and Ishman (2008).

Paragraph	Total sentences	With loaded language/fallacies	Rate
¶1 (Opening)	3	3	100%
¶2 (Chevrons/craters)	8	3	38%
¶3 (Chevron terminology)	4	1	25%
¶4 (YDIH introduction)	4	3	75%
¶5 (YDIH evidence)	10	7	70%
¶6 (Evidence continued)	6	3	50%
¶7 (Ubiquitous spherules)	5	1	20%
¶8 (Nanodiamonds)	4	2	50%
¶9 (Other evidence)	5	2	40%
¶10 (Closing)	2	2	100%
TOTAL	51	27	52.9%

Table 2: Distribution of sentences containing loaded language and logical fallacies across sections in Pinter et al. (2011).

Section	Total sentences	With loaded language/fallacies	Rate
Abstract	12	9	75%
§1 Introduction	18	11	61%
§1.1 The hypothesis	22	8	36%
§2 Early YDB markers (§2.1–2.6)	68	12	18%
§2.7 Summary	8	6	75%
§3 Remaining markers intro	3	1	33%
§3.1 Carbon spherules	28	6	21%
§3.2 Magnetic grains/spherules	32	8	25%
§3.2.1 Additional results	22	3	14%
§3.3 Wildfire/fire evidence	38	10	26%
§3.3.1 Additional results	16	2	12%
§3.4 Nanodiamonds	42	8	19%
§4 Discussion	8	5	62%
§4.1 Catastrophic vs. non-catastrophic	28	14	50%
§4.2 Terrestrial vs. ET	18	6	33%
§4.3 Impact signatures at YDB	22	10	45%
§5 Conclusions	30	22	73%
TOTAL	415	141	34.0%

Boslough et al. (2012) [5]

Paper: Boslough, M., Nicoll, K., Holliday, V., Daulton, T.L., Meltzer, D., Pinter, N., Scott, A.C., Surovell, T., Claeys, P., Gill, J., Paquay, F., Marlon, J., Bartlein, P., Whitlock, C., Grayson, D., and Jull, A.J.T. (2012) “Arguments and Evidence Against a Younger Dryas Impact Event.” *Climates, Landscapes, and Civilizations*, AGU Geophysical Monograph Series 198, pp. 13–26.

This paper has the lowest overall rate of the four (32.9%), reflecting physics content in §2.2 and legitimate paleoclimate discussion in §3.2. The tendentious rhetoric concentrates in the sections most readers will see first and last — the Abstract, Introduction, and Conclusions [Table 3](#) ([Appendix 3](#)).

Holliday et al. (2023) [6]

Paper: Holliday, V.T., Daulton, T.L., Bartlein, P.J., Boslough, M.B., Breslawski, R.P., Fisher, A.E., Graybill, I.A., Pinter, N., Scott, A.C., Surovell, T.A., et al. (2023) “Comprehensive Refutation of the Younger Dryas Impact Hypothesis (YDIH).” *Earth-Science Reviews* 247: 104502 ([Appendix 4](#)).

The longest at 96,345 words, this paper contains approximately 537 narrative sentences. Of these, 170 contain tendentious language or logical fallacies (31.7%) [Table 4](#). The highest concentrations again appear in the framing sections — the Abstract (88%), §15 Promotion Outside Science (56%), and the Conclusions (73%) — but unlike the other three papers, such language also appears in the technical sections, where no section is free of them. The infractions are distributed across twenty-five categories. The most frequent are overstatement (22 instances), dismissive characterization (20), prejudicial qualifiers such as “purported” and “so-called” (15), prejudicial framing (14), and accusations of falsehood (14). The

Table 3: Distribution of sentences containing loaded language and logical fallacies across sections in Boslough et al. (2012).

Section	Total sentences	With loaded language/fallacies	Rate
Abstract	12	7	58%
§1 Introduction	28	14	50%
§2 Fundamental Flaws header	4	3	75%
§2.1 Inconsistencies	10	5	50%
§2.2 Physical Implausibility	32	4	12%
§2.3 Infinitesimal Likelihood	18	6	33%
§3 Evidence-Based Arguments intro	10	5	50%
§3.1 No Impact Markers or Crater	18	6	33%
§3.2 Nonunique Events (§3.2.1–3.2.5)	28	4	14%
§3.3 Irreproducibility (§3.3.1–3.3.6)	38	8	21%
§3.4 Radiocarbon Dating	16	5	31%
§4 Conclusions	8	6	75%
TOTAL	222	73	32.9%

paper also contains ad hominem attacks (12), accusations of incompetence (6), condescension (8), motive imputation (4), guilt by association (5), the pseudoscience label (3), and language — documented in the Appendix — that is close to that used in formal misconduct investigations. Borderline cases were resolved in favor of the authors, and the count reported here represents a conservative application of the criteria described in the Methods section; a less restrictive reading of the same criteria would yield a higher figure.

The range of derisive vocabulary deployed in this single paper is likely unprecedented in the peer-reviewed literature. Prejudicial qualifiers applied to YDIH evidence before it is examined — ‘purported,’ ‘claimed,’ ‘supposed,’ ‘so-called,’ ‘proclaimed,’ ‘alleged,’ ‘putative’ — appear scores of times. Dismissive characterizations include ‘fanciful,’ ‘baseless,’ ‘spurious,’ ‘meaningless,’ ‘preposterous,’ ‘ridiculous,’ ‘nonsensical,’ ‘outlandish,’ ‘bizarre,’ ‘absurd,’ ‘dubious,’ ‘pointless,’ and ‘pure fiction.’ Accusatory terms include ‘falsely,’ ‘misleading,’ ‘misstatements of fact,’ ‘blatantly untrue,’ ‘deceptive,’ ‘negligent,’ and ‘malfeasance.’ Terms implying incompetence — ‘misunderstanding,’ ‘misinterpretation,’ ‘misperception,’ ‘misapprehension,’ ‘befuddled’ — appear more than thirty times. Delegitimizing labels include ‘pseudoscience,’ ‘pseudoarchaeological,’ ‘fringe science,’ and ‘not rooted in science.’ No comparable vocabulary appears in any of the evidentiary papers examined in this study or in any other scientific paper with which the author is familiar.

Table 4: (Holliday et al. 2023): Distribution of sentences containing loaded language and logical fallacies across sections in Holliday et al. (2023).

Section	Total sentences	With loaded language/fallacies	Rate
Abstract	16	14	88%
§1 Introduction	28	18	64%
§2 Defining the Younger Dryas	22	3	14%
§3 Flawed Fundamental Assumptions	38	29	76%
§4 Flawed Sampling	20	13	65%
§5 Inadequate Dating (all)	55	22	40%
§6 Misinterpreted Black Mats	28	4	14%
§7 Multifarious Impact Scenarios	30	7	23%
§8 Impact Indicators/Craters	25	4	16%
§9 Wildfires/Charcoal	32	5	16%
§10 Microspherules	35	2	6%
§11 Platinum	22	2	9%
§12 Nanodiamonds	40	5	12%
§13–14 Other Evidence/Abandoned; Same Specimens	31	7	23%
§14 Promotion Outside Science	18	10	56%
§15 Discussion	35	9	26%
Conclusions	22	16	73%
TOTAL	~537	~170	31.7%

Accusatory language tantamount to allegations of misconduct

Two statements in Holliday et al. (2023) earn special emphasis:

Evidence and arguments purported to support the YDIH involve flawed methodologies, inappropriate assumptions, questionable conclusions, misstatements of fact, misleading information, unsupported claims, irreproducible observations, logical fallacies, and selected omission of contrary information.

Claiming that a paper states the opposite conclusion to make a point about purported impacts represents scientific malfeasance.

These accusatory phrases are the language of university and agency scientific misconduct investigations, even though no such allegations have been made against any YDIH proponent.

Evidentiary papers

The four opposition papers analyzed above are extended critical reviews that argue against the YDIH. An obvious question is whether comparable rates of loaded language and logical fallacies appear in evidentiary papers—that is, ones whose primary purpose is to report new data rather than to mount a critical review. To answer, we consider a sample of three evidentiary papers: Firestone et al. (2007), Surovell et al. (2009), and Kennett et al. (2015) [7]. The threshold for evaluating a sentence is the same for these three as in the main study.

Firestone et al. (2007)

Paper: Firestone, R.B.; West, A.; Kennett, J.P.; Becker, L.; Bunch, T.E.; Revay, Z.S.; Schultz, P.H.; Belgia, T.; Kennett, D.J.; Erlandson, J.M.; et al. “Evidence for an Extraterrestrial Impact 12,900 Years Ago that Contributed to the Megafaunal Extinctions and the Younger Dryas Cooling.” *Proc. Natl. Acad. Sci. USA* 2007, 104(41), 16016–16021 ([Appendix 5](#)).

This paper founded the Younger Dryas Impact Hypothesis. It is a data-dense, six-page PNAS article presenting seven categories of evidence from ten Clovis-age sites and fifteen Carolina Bays across North America and one site in Belgium. The paper is organized along standard lines: evidence by impact marker type, then a Discussion addressing each marker category, the nature of the event, environmental effects, and the fate of Clovis people and megafauna.

The rhetorical issues concentrate in the Abstract, the opening Introduction paragraph, the “Nature of the Event” subsection of the Discussion, and the Conclusions. The infractions are considerably less severe, less pervasive, and less structurally central than those documented in the four opposition papers analyzed in the main study. The manuscript contains

approximately 175 narrative sentences. Of these, 12 contain loaded language or logical fallacies (6.9%) [Table 5](#).

Surovell et al. (2009)

Paper: Surovell, T.A., Holliday, V.T., Gingerich, J.A.M., Ketron, C., Haynes, C.V., Hilman, I., Wagner, D.P., Johnson, E., and Claeyes, P. (2009). “An independent evaluation of the Younger Dryas extraterrestrial impact hypothesis.” *Proc. Natl. Acad. Sci. USA* 106(43): 18155–18158 ([Appendix 6](#)).

The authors searched for extraterrestrial microspherules at seven Younger Dryas sites, including two examined by Firestone et al. (2007): Blackwater Draw and Topper. At three sites, including Topper, they found no microspherule peaks at any stratigraphic level; at the other four, including Blackwater Draw, they found microspherules but no peak at the YDB. Their abstract concluded that they found “no support for an extraterrestrial cause of the YD event and New World Pleistocene extinctions.” But this is a classic absence-of-evidence argument. They had shown that they had not been able to replicate the microspherule peaks, not that such peaks were inherently irreproducible. Firestone et al. (2007) included a photograph of microspherules from Blackwater Draw and three other sites — proof of existence that Surovell et al. do not mention. The manuscript contains approximately 60 narrative sentences. Of these, 8 contain loaded language or logical fallacies (13.3%) [Table 6](#).

Kennett et al. (2015) [7]

Paper: Kennett, J.P., Kennett, D.J., Culleton, B.J., et al. (2015). “Bayesian chronological analyses consistent with synchronous age of 12,835–12,735 Cal B.P. for Younger Dryas boundary on four continents.” *Proc. Natl. Acad. Sci. USA* 112(32): E4344–E4353 ([Appendix 7](#)).

An extraterrestrial impact would have been instantaneous, so that, if the YDIH is correct, within the precision of the radiocarbon method the age of the YD boundary should be synchronous wherever it is sampled.

In 2014, Meltzer et al. published a paper titled “Chronological evidence fails to support claim of an isochronous widespread layer of cosmic impact indicators dated to 12,800 years ago.”

Table 5: Distribution of sentences containing loaded language and logical fallacies across sections in Firestone et al. (2007).

Section	Total sentences	Faulty sentences	Rate
Abstract	8	2	25%
Introduction	12	2	17%
Results (all marker sections)	55	0	0%
Discussion — Age/Peaks/Markers/Iridium/Ice Core/Radioactive	50	2	4%
Discussion — Nature of Event/Environmental Effects/Climate	30	4	13%
Discussion — Clovis and Megafauna	10	1	10%
Conclusions	10	1	10%
TOTAL	175	12	6.9%

Table 6: Distribution of sentences containing loaded language and logical fallacies across sections in Surovell et al. (2009).

Section	Total sentences	Faulty sentences	Rate
Abstract	4	0	0%
Introduction	4	0	0%
Results	28	2	7%
Discussion	16	5	31%
Methods	8	1	13%
TOTAL	60	8	13.3%

Their abstract concluded, “There is no reason or compelling evidence to accept the claim that a cosmic impact occurred ~12,800 y ago and caused the Younger Dryas.” [8].

By the time Kennett et al. submitted their paper, the YDIH proponents had been publicly criticized not only by Meltzer et al. (2014) but also in the first three opposition papers analyzed in this study. It would have been understandable had Kennett et al. (2015) responded in kind, but they did not.

Kennett et al. reported radiocarbon dates for 23 YDB sites in 12 countries on four continents and found that the “...ages are consistent with synchronous deposition of the YDB layer within the limits of dating uncertainty (~100 y).” The manuscript contains approximately 210 narrative sentences. Of these, 11 contain loaded language or logical fallacies (5.2%) Table 7.

Summary

Table 8 summarizes the results of the seven analyses. The average rate of faulty sentences for the four critical review papers is 37.8% and for the three evidentiary ones, 8.3%, more than a fourfold difference.

Limitations

Classifying tendentious language and logical fallacies requires judgment, and two analysts applying the same criteria would not necessarily produce identical results. The percentage figures reported here should not be mistaken for the kind of precision that attaches to physical measurements.

Table 7: Distribution of sentences containing loaded language and logical fallacies across sections in Kennett et al. (2015).

Section	Total sentences	Faulty sentences	Rate
Abstract + Significance	18	0	0%
Introduction	45	5	11%
Results	105	6	6%
Bayesian background + Synchronicity	25	0	0%
Conclusions	17	0	0%
TOTAL	210	11	5.2%

The presence of such language does not by itself determine the correctness of scientific conclusions.

What would not shift materially is the relative difference between the two groups of papers. For that gap to disappear, an analyst would have to reclassify hundreds of sentences in the critical reviews while leaving the evidentiary papers largely unchanged, or find comparable hundreds of faulty sentences in the evidentiary papers that this study overlooked. Neither outcome is plausible under any reasonable application of the criteria described in the Methods section. The figures are best understood as indicative of the patterns found.

Conclusion

The pattern matters because language does not merely color a scientific disagreement — it affects how readers judge the researchers on the other side of an argument. The four critical reviews examined in this study contain, on average, loaded language or logical fallacies in roughly four in ten narrative sentences — a rate more than four times that found in evidentiary papers on either side of the debate. Critical reviews are apt to employ stronger evaluative language than data papers, but the difference documented here goes well beyond evaluative language. It extends to ad hominem attacks, motive imputation, guilt by association, accusations approaching the language of misconduct investigations, and the repeated application of prejudicial labels — “pseudoscience,” “fringe science,” “cautionary tale” — before the evidence under discussion has been assessed.

The effect of such language is cumulative. A reader who encounters “purported” or “so-called” once may register a reasonable note of caution; one who encounters such qualifiers dozens of times across a single paper is being led toward a conclusion about the researchers rather than about the evidence. Loaded rhetoric does not ask readers to weigh evidence; it asks them to distrust the people who produced it. When peer-reviewed papers in respected journals question the competence and motives of their opponents, treat the normal revision of ideas as evidence of bad faith, and frame a hypothesis as a danger to the scientific community, the damage extends beyond the immediate controversy. If that claim

Table 8: Summary of the analyses.

Paper	Sentences analyzed	Faulty sentences	Rate
Critical-Review Papers			
Pinter & Ishman (2008)	51	27	52.9%
Pinter et al. (2011)	415	141	34.0%
Boslough et al. (2012)	222	73	32.9%
Holliday et al. (2023)	536	169	31.5%
Evidentiary Papers			
Firestone et al. (2007) — introduction	175	12	6.9%
Surovell et al. (2009) — opposition	60	8	13.3%
Kennett et al. (2015) — pro-YDIH	210	11	5.2%

is accepted at face value, it indicts not only a hypothesis but the institutions and processes on which scientific credibility depends. In that sense, the issue is not only the fate of a single hypothesis, but the preservation of the evidentiary standards by which scientific claims should be judged.

Conflict of interest

The author has published a Kindle book on the YDIH titled *Deadly Voyager*. He has no institutional or funding

relationship with any of the researchers on either side of the debate.

AI disclosure

In addition to the statement above on the author's use of AI to assist in screening articles, he used AI-based tools selectively, as writing and editorial aids. He retains full responsibility for the analysis, interpretation of evidence, and arguments presented.

References

1. Firestone, R.B.; West, A.; Kennett, J.P.; Becker, L.; Bunch, T.E.; Revay, Z.S.; Schultz, P.H.; Belgia, T.; Kennett, D.J.; Erlandson, J.M.; et al. Evidence for an Extraterrestrial Impact 12,900 Years Ago That Contributed to the Megafaunal Extinctions and the Younger Dryas Cooling. *Proc. Natl. Acad. Sci. U. S. A.* **2007**, *104*, 16016–16021, doi:10.1073/pnas.0706977104.
2. Surovell, T.A.; Holliday, V.T.; Gingerich, J.A.M.; Ketron, C.; Haynes, C.V.; Hilman, I.; Wagner, D.P.; Johnson, E.; Claeys, P. An Independent Evaluation of the Younger Dryas Extraterrestrial Impact Hypothesis. *Proc. Natl. Acad. Sci. U. S. A.* **2009**, *106*, 18155–18158, doi:10.1073/pnas.0907857106.
3. Pinter, N.; Ishman, S.E. Impacts, Mega-Tsunami, and Other Extraordinary Claims. *GSA Today* **2008**, *18*, 37, doi:10.1130/GSAT01801GW.1.
4. Pinter, N.; Scott, A.C.; Daulton, T.L.; Podoll, A.; Koeberl, C.; Anderson, R.S.; Ishman, S.E. The Younger Dryas Impact Hypothesis: A Requiem. *Earth-Sci. Rev.* **2011**, *106*, 247–264, doi:10.1016/j.earscirev.2011.02.005.
5. Boslough, M.; Nicoll, K.; Holliday, V.; Daulton, T.L.; Meltzer, D.; Pinter, N.; Scott, A.C.; Surovell, T.; Claeys, P.; Gill, J.; et al. Arguments and Evidence Against a Younger Dryas Impact Event. In *Geophysical Monograph Series*; Giosan, L., Fuller, D.Q., Nicoll, K., Flad, R.K., Clift, P.D., Eds.; American Geophysical Union: Washington, D. C., 2012; pp. 13–26 ISBN 978-1-118-70432-5.
6. Holliday, V.T.; Daulton, T.L.; Bartlein, P.J.; Boslough, M.B.; Breslawski, R.P.; Fisher, A.E.; Jorgeson, I.A.; Scott, A.C.; Koeberl, C.; Marlon, J.R.; et al. Comprehensive Refutation of the Younger Dryas Impact Hypothesis (YDIH). *Earth-Sci. Rev.* **2023**, *247*, 104502, doi:10.1016/j.earscirev.2023.104502.
7. Kennett, J.P.; Kennett, D.J.; Culleton, B.J.; Aura Tortosa, J.E.; Bischoff, J.L.; Bunch, T.E.; Daniel, I.R., Jr.; Erlandson, J.M.; Ferraro, D.; Firestone, R.B.; et al. Bayesian Chronological Analyses Consistent with Synchronous Age of 12,835–12,735 Cal B.P. for Younger Dryas Boundary on Four Continents. *Proc. Natl. Acad. Sci. U. S. A.* **2015**, *112*, E4344–E4353, doi:10.1073/pnas.1507146112.
8. Meltzer, D.J.; Holliday, V.T.; Cannon, M.D.; Miller, D.S. Chronological Evidence Fails to Support Claim of an Isochronous Widespread Layer of Cosmic Impact Indicators Dated to 12,800 Years Ago. *Proc. Natl. Acad. Sci. U. S. A.* **2014**, *111*, E2162–E2171, doi:10.1073/pnas.1401150111.

Appendix 1: Pinter, N.; Ishman, S.E. Impacts, Mega-Tsunami, and Other Extraordinary Claims. GSA Today 2008, 18, 37, doi:10.1130/GSAT01801GW.1.

#	Category	Quotation or paraphrase	Location	Comment
Loaded Language & Prejudicial Framing				
1	Loaded Language — 'Proliferation'	"A proliferation of reports of impact events and sites that eschew simple, less spectacular alternative explanations"	¶1, sent. 1	The recent impact literature is framed as unwarranted before any specific claims are examined.
2	Loaded Language — 'Story'	"The 12.9-ka impact story has struggled to bring its disparate evidence under a single umbrella"	¶5, ¶6	Calling the YDIH a "story" rather than a hypothesis makes it sound more like fiction than science.
3	Loaded Language — 'Frankenstein Monster'	"Together they are a Frankenstein monster, incompatible with any single impactor or any known impact event"	¶6, sent. 5	"Frankenstein monster" is openly derisive. It insults the hypothesis rather than weighing the evidence.
4	Loaded Language — 'Runs Roughshod'	"The 12.9-ka impact theory also runs roughshod over a wide range of other evidence"	¶9, sent. 1	'Runs roughshod' implies reckless trampling of established knowledge, without assessing the evidence.
5	Loaded Language — 'Fishing Expedition'	"Spectacular explanations on long fishing expeditions for shreds of support"	¶10, sent. 1	'Fishing expedition' and 'shreds' are dismissive.
6	Loaded Language — 'Purged'	"The term 'chevron' should be purged from the impact-related literature"	¶3, sent. 3	"Purged" treats the term as something to be eliminated rather than debated.
7	Loaded Language — 'Wild'	"Observations and claims so wild that other work by these authors invites careful scrutiny"	¶5, sent. 2	"So wild" is dismissive language. It passes judgment before any evidence is considered.
8	Loaded Language — 'Convenient'	"Airbursts are a convenient explanation, given the lack of an impact crater, tektites, shocked quartz, or high-pressure minerals"	¶5, sent. 4	'Convenient' implies the explanation was chosen to obscure the alleged lack of impact evidence.
9	Loaded Language — 'Dimples'	"Identifying impact sites by searching for dimples on Earth's surface is a dubious proposition"	¶2, sent. 7	'Dimples' trivializes the ocean-floor topography used to identify potential impact structures.
10	Overstatement	"In actuality, almost all of the material reported at 12.9 ka is ubiquitous throughout the geological record"	¶7, sent. 1	The phrase "in actuality" frames this overstatement as a correction of the YDIH, giving it the authority of a settled matter when the underlying claim has not been demonstrated at that level of generality.
Bundling & Guilt by Association				
11	Bundling Guilt by Association	The paper addresses both Holocene mega-tsunami claims and the YDIH in a single article, with the transition: "Just as close scrutiny of the Holocene impacts belies an extraterrestrial source..."	Structure; ¶4, sent. 1	By linking Holocene mega-tsunami claims and the YDIH within a single argumentative frame, the paper encourages readers to transfer skepticism from one case to the other.
12	Guilt by Association — Sheep Watering Hole	"Speranza et al. (2004) documented a sheep watering hole identified as the 'Sirente Crater'"	¶2, sent. 8	Citing a misidentified sheep watering hole as a representative example of impact-site identification tars YDIH researchers with the same brush, without showing their methods share the flaw.
13	Guilt by Association — Argentinian Depressions	"Similar elliptical depressions in Argentina, once claimed as an oblique impact swarm, were recently debunked and are now recognized as eolian"	¶5, sent. 10	Links Carolina Bay claims to debunked Argentinian depressions — implying that the Bays may also be aeolian, not of impact origin.
14	Poisoning the Well	"Originated in Firestone and Topping (2001) and the Firestone et al. (2006) book"	¶5, sent. 2	This wording links the hypothesis to a popular book rather than to the peer-reviewed article they criticize.
15	Scare Quotes	"mega-tsunami," "crater," "chevron," "nanodiamonds"	Throughout	Terms introduced by YDIH and mega-tsunami proponents are placed in scare quotes, signaling skepticism before any analysis is presented.

#	Category	Quotation or paraphrase	Location	Comment
Ad Hominem & Motive Imputation				
16	Motive Imputation — Attention-Seeking	"Both stories have played out primarily in the popular press, highlighting how successful impact events can be in attracting attention"	¶10, sent. 2	This shifts from judging the claim to speculating about the attention it received. The point is made by implying motive rather than by examining evidence.
17	Motive Imputation — Funding	"The National Science Foundation now emphasizes 'transformative' research, and few events are as transformative as an impact"	¶10, sent. 4	This goes beyond criticism of evidence and suggests a non-scientific motive.
18	Ad Hominem — 'Science by Press Release'	"This type of 'science by press release' and spectacular stories to explain unspectacular evidence"	¶10, sent. 5	"Science by press release" shifts attention from evidence to publicity rather than addressing the merits of the claim.
Begging the Question & Appeals to Authority				
19	Appeal to Authority — Sagan	"Carl Sagan once said that 'extraordinary claims require extraordinary evidence'; we argue that these impacts do not meet that standard"	¶11, sent. 3	What counts as "extraordinary" is left undefined, yet the sentence treats Sagan's dictum as though it were a formal standard of evidence rather than a heuristic. The undefined term does all the argumentative work: the authors invoke the principle, declare without demonstration that it has not been met, and move on.
20	Appeal to Tradition — Carolina Bays	Firestone and colleagues return to an impact origin for the Bays, ignoring a half-century of mainstream research	¶15, sent. 9	The sentence treats the duration of a consensus as evidence for its correctness, which is an appeal to tradition.
Straw Man & Misrepresentation				
21	Straw Man — Scope Inflation	"Trigger for the Younger Dryas climate event, extinction of Pleistocene mega-fauna, demise of the Clovis culture, the dawn of agriculture, and other events"	¶14, sent. 2	Lumps together core claims (YD cooling, megafauna) with peripheral ones ('dawn of agriculture') making the hypothesis sound implausible.
22	Framing Normal Revision as Weakness	"The nature of the 12.9-ka event changes radically with each iteration, from a supernova-generated 'cosmic ray jet' ... to a massive atmospheric airburst ... to 'multiple ET airbursts along with surface impacts'"	¶15, sent. 3	Scientific hypotheses are routinely revised as evidence accumulates. The sentence treats that process as a defect — as though each revision were evidence of confusion rather than of a hypothesis responding to new data.
Untested Counter-Hypotheses & Asymmetric Standards				
23	Asymmetric Evidentiary Standard	"We suggest that the data are not consistent with the 4–5-km-diameter impactor that has been proposed, but rather with the constant and certainly noncatastrophic rain of sand-sized micrometeorites"	¶14, sent. 4	An alternative explanation is offered without supporting evidence. The micrometeorite-fallout hypothesis is stated as though it were self-evident, while the YDIH is held to a stricter standard of demonstration.
24	Asymmetric Evidentiary Standard	"We suggest that these levels simply represent the expected composition of micrometeorite ablation fallout"	¶18, sent. 1	The alternative explanation is restated, again without quantitative support. The word "simply" implies the explanation is obvious and requires no demonstration — a standard not applied to the hypothesis being criticized.
25	Asymmetric Evidentiary Standard	"Nanodiamonds may represent a true extraterrestrial signature, but this material was identified only obliquely and requires rigorous corroboration"	¶18, sent. 3	The sentence asks more of the YDIH evidence than of their micrometeorite claim.

Appendix 1: Continued

#	Category	Quotation or paraphrase	Location	Comment
26	Overstatement of Citation Support	"Extensive literature documenting widespread burning at the vanguard of human migration into the Americas (e.g., Moreno, 2000; Pinter and Anderson, 2006)"	¶9, sent. 5	The phrase "extensive literature" implies broad and independent support, but only two sources are cited, one of which is the authors' own conference abstract. The characterization overstates the evidentiary base.
Appeal to Consequences				
27	Appeal to Consequences — Scientific Credibility	"In an era when evolution, geologic deep time, and global warming are under assault, this type of 'science by press release' and spectacular stories to explain unspectacular evidence consume the finite commodity of scientific credibility."	¶10, sent. 5	By placing the YDIH alongside attacks on evolution, geologic deep time, and global warming, the sentence frames the hypothesis within a context of science denial rather than addressing the evidence directly.

Appendix 2: Pinter, N.; Scott, A.C.; Daulton, T.L.; Podoll, A.; Koeberl, C.; Anderson, R.S.; Ishman, S.E. *The Younger Dryas Impact Hypothesis: A Requiem*. *Earth-Science Reviews* 2011, 106, 247–264, doi:10.1016/j.earscirev.2011.02.005.

#	Category	Quotation or paraphrase	Location	Comment
Loaded Language & Prejudicial Framing				
1	Begging the Question	"The Younger Dryas impact hypothesis: A requiem"	Title	A requiem is for something dead. The title therefore assumes that the hypothesis has already been laid to rest, rather than treating it as a question still under investigation.
2	Loaded Language — 'Cautionary Tale'	"The YD impact hypothesis provides a cautionary tale for researchers, the scientific community, the press, and the broader public."	Abstract, final sent.	"Cautionary tale," presents the hypothesis as a warning or embarrassment, not simply as a disputed scientific proposal.
3	Loaded Language — 'Impact Bandwagon'	"Some researchers, when confronted with any unusual geological evidence, too readily jump aboard the 'impact bandwagon' (Koeberl, 2004; Reinold, 2007)."	§5 Conclusions	"Impact bandwagon," suggests fashion and groupthink rather than a serious attempt to explain evidence.
4	Loaded Language — 'Fixation'	"The fixation of the YD impact hypothesis on continental-scale fire."	§3.3, p.254	"Fixation," suggests obsession, not a scientific focus on a line of evidence.
5	Loaded Language — 'Quest'	"Several have stated that they will continue their quest until the hypothesis is confirmed."	§5 Conclusions	"Quest" casts continued research as a crusade rather than normal scientific work.
6	Loaded Language — 'Perplexing Explanations'	"Perplexing explanations aside, these dates seem to confirm suspicions that Firestone's samples from the Carolina Bays lack stratigraphic context"	§2.6, p.251	"Perplexing," dismisses the explanation without answering it.
7	Loaded Language — 'Eschewing'	"Perhaps the clearest example of YD impact research eschewing gradual, uniformitarian explanations."	§4.1, p.260	"Eschewing" suggests deliberate avoidance of better explanations, not a disagreement over interpretation.
8	Loaded Language — 'Story'	"The outcome of the impact story remained open at that time"	§5 Conclusions	Calling it an "impact story" instead of a hypothesis makes it sound like narrative rather than science.
9	Loaded Language — 'Spectacular'	"The spectacular nature of impact events typically mean that these claims receive disproportionate and often premature attention in the popular press and media (Pinter and Ishman, 2008a)"	§5 Conclusions	"Spectacular" suggests that the appeal is theatrical or media-driven rather than evidentiary.
Poisoning the Well & Guilt by Association				
10	Poisoning the Well — Popular Book	"These early sources contain a number of suggestions – impact origin of glacial drumlins, supernova eruptions leading to 'deadly nerve toxins' in Pleistocene algal mats, etc. – that are highly unlikely"	§1, p.248	The paper begins with earlier and more speculative claims rather than with the peer-reviewed hypothesis itself. That makes the later work easier to dismiss by association.
11	Poisoning the Well — Morrison Quote	"Morrison (2010) suggested that 'if more scientists and science journalists had been aware of [Firestone et al. (2006)] when the YD hypothesis was first published in PNAS, it might never have gained traction."	§1, p.248	The quotation suggests that the hypothesis gained traction because readers were not well informed. That works against the hypothesis without addressing its evidence.
12	Guilt by Association — 'Pathological Science'	"Many scientists are unaware of the surprising number of hypotheses that have gone badly astray, often after widespread initial interest and support (Langmuir and Hall, 1989; Gratzner, 2000; Park, 2000)"	§5 Conclusions	This implies that the YDIH is apt to meet the same fate, without addressing the evidence.

Appendix 2: Continued

#	Category	Quotation or paraphrase	Location	Comment
13	Guilt by Association — 'Wayward Hypotheses'	"Characteristics of these wayward hypotheses include claims that are spectacular, data that are subjective or at the limit of precise measurement, and criticisms met with ad hoc excuses and/or shifts in the original claims (after Langmuir and Hall, 1989)"	§5 Conclusions	The list of traits associated with "wayward hypotheses" encourages readers to place YDIH in that category by resemblance.
14	Guilt by Association — 'Too Many Circles'	"As one impact scientist has put it, 'Too many people seeing too many circles.'"	§5 Conclusions	This is opinion, not evidence.
False Analogy				
15	False Analogy — Spawning Fish and Gyroscopic Forces	"Origin of the Carolina Bays was debated for many years, with some notably odd mechanisms proposed (e.g., 'gyroscopic forces,' Cooke, 1945; spawning fish, Grant, 1945)"	§2.6, p.250	By recalling plainly odd earlier proposals, the sentence places the impact interpretation in a frame of eccentricity.
16	Internal Inconsistency	The paper argues that a 4.6 km impactor would create a 50–100 km crater, implying the YDIH is physically impossible without one. But then notes airbursts are "associated with small impactors, perhaps <160 m diameter."	§4.3, p.262	The paper argues that a 4.6 km impactor would require a 50–100 km crater, then notes that airbursts are associated with impactors smaller than 160 m — more than an order of magnitude smaller — without acknowledging the mismatch.
Begging the Question & Rigged Frameworks				
17	Rigged Three-Outcomes Framework	"Outcome 1: the original observations and their interpretations reproduced, confirming the impact origin ... Outcome 2: the original observations themselves reproduced but not their interpretation ... Outcome 3: the original results proven to be non-reproducible"	§1.1, p.249	The three-part framework appears balanced, but two of the three outcomes are unfavorable to the YDIH, and those two are more loosely specified than the first, making it easier to slot ambiguous results into a negative category.
18	Prejudicial Framing	"12 lines of purported evidence of a YD impact"	§1.1, p.249	"Purported" signals doubt before the evidence is discussed. The skepticism is built into the wording.
19	Scare Language	"So-called 'carbon elongates,'" "so-called glass-like carbon"	§3.1, §5	The phrase uses sarcasm in place of neutral analysis.
Straw Man & Misrepresentation				
20	Straw Man — Cherry-Picking Weakest Claims	"A version of the hypothesis first appeared in Firestone and Topping (2001), with substantial elaboration in the Firestone, West, and Warwick-Smith (2006) book"	§1, p.248	The paper emphasizes the earliest and most speculative versions of the idea, making the later peer-reviewed version easier to dismiss.
21	Loaded Language	"The YDIH introduced a grand, potentially unifying solution promising to tie together some or all of these post-LGM changes"	§1, p.248	"Grand" and "potentially unifying" make the hypothesis sound sweeping and overreaching before the evidence is considered.
22	Ridicule as Argument	"If this trend in the YD layer thickness were to continue — from meters to cm to mm to zero — then YD proponents and skeptics would find themselves in agreement"	§3.2, p.253	This is sarcasm, not evidence.
23	Loaded Language	"YD impact proponents jumped to a catastrophic causal mechanism"	§4.1, p.260	Implies the proponents got ahead of the evidence.

Appendix 2: Continued

#	Category	Quotation or paraphrase	Location	Comment
Ad Hominem, Motive Imputation & Appeal to Authority				
24	Ad Hominem — 'Claims So Wild'	"Both of which contain observations and claims so wild that other work by these authors invites careful scrutiny"	§1, p.248 (echoing 2008)	"So wild" is dismissive language. It passes judgment before any evidence is considered.
25	Motive Imputation — Media Attention	"Remarkable attention in the popular media ... numerous print articles worldwide, at least three television documentaries (for National Geographic, Nova, and History Channel), and a variety of on-going Web-based commentary"	§1, p.248	The emphasis on media attention shifts the issue from evidence to publicity. It encourages readers to associate the hypothesis with spectacle.
26	Motive Imputation — 'Premature Attention'	"These claims receive disproportionate and often premature attention in the popular press and media (Pinter and Ishman, 2008a)"	§5 Conclusions	The sentence implies that public attention counts against the claim. That is not evidence.
27	Appeal to Authority — Impact Science Community	"Some disciplines have remained critical of the hypothesis (e.g., meteoritics and impact science), whereas others have seen broader acceptance"	§1, p.248	This appeals to disciplinary authority. It suggests that acceptance or rejection by a field is itself evidence.
28	Appeal to Authority — 'Mainstream Impact Science'	"The YD impact hypothesis has gained little traction in the mainstream impact science community because it eschews tested and accepted impact evidence"	§4.3, p.262	This appeals to the judgment of a disciplinary community in place of direct evidentiary demonstration.
Self-Contradiction & Double Standards; Absence of Evidence treated as Evidence of Absence.				
29	Absence of Evidence treated as Evidence of Absence.	"Surovell et al. (2009) duplicated... techniques outlined in Firestone et al. (2007) ...test[ing] seven sites across North America, finding magnetic grains and spherules throughout all seven sequences, but with no defined peak."	§3.2	A failure to reproduce a distinct peak at these sites does not by itself establish that such peaks are absent everywhere.
30	Double Standard — Peer Review	The paper criticizes YDIH evidence published in PNAS while presenting its own new spherule counts, charcoal analyses, and TOC data that had not undergone equivalent independent peer review.	§3.2.1, §3.3.1	This does not invalidate the new results, but it does create an asymmetry in how evidentiary authority is invoked.
31	Double Standard — Reproducibility	"None of the original YD impact signatures have been subsequently corroborated by independent tests"	Abstract	Statement leaves out published replication claims and therefore states the matter more categorically than the record warrants.
32	Self-Contradiction — Firestone Protocol Critique	The paper simultaneously (a) claims to have followed Firestone's protocols to test his results, and (b) criticizes those protocols as capturing terrestrial grains. If the protocols are flawed, results obtained using them cannot be compared to Firestone's.	§3.2, §3.2.1, §4.2	The paper uses Firestone's protocols and also faults them as flawed. That creates tension in the argument.
Inconsistent Standards				
33	Inconsistent Standards — Accusing Others of Selection Bias	The Abstract warns that "sparse but ubiquitous materials seem to have been misreported and misinterpreted as singular peaks at the onset of the YD"	Abstract	The abstract accuses others of misreporting and misinterpreting peaks, but it also tells the reader in advance how to view the evidence.
34	Framing Normal Revision as Weakness	"In the face of growing contradictory evidence, YD impact proponents have presented a range of rapidly changing ad hoc explanations which contradict documented impact processes"	§4.3, p.262	"Ad hoc explanations" treats revision as evasion rather than analysis. The phrase passes judgment before the particular revisions are examined.

Appendix 2: Continued

#	Category	Quotation or paraphrase	Location	Comment
Untested Counter-Hypotheses				
35	Untested Alternative — Fungal Sclerotia	"The carbonaceous spherules and elongate forms are indistinguishable from fungal sclerotia and/or arthropod coprolites"	§3.1.1, p.251	The word "indistinguishable" states identity as established rather than as a hypothesis requiring independent confirmation. Morphological resemblance between two types of object does not establish that they are the same thing.
36	Untested Alternative — Micrometeorite Ablation Fallout	"Pinter and Ishman (2008a, b) first pointed out that all of the YD spherules reported as evidence of a catastrophic YD impact event were consistent with the diffuse, constant, and non-catastrophic input of micrometeorite ablation fallout"	§4.1, p.260	This alternative is repeated from the 2008 paper, but still without a quantitative demonstration that micrometeorite fallout could account for the observed concentrations.
37	Untested Alternative — Graphene/Graphane for Nanodiamonds	"Most or all of the material reported by Firestone et al. (2007a) and Kennett et al. (2008, 2009a, b) as nanodiamond likely consists instead of graphane and/or graphene"	§5 Conclusions	The underlying study may support some cases of misidentification, but "most or all" goes beyond what the evidence shown there can establish.
Appeal to Consequences				
38	Appeal to Consequences — Scientific Credibility	"This type of 'science by press release' and spectacular stories to explain unspectacular evidence consume the finite commodity of scientific credibility" (citing Pinter and Ishman, 2008a)	§5 Conclusions (via self-citation)	This argues from possible damage to scientific credibility rather than from the merits of the evidence itself.
39	Appeal to Consequences — 'Broader Lessons'	"We suggest that much can be gained by stepping back and looking at the broader lessons for the earth sciences, impact science, archeology, and other affected fields"	§5 Conclusions, final sent.	The conclusion frames YDIH as a lesson in scientific failure rather than simply as a disputed hypothesis still the subject of research.
40	Absence of Evidence treated as Evidence of Absence. — Impact Crater	"No geological structure dating to the onset of the YD has been identified, nor have any of the traditional impact markers"	§1.1, p.249	The absence of a crater is treated as disproof. At the time of this paper, the YDIH had already proposed airburst and ice-sheet-impact scenarios under which a conventional preserved crater would not be expected. The objection therefore addresses a version of the hypothesis that its proponents had moved beyond.
41	Begging the Question	"Of the 12 lines of evidence originally proposed, none has been confirmed by other independent, mainstream researchers (Outcome 1 above)"	§4, p.259	The conclusion that none of the twelve lines of evidence has been independently confirmed depends on the paper's own restrictive definition of what counts as independent confirmation. The criteria are defined so that the desired conclusion follows.
42	Selective Framing	"Tian et al. (2010) examined deposits at Lommel, Belgium and identified cubic diamonds from 5 to 100 nm in diameter in YDB-age sediments ... Cubic nanodiamonds were also identified in surface soils"	§3.4, p.259	The paper notes Tian et al.'s positive identification of cubic nanodiamonds in YDB-age sediments at Lommel, Belgium, then immediately redirects the reader toward the possibility that they may be terrestrial. The positive finding is acknowledged but framed so as to minimize its significance.

Appendix 3: Boslough, M.; Nicoll, K.; Holliday, V.; Daulton, T.L.; Meltzer, D.; Pinter, N.; Scott, A.C.; Surovell, T.; Claeys, P.; Gill, J.; et al. *Arguments and Evidence Against a Younger Dryas Impact Event*. In *Geophysical Monograph Series*; Giosan, L., Fuller, D.Q., Nicoll, K., Flad, R.K., Clift, P.D., Eds.; American Geophysical Union: Washington, D.C., 2012; pp. 13–26. ISBN 978-1-118-70432-5.

#	Category	Quotation or paraphrase	Location	Comment
Loaded Language & Prejudicial Framing				
1	Loaded Language — 'Fatally Flawed'	"We consider the Firestone et al. [2007] impact hypothesis to be fatally flawed because it violates physical conservation laws"	§2, p.15	"Fatally flawed" states the conclusion at the outset before evidence is presented.
2	Loaded Language — 'Statistically Impossible'	"The probability of this occurring is infinitesimal and is an event that is so improbable it can be called 'statistically impossible'"	§2.3, p.19	"Statistically impossible" is absolute language that states a probabilistic argument more categorically than the underlying analysis can support.
3	Loaded Language — 'Professed'	"Other professed evidence includes Pt-group element peaks"/"seven professed markers"	§1, p.14; §3.3, p.21	'Professed' signals skepticism toward the evidence before it is discussed in detail.
4	Prejudicial Framing — 'Purported' (×10)	"Purported carbon-rich 'black mat'"/"purported markers of the impactor"/"purported YD impact"/etc.	Throughout (10 occurrences)	'Purported' appears 10 times, systematically labeling YDIH evidence as uncertain before discussing it.
5	Loaded Language — 'Putative' (×6)	"The putative impactor"/"the putative YD impact"/"the putative 4 km, 10' Mt comet"	Throughout (6 occurrences)	Repeated use of 'putative' contributes to a consistently skeptical framing of the hypothesis and its proposed mechanisms.
Poisoning the Well				
6	Poisoning the Well — Popular Book	"The 2007 hypothesis is an outgrowth of the book 'Cycle of Cosmic Catastrophes' by Firestone et al. [2006], in which the hypothesized comet was just one manifestation of a much greater cycle of catastrophes initiated by a nearby supernova at 41 ka"	§2.1, p.15	The opening comparison links the peer-reviewed paper to broader claims from a popular book before the paper's own evidence is assessed. The issue to be discussed is the peer-reviewed PNAS article.
7	Poisoning the Well	"Subjected the Earth to cosmic and thermal neutron radiation so strong that terrestrial materials still remain radioactive ... destabilized the Earth's magnetic field and exposed it to another wave of particle irradiation"	§2.1, p.15	The paper evaluates a later peer-reviewed article through the lens of an earlier popular book. Unless the relevant claims are shown to be substantively the same, this is guilt-by-association and a straw man argument.
8	Poisoning the Well — NOVA Documentary/YouTube	"Specimens collected during an expedition for the 2008 filming of the PBS NOVA documentary 'The Last Extinction' ... have not yet been made available for independent analysis"	§1, p.15	The sentence implies that YDIH researchers have withheld specimens from independent analysis, but no documentation of actual withholding is provided. Raising the possibility without supporting it plants doubt about the researchers' openness before any evidence is examined.
9	Framing Normal Revision as Weakness	"The YD impact hypothesis is therefore not a single concise or coherent evolving explanation, but rather an overlapping set of multiple hypotheses that are sometimes conflated"	§1, p.14	Scientific hypotheses are revised as evidence accumulates, and revision is not the same thing as incoherence. The sentence treats normal scientific development as a defect.

Appendix 3: Continued

#	Category	Quotation or paraphrase	Location	Comment
Straw Man & Selective Targeting				
10	Straw Man	The scope of analysis in the present paper is limited to the hypothesis stated by Firestone et al. [2007] and subsequent publications by coauthors.	§2.1, p.15	The paper says it is evaluating the 2007 peer-reviewed hypothesis, but then shifts attention to the broader and more speculative 2006 book version.
11	Straw Man — Probability Applies Only to Extreme Version	"The a priori odds of the impact of a >4 km comet in the prescribed configuration on the Laurentide Ice Sheet during the specified time period are infinitesimal, about one in 10 ¹⁵ "	Abstract, p.13	The probability argument applies to an especially extreme version of the scenario and therefore does not necessarily bear with equal force on smaller or differently configured versions.
12	Selective Omission — Napier (2010) Taurid Stream	The paper does not address the Napier (2010) Taurid Complex model, which proposes a fragmented giant comet as a source of the Taurid meteoroid stream, with dramatically higher impact probabilities than isolated NEOs.	Absent	Napier (2010), published before this paper, proposed a fragmented giant comet as a source of the Taurid meteoroid stream — a model under which impact probabilities differ substantially from those derived from random NEO flux alone. The omission is significant because the probability argument is central to the paper's case, and Napier's model bears directly on it.
Begging the Question				
13	Begging the Question — 'Fatally Flawed' as Premise	"Even in the absence of counterevidence, we consider the Firestone et al. [2007] impact hypothesis to be fatally flawed"	§2, p.15	States the conclusion in advance of the detailed evidentiary discussion.
14	Begging the Question — 'Paradoxically'	"Support for the hypothesis is drawn entirely from indirect evidence and, paradoxically, from the lack of observed physical evidence"	§1, p.14	'Paradoxically' frames the YDIH's explanation for missing craters (ice sheet impact, airburst) as self-contradictory rather than as a testable prediction.
Ad Hominem & Motive Imputation				
15	Overgeneralization from a Single Datum	"An aliquot of carbon spherules that was provided by this group for the detection and verification of nanodiamonds was contaminated with a modern-aged carbon spherule"	§1, p.15; §3.4, p.23	Contamination of a single specimen is a legitimate methodological concern worth reporting. The problem is the weight it is asked to carry: placed prominently in both the introduction and §3.4, a single anomalous result from one site is used to cast doubt on the chronological framework of the entire hypothesis. One unexplained datum warrants investigation, not a general inference about the reliability of the research program.
16	Motive Imputation — Press Conference/YouTube	"One of the impact proponents (A. West) presented it at a press conference in Acapulco, May 2007, stating '... we think a similar thing happened for this event.'"	§2.2, p.17	Citing a YouTube video of a press conference — with URLs — serves to characterize YDIH communication as media spectacle.
17	Motive Imputation — 'Specimens Not Made Available'	"Specimens ... have not yet been made available for independent analysis"	§1, p.15	Implies YDIH researchers are withholding evidence without supporting documentation.
Absence of Evidence Treated as Evidence of Absence				
18	Absence of Evidence treated as Evidence of Absence. — No Crater	"The most striking lack of physical evidence for the YD impact is the absence of any impact crater of the appropriate age"	§3, p.19	The absence of a crater is treated here as a major objection, even though some versions of the hypothesis do not require a conventional preserved crater.

Appendix 3: Continued

#	Category	Quotation or paraphrase	Location	Comment
19	Absence of Evidence treated as Evidence of Absence. — No Shocked Minerals	"No impact craters of the appropriate size and age are known, and no unambiguously shocked material (coesite, stishovite, shatter cones, etc.) ... have been found in any YD dated material"	§1, p. 15	Again, treats the Absence of Evidence as Evidence of Absence.
20	Absence of Evidence treated as Evidence of Absence. — Meteor Crater	"Meteor Crater is an unambiguous example of a well-preserved impact structure ... but not a single similar geomorphic feature from an impact event is known for YD time"	§3.1, p. 19	The comparison invokes a well-preserved crater formed under different conditions than those proposed in the YDIH scenario
Double Standards & Internal Inconsistency				
21	Selective Omission	"A subset of the new YD impact scenarios recently published by Israde-Alcántara et al. [2012] are likewise unremarkable in terms of probability because of the much smaller size and lack of a prescribed unusual configuration and composition"	§2.3, p. 19	The paper acknowledges that recent YDIH scenarios have ordinary probabilities.
22	Overgeneralization from a Single Datum	"Only one microsphere has been dated thus far and is 207 ± 87 years BP ... This result suggests that there are geochronology problems"	§3.4, p. 23	A single anomalous radiocarbon date is used to cast doubt on an entire chronological framework. One unexplained result warrants investigation, not a general inference about geochronology.
23	Internal Inconsistency — Physics Critique vs. Smaller Impactors	The entire §2.2 (Physical Implausibility) addresses only the 4 km comet scenario. The paper acknowledges the Israde-Alcántara et al. 2012 version is 'a major departure' with an object '3 orders of magnitude smaller in terms of mass and energy' — yet never subjects this version to the same physics analysis.	§1, p. 14; §2.2, pp. 16–17	If the physics critique applies only to the extreme version, and the smaller version is 'unremarkable in terms of probability,' then the force of the paper's central probability argument is reduced, at least with respect to the smaller-scenario versions.
Inconsistent Standards				
24	Repetition of Refuted Argument	"Several subsequent elaborations of the hypothesis incorporate increasingly low probability events, leading to a proposed impact configuration that has only an infinitesimal probability"	§2, p. 15	This is the same argument of statistical improbability of a YD impact.
25	Inconsistent Standards — 'Pattern of Irreproducibility'	"There has been a pattern of irreproducibility and misinterpretation of evidence"	§1, p. 15	'Pattern' implies systematic failure. But by the time this paper was written, some proponents had already published claimed replications, which makes the blanket wording vulnerable.
Appeal to Authority & Circular Citation				
26	Circular Citation — Pinter et al. 2011 as Definitive	"The most comprehensive review is that of Pinter et al. [2011a]" / "For a detailed review, see the work of Pinter et al. [2011a]"	§1, p. 14; §3, p. 19	Pinter et al. 2011 — whose own rhetorical problems are documented in the section above — is cited as the authoritative review, not the papers of the proponents.
27	Circular Citation — Self-Reinforcing Network	The paper cites Pinter & Ishman 2008, Pinter et al. 2011, Surovell et al. 2009, Daulton et al. 2010, Scott et al. 2010, Paquay et al. 2009, Holliday & Meltzer 2010, and Meltzer & Holliday 2010 — all authored by overlapping subsets of the same set of coauthors.	Throughout	The paper's central critical authority is a 2011 paper by an overlapping group of the same coauthors. Critics citing critics does not constitute independent confirmation of their conclusions.

Appendix 4: Holliday, V.T.; Daulton, T.L.; Bartlein, P.J.; Boslough, M.B.; et al. *Comprehensive Refutation of the Younger Dryas Impact Hypothesis (YDIH)*. Earth-Science Reviews 2023, 104502.

#	Category	Quotation or paraphrase	Location	Comment
ABSTRACT				
1	Prejudicial Qualifier	A series of publications purport to provide evidence that the Earth was subjected to an extraterrestrial event	Abstract, sent. 1	'Purport' casts doubt on the cited publications before their evidence is discussed.
2	Prejudicial Framing	The varied and sometime conflicting speculations in those publications have become known collectively as the 'Younger Dryas Impact Hypothesis'	Abstract, sent. 2	'Speculations' frames the cited publications as conjectural rather than evidence-based and the hypothesis a hodge-podge.
3	Impossible Standard	It has yet to converge into a hypothesis with a self-consistent scenario involving orbital dynamics, impact physics, geology, geochemistry, paleobotany, paleoclimatology, and anthropology	Abstract, sent. 3	Demands simultaneous consistency across seven disciplines — a standard not applied to other hypotheses.
4	Prejudicial Framing	The YDIH invokes a cosmic event at a moment in time to explain complex processes that varied in space and time around the globe	Abstract, sent. 4	Reduces the hypothesis to a simplistic and unsuccessful formula before examining its evidence.
5	Straw Man	No craters have been identified that date to the onset of the Younger Dryas	Abstract, sent. 5	The YDIH has proposed airburst and ice-sheet-impact scenarios under which a conventional preserved crater would not be expected.
6	Prejudicial Framing	The physical evidence offered in support of an impact is nano to microscopic in scale	Abstract, sent. 6	Frames micro-scale evidence as inherently inferior, though K/Pg impact evidence also includes micro-scale markers such as iridium anomalies and shocked quartz.
7	Prejudicial Qualifier	Very few sites with high levels of any of the purported indicators have accurate and high-precision dating to 12.9 ka	Abstract, sent. 9	'Purported' systematically labels YDIH evidence as uncertain before it is discussed.
8	Prejudicial Qualifier	The identification and quantification of several purported impact indicators is also questionable	Abstract, sent. 10	'Purported' and 'questionable' compound skeptical framing.
9	Prejudicial Qualifier	The claim that a suite of supposed indicators is unique to that moment is not substantiated with data	Abstract, sent. 11	'Supposed' frames the indicators as doubtful before the data are considered.
10	Categorical Dismissal	There is no obvious evidence of environmental cataclysm at that time in the vast published geomorphic or paleobotanical records	Abstract, sent. 12	Categorical dismissal that does not acknowledge the breadth of sites and markers that proponents cite.
11	Categorical Dismissal	There is no support for the basic premise of the YDIH that human populations were diminished	Abstract, sent. 13	Categorical claim presented without qualification.
12	Accusation	Evidence and arguments purported to support the YDIH involve flawed methodologies, inappropriate assumptions, questionable conclusions, misstatements of fact, misleading information, unsupported claims, irreproducible observations, logical fallacies, and selected omission of contrary information	Abstract, sent. 14	Nine separate accusations compressed into a single sentence, conveying a general impression of disrepute, even misconduct, before any evidence is examined.
13	Overstatement	We address and draw attention to these critical failings	Abstract, sent. 15	'Critical failings' pre-judges the outcome of the review.
14	Begging the Question	We demonstrate that research in numerous fields has shown the YDIH should be rejected	Abstract, sent. 16	States the conclusion of the review as a premise in the abstract, before any evidence is presented.

Appendix 4: Continued

18

#	Category	Quotation or paraphrase	Location	Comment
§1 INTRODUCTION				
15	Prejudicial Qualifier	<i>That event supposedly caused climate changes that define the onset of the YD stadial</i>	§1, ¶1	'Supposedly' signals skepticism before the evidence is examined.
16	Overstatement	<i>A comprehensive and self-consistent statement that describes the YDIH, clarifies confusing/contradictory data, arguments, and interpretations, does not exist</i>	§1, ¶1	'Confusing/contradictory' characterizes the entire YDIH literature as incoherent before it is reviewed.
17	Delegitimizing Language	<i>The YDIH has a long, checkered history that is not rooted in science</i>	§1, ¶4	'Checkered history' and 'not rooted in science' are strong delegitimizing claims placed before the detailed review begins.
18	Poisoning the Well	<i>One of the earliest versions of the hypothesis is the speculative book by Donnelly (1883), which claims a comet struck North America forming the Great Lakes</i>	§1, ¶4	Links the modern YDIH to a 19th-century speculation before the peer-reviewed literature is assessed.
19	Accusation of Incompetence	<i>The book is based on fanciful speculation and demonstrates a remarkable lack of understanding of the archaeological and stratigraphic data discussed</i>	§1, ¶4	'Fanciful speculation' and 'remarkable lack of understanding' are strongly derisive characterizations of the Firestone et al. (2006) book.
20	Accusation of Falsehood	<i>It contains many examples of misleading or blatantly untrue statements</i>	§1, ¶4	'Blatantly untrue' approaches an accusation of deliberate dishonesty.
21	Pseudoscience Label	<i>Was described by Morrison (2010) as 'pseudoscience'</i>	§1, ¶4	Applies the 'pseudoscience' label to the precursor work, casting the later hypothesis under the same shadow.
22	Delegitimizing Language	<i>The 2006 book and the other papers were not an auspicious prelude to the 2007 paper by Firestone et al.</i>	§1, ¶5	Frames the 2007 paper as tainted by its non-peer-reviewed predecessors before its own content is examined.
23	Prejudicial Qualifier	<i>Highly speculative interpretations of the origins of magnetic spheres</i>	§1, ¶5	'Highly speculative' pre-judges the interpretations.
24	Accusation	<i>Claiming evidence where none exists and providing misleading citations may be accidental, but when conducted repeatedly, it becomes negligent and undermines scientific advancement as well as the credibility of science itself</i>	§1, ¶5	Moves from criticism of specific claims to a characterization of the authors' conduct as negligent and a threat to science itself.
25	Accusation	<i>Also culpable is the failure of the peer review process to prevent such errors of fact from entering the literature</i>	§1, ¶5	Blames peer reviewers at PNAS and other journals for accepting YDIH papers.
26	Ridicule	<i>The 'pal reviews' (as some refer to them) were significantly curtailed in 2010, in part due to the YDIH controversy</i>	§1, ¶5	Uses a derisive term to characterize the PNAS contributed-review system.
27	Dismissive Characterization	<i>The most wildly speculative evidence backed with no viable support</i>	§1, ¶8	'Wildly speculative' is dismissive language applied before the evidence is examined in the sections referenced.
28	Overstatement	<i>These are baseless interpretations or assertions that contradict extensive data sets</i>	§1, assumption (g)	'Baseless' is a categorical dismissal applied before supporting discussion.
29	Accusation of Falsehood	<i>Sweatman (2021, p 14) falsely asserts that rebuttals to Wolbach et al. (2018a, 2018b) 'were already addressed' but provides no references</i>	§1, ¶3	'Falsely asserts' is an accusation of dishonesty.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
30	Motive Imputation	<i>In part due to an AGU symposium in 2007 that drew considerable attention from the news media</i>	§1, ¶4	Implies media attention is relevant to evaluating the scientific merits of the hypothesis.
31	Overstatement	<i>Showing that several are flawed or fundamentally false, any one of which would reject the overall hypothesis</i>	§1, ¶6	'Fundamentally false' states a conclusion before presenting the evidence that supports it.
32	Framing Normal Revision as Weakness	<i>Conflicting and disjointed</i>	§1, assumption (i)	'Disjointed' frames the variety of impact scenarios as a defect rather than as normal scientific development.
§2 DEFINING THE "YOUNGER DRYAS"				
33	Scare Quotes	<i>Many so-called wildfire and impact proxies used by YDIH proponents</i>	§2, final ¶	'So-called' signals skepticism toward the proponents' terminology.
34	Accusation of Competence	<i>Wolbach et al.'s (2018a, 2018b) and Sweatman's (2021) misunderstanding of paleofire records</i>	§2/§3.3 transition	'Misunderstanding' characterizes the opposing view as incompetence rather than disagreement.
35	Overstatement	<i>The YDIH evidently was conceived to solve another problem that does not exist</i>	§2/§3.3	Dismisses the entire motivation for the YDIH as misguided.
§3 FLAWED FUNDAMENTAL ASSUMPTIONS				
36	Accusation of Competence	<i>Blatant misstatements along with misunderstandings about the archaeological, paleontological, and paleoclimatological records</i>	§3, sent. 1	'Blatant misstatements' accuses the authors of obvious errors — possibly deliberate — before the specifics are examined.
37	Prejudicial Framing	<i>Flawed fundamental assumptions in the YDIH</i>	§3 title	The section title pre-judges the assumptions as 'flawed' before they are examined.
§3.1 MISUNDERSTOOD DECLINE OF CLOVIS PALEOINDIANS				
38	Prejudicial Framing	<i>Misunderstood decline of Clovis Paleoindians</i>	§3.1 title	'Misunderstood' pre-judges the YDIH proponents' interpretation before the evidence is presented.
39	Prejudicial Qualifier	<i>Firestone et al. (2006, p 2) proclaimed evidence for 'a violent calamity'</i>	§3.1, ¶1	'Proclaimed' carries connotations of self-promotion rather than scientific reporting.
40	Prejudicial Qualifier	<i>Powell (2020) proclaimed without evidence that 'scientists have struggled to explain' the disappearance of Clovis</i>	§3.1, ¶3	'Proclaimed without evidence' combines the motive-laden verb with an accusation of evidentiary absence.
41	Condescension	<i>No, they have not.</i>	§3.1, ¶3	A short dismissal that reads as scolding rather than analytical engagement.
42	Ad Hominem	<i>Such statements demonstrate either a selective choice of data or a fundamental misunderstanding of the geoarchaeological record</i>	§3.1, ¶4	Characterizes YDIH proponents as either dishonest or incompetent.
43	Overstatement	<i>This non-issue was dismissed over a decade ago</i>	§3.1, ¶3	'Non-issue' categorically dismisses the question without engaging the evidence proponents present.
44	Accusation of Falsehood	<i>All of the quoted statements regarding Clovis archaeology derive from the false assertions about it at the Blackwater Draw site</i>	§3.1, ¶4	'False assertions' is an accusation of factual error presented as already established.
45	Condescension	<i>Insistence is not a substitute for data</i>	§3.1, ¶3	A scolding remark directed at Sweatman (2021) that addresses tone rather than evidence.
46	Overstatement	<i>There is no dated, in situ archaeological evidence nor other data to support claims that Clovis populations experienced a catastrophe</i>	§3.1, ¶3	Attributes position (a catastrophe) to proponents that they have not taken.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
47	Overstatement	<i>The YDIH is an ET explanation for an archaeological problem that does not now and has not existed in the past</i>	§3.1, ¶13	Dismisses the entire line of YD research as based on a non-existent problem.
48	Accusation of Negligence	<i>But YDIH proponents never acknowledge the voluminous archeological, stratigraphic, and chronological data for the site that clearly contradict these claims</i>	§3.1, ¶14	'Never acknowledge' implies deliberate avoidance rather than disagreement.
49	Scare Quotes	<i>There is no evidence for a 'culturally dead zone' as described by LeCompte et al.</i>	§3.1, ¶14	Scare quotes around 'culturally dead zone' signal dismissal.
§3.2 MISUNDERSTOOD MEGAFAUNA EXTINCTIONS				
50	Prejudicial Framing	<i>Misunderstood megafauna extinctions</i>	§3.2 title	Same prejudicial framing as §3.1 title.
51	Accusation of Falsehood	<i>Firestone et al. (2007, p 16016) mischaracterize megafaunal extinctions</i>	§3.2, ¶11	'Mischaracterize' accuses the authors of inaccuracy before the counter-evidence is presented.
52	Tu Quoque (you also)	<i>Their argument about a misunderstood extinction event they perceive to be unlikely more appropriately applies to the YDIH</i>	§3.2, ¶12	Turns the proponents' own framing against them — a rhetorical move rather than an evidence-based rebuttal.
53	Ridicule	<i>Finding extinct species stratigraphically below the 'black mat' ... has little significance. All manner of extinct species, including dinosaurs, are 'below' YDC deposits</i>	§3.2, ¶11	The dinosaur comparison is sarcasm that trivializes the stratigraphic argument rather than engaging it analytically.
54	Prejudicial Qualifier	<i>Sweatman (2021, p 2–3) claimed</i>	§3.2, ¶11	'Claimed' is used systematically as a skeptical substitute for 'stated' or 'reported.'
55	Accusation of Negligence	<i>Hagstrum et al. (2017) fail to present a single example of evidence that is widely accepted as diagnostic of an impact event</i>	§3.2, ¶14	In a peer-reviewed article, Hagstrum et al. reported large quantities of impact-related microspherules
56	Accusation of Negligence	<i>None of these papers advocating for the YDIH by bringing in the extinction issue confront the complex issues</i>	§3.2, ¶15	'None... confront' characterizes the entire literature as evasive.
57	Prejudicial Qualifier	<i>Hagstrum et al. (2017) is highly speculative</i>	§3.2, ¶14	Categorical dismissal without detailed engagement with specific evidence.
§3.3 PROBLEMATIC CHRONOLOGIC AND PALEOCLIMATIC ASSUMPTIONS				
58	Prejudicial Framing	<i>Problematic chronologic and paleoclimatic assumptions</i>	§3.3 title	The section title pre-judges the assumptions as 'problematic.'
59	Prejudicial Qualifier	<i>A purported impact produced synchronous changes</i>	§3.3, ¶12	Continues systematic application of 'purported' to YDIH claims.
60	Accusation of Competence	<i>Wolbach et al.'s (2018a, 2018b) and Sweatman's (2021) misunderstanding of paleofire records over the last glacial cycle</i>	§3.3	'Misunderstanding' characterizes opposing scientists' work as incompetent rather than disputable.
61	Accusation of Bias	<i>This is in keeping, however, with a methodological approach of looking only where one expects to find something, and not elsewhere</i>	§3.3	Accuses YDIH proponents of confirmation bias.
62	Overstatement	<i>The YDIH evidently was conceived to solve another problem that does not exist</i>	§3.3	Dismisses the entire motivating question—the cause of the YD—for the hypothesis.
63	Condescension	<i>Simple inspection of the data also contradicts the claims</i>	§3.3	'Simple inspection' implies the error is obvious, which is condescending if the data are genuinely contested.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
§4 FLAWED SAMPLING				
64	Prejudicial Framing	Flawed sampling	§4 title	Pre-judges the sampling as 'flawed' before examining it.
65	Accusation of Bias	An issue of confirmation bias	§4, ¶1	Accuses YDIH proponents of a systematic cognitive error.
66	Begging the Question	This is a circular argument	§4, ¶1	Labels the reasoning as circular in an accusatory tone rather than demonstrating the circularity analytically.
67	Accusation of Falsehood	Wolbach et al. (2020, p 97) falsely allege	§4.1	'Falsely allege' is an accusation of dishonesty.
68	Ad Hominem	Sweatman may not be familiar with sedimentary logs nor their interpretation in a geologic context	§4.1	Questions Sweatman's professional competence rather than addressing his argument.
69	Dismissive Characterization	Sweatman's (2021) assertion is ridiculous	§4.1	'Ridiculous' is openly derisive.
70	Ad Hominem	Clearly the proponents are unfamiliar with sampling in fluvial sediments	§4.1	Questions the proponents' competence rather than addressing their methods.
71	Accusation of Falsehood	This statement is misleading in terms of both sampling and fact	§4.2	'Misleading' may imply intent to deceive.
72	Accusation of Negligence	The failure of Moore et al. (2020) is that they did not perform a comparative study	§4.2	'Failure' is a strong characterization of a methodological choice in a peer-reviewed article.
73	Dismissive Characterization	Scoria is relatively common and does not require an extraordinary source such as an impact	§4.2	Dismissive framing undercuts engagement with Moore et al.'s specific findings.
74	Motive Imputation	Impact proponents are not really interested in systematically testing the YDIH	§4.1	Imputes deceptive motive rather than evaluating the sampling design on its merits.
75	Dismissive Characterization	It is incomprehensible how this argument can be taken seriously	§4.1	'Incomprehensible' is rhetorical rather than analytical.
76	Dismissive Characterization	Ambiguous/meandering (magnetic and carbon spherules, Section 10)	§4, referencing §10	'Meandering' characterizes the research program pejoratively.
§5 INADEQUATE DATING AND STRATIGRAPHIC CONTEXT				
77	Prejudicial Framing	Inadequate dating and stratigraphic context	§5 title	Pre-judges the dating as 'inadequate.'
78	Accusation of Falsehood	A variety of unsupported or misleading claims about dating	§5, sent. 1	'Unsupported or misleading' accuses the proponents of making claims without foundation or with intent to deceive.
79	Condescension	Befuddled dating the beginning of the YDC	§5.1 title	'Befuddled' is condescending — it characterizes the proponents as confused.
80	Dismissive Characterization	This is an unnecessary effort to solve another nonexistent problem	§5.1, ¶1	Dismisses the entire line of inquiry as pointless.
81	Delegitimizing Language	Pseudoarchaeological divined date of the impact event	§5.2 title	'Pseudoarchaeological' and 'divined' are strongly derisive.
82	Guilt by Association	These ideas appear to originate in the fanciful books by Andrew Collins (2014)... and by Graham Hancock (2015)	§5.2	Links Sweatman's academic work to popular authors known for speculative claims.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
83	Prejudicial Framing	Deficient dating of YDIH sites	\$5.3 title	Pre-judges the dating as 'deficient.'
84	Dismissive Characterization	Which is of course preposterous	\$5.3	'Preposterous' is openly derisive rather than analytical.
85	Condescension	The ages of the authors of this commentary could be modelled to statistically date to the signing of the Declaration of Independence (1776 CE). The modelling could be statistically correct, but obviously meaningless.	\$5.3	A sarcastic analogy that mocks the Bayesian modeling approach.
86	Overstatement	These are baseless assertions that defy fundamental principles of objective science	\$5.3	'Baseless' and 'defy fundamental principles' are strongly dismissive.
87	Accusation of Bias	Platinum (Pt) anomalies are used by YDIH proponents to unquestioningly support the YDIH	\$5.4	'Unquestioningly' characterizes the proponents as uncritical.
88	Rhetorical Flourish	This astonishing admission demonstrates that the Pt zone is mixed among Early Archaic artifacts	\$5.4	'Astonishing admission' is a rhetorical flourish that dramatizes a data point.
89	Accusation of Falsehood	Other claims regarding dating are equally curious, if not spurious	\$5.5	'Spurious' accuses the claims of being false or fabricated.
90	Ad Hominem	No understanding of soil forming processes	\$5.6	Accuses proponents of lacking basic knowledge of soil science.
\$5.6-5.8 CONTINUED				
91	Accusation of Competence	Logical lapses in dating Usselo and Finow soils	\$5.6 title	'Logical lapses' characterizes the proponents' reasoning as defective.
92	Accusation of Falsehood	This passage is rife with misleading inferences and a fundamental lack of understanding of the Usselo soil	\$5.6	Combines accusation of misleading language with accusation of incompetence.
93	Overstatement	This is another unsupported assertion with no factual basis	\$5.6	Categorical dismissal.
94	Overstatement	There is no possibility that the sites are synchronous	\$5.6	Categorical statement that leaves no room for the proponents' interpretation.
95	Accusation of Falsehood	These claims are false	\$5.7	Direct accusation of falsehood.
96	Dismissive Characterization	Leaving aside the bizarre comment about a 'well-adjusted' culture	\$5.7	'Bizarre' mocks Powell's phrasing rather than addressing his argument.
97	Ad Hominem	Powell (2022) may be unaware/he apparently is unaware	\$5.7	Questions Powell's knowledge of the archaeological literature.
98	Accusation of Falsehood	Powell (2022, p. 36) offers other unsubstantiated and factually incorrect claims regarding Clovis archaeology	\$5.7	'Unsubstantiated and factually incorrect' stacks two accusations of incompetence.
\$6 MISINTERPRETED BLACK MATS				
99	Prejudicial Framing	Misinterpreted black mats	\$6 title	Pre-judges the interpretation as wrong.
100	Dismissive Characterization	The only thing 'enigmatic' about the black mat is its attribution to an impact	\$6, ¶2	Dismissive rather than analytical.
101	Overstatement	Discussions of the black mat by impact proponents are grossly oversimplified	\$6, ¶2	'Grossly oversimplified' is strongly dismissive.
102	Overstatement	The YDIH is rife with further contradictions regarding the black mat	\$6, ¶4	'Rife with contradictions' frames the entire literature as incoherent.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
\$7 MULTIFARIOUS YDB IMPACT SCENARIOS				
103	Framing Normal Revision as Weakness	Multifarious YDB impact scenarios	\$7 title	'Multifarious' frames the variety of scenarios as a defect.
104	Dismissive Characterization	These various suggestions and interpretations are contrary to common knowledge... They represent pure fiction with little science	\$7, ¶13	'Pure fiction' is an extreme characterization.
105	Accusation of Falsehood	Firestone (2009a, section 6) falsely claims	\$7, ¶15	'Falsely claims' is a direct accusation of dishonesty.
106	Dismissive Characterization	Pino et al. (2019, p 21) proposed a prodigious number of impacts	\$7	'Prodigious' implies implausibility through word choice.
107	Prejudicial Qualifier	Sweatman (2021, p 1) in his review of the YDIH inaccurately proclaimed	\$7	'Inaccurately proclaimed' combines accusation of error with motive-laden verb.
108	Motive Imputation	A possible motivation for such claims might be found in the claims of nanodiamond-containing carbon spherules	\$7	Speculates about the proponents' non-scientific motivations.
109	Dismissive Characterization	Leaving many claimed YDIH impact markers unexplained enigmas	\$7	'Unexplained enigmas' frames the proponents' position as incoherent.
\$8 GENERALLY ACCEPTED IMPACT INDICATORS/\$8.1 PROPOSED CRATERS				
110	Rhetorical Flourish	The most direct evidence of a YDB impact is conspicuously lacking	\$8, sent. 1	'Conspicuously' adds rhetorical emphasis to an absence-of-evidence argument.
111	Dismissive Characterization	A main problem with many of the more outlandish claims made about the YDB 'impact evidence'	\$8, ¶13	'Outlandish' is dismissive.
112	Dismissive Characterization	This is a pointless endorsement	\$8.1	'Pointless' dismisses Sweatman's discussion as worthless.
113	Dismissive Characterization	A wide and sometimes wild range of claimed particulate and geochemical indicators	\$8.1, final ¶	'Wild' is dismissive.
\$9 WILDFIRES/CHARCOAL				
114	Prejudicial Framing	Misperception of Global Charcoal as evidence of impact	\$9.1 title	'Misperception' pre-judges the proponents' interpretation.
115	Prejudicial Framing	Misinterpretation of the NGRIP ammonium-ion record	\$9.2 title	Same prejudicial framing in the section title.
116	Prejudicial Framing	Miscellaneous wildfire misapprehensions	\$9.3 title	Three section titles in succession frame the proponents' work as error.
117	Motive Imputation	Because these assertions can so easily be refuted by simple inspection of the data... we wonder why they are still being made	\$9.2	Implies bad faith or willful ignorance.
118	Dismissive Characterization	Sweatman (2021, p 14) offers a convoluted argument on this point	\$9.3	'Convoluted' characterizes the argument as confused rather than engaging its substance.
\$10 SPHERULES/MICROSPHERULES				
119	Tu Quoque	The condescending argument about procedural errors is an after-the-fact explanation of inconvenient data	\$10	'Condescending' and 'inconvenient data' are loaded characterizations.
120	Accusation of Competence	Sweatman was not paying attention to what is in the 2016 paper and apparently not aware of the literature on the locality	\$10/\$14	'Not paying attention' is a personal criticism rather than a substantive rebuttal.
\$11 PLATINUM GROUP ELEMENTS				

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
121	Accusation of Falsehood	Sweatman (2021, p 8) falsely claimed	§11	Direct accusation of making false statements.
122	Accusation of Falsehood	Sweatman (2021, p 20) also falsely claims	§11	Second direct accusation of false statements in the same section.
§12 NANODIAMONDS				
123	Overstatement	All measurements of nanodiamond concentration in sediments/ice is scientifically meaningless	§12, ¶1	'Scientifically meaningless' is a categorical dismissal of an entire body of measurements.
124	Prejudicial Qualifier	Their dubious synthesis experiments (Kimbel et al., 2008)	§12.4	'Dubious' pre-judges the experiments.
125	Accusation	One could interpret the Kinzie et al. (2014) paper as deceptive	§12.6	Approaches an accusation of scientific fraud.
126	Dismissive Characterization	Kinzie et al. (2014, p 492) perplexingly conclude	§12.2	'Perplexingly' characterizes the conclusion as baffling rather than engaging its reasoning.
127	Dismissive Characterization	Under nonsensical, by any standard, formation conditions for diamond	§12.5	'Nonsensical' categorically dismisses the patent application's claims.
§13 FANCIFUL YDIH INDICATORS				
128	Dismissive Characterization	Fanciful YDIH indicators, abandoned claims, and mislaid or missing evidence	§13 title	'Fanciful' and 'mislaid' are openly derisive.
129	Accusation	Claiming that a paper states the opposite conclusion to make a point about purported impacts represents scientific malfeasance	§13.1	'Scientific malfeasance' is a term associated with formal misconduct — the most severe accusation in the paper.
130	Dismissive Characterization	Preposterous fringe ideas continue to plague the YDIH	§13.3	'Preposterous' and 'fringe' are strongly derisive.
131	Delegitimizing Language	Its highly speculative nature certainly reflects on the credibility of the authors that were involved	§13, ¶1	Moves from criticism of evidence to questioning the credibility of named researchers.
132	Accusation of Negligence	How such a key component of the YDIH was lost is unclear	§13.3	Implies negligence or concealment regarding a lost mammoth tusk.
133	Overstatement	This naturally induces skepticism of results derived from data not presented	§13.6	While reasonable in principle, the framing extends skepticism to the entire body of YDIH work.
§14 SAME SPECIMENS STUDIED BY DIFFERENT GROUPS				
134	Rhetorical Flourish	One revealing aspect of the YDIH debate is that contradictory results are obtained when different groups study the same specimens	§14, sent. 1	'Revealing' implies the contradictory results expose something damaging about the proponents' work rather than reflecting normal scientific variability.
§15 UNPARALLELED PROMOTION OUTSIDE SCIENTIFIC LITERATURE				
135	Ad Hominem	The principal YDIH authors created and ran websites to promote the YDIH and other fringe science outside the constraint of peer review, raise money, and engage in personal attacks on skeptics	§15	Triple accusation: (1) 'fringe science,' (2) fundraising implications, (3) 'personal attacks' — none documented in this sentence.
136	Ad Hominem	Martin Sweatman in preparing his review of the YDIH (Sweatman, 2021), which has the appearance of being independent, interacted with webmasters of one of these sites	§15	'Appearance of being independent' questions the paper's independence through association.
137	Ad Hominem	Disclosure of conflict of interest (either potential or the appearance of) is lacking in YDIH publications	§15	Raises the issue of conflict of interest in a way that edges toward an accusation of ethical impropriety.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
138	Ad Hominem	Firestone et al. (2007) stated, 'The authors declare no conflict of interest' despite the fact the paper furthers and promotes the main subject of an earlier for-profit book	§15	Treats prior popular publication of a popular book as a conflict of interest in itself.
139	Guilt by Association	The week that a preprint of Sweatman (2021) was posted on Sweatman's website, Cosmic Tusk published an announcement... describing the author as 'indefatigable genius and digital friend of the Tusk'	§15	A blog's praise for a researcher is presented as evidence of collusion.
140	Ad Hominem	In the YDIH review paper by Powell (2022), Powell fails to disclose his self-published book <i>Deadly Voyager</i> (Powell, 2020), which promotes the YDIH	§15	Treats prior popular publication on the same subject as a conflict of interest.
141	Guilt by Association	Non-scientists (e.g., Collins, 2014; Hancock, 2015 and others) have also written popular press books that promote the sensational nature of the YDIH	§15	YDIH researchers are held responsible for books written by authors they do not control.
142	Guilt by Association	These books blur peer-reviewed scientific literature together with imaginative speculation and influence the perception of the news media	§15	Blames YDIH researchers for media coverage generated by third-party authors.
143	Guilt by Association	The journal <i>Science</i> listed its discovery as one of the runner ups to the <i>Breakthrough of the Year</i> for 2018	§15	YDIH researchers are blamed for <i>Science</i> magazine's editorial judgment.
144	Ad Hominem	The announcement included several links to <i>Prehistory Decoded</i> , including the Amazon page from which it can be purchased	§15	A researcher is criticized for having a popular book available for purchase.
§16 DISCUSSION	Overstatement	The YDIH is a concept originating from earlier baseless ideas that merged together and morphed into its present disjointed form	§16, ¶13	'Baseless ideas' and 'disjointed form' are strongly dismissive characterizations.
146	Ad Hominem	Sweatman (2021) and Powell (2022) in their summaries seem unaware of the critical and fundamental importance (primacy) of skepticism in science	§16, ¶13	Questions the authors' understanding of basic scientific practice rather than addressing their evidence.
147	Overstatement	This misuse of the concept of statistical consistency... is obviously and grossly in error	§16, ¶12	'Obviously and grossly' are rhetorical intensifiers that assert what should be demonstrated.
148	Prejudicial Qualifier	Most of these studies are not independent, and the claims of Sweatman and Powell are based on dating and purported impact indicators that we show are spurious	§16, ¶12	'Spurious' accuses the evidence of being false.
149	Categorical Dismissal	If there was an ET impact, it had no terrestrial consequences	§16	Categorical dismissal that does not acknowledge the breadth of sites YD proponents point to.
150	Rhetorical Flourish	These issues highlight some of the reasons for our frustration in dealing with the YDIH and results in some of our strong wording	§16, ¶15	Acknowledges that the strong language is driven by frustration — a candid admission that the rhetorical register reflects emotion.
151	Accusation	Most of these are misstated, ignored, or simply declared as wrong, without evidence, and errors of fact are offered instead	§16, ¶15	Characterizes the proponents' response as a pattern of ignoring or misstating criticism.
152	Overstatement	Claims that critiques were dealt with in detail are demonstrably baseless	§16, ¶15	'Demonstrably baseless' is a strong characterization.
153	Ridicule	Carried to its logical end, no more field work or laboratory analyses are required in scientific debate	§16, ¶13	Sarcastic overstatement of the proponents' position.

Appendix 4: Continued

#	Category	Quotation or paraphrase	Location	Comment
§17 CONCLUSIONS				
154	Pseudoscience Label	The YDIH evolved directly from pseudoscience	§17, sent. 1	Opens the Conclusions with the most damaging label in scientific discourse.
155	Overstatement	Seriously plagued by poorly documented interpretations and baseless assertions	§17, sent. 1	'Baseless assertions' stacks the accusation.
156	Overstatement	A broad array of serious flaws persists in the YDIH	§17, ¶1	Characterizes the entire body of work as persistently flawed.
157	Overstatement	The idea that the Clovis archaeological record was terminated by some sort of environmental catastrophe is baseless	§17, conclusion A.2	'Baseless' is a categorical dismissal.
158	Prejudicial Qualifier	Purported impact indicators have not been shown to be uniquely associated with an impact and the claim that a suite of proclaimed indicators	§17, conclusion C.5	Double skeptical framing: 'purported' and 'proclaimed.'
159	Scare Quotes	So-called 'black mats' are not unique to the YDB or YDC	§17, conclusion C.8	'So-called' casts doubt on an established geological term.
160	Categorical Dismissal	There is no viable evidence for synchronous wildfires across one or more continents at any time including at the onset of the YD/GS-1	§17, conclusion C.9	Categorical dismissal that does not engage the charcoal and soot evidence proponents cite.
161	Categorical Dismissal	Were from sediments/ice with poor age control (e.g., all of them)	§17, conclusion C.10	'All of them' is categorical overstatement.
162	Pseudoscience Label	Although the 2007 paper did not contain all the pseudoscience of its predecessors, it was nevertheless plagued with poor age control, faulty assumptions, and misstatements of fact	§17, ¶12	Continues the pseudoscience framing.
163	Accusation	Based on the many misstatements of fact documented here, many YDIH proponents do not pay attention to the scientific geological and archaeological literature cited in the papers they read and write	§17, ¶14	Accuses researchers of not reading the articles they cite.
164	Accusation	Furthermore, in the case of the YDIH, the peer review process has obviously failed to prevent publication of misstatements of fact	§17, ¶14	Blames peer reviewers at multiple journals for accepting YDIH papers.
165	Condescension	We implore future investigators on both sides of the YDIH issue to do their homework	§17, ¶14	'Do their homework' is scolding language used by teachers addressing students.
166	Condescension	Assessment of the YDIH should include some familiarity with late Quaternary paleoclimatology, terrestrial stratigraphy, geomorphology	§17, ¶14	'Some familiarity' is condescending, implying YDIH proponents lack basic competence.
167	Condescension	We urge the YDIH proponents to follow the 'method of multiple working hypotheses' (Chamberlin, 1890), which has well served scientific research for over a century	§17, ¶15	Lectures the opposing side on proper scientific method, whereas earlier they are criticized for not having settled on a single hypothesis.
168	Accusation	Over time, these misstatements can be misconstrued as actual evidence that is then perpetuated in the literature providing false support to hypotheses, which ultimately undermines the scientific process and its credibility	§17, ¶14	Frames YDIH publications as damaging the credibility of science itself.
169	Impossible Standard	Proponents of the YDIH must provide unambiguous evidence from unambiguous stratigraphic context unambiguously dated using high precision numerical age control from multiple sites across at least North America if not other continents	§17, ¶16	Repeating 'unambiguous' three times sets a standard not applied to other hypotheses in Earth science.

Appendix 5: Firesone, R.B.; West, A.; Kennett, J.P.; Becker, L.; Bunch, L.; Schultz, P.H.; Belgya, T.; Kennett, D.J.; Erlandson, J.M.; et al. “Evidence for an Extraterrestrial Impact 12,900 Years Ago that Contributed to the Megafaunal Extinctions and the Younger Dryas Cooling.” *Proc. Natl. Acad. Sci. USA* 2007, 104(41), 16016–16021. All quotations verified against the published text.

#	Category	Quotation or paraphrase	Location	Comment
Scope Inflation & Overstatement				
1	Scope Inflation	The title and Abstract simultaneously attribute YD cooling, megafaunal extinctions, and Clovis cultural disruption to a single impact event.	Title; Abstract	Three large, independently contested propositions are advanced at once on the basis of one paper's data. The paper's actual evidence concerns impact markers at the YDB; the connections to cooling, extinction, and cultural change are inferred, not demonstrated. Opponents who accuse the YDIH of scope inflation have a legitimate target here.
2	Loaded Language — ‘Too Broad and Ecologically Deep’	“The extinctions were too broad and ecologically deep to support those hypotheses.”	Introduction, p. 16016	‘Too broad and ecologically deep’ is evaluative language that states a contested conclusion as established fact before the ET evidence is introduced. ‘Unique’ in the preceding sentence does similar work, implying that ordinary explanations cannot apply.
3	Overstatement in Conclusions	“These associations, if confirmed, offer the most complete and recent geological record for an ET impact and its effects, such as global climate change and faunal extinction.”	Conclusions, p. 16021	‘The most complete and recent’ is superlative language that overstates what the evidence at the time of publication establishes. The conditional ‘if confirmed’ hedges, but the superlative framing is premature.
Speculation Without Demonstration				
4	Untested Mechanism Presented as Contribution	The mechanism by which a fragmented impactor triggers millennium-long YD cooling is proposed in the title and Abstract but not demonstrated within the paper.	Title; Abstract; Discussion — Climate	The Conclusions acknowledge that “the current geologic and geochemical evidence is insufficient to fully understand impact dynamics.” The connection to YD cooling is speculative at the time of publication, though the title and Abstract treat it as an established contribution.
5	Accumulation of Untested Mechanisms	The Discussion enumerates at least three distinct cooling mechanisms (ozone depletion, atmospheric injection of aerosols, injection of water vapor and ice), each presented as a possible contributor.	Discussion — Climate, p. 16020–16021	Each mechanism is individually speculative and not independently demonstrated in this paper. Presenting multiple speculative mechanisms in parallel does not add up to a demonstrated causal chain. Opponents who accuse the YDIH of accumulating untested alternatives have a partial basis here, even though the paper is appropriately hedged throughout the section.
6	Unpublished Data Cited to Fill Evidentiary Gap	“Hypervelocity oblique impact experiments (P.H.S., unpublished data) indicate that a low-impedance surface layer, such as an ice sheet, can markedly reduce modification of the underlying substrate.”	Discussion — Nature of Event, p. 16020	Unpublished results from one of the paper's own coauthors are used to explain the absence of a crater—a significant gap in the evidence. Results that cannot be independently evaluated should not bear the evidentiary weight assigned here.
False Analogy				
7	False Analogy — Tunguska Scale Mismatch	“In 1908, at Tunguska, Siberia, a object ~150 m in diameter... produced a <15-megaton airburst... yet produced no crater or shock metamorphism.”	Discussion — Nature of Event, p. 16020	Tunguska is invoked to explain why the YD event left no crater. But the proposed YD impactor is on the order of 4 km—more than a twentyfold difference in linear dimension and a roughly ten-thousand-fold difference in mass and energy. Scaling Tunguska's dynamics to the YD event requires quantitative demonstration, not analogy.

#	Category	Quotation or paraphrase	Location	Comment
Ambiguous Evidence Presented as Supporting				
8	Ambiguous Evidence Presented as Supporting	"However, some Bay dates are reported to be >38 ka, older than the proposed date for the YD event."/"we cannot yet determine whether any Bays were or were not formed by the YD event."	Results, p. 16017; Discussion, p. 16019	Fifteen Carolina Bay sites are included in the evidence base while the paper concedes that their origin is undetermined and that some dates predate the proposed event by tens of thousands of years. Including contested sites as supporting evidence while acknowledging they may not be relevant invites legitimate criticism.
Begging the Question				
9	Begging the Question — 'Impact-Related' as Established	Throughout the paper, markers are called "ET markers," "impact tracers," "impact-related markers," and "event-related markers."	Throughout	The terminology presupposes the extraterrestrial origin of the markers before that origin has been established. More neutral terms ("proposed impact markers" or simply "YDB markers") would avoid begging the question. This is the same framing issue identified in Kennett et al. (2015).
Internal Tension				
10	Hedging That Undermines the Core Claim	"These ratios... cannot be explained at this time, but the YDB abundance... most likely resulted from... a new and unknown type of impactor."	Discussion — Magnetic Microspherules, p. 16019	The paper concedes that the composition of key markers cannot be explained and that the impactor may be of an unknown type. This is intellectually honest, but opponents who call the evidence 'internally inconsistent' have a partial basis in this passage.
Loaded Language				
11	Loaded Language — 'Devastating'	"The YD event would have created a devastating, high-temperature shock wave with extreme overpressure."	Discussion — Environmental Effects, p. 16020	'Devastating' goes beyond what the evidence in this paper establishes. The environmental effects are inferred from the marker assemblage and from modeling by Toon et al. (1997), not observed directly. 'Severe' or 'large-scale' would be more defensible.
12	Loaded Language — 'Devastating' (repeated)	"The impact-related effects would have been devastating for animals and plants."	Discussion — Clovis and Megafauna, p. 16021	Again, 'devastating' states as established what the paper proposes as hypothesis. The evidence that follows—mammoth bones, Clovis tools, rapid burial—is powerful, but the framing word front-loads the conclusion.

Appendix 6: Surovell, T.A.; Holliday, V.T.; Gingerich, J.A.M.; Ketron, C.; Haynes, C.V.; Hilman, I.; Wagner, D.P.; Johnson, E.; Claeys, P. 'An Independent Evaluation of the Younger Dryas Extraterrestrial Impact Hypothesis.' *Proc. Natl. Acad. Sci. USA* 2009, 106(43), 18155–18158.

#	Category	Quotation or paraphrase	Location	Comment
Absence of Evidence & Logical Overreach				
1	Loaded Language	"a discrepancy between the two studies that is particularly troublesome"	Results, ¶12	'Particularly troublesome' is evaluative, not descriptive. The sentence could simply note that the discrepancy requires explanation. The loaded qualifier does argumentative work that the data alone cannot support.
2	Absence of Evidence Treated as Evidence of Absence	"We find no evidence for a peak in microspherules... In short, we find no support for the extraterrestrial impact hypothesis as proposed by Firestone et al."	Results → Discussion	The paper tests magnetic grains and microspherules at seven sites—two of nine marker categories reported by Firestone et al. A negative result on two markers does not license rejection of the full hypothesis. This is the paper's central logical flaw.
3	Straw Man	The paper states it "followed those of the original Firestone et al. study" but tests only magnetic grains and microspherules, omitting nanodiamonds, fullerenes with ET helium, iridium, charcoal, soot, PAHs, and glass-like carbon.	Methods; implied throughout	The paper presents itself as testing "the Firestone hypothesis," but it actually tests two of nine marker categories. Concluding that the hypothesis is "unsupported" overstates what a two-marker replication attempt can establish.
Asymmetric Standards & Selective Citation				
4	Asymmetric Evidentiary Standard	"it remains unclear what factors control the presence, absence, and relative abundance of magnetic microspherules"	Results, final ¶1	The paper applies strict standards to YDIH evidence (requiring a distinct, reproducible peak) while acknowledging that the behavior of the proposed alternative—micrometeorite background fallout—is itself unclear. No quantitative demonstration is offered that the alternative fits the observations.
5	Selective Citation — Pinter & Ishman as Framework	Pinter & Ishman (2008) cited as providing the interpretive alternative (micrometeorite ablation fallout) without independent evaluation.	Discussion	Pinter & Ishman (2008) is adopted as the alternative explanation, yet that paper also offers no quantitative demonstration that micrometeorite fallout accounts for the observed concentrations and distributions. Surovell et al. inherits the assumption without testing it.
Overgeneralization & Loaded Language				
6	Overgeneralization from Limited Sample	"we find no support for the extraterrestrial impact hypothesis"—drawn from seven of the original twenty-five sites	Discussion	Firestone et al. reported results from ten Clovis-age sites and fifteen Carolina Bays. A negative result at seven sites, using two marker categories, is a significant discrepancy but does not establish a general absence of the effect.
7	Loaded Language — 'Should Exhibit'	"seven sites that should exhibit this evidence if the impact hypothesis is credible"	Discussion	'Should exhibit' assumes that a confirmed impact would necessarily produce detectable peaks at these specific sites under the sampling conditions used. Site-specific depositional factors and spatial heterogeneity of ejecta are not addressed. The phrase loads the negative result with more interpretive weight than it can bear.
8	Insufficient Methodological Validation	"our identifications... have been confirmed by Allen West, one of the authors of the Firestone et al. article"	Discussion	Citing confirmation by one YDIH coauthor establishes that West recognized the objects as candidates, but it does not establish that the identification criteria were sufficient to detect the full range of objects Firestone et al. reported. Methodological adequacy requires more than agreement between two researchers examining the same material.

Appendix 7: Kennett, J.P.; Kennett, D.J.; Cullen, B.J.; Aura Tortosa, J.E.; Bischoff, J.L.; Bunch, T.E.; Daniel, I.R., Jr.; Erlandson, J.M.; Ferraro, D.; Firestone, R.B.; et al. Bayesian Chronological Analyses Consistent with Synchronous Age of 12,835–12,735 Cal B.P. for Younger Dryas Boundary on Four Continents. *Proc. Natl. Acad. Sci. USA* 2015, 112(32), E4344–E4353.

#	Category	Quotation or Paraphrase	Location	Comment
Loaded Language				
1	Loaded Language — 'improperly'	"They often improperly compared YDB dates by using median ages without considering inherent uncertainties"	Introduction, p. E4345	'Improperly' goes beyond neutral disagreement and characterizes the opponents' methodology as incorrect before the evidence is laid out. 'Without considering' would suffice on its own.
2	Loaded Language — 'unfounded'	"This conclusion is unfounded, because the probability distribution of that date (12,800–11,400 Cal B.P.) overlaps the published YDB range"	Barber Creek description	'Unfounded' is a strong dismissal. The rebuttal that follows is substantive, but the label exceeds what is needed. A more neutral phrasing: 'this conclusion does not follow.'
3	Loaded Language — 'incorrect' + 'overlooked'	"However, their conclusion is incorrect, because they did not consider the uncertainties for their date and overlooked the substantial old wood effect"	Arlington Canyon, p. E4346	'Incorrect' is direct and defensible, but combined with 'overlooked,' the sentence implies negligence rather than disagreement.
4	Loaded Language — 'usually claimed'	"Calibrated radiocarbon dates near 12,800 Cal B.P. cannot have the usually claimed precision of a few decades"	Introduction, p. E4345	'Usually claimed' implies that opponents routinely overclaim precision. More neutral: 'commonly reported.'
5	Loaded Language — 'inappropriate'	"It is inappropriate to mix dates from non-proxy layers with those from the proxy-rich layer when dating a potential YDB layer"	Aalsterhut description	'Inappropriate' characterizes van Hoesel et al.'s procedure as a methodological error. The underlying point is sound, but the word carries a normative charge.
Dismissal of Critics				
6	Dismissal — 'overlooked' (x2)	"They overlooked the presence of one age of 12,825 ± 55 Cal B.P."/"overlooked the substantial old wood effect"	Abu Hureyra; Arlington Canyon	Used twice about Meltzer et al. 'Overlooked' implies negligence — that the critics failed to notice something they should have seen. 'Did not address' or 'did not account for' would be more neutral.
7	Dismissal — 'contradicted their stated position'	"They contradicted their stated position by comparing YDB single dates without using the appropriate 68% or 95% probability"	Results, p. E4345	Accuses Meltzer et al. of internal inconsistency. The charge may be warranted, but the phrasing is pointed rather than neutral.
Begging the Question				
8	Begging the Question — impact as prior	"The YDB impact event also may have affected atmospheric radiocarbon concentrations through extensive biomass burning"	Introduction, p. E4345	Treats the impact as a possible cause of radiocarbon anomalies within a paper whose purpose is to establish the dating of that event. Hedged with 'may have,' but still circular.
9	Begging the Question — 'impact-related' as established	Throughout the paper, proxies are called "impact-related spherules," "impact proxies," "YDB impact proxies"	Throughout	The term 'impact-related' presupposes the origin of the spherules. Opponents would call them 'proposed impact proxies' or simply 'spherules.' This is a consistent framing choice rather than a single sentence.
Selective Framing				
10	Selective Framing — dating limitations	The Introduction devotes ~25 sentences to listing reasons why radiocarbon dates may be inaccurate (old wood, calibration plateaus, fractionation, hard water, etc.), without a balancing passage on circumstances under which radiocarbon dating performs well.	Introduction, pp. E4344–E4345	This framing is common in papers that introduce a methodological correction, but it still creates an asymmetric impression, lowering the reader's confidence in the dating standards that critics invoke.
Asymmetric Standard				
11	Asymmetric Standard — 'did not use established principles'	"They did not use established principles of 'chronological hygiene'"	Results, p. E4345	Accuses Meltzer et al. of failing to meet a methodological standard. The phrasing implies that the authors' own methods meet that standard fully, though this is not demonstrated comparatively.