

### **Impact did not Cause Climate Change, Extinction, or Clovis Termination at 12.9 ka**

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We present arguments against an extraterrestrial impact as the agent for an abrupt climate change at the 12.9 ka Younger Dryas boundary, terminal Pleistocene extinctions of N. American megafauna, and the supposed termination of the Clovis culture. Our rejection of this hypothesis is based on multiple independent lines of reasoning and evidence.

**Physical impossibility:** There is no mechanism that can cause a comet to explode at a sufficient altitude for continental-scale destruction, and no physical process that can sufficiently disperse fragments.

**Statistical impossibility:** The *a priori* probability of the extraordinarily-configured impact swarm is effectively zero.

**Lack of physical model:** No physics-based model has been proposed for the putative impact/airburst that can be subjected to scientific scrutiny.

**Lack of physical evidence:** There are no craters or unambiguous impact markers of the correct age in N. America.

**Irreproducibility:** Pt-group analyses failed to confirm the meteoritic signature identified as high Ir concentrations in bulk sediments and in magnetic spherules. There are no peaks in magnetic grains or microspherules in sediments corresponding to the claimed event. Hex diamonds could not be identified. Carbon spherules have morphologies and internal structures identical to fungal sclerotia, and carbon elongates represent arthropod coprolites.

**Archeology:** Archaeological, geochronological, and stratigraphic data fail to provide evidence of a demographic collapse of post-Clovis human populations

**Stratigraphy:** There are no regional stratigraphic marker beds or other indicators of regional geomorphic instability at 12.9 ka; black mats are time-transgressive in arid western N. America.

**Extinctions:** The dung fungal (*Sporormiella*) proxy for megafaunal presence indicates that some Pleistocene megaherbivores declined from 14.6 to 13.7 ka, well before the proposed impact; the

chronology of extinction for over half remains unresolved.

**Paleoclimate/paleoecology:** N. American charcoal and pollen records show rapid changes in vegetation and fire regimes, consistent with the climate changes at both the beginning and end of the Younger Dryas interval. The paleo records, however, do not show evidence of continental-scale wildfire at any time during the last glacial-interglacial transition (15 to 10 ka).

Premature and continued invocation of an exceedingly rare external agent, without adequate evidence, to explain climate change, extinction, and supposed human population collapse distracts from our effort to understand the complex links and cascading effects of environmental variability on society.

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