LETTER

Inconsistent impact hypotheses for the Younger Dryas

Israde-Alcántara et al. (1) presented evidence from Lake Cuitzeo sediments and argued that it supports the Younger Dryas (YD) impact hypothesis of Firestone et al. (2) for a major extraterrestrial impact event "involving multiple airburst(s) and/or ground impact(s) at 12.9 ka." Firestone et al. (2) did not specify the details of the impact but proposed that it had "continent-wide effects" and was "most likely a comet." The YD hypothesis "requires an energy of 10^7 megatons, equivalent to a >4-km-wide comet." Because no late Pleistocene craters have been identified, Firestone et al. (2) argue for prior fragmentation of a large impactor and suggest that multiple 2-km objects struck the Laurentide Ice Sheet at oblique angles.

The Israde-Alcántara et al. (1) YD impact model was quite different in character and magnitude. They proposed a comet or asteroid, "possibly a previously fragmented object that was once greater than several hundred meters in diameter." The limiting size of the impactor proposed by Israde-Alcántara et al. (1) is therefore approximately three orders of magnitude smaller in terms of mass and kinetic yield (explosive energy). It would therefore fall far short of the criterion cited by Firestone et al. (2) for continent-wide damage, even if it were possible for it to explode at its optimal height of burst. As such, the impact proposed by Israde-Alcántara et al. (1) cannot have caused the widespread environmental, paleontological, and archeological effects that Firestone et al. (2) were attempting to explain and is not consistent with the original YD impact hypothesis.

Israde-Alcántara et al. (1) also cited the model of Boslough and Crawford (3), who showed that small impactors (120 m in diameter) generate airbursts that can pyrolize biomass and melt silicates on the surface. However, Boslough and Crawford (3) also showed that airburst events of this magnitude are also crater-forming impacts. Their airburst model cannot directly be applied to an object several hundred meters in diameter, which would be one to two orders of magnitude more massive and energetic. Most of the kinetic energy of an object several hundred meters in diameter would be partitioned into a surface explosion and crater formation, not an airburst.

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1. Israde-Alcántara I, et al. (2012) Evidence from central Mexico supporting the Younger Dryas extraterrestrial impact hypothesis. *Proc Natl Acad Sci USA* 109: E738–E747.
2. Firestone RB, et al. (2007) 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* 104:16016–16021.
3. Boslough MBE, Crawford DA (2008) Low-altitude airbursts and the impact threat. *Int J Impact Eng* 35:1441–1448.

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