Challengers to Clovis-age impact theory missed key protocols, study finds

September 18 2012

An interdisciplinary team of scientists from seven U.S. institutions says a disregard of three critical protocols, including sorting samples by size, explains why a group challenging the theory of a North American meteor-impact event some 12,900 years ago failed to find iron- and silica-rich magnetic particles in the sites they investigated.

Not separating samples of the materials into like-sized groupings made for an avoidable layer of difficulty, said co-author Edward K. Vogel, a professor of psychology at the University of Oregon.

The new independent analysis—published this week in the online Early Edition of the Proceedings of the National Academy of Sciences—did, in fact, isolate large quantities of the "microspherules" at the involved sites where the challengers previously reported none. Lead author Malcolm A. LeCompte, an astrophysicist at Elizabeth City State University in North Carolina, said the findings support the climate-altering cosmic impact, but his team stopped short of declaring this as proof of the event.

The Clovis-age cosmic-impact theory was proposed in 2007 by a 26-member team led by Richard B. Firestone. That team included University of Oregon archaeologists Douglas J. Kennett and Jon M. Erlandson. While other groups have found corroborating evidence of a potential cosmic event, other groups reported difficulties doing so. One group, led by Todd A Surovell of the University of Wyoming, did not find any microspherule evidence at five of seven sites they tested,

including two previously studied locations where Firestone reported large numbers of microspherules.

"In investigating the two common sites and a third tested only by Surovell's team, we found spherules in equal or greater abundance than did the Firestone team, and the reported enhancement was in strata dated to about 13,000 years before the present," LeCompte said. "What we've done is provide evidence that is consistent with an impact, but we don't think it proves the impact. We think there's a mystery contained in the Younger Dryas strata, and that we've provided some validation to the original research by Firestone's group."

The particles in question, the team concluded, are terrestrial as was claimed by the Firestone group, and not of meteoric origin as claimed by other challengers including Surovell's group, and are similar to metamorphic material in Earth's crust. That determination was made using electron microscopy and spectroscopy.

"These spherules have evidence of very high-temperature melting and very rapid cooling, which is characteristic of debris ejected from an impact," LeCompte said. Speherules would have melted at temperatures approaching 2,000 degrees Celsius (more than 3,000 degrees Fahrenheit), he added. Cosmic materials, including the some microspherules, regularly fall to earth from space due to meteorite ablation, but the spherules found in soils dating to 13,000 years ago are much different, he added. Other researchers had suggested that these spherules were deposited by a cosmic rain or resulted through slow, terrestrial processes occurring under ambient conditions.

LeCompte and some key collaborators wondered why Surovell didn't find any spherules, and that led them to Vogel. Many of the spherules investigated were tiny, ranging in size from 20 to 50 micrometers (microns); about the diameter of a human hair.

"The inherent difficulty in finding these small, relatively rare magnetic microspherules suggested there may be inherent limitations in human faculties that needed to be addressed, and that's how and why we sought out UO Professor Ed Vogel. His research into human cognitive capabilities proved so important in understanding both why the search was so difficult and why size-sorting was effective and important in making it easier," LeCompte said.

Vogel specializes in the ability of people to find specific items amid multiple distractions.

"A visual search is a very error-prone process," Vogel said. "This was a case of looking at millions of particles from which you are hoping to find something that might be present much less than 0.1 percent of the time." Size-sorting, he said, is vital because it is easier to find a target item with a characteristic shape and color when all of the many more-distracting objects are very similar. "It is a slow, tedious process to examine such quantities of materials with the human eyes when object sizes are extremely dissimilar."

"Science is only as good as the humans who conduct it, and this study shows how the minds of researchers can operate in some surprising ways," said Kimberly Andrews Espy, UO vice president for research and innovation, and dean of the graduate school. "Dr. Vogel's excellent work, which illustrates the importance of understanding how the human mind processes information and the consequences it can have beyond making everyday computations, reflects the University of Oregon's strengths in interdisciplinary research."

LeCompte described Surovell's study "as possibly the most damning of the reports that had challenged the original theory."

"Todd had worked very hard and couldn't find the spherules, but I think

he made some fatal errors that need to be pointed out," LeCompte said. "It is instructive in that we initially made the same mistake and came to the same erroneous conclusion, but then we corrected our mistake. I would say this is a case of a missed opportunity due to their deviations from the protocol."

Two other critical protocol deviations not followed by the challengers involved the amounts of material examined and the use of microscopy techniques specified in Firestone's original research. Another two minor aspects of the protocol also were not repeated, reported LeCompte's team, which, in addition to Vogel, included an archaeologist, two materials scientists, a botanist, a periglacial geographer and an aerospace engineer.

LeCompte's team—using the protocols of Firestone's group and electron microscopy—additionally studied a quarry site in Topper, S.C., where Clovis-age people had made stone tools. After removing chert debris associated with tool making in soil at the depth of the Clovis occupation, LeCompte said, researchers observed virtually no spherules below it, while in soil just above the chert fragments they found a spike in the number of telltale spherules.

Further above that level, he noted, the soil layers were essentially "a dead zone" somewhat analogous to the K-T boundary, or "tombstone layer," from an extinction event that occurred 65 million years ago. At Topper, the dead zone showed almost no trace of human habitation for perhaps as long as 1,000 years duration.

"This suggests that something very dramatic happened," LeCompte said.

"The effects of such an impact would have been catastrophic on a global scale," said co-author Barrett Rock, a botanist at the University of New Hampshire. "On the order of 36 ice-age species became extinct, and the

Clovis human culture eventually lost. All of this in response to dramatic changes in the vegetation at the base of the faunal food chain."

Provided by University of Oregon