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A 65-Million-Year-Old Murder Mystery What Killed the Dinosaurs?

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A 65-Million-Year-Old Murder Mystery

What Killed the Dinosaurs? IWU Chemistry Students-Faculty Probe Ancient Soot for Clues

BLOOMINGTON, Ill.--It's a 65-million-year-old murder mystery and Illinois Wesleyan University students and faculty are sifting through clues like a Sherlock Holmes, Sam Spade, or Columbo, savvy detectives closing in on a killer.

The victims: Life on Earth, including huge creatures like 35-ton brontosaurs and about 35 species of other dinosaurs who roamed the Earth at the time.

The murder weapon: A giant meteorite, perhaps six miles in diameter, that smashed into the Earth at upward of 45,000 miles-an-hour. Crashing into the northern edge of Mexico's Yucatan peninsula, the meteorite carved a crater 60-100 miles wide, releasing 1,000 times more energy than all the nuclear weapons stockpiled at the height of the Cold War.

The clue: Soot. Soot contains certain types of carbon, a telltale sign of a raging global fire--"the big barbecue"--triggered by the meteorite's crash. This fire and other conditions killed the dinosaurs and thousands of species of plants and other animals.

Wolbach's Theory

The wildfire theory of the dinosaurs' extinction was proposed in 1985 by Wendy Wolbach, a University of Chicago graduate student working on a doctorate in chemistry, and two colleagues. Wolbach, now an IWU assistant professor and chair of the Chemistry Department, is continuing her pioneering research with the help of two IWU students: Susanna Widicus, a freshman chemistry major from Mt. Vernon, Ill., and Sarah Moecker, a sophomore biology-chemistry double major from Oak Forest, Ill.

Widicus and Moecker are following an example set by Wolbach when she was an undergraduate researcher at Franklin and Marshall College. For four summers as a college student, Wolbach conducted chemistry research into subjects like temperature changes associated with chemical reactions in solutions, especially the chemical bonds formed and broken in those reactions. Wolbach had five published research papers by the time she graduated from college.

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"The biggest benefit of student research," Wolbach said, "is that students learn to be resourceful in the laboratory. They don't have a lab instructor at their side and students learn to answer questions themselves and they learn experimental design.

"Research gives students confidence to work in the lab," Wolbach added, "and to develop laboratory techniques. It helps them decide whether research is something they want to do for the rest of their lives. I had the opportunity in college to do research and I'm trying to provide the same opportunity for the next generation."

Wolbach's philosophy fits in nicely with Widicus' career plans.

"I'd like to be a research chemist," Widicus said. "I'd like to do my own research perhaps with government funding and work in a university setting."

The Research Trail

Wolbach started on the saga of the dinosaurs' death in 1984, when she obtained a piece of clay from Denmark. It was rich in iridium, a scarce substance on Earth, but a trademark material found in meteorites. The clay came from a rock layer dubbed, the Cretaceous-Tertiary boundary (KTB), sedimentary rocks dating to the death of the dinosaurs.

Wolbach was hunting for iron or stone fragments. She wanted to pinpoint what type of meteorite had collided with the Earth. Instead, she found large quantities of elemental carbon, which turned out to be soot from fires.

"The carbon particles I found," Wolbach said, "looked like mini-grapes. The only way nature produces carbon in that structure is soot, which is produced in fires. If there was a major fire after the meteorite hit the Earth, we would see soot in samples from Denmark and around the world. We looked at sedimentary rocks 65 million years old from

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other geographically distant sites and found soot in them, too. The fire was a global phenomenon."

Research Findings Published

Her discovery was first published on the front page of the *New York Times* in 1985. A *Science* magazine article she co-authored, "Cretaceous Extinctions: Evidence for Wildfires and Search for Meteoritic Material," followed later that year. As Wolbach's research has unfolded and more than a dozen sites were studied, nine other articles have been published in scientific journals.

Discover magazine, the 1.1-million circulation monthly, wrote in its January, 1994, edition: "A global conflagration [a huge fire 65 million years ago that killed the dinosaurs after the Earth was struck by an asteroid] was first hypothesized eight years ago by Wendy Wolbach, now a geochemist at Illinois Wesleyan University, after she found a layer of soot in . . . deposits from many parts of the world."

The meteorite-Earth collision theory of the dinosaurs' demise was proposed in 1980 by Nobel Prize-winning physicist Luis Alvarez and his son, Walter, a University of California, Berkeley, geologist. When Walter Alvarez visited IWU in September, 1993, he said: "Wendy Wolbach has discovered--recovered--a crucial, lost event in Earth history, that no one ever knew about. An event which helped cause the extinction of the dinosaurs, making possible the evolution which led to human beings. What a fabulous discovery!"

Current IWU Research

"What we're doing now," Wolbach explained, referring to the work she is doing with IWU students Widicus and Moecker, "is filling in the gaps and trying to answer questions raised by various discoveries."

Wolbach's studies focused on rock samples from about a dozen ocean or shore line sites. Widicus and Moecker are studying rock samples from the western United States, a swampy area when the meteorite crashed into the Earth that now is dominated by the Rocky Mountains.

"We're looking for the same type of soot I found at other types of sites in the middle of a continent," Wolbach explained.

Moecker, for example, is examining rock samples from four or five sites, ranging from Arizona to the Canadian Rockies.

Widicus said: "I'm probably going to work on this research for four years. I love this

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type of hands-on work and applying what I learn in class in the lab. I have access to a scanning electron microscope--most people don't get their hands on an instrument like that until they're in graduate school."

The SEM allows the student researchers to examine the molecular structure of the rock samples. It is among the high-tech instrumentation housed in IWU's $25 million Center for Natural Science, which opened in 1995.

The students will continue their studies during the summer, supported by an IWU research grant. They're working with rock samples from various sources, including Chicago's Field Museum. They also will be working with about 30 rock samples from Norway.

Searching for New Sources of Soot

If Moecker and Widicus find carbon-based soot particles from landlocked sites, similar to what Wolbach found at marine sites, it would help build the case for a global wildfire sparked by the meteorite crash into the Earth. When that happened, scientists hypothesize that dust from the meteorite and crater was thrown into the stratosphere, where it was blown around the world by 600-mile-per-hour winds (dubbed "hypercanes") before settling to Earth. This enormous amount of dust shrouded the Earth, making it cold and dark.

"The sky was black for months," Wolbach said, "and up to 85 percent of the Earth's species died at the time."

Other environmental fallout from the meteorite crash were tsunamis (tidal waves) since the site of the meteorite's collision with the Earth was partially under water, acid rain, destruction of the Earth's protective ozone layer, and a long-term greenhouse effect from carbon dioxide and water released by the impact.

Laboratory Process

The lab work Widicus and Moecker are doing is intricate and time-consuming. The process begins with crushing rocks and immersing them in acid to separate out minerals and reduce the sample down to elemental carbon or soot. After samples are dried, they are examined with the SEM for the characteristic grape-like molecular shape of soot. The students photograph the samples and calculate how much soot is in samples, comparing their results to previous findings. It can take upward of 600 hours--or 25 days--just to reduce samples down to elemental carbon.

The students are eyeing the prospect of working with rock samples from the 1.8

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billion-year-old Sudbury crater in Ontario, Canada. Some scientists, according to Wolbach, have wondered about whether the soot from the wildfires is residue from vegetation like burnt trees or from carbon in the meteorite. Material from the Sudbury crater will allow the researchers to study rock samples from before there was life on Earth to see if soot can be formed from meteorite carbon.

Other Related Research

In addition to the search for soot and other indications of combustion associated with the massive meteorite collision with the Earth 65 million years ago, IWU student researchers are investigating:

- Deep sea drill cores for combustion products transported from land through the air in an attempt to understand the global distribution of fine particles.
- Ice core samples from the Arctic to help understand contemporary rain forest burning patterns and soot transport.
- Impact craters as way to understand ignition mechanisms and possible fuel sources for ancient fires.
- Carbon-rich shales in an effort to improve chemical methods used to isolate soot and other combustion products from sedimentary rock.

Could It Happen Again?

Disaster films--like the made-for-TV movie, "Asteroid"--and recent flybys of Earth by comets have triggered speculation about whether a giant meteorite could again hit the planet. It's estimated that tons of dust-sized particles hit the Earth annually, according to a pamphlet written by Wolbach. Larger objects are less likely to strike the Earth because they occur less frequently in space. Each year, the Earth is hit by 15-20 baseball-sized objects, but something the size of the KTB meteorite might collide with the planet only every 26-33 million years. It has been about 15 million years since the last impact of that size.

However, the Earth is located in a "meteor swarm" of dead comets and asteroids with orbits crossing the Earth's path. It is impossible, Wolbach wrote, to predict when the orbits of these objects will cross our orbit while the Earth is there, as the orbits of only an estimated five percent of orbiting objects are known.

Wolbach concluded: "It is just a matter of time before Earth suffers another giant

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impact, with environmental consequences no less severe for us than they were for the dinosaurs 65 million years ago."

"I'm very lucky to be working with Professor Wolbach," Moecker said. "She's done all this research--and has written scientific papers. She came up with the global fire hypothesis. It's cool to work with her and have the chance to publish scientific papers."

IWU, founded in 1850, enrolls about 1,900 students in a College of Liberal Arts, College of Fine Arts, and a four-year professional School of Nursing. A $15 million athletics and recreation center opened in the fall of 1994; and a $25 million science building opened in the fall of 1995. The $4.6 million Center for Liberal Arts--a facility housing 60 faculty offices, six classrooms, and other facilities for social science, humanities, business and economics, and interdisciplinary studies' faculty--is slated to open next fall, as well as a $6.8 million residence hall, accommodating about 118 students. The Carnegie Commission for the Advancement of Teaching promoted Illinois Wesleyan to a "Baccalaureate I" institution in 1994, a classification that places it among 161 highly selective National Liberal Arts Colleges in the annual *U.S. News & World Report* rankings. *Baron's Profiles of American Colleges*, another respected college guide, rated IWU "highly competitive (+)" in its latest edition.

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