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Meteor May Have Started Dinosaur Era

By KENNETH CHANG

The age of dinosaurs, which ended with the cataclysmic bang of a meteor impact 65 million years ago, may also have begun with one.

Researchers report today in the journal Science the first direct, though tentative, geological evidence of a meteor impact 200 million years ago, coinciding with a mass extinction that eliminated half of the major groups of life and opened the evolutionary door for what was then a relatively small group of animals: dinosaurs.

"There is a geochemical signature of something important happening, probably an asteroid impact, just before the time in which familiar dinosaur-dominated communities appear," said the lead author of the article, Dr. Paul E. Olsen, a professor of earth and environmental sciences at Columbia University's Lamont-Doherty Earth Observatory in Palisades, N.Y.

Scientists have known about the extinction -- one of five or six known mass extinctions in the history of Earth -- but until recently they thought the changes had occurred slowly, over hundreds of thousands or millions of years, perhaps because of huge volcanic eruptions or climate changes.

In the layer of rock corresponding to the extinction, the scientists found elevated amounts of the rare element iridium.

A precious metal belonging to the platinum group of elements, iridium is more abundant in meteorites than in rocks on Earth.

A similar spike of iridium in 65 million-year-old rocks gave rise in the 1970's to the theory that a meteor caused the demise of the dinosaurs. That theory remained controversial for years until it was corroborated by other evidence and the impact site was found off the Yucatán Peninsula. Scientists will need to examine the new iridium anomaly similarly.

The levels are only about one-tenth as high as those found at the later extinction.

That could mean that the meteor was smaller or contained less iridium or that a meteor was not involved. Iridium can also come from the Earth's interior, belched out by volcanic eruptions.

Dr. Michael J. Benton, a professor of vertebrate paleontology at the University

of Bristol in England, described the data as "the first reasonably convincing evidence of an iridium spike."

In the same rock layer, Dr. Olsen and his colleagues found a high concentration of fern spores -- considered an indicator of a major disruption in the environment. Because spores carried by the wind can travel long distances, ferns are often the first plants to return to a devastated landscape.

The scientists found more evidence of rapid extinction in a database of 10,000 muddy footprints turned to rock in former lake basins from Virginia to Nova Scotia.

Although individual species cannot usually be identified solely from their footprints -- the tracks of a house cat, for example, resemble those of a baby tiger -- footprints are much more plentiful than fossil bones and can provide a more complete picture of the types of animals walking around.

"It makes it very easy for us to tell the very obvious signals of massive fauna change," Dr. Olsen said.

Because the sediment piles up quickly in lake basins, the researchers were able to assign a date to each footprint, based on the layer of rock where it was found.

They determined that the mix of animals walking across what is now the East Coast of North America changed suddenly about 200 million years ago.

The tracks of several major reptile groups continue almost up to the layer of rock marking the end of the Triassic geologic period 202 million years ago, then vanish in younger layers from the Jurassic period.

"I think the footprint methodology is very novel and very exciting," said Dr. Peter D. Ward, a professor of geology at the University of Washington. He called the data "very suggestive."

But he said the iridium anomaly was "a pretty minimal signal" that required more research.

Last year, researchers led by Dr. Ward reported that the types of carbon in rock changed abruptly at this time, indicating a sudden dying off of plants over less than 50,000 years. The footprint research reinforces the hypothesis that the extinction was sudden.

Several groups of dinosaurs survived that extinction, and the footprints show that new groups emerged soon afterward. Before the extinction, about one-fifth of the footprints were left by dinosaurs; after the extinction, more than half were from dinosaurs. The changes, the researchers said, occurred within 30,000 years -- very quickly on geological time scales.

Among the creatures that disappeared in the extinction were the dominant predators at the time: 15-foot-long rauisuchians with great knifelike teeth and

phytosaurs that resembled large crocodiles.

Dinosaurs first evolved about 230 million years ago, but they were small, competing in a crowded ecological niche.

Before the extinction 200 million years ago, the largest of the meat-eating dinosaurs were about the size of large dogs. "Not terribly impressive," Dr. Olsen said.

The dinosaurs quickly grew. The toe-to-heel length of the foot of a meat eater from the Jurassic period was on average 20 percent longer than its Triassic ancestor. Larger feet can carry bigger bodies; the scientists infer the dinosaurs doubled in weight, eventually evolving into fearsome velociraptors, Tyrannosaurus rex and other large carnivorous dinosaurs.

The spurt in evolution is similar to the rise of mammals after the extinction of dinosaurs. Mammals, no larger than small dogs during the age of dinosaurs, diversified into tigers, elephants, whales and people after the reptilian competition died away.

The success of the dinosaurs after the Triassic-Jurassic extinction may be why they did not survive the second extinction.

"Small animals always do better in catastrophic situations," Dr. Olsen said, "because they can survive on smaller amounts of food."

He also pointed out that scientists now believe the small dinosaurs did survive. "We just call them birds," he said.