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The Fireball That Killed the Dinosaurs Could Help Us Find Life on Other Planets

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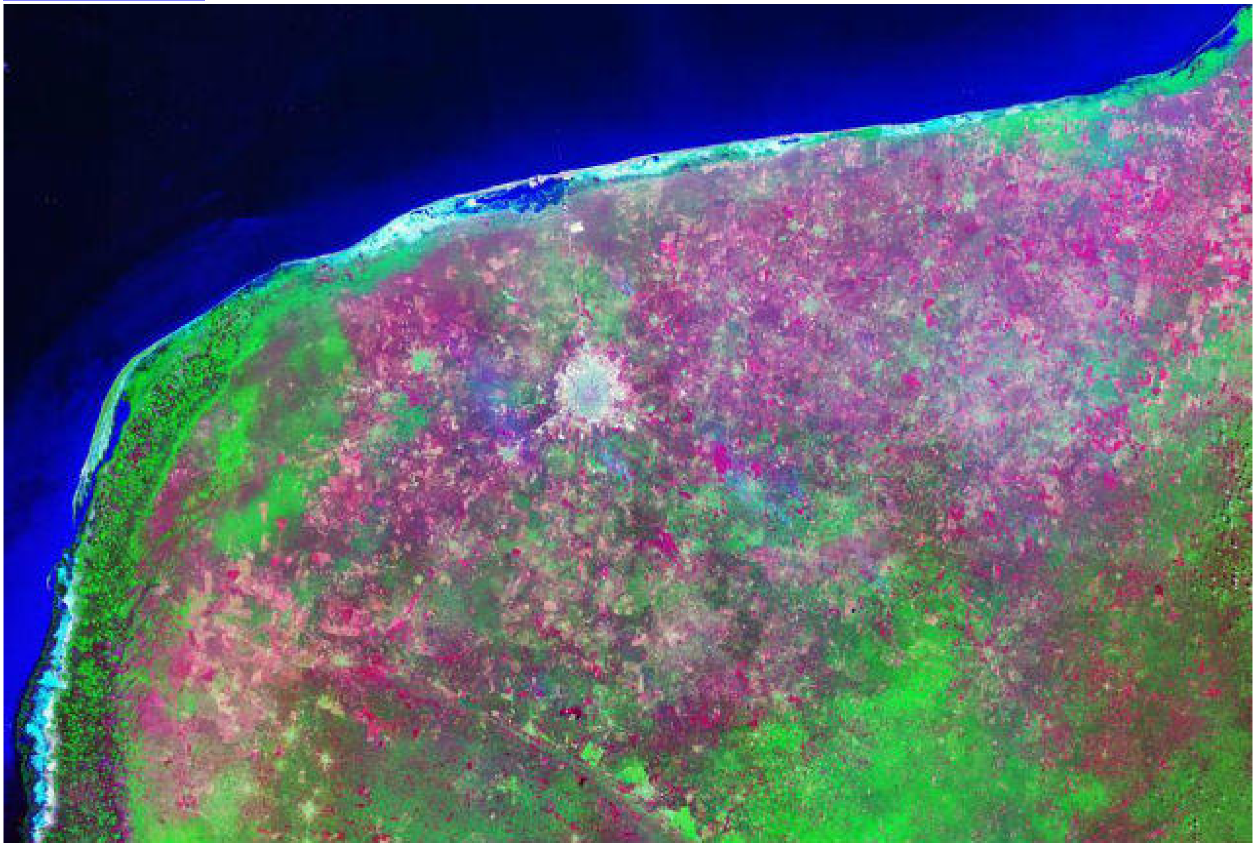

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When David Kring of the University of Arizona gave a presentation at the Lunar and Planetary Science Conference in 1991, he didn't expect a packed crowd for his talk on the petrology of the Chicxulub Structure in the Yucatan, Mexico. Normally, Kring knew, impact-cratering sessions were presented in the smallest room—the miserable Room D, a shoebox on the second floor. But the magnitude of his announcement attracted scientists across fields and disciplines, so he was bumped up to the main room.

Kring had been investigating a place called the Yucatán-6 borehole, and he and his team had discovered shock quartz and impact melt fragments in two thumb-sized bits of rock that were over half a mile beneath the surface of the Earth. This was evidence that the hole, thought for a very long time to be a volcanic center, was actually an impact structure. And not just any "impact structure," and not just *any* crater—but the crater of all craters on Earth. The one behind the death of the dinosaurs 66 million years ago.

Last year, Kring was part of an expedition in which scientists drilled into Chicxulub to investigate how the disastrous collision of fireball and Earth that killed the dinosaurs also created the conditions for life to begin anew. Last month, Kring and his colleagues returned to the Lunar and Planetary Science Conference to present their findings from the new core samples they took on that expedition. The results provide new clues about how life may have begun on Earth about 4 billion years ago—and point us towards how and where we can look for life across the universe.

THE SMOKING CANNON

Back in the early 1990s, Kring knew what he was looking for—a crater of the size and magnitude that would provide evidence of catastrophic extinction—but he didn't know where to look. "It was a race to find the impact site," Kring tells mental_floss, "and we had made a discovery of this very thick impact ejecta deposit in Haiti, which pointed us to [the Yucatan]."

Impact ejecta is what's blasted from the Earth or other body when a meteor crashes into it. In this case, a giant chunk of the Earth was blown a thousand miles away. Until the Haiti discovery, people were looking all over the planet for the crater. But now they had a target region. Meanwhile, Petroleos Mexicanos, an oil company, had drilled down into what they thought was a "geophysical anomaly" in the Yucatan—a salt dome, maybe, where there might be oil. That's when Kring and his colleagues re-examined samples collected from the site and realized there were features consistent with an impact.

That the Yucatan site was still intact to be found wasn't a given. In the last 65 million years, half of the seafloor has been subducted, where one tectonic plate slides beneath another—which would have prevented scientists from discovering samples. When Kring and his team looked at the samples they were able to take, there was shock quartz in one of the layers. "The minute you see shock quartz, that is absolutely, categorically diagnostic of impact," says Kring. "You know that's not a buried volcano. It's an impact crater, and that's your eureka moment."

When Kring found the Chicxulub Crater, it finally provided scientific evidence for the Impact Mass Extinction Hypothesis. Developed by physicist Luis Alvarez, the theory proposes that the extinction of the dinosaurs was caused by a catastrophic asteroid impact with the Earth. The theory made a lot of sense. An impact of such magnitude would certainly leave a mark, after all. The dominant alternative hypothesis was that overdrive volcanic activity caused catastrophic climate change, leaving the dinosaurs in a bad spot. Finding an impact crater of this magnitude, scientist Gene Shoemaker would later tell *Time* magazine, was "the smoking cannon."

The discovery that impact cratering is not only a geological process but a *biological* one caused a major shift in scientific thinking during the 20th century. The idea that you could have catastrophic events completely change the evolutionary path of the planet was staggering in its implication. Impact Mass Extinction Hypothesis, and the subsequent discovery of Chicxulub Crater, were argued by some as fundamentally more important, and bigger shifts in the tenets of geology, than learning about continental drift.

THE ORIGIN OF LIFE ON EARTH

When a fireball hit the Earth 66 million years ago, the Mesozoic Era (the Age of Reptiles) ended and the Cenozoic—the Age of Mammals—began. One second before the strike, in the part of the sea that must have had a dark shadow pooling rapidly outward as the asteroid approached, 50-foot sea monsters called mosasaurs swarmed and devoured fish and mollusks. One second after the asteroid hit, those mosasaurs were gone, and chunks of the planet were blown thousands of miles in every direction. Every continent on Earth was devastated in the blink of a geologic eye. A 300-foot tsunami washed across North and South America. The Sun was blotted out. Plants relying on photosynthesis declined or went extinct. If you were a dinosaur who couldn't fly, you were done for. Seventy-five percent of all species of life were obliterated.

But bad as that sounds, approximately 4 billion years ago, an impact likely larger even than Chicxulub would have vaporized the sea and created a rock vapor atmosphere for thousands of years. The impacts would have produced vast subsurface hydrothermal (hot water) systems that were perfect crucibles for prebiotic chemistry. The new core samples taken from deep in Chicxulub provide physical evidence of this theory. The samples are fractured and permeable—perfect for the circulation of hot fluid. Moreover, they also have signatures of hot fluids and altered rock and hydrothermal minerals.

The hydrothermal systems caused by an asteroid collision may have lasted for as long as 2.3 million years. This is critical, because life needs time to establish itself and evolve. Those systems would have evolved into perfect habitats for the evolution of life.

Kring's Chicxulub research suggests that these are the types of places life evolved in early Earth history. Further research will look at the analysis of rock samples for radiometric signatures, to try to determine how long that system persisted. It's also given rise to a new theory: the Impact Origin of Life Hypothesis.

This impact origin of life theory is not necessarily limited to Earth, as research from Susanne Schwenzer, Oleg Abramov, and others suggest. "It is generically translatable," says Kring. "Impact cratering, as it turns out, is an important heat engine for planetary bodies. Impact events on icy satellites can melt icy shells and produce seeds. You need liquid water for life. That may have had a role of life in our outer system." This also applies to extrasolar planetary systems.

Whether life originated anywhere beyond Earth is still to be determined, but this is a big step toward understanding what conditions to look for. You can be sure when it's announced, that scientist will certainly play to a standing-room-only crowd yet again.

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