PHOTOGRAPH BY TIM PEAKE, ESA, NASA

Here's What Happened the Day the Dinosaurs Died

An impact calculator helps scientists paint a vivid picture of the immediate aftermath of the deadly asteroid strike.

BY **ROFF SMITH**

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Imagine sunrise on the last day of the Mesozoic era [http://www.ucmp.berkeley.edu/mesozoic/mesozoic.php] , 66 million years ago. Shafts of sunlight rake through the swamps and coniferous forests along the coast of what is now Mexico's Yucatán Peninsula. The blood-warm seas of the Gulf of Mexico teem with life.

As this lost world of dinosaurs and outsize insects squawks and buzzes and whirs to life, an asteroid the size of a mountain is hurtling toward Earth at about 40,000 miles (64,000 kilometers) an hour.

For a few fleeting moments, a fireball that appears far bigger and brighter than the sun streaks through the sky. An instant later, the asteroid slams into Earth with an explosive yield estimated at over 100 trillion tons of TNT.

The impact penetrates Earth’s crust to a depth of several miles, gouging a crater [http://onlinelibrary.wiley.com/doi/10.1002/2015JB012615/full] more than 115 miles (185 kilometers) across and vaporizing thousands of cubic miles of rock. The event sets off a chain of global catastrophes that wipe out 80 percent of life on Earth—including most of the dinosaurs [http://news.nationalgeographic.com/2016/04/160418-what-killed-dinosaurs-chicxulub-crater-drill-science/] .

This apocalyptic tale has been described in countless books and magazines ever since the asteroid impact theory [http://paleobiology.si.edu/dinosaurs/info/everything/why_2.html] was first put forth in 1980. The identification of Chicxulub Crater in the Gulf of Mexico during the 1990s then gave scientists an accurate idea of the “when” and the “where.”

But exactly how the fallout killed off so much life on Earth has remained a tantalizing mystery.

This is a piece of the asteroid that made the Chicxulub Crater.

PHOTOGRAPH BY FAITH TUCKER, NASA

Last month, a team of British scientists working on an off-shore drilling platform in the Gulf of Mexico obtained the first-ever core samples [http://www.eso.ecord.org/expeditions/364/364.php] from the “peak ring” of the Chicxulub Crater. This ring is where the shocked Earth rebounded in the seconds following the impact, and the swelling formed a large circular structure within the crater walls. By studying its topsy-turvy geology, researchers hope to gain a better understanding of the phenomenal forces unleashed that day.

Reliving Catastrophe

What is already known would beggar the imaginations of Hollywood scriptwriters. Using an “impact calculator [http://purdue.edu/impactearth] ” developed by a team of geophysicists from Purdue University and Imperial College London, users can enter in a few key details, such as the asteroid’s size and speed, to paint a vivid picture of events.

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say within 1,000 kilometers [625 miles], you would be instantaneously, or within a few seconds, killed by the fireball."

Scientists used a drill to investigate the Chicxulub Crater.

PHOTOGRAPH BY ERWAN LE BER, INTERNATIONAL OCEAN DISCOVERY PROGRAM

Indeed, if you were near enough to see it, you were dead, says Gareth Collins [http://www.imperial.ac.uk/people/g.collins] , a lecturer on planetary science at Imperial College who helped develop the program.

Nine seconds after impact, an observer at that distance would have been roasted by a blast of thermal radiation. Trees, grass, and shrubs would have spontaneously burst into flame, and anyone present would have suffered instant third-degree burns over their entire bodies.

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“A seismic event of this size would be the equivalent of all the world’s earthquakes for the past 160 years going off simultaneously,” says Rick Aster [https://sites.warnercnr.colostate.edu/aster/] , professor of seismology at Colorado State University and former president of the Seismological Society of America.

At just over eight minutes post-impact, ejecta would start to spill down, smothering the burning landscapes beneath a blanket of hot grit and ash. Closer to the impact zone, the ground would be buried beneath hundreds, even thousands, of feet of rubble.

About 45 minutes later, a blast of wind would tear through the region at 600 miles (965 kilometers) an hour, scattering debris and leveling anything that might still be standing. The sound of the explosion would arrive at the same time, a 105-decibel roar as deafening as a jet making a low pass flyover.

These rocks were brought up by scientists from the Chicxulub Crater.

PHOTOGRAPH BY DAVE SMITH, INTERNATIONAL OCEAN DISCOVERY PROGRAM

Further afield, out of range of the direct effects of the explosion, an observer would be treated to the spectacle of darkening skies and an apocalyptic display of shooting stars created by the impact debris raining back on Earth.

“They wouldn’t have looked quite like regular shooting stars or meteors,” says Collins. “Meteors burn up at higher speeds and get hotter. These would have been re-entering the atmosphere at lower altitudes, traveling slower and emitting infrared radiation. I’m not entirely sure what that would look like. Some sort of red glow would be my guess.”

After the red glow, the sky would darken as ash and debris swirling around the globe created a creeping twilight.

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People gaze at Tristan the *Tyrannosaurus rex* in Berlin, Germany. Tristan was found in Montana and is one of the best preserved large dinosaur skeletons ever discovered.

PHOTOGRAPH BY AXEL SCHMIDT, GETTY IMAGES

End Times

While most accounts focus on the spectacular violence of those first few minutes to days after the impact, it was the long-term environmental effects that ultimately wiped out most dinosaurs and much of the rest of life on Earth.

The prevailing dimness caused by the dust cloud meant photosynthesis would have been dramatically reduced. The soot and ash would have taken months to wash out of the atmosphere, and when it did, the rain would have fallen as acidic mud. Massive fires would have produced huge amounts of toxins that temporarily destroyed the planet's protective ozone layer.

Then there was the carbon footprint of the impact itself, which released an estimated 10,000 billion tons of carbon dioxide, 100 billion tons of carbon monoxide, and another 100 billion tons of methane in one fell swoop, according to geologist David Kring [http://www.lpi.usra.edu/exploration/teamMembers/kring/] of the Lunar and Planetary Institute.

In effect, the aftermath of the asteroid was probably a powerful one-two punch of nuclear winter followed by dramatic global warming. And that's where the core samples freshly pulled from Chicxulub Crater can help fill in gaps in this infamous story.

"The drilling program will help us understand how all this affected the post-impact climate—how much material was ejected into the stratosphere and what that material was," says Morgan.

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