Timeline of a mass extinction: New evidence points to rapid collapse of Earth's species 252 million years ago

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Graphic: Christine Daniloff

Since the first organisms appeared on Earth approximately 3.8 billion years ago, life on the planet has had some close calls. In the last 500 million years, Earth has undergone five mass extinctions, including the event 66 million years ago that wiped out the dinosaurs. And while most scientists agree that a giant asteroid was responsible for that extinction, there's much less consensus on what caused an even more devastating extinction more than 185 million years earlier.

The end-Permian extinction occurred 252.2 million years ago, decimating 90 percent of marine and terrestrial species, from snails and

small crustaceans to early forms of lizards and amphibians. “The Great Dying,” as it’s now known, was the most severe mass extinction in Earth ’s history, and is probably the closest life has come to being completely extinguished. Possible causes include immense volcanic eruptions, rapid depletion of oxygen in the oceans, and — an unlikely option — an asteroid collision.

While the causes of this global catastrophe are unknown, an MIT-led team of researchers has now established that the end-Permian extinction was extremely rapid, triggering massive die-outs both in the oceans and on land in less than 20,000 years — the blink of an eye in geologic time. The researchers also found that this time period coincides with a massive buildup of atmospheric carbon dioxide, which likely triggered the simultaneous collapse of species in the oceans and on land.

With further calculations, the group found that the average rate at which carbon dioxide entered the atmosphere during the end-Permian extinction was slightly below today’s rate of carbon dioxide release into the atmosphere due to fossil fuel emissions. Over tens of thousands of years, increases in atmospheric carbon dioxide during the Permian period likely triggered severe global warming, accelerating species extinctions.

The researchers also discovered evidence of simultaneous and widespread wildfires that may have added to end-Permian global warming, triggering what they deem “catastrophic” soil erosion and making environments extremely arid and inhospitable.

The researchers present their findings this week in Science, and say the new timescale may help scientists home in on the end-Permian extinction’s likely causes.

“People have never known how long extinctions lasted,” says Sam

Bowring, the Robert R. Schrock Professor of Earth, Atmospheric and Planetary Sciences (EAPS) at MIT. “Many people think maybe millions of years, but this is tens of thousands of years. There’s a lot of controversy about what caused [the end-Permian extinction], but whatever caused it, this is a fundamental constraint on it. It had to have been something that happened very quickly.”

Rocks in a hard place

Bowring worked with a group of American and Chinese researchers to pinpoint the extinction’s duration. The group analyzed volcanic ash beds from Meishan, a region in southern China where an old limestone quarry exposes rocks containing abundant fossils from the Permian period, as well as the very first fossils that signified a recovery from extinction, during the Triassic period. The rocks of the region have been widely studied as the best global example of the Permian-Triassic Boundary (PTB).

The group collected clay samples from ash beds both above and below rock layers from the PTB. In the lab, they separated out zircon, a robust mineral that can survive intense geological processes. Zircon contains trace amounts of uranium, which can be used to date the rocks in which it is found. Bowring and his colleagues analyzed 300 of the “best-looking” grains of zircon, and found the rocks above and below the mass-extinction period spanned only a 20,000-year phase.

Bowring says now that researchers are able to precisely date the end-Permian extinction, scientists will have to re-examine old theories. For example, many believe the extinction may have been triggered by large volcanic eruptions in Siberia that covered 2 million square kilometers of Earth — an area roughly three times the size of Texas.

“In the old days you could say, ‘Oh, it’s about the same time, therefore

it's cause and effect,'" Bowring says. "But now that we can date [the extinction] to plus or minus 20,000 years, you can't just say 'about the same.' You have to demonstrate it's exactly the same."

'Something unusual going on'

The group also analyzed carbon-isotope data from rocks in southern China and found that within the same period, the oceans and atmosphere experienced a large influx of carbon dioxide. Dan Rothman, a professor of geophysics in EAPS, calculated the average rate at which carbon dioxide entered the oceans and atmosphere at the time, finding it to be somewhat less than today's influx due to fossil fuel emissions.

"The rate of injection of CO2 into the late Permian system is probably similar to the anthropogenic rate of injection of CO2 now," Rothman says. "It's just that it went on for … 10,000 years."

Rothman says the total amount of CO2 pumped into Earth over this time period was so immense that it's not immediately clear where it all came from.

"It's just not easy to imagine," Rothman says. "Even if you put all the world's known coal deposits on top of a volcano, you still wouldn't come close. So something unusual was going on."

Provided by Massachusetts Institute of Technology

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