

The end of the Earth actually happened about 250 million years ago

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About 252 million years ago, almost all life on Earth disappeared. Known as **the Permian-Triassic mass extinction event – or the Great Extinction – it was the largest recorded catastrophe in our planet's past 539 million years.**



Up to 94% of marine species and 70% of terrestrial vertebrate families were wiped out. Tropical forests – which act as vital carbon sinks that help regulate the planet's temperature today – were also severely depleted.

Scientists have long agreed that the event was triggered by a sudden surge of greenhouse gases, leading to rapid and intense warming of the Earth. But what remains a mystery is why these extremely hot conditions persisted for millions of years.

The cause of the mass extinction has now been published in the journal Nature Communications. The decline of the rainforests has trapped the Earth in a 'hothouse' state, confirming scientists' suspicions that when the planet's climate passes certain 'tipping points,' a truly catastrophic ecological collapse could occur.

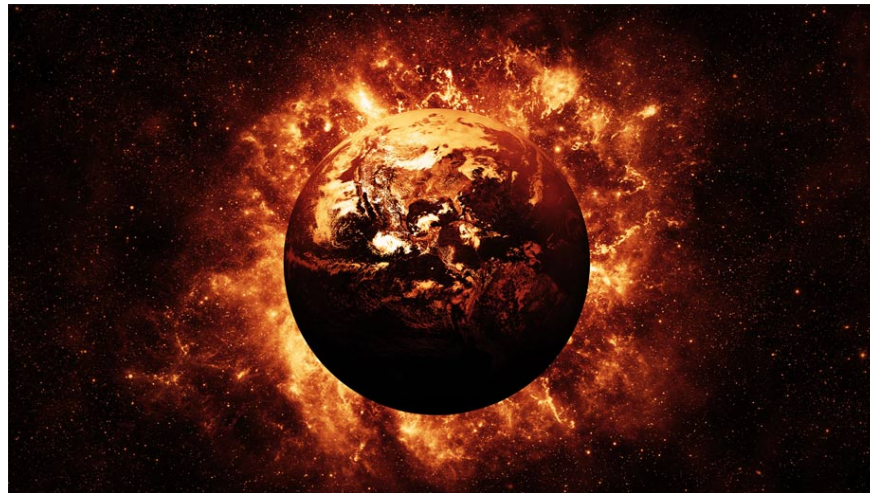
A major eruption

The cause of the Permian-Triassic mass extinction was the eruption of a large amount of molten rock in what is now Siberia, known as the Siberian Traps. This molten rock erupted into a sedimentary basin rich in organic matter.

The molten rock was hot enough to melt the surrounding rocks and release large amounts of carbon dioxide into the Earth's atmosphere over a short period of time, as little as 50,000 years, but possibly as long as 500,000 years. The rapid increase in carbon dioxide in the Earth's atmosphere and the resulting increase in temperature are thought to have been the primary extinction mechanism for most life at that time.

On land, it is thought that surface temperatures rose by 6°C to 10°C – too fast for many life forms to evolve and adapt to. In other similar eruptions, the climate system has typically returned to its previous state within 100,000 to a million years.

But these 'super greenhouse' conditions, which resulted in average equatorial surface temperatures of up to 34°C (about 8°C warmer than the current average equatorial temperature), persisted for about five million years.



Forest destruction

Scientists looked at the fossil record of a range of terrestrial plant communities, such as arid, tropical, subtropical, temperate and scrubland. They analysed how the communities changed from just before the mass extinction event, until about eight million years later.

It is hypothesized that the Earth warmed too quickly, leading to the extinction of vegetation at low to mid-latitudes, especially tropical rainforests. As a result, the efficiency of the organic carbon cycle was significantly reduced immediately after the volcanic eruptions.

Plants, unable to stand up and move on their own, were greatly affected by the changing conditions.

Before the event, many peat bogs and tropical and subtropical forests existed around the equator and absorbed carbon.

However, when the team reconstructed plant fossils from fieldwork, records, and databases around the event, they realized these biomes were completely wiped out from the tropical continent, resulting in a 'coal gap' in the geological record that lasted millions of years.

These forests are replaced by small lycopods, only 2 to 20 cm tall.

Larger plant populations remained at the poles, in coastal regions, and in lowland mountains where temperatures were slightly cooler. After about five million years, they had largely repopulated the Earth. However, these plants were also less efficient at fixing carbon in the organic carbon cycle.

This is somewhat similar to considering the impact of replacing all of today's tropical rainforest with the mallee-scrub and spinifex flora we might see in the Australian outback.

Finally, the forest is back

Using evidence from the present, scientists estimate the rate at which plants absorb atmospheric carbon dioxide and store it as organic matter for each of the different biomes suggested in the fossil record.

They then used a newly developed carbon cycle model called SCION to test their hypothesis numerically. Analysis of the model results showed that the initial temperature increase from the Siberian Traps was maintained for five to six million years after the event due to a decrease in net primary productivity.

Only when plants recover and the organic carbon cycle restarts will the Earth gradually escape super-greenhouse conditions.



Maintain climate balance

It is difficult to draw parallels between past climate change and what we are experiencing today. That is because the rate of change in the past was typically measured over tens to hundreds of thousands of years, whereas we are experiencing change now over decades to centuries.

However, an important implication of this research is that life on Earth, although resilient, cannot respond to large changes in short timescales without dramatic changes in the biological landscape.

In the case of the Permian-Triassic mass extinction, plants did not have time to adapt in a short period of time such as 1,000 to 10,000 years. This led to a major extinction event.

Overall, the results underscore the importance of tropical and subtropical plant communities and environments for maintaining climate balance. In turn, they suggest that the loss of these communities could contribute to further warming of the climate – and act as a catastrophic climate tipping point.

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