The Permian Extinction

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The Permian extinction, also known as the Permian-Triassic extinction event or the Great Dying, is the most severe extinction event known to Earth. Marking the end of the Permian period to the beginning of the Triassic period and the turn of the Paleozoic era to the Mesozoic era, life on Earth was never the same. But what exactly do we know about the Permian extinction? When and Why did it happen? What caused it? How did it affect all the different kinds of life on Earth? And how was Earth different post-mass extinction? While we are still yet to know everything, scientists have reached a consensus on most questions posed by the Permian extinction.

Dating the Permian Extinction

Throughout more recent history, the dating for the Permian extinction has fluctuated with the updates of technology and scientific discoveries. For example, until 1964, 225 million years was the accepted age of the event, and then 235 million years until 1973 (Erwin, 1993, p. 83). However, with improvements, scientists have dated the Permian extinction to a narrow 251.941 ± 0.037 and 251.880 ± 0.031 million years ago (Burgess et al., 2014). This extinction lasted approximately 60 ± 48 thousand years (Burgess et al., 2014). Getting a reliable date of the event was once deemed too challenging of a task as there was yet to be an appropriate dating method that could use the poor data available (Erwin, 1993, p. 84). With the needed improvements, scientists could pinpoint an approximate date with a relatively small margin of error of only a few million years. While that may seem like a large margin of error, it is small in perspective of the millions of years since the event occurred.

Proposed Causes

While researchers have a good idea of when the Permian extinction event occurred, determining the cause of the event has proven more ambiguous. Due to the extreme number of years since the event, its evidence has been long destroyed and recycled by tectonic activity (NASA, 2023). With this lack of concrete evidence of what caused the extinction, scientists have yet to reach a unanimous explanation. Among those possibilities include severe volcanic activity, a string of environmental changes brought on by the formation of Pangea, and an impact event (NASA, 2023).

The leading hypothesis of the Permian extinction is severe volcanism. There were massive eruptions in what is now the Siberian Traps region, where 1.5 million km^3 of lava flowed from a fissure in the crust (NASA, 2023). The extent of this eruption would have caused vast damage, including the release of greenhouse gasses that have dramatic climate-changing effects (NASA, 2023). This release of carbon dioxide from the Siberian Traps was rapid, shocking the ecosystems (Cui et al., 2021). The surface pH of the ocean lowered abruptly, and the global temperature increased (Cui et al., 2021). Also, the increase in carbon dioxide may have caused a widespread anoxic event, where the oceans were depleted of dissolved oxygen (Cui et al., 2021). Along with anoxia, the acidification of the oceans and on land furthered the destruction of life on Earth (Cui et al., 2021). Additionally, the dating of the extinction and the eruptions are approximately aligned, supporting volcanism as a cause of the event (Burgess et al., 2014).

While not as significant as the volcanism hypothesis, another hypothesis of the Permian extinction is the effects of the formation of Pangea. When the continents converged to form the supercontinent Pangea, the weather patterns shifted, ocean currents changed course, coastlines and shallow marine ecosystems were destroyed, and sea levels dropped (NASA, 2023). As a result of these changes, the environmental stress placed upon terrestrial and marine organisms was immense and led many species to extinction. Terrestrial habitats experienced a severe change in temperature patterns, leading to widespread habitat loss (“Permian Period,” 2017). However, marine habitats faced the brunt of the problems posed by the formation of Pangea with the destruction of many shallow marine basins, which are the primary habitat of marine invertebrates (“Permian Extinction,” 2024).

The hypothesis that an asteroid caused the Permian extinction is probably the most heavily debated reasoning. Previously, researchers had thought that the extinction had occurred slowly over millions of years. However, new studies indicate that number is closer between 8,000 to 100,000 years (NASA, 2023). These new studies show that the extinction event was abrupt and imply that an impact could have been the reason for a relatively quick mass extinction. Additionally, molecules with trace amounts of elements more common in space were found in the rock layers of known impact events, indicating the possibility that an asteroid was a catalyst of the Permian extinction (NASA, 2023).

The Effect on Life

During the Permian extinction, Earth experienced mass devastation on a scale unlike any other extinction event. Life on Earth before the extinction was thriving; Earth had all kinds of living things: trees, plants, lizards, proto-mammals, insects, fish, mollusks, and microbes, but nearly all species were erased with the event (NASA, 2023). It's estimated that 90 percent of marine and 70 percent of land species became extinct (NASA, 2023). This mass extinction of life on Earth served almost as a reset for Earth. As previously mentioned, the duration that species were actively going extinct lasted from 8,000 to 100,000 years and while the mass extinction was not instant, those thousands of years were not the slowest in the scale of geologic time. During this period, the harsh conditions made it unlikely that a species could evolve to fit its environment.

The Aftermath

There is no denying that the period of ecological turmoil brought by the Permian extinction left a lasting mark on Earth, reshaping its ecosystems and altering the course of evolution. It took approximately 5 million years for Earth to recover from such an event (Bowring et al., 1999). This recovery period was marked by the evolution of new species and the diversification of surviving species. These species that failed to go extinct are fundamental to the evolution of animals we see today. Without the Permian extinction, the world as we know it would be a very different place.

Deliverable: Permian Extinction Website

Using my background in computer science, I thought it would be nice to make a website that provided a user-friendly, summarized version of the research I gathered on the Permian extinction. While making this website, I envisioned a user with no prior knowledge of the event so that a person with any background could understand and learn the fundamentals. The website includes both a facts page containing the most frequently asked questions and a timeline of events page that tries to add perspective to the mass extinction.

Project Rational

I chose to base this project on the Permian extinction because of my interest and curiosity about its potential causes and how it fundamentally altered the course of evolution. I

also find it fascinating how researchers can study events that took place so many years ago and how evidence of the Permian extinction still remains to this day. Initially, I debated between the K-2 extinction and the Permian extinction but ultimately the sheer size and significance of the Permian extinction made a more interesting decision.

References

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