The Traprock, Vol. 2, December 2003, pp. 15 - 18

Mass Extinction

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This paper discusses methane driven oceanic eruptions and other possible causes for mass extinction during the end-Permian era and the Triassic-Jurassic boundary. During the earth's vast history, devastating events have caused colossal destruction to terrestrial and oceanic life. There are numerous scientific explanations for mass extinctions including volcanic eruption, methane eruption, and asteroid impact. Greenhouse models and volcanic eruption cycles, in conjunction with known extinction evidence help explain why methane driven oceanic eruptions were the most likely cause of extinction that occurred at the Triassic-Jurassic boundary. Researchers and Scientists work vigorously to piece together this mystifying puzzle. Some pieces were scattered all over the Earth, and others have been destroyed. Many pieces have been retrieved and reconstructed to develop a picture that will explain the cause of several mass extinctions and catastrophic events the Earth has been through.

Introduction:

Scientific evidence confirms that devastating events caused colossal destruction to terrestrial and oceanic life. Scientists in different fields are currently generating hypotheses to shed light on these unexplained events. One hypothesis is that methane driven oceanic eruptions lead to mass extinctions. Another theory claims that cycles of volcanic and oceanic eruptions cause the greenhouse effect. A third theory is that asteroid collisions cause mass extinctions.

Mass Extinction:

Mass extinctions are defined by periodic rises in extinction rates caused by global catastrophes instead of small changes in habitat and competition. Throughout history, a few catastrophic extinctions have caused the earth's biodiversity and ecosystems to suffer dramatically. Geologists use mass extinctions to break up geological time. Not only do these events entail the large number of species that went extinct in the same period of time, these events occur within a few million years and they affected all ecosystems on a global level. The five main extinction events used by geologists to mark changes in geological time are the late Ordovician event 438 million years ago, the late Devonian event 360 million years ago, the end Permian extinction 245 million years ago, the Triassic Jurassic boundary extinction, and the Cretaceous Tertiary that ended 65 million years ago. The two extinction events explained in this paper are the Late-Permian boundary and the Triassic-Jurassic boundary. (See Figure 1, Paine, 2001)

GEOLOGIC BOUNDARIES	
Period or Epoch	**Ma**
Precambrian/Cambrian	570
Cambrian/Ordovician	505
Ordovician/Silurian	438
Silurian/Devonian	408
Frasnian/Famennian (Trilobites)	367
Devonian/Carboniferous	350
Carboniferous/Permian	286
Permian/Triassic	250
Triassic/Jurassic	? 208
Jurassic/Cretaceous	144
*Cretaceous/Tertiary (Dinosaurs)	65

The Permian extinction occurred 251 million years ago when approximately ninety five percent of marine species and seventy percent of land families went extinct. Evidence shows that the majority of the extinction occurred in the areas of low latitude equatorial regions, where most of the dominant

Paleozoic groups in the sea disappeared. There were also dramatic changes on land, with widespread extinction among plants, insects, amphibians and reptiles. (Benton, 2003) Before the late-Permian mass extinction occurred, complex ecosystems were rich with corals, bryozoans, crinoids, and fishes. The ecosystems were located near China and the Jameson land in East Greenland. In the earliest Triassic period, the reefs had disappeared, along with the organisms that were specialized to form reef structures. (Benton, 2003) All of this evidence indicates that a mass extinction occurred between the late Permian and the early Triassic period.

Another mass extinction that marked its place in history occurred at the Triassic-Jurassic boundary two hundred million years ago. This extinction was not as drastic and devastating as the one during the late Permian era, but it destroyed twenty three percent of land and sea families, respectively. During this period, most ammonoids, brachiopods, bivalves, gastropods, and marine reptiles went extinct. There were also large-scale changeovers in floras, amphibian and reptile groups. (Benton 2003)

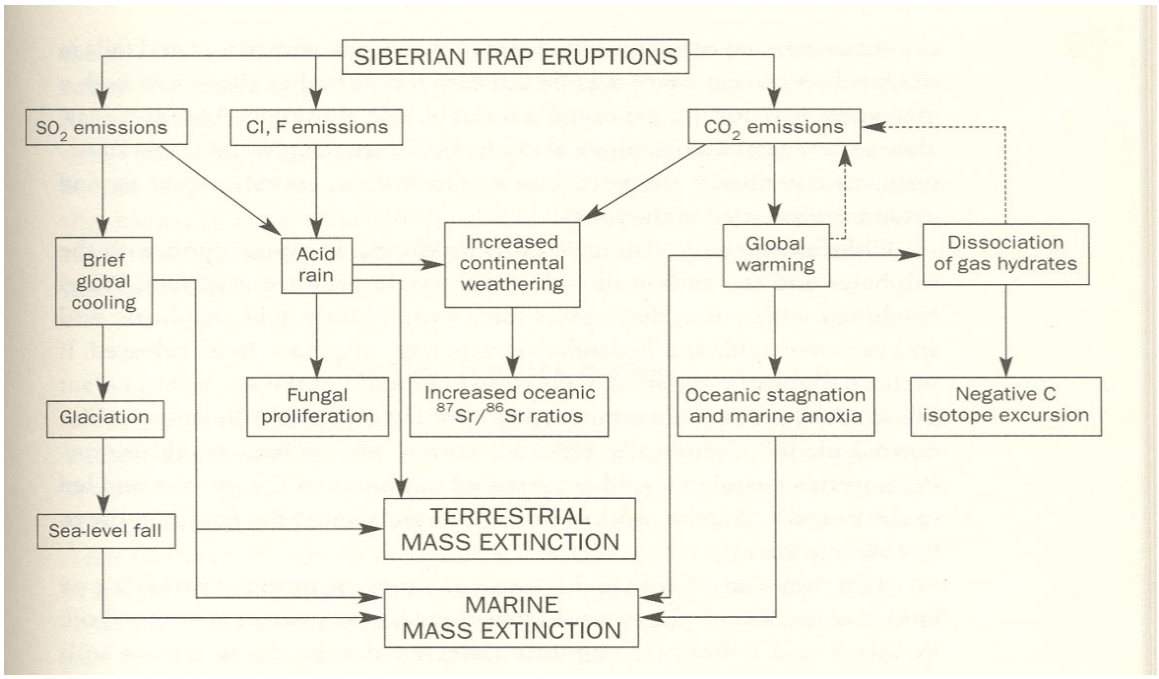

Figure 2 (Benton, 2003)

Theories on Mass Extinction:

Gregory Ryskin suggests that during the Triassic-Jurassic era, methane oceanic eruptions caused the extinction of aquatic and terrestrial life as a result of lethal levels of carbon dioxide, and a corresponding greenhouse effect. (Ryskin, 2003) Methane gas is released from decaying marine animal carcasses into the ocean environment. During a warm time period, this methane gas would individually bubble up the water column as it was released. During cold periods, the methane is accumulated as a hydrate, and becomes trapped below the sea floor. When the temperature again rises, the methane hydrate is released and erupts from below the sea floor, leaving pock marks for evidence. Scientists believe today, "10,000 billion tons of methane carbon stored beneath the ocean" and that, "If only a small fraction of the stored methane were to escape into the atmosphere, the resulting greenhouse effect would be enormous." (DFG-Research Center Ocean Margins Bremen.)

Scientists believed during the Triassic- Jurassic boundary, these numbers would have been much higher due to earlier extinctions, and the resulting affect would have been greater. The release of methane and its effect on global warming would

only be a small part of its role in a mass extinction. The highly flammable mixture of methane and carbon dioxide gas in the air could easily be ignited by lightning and other heat sources. The carbon dioxide generated by the fires and the remaining methane would fuel the greenhouse effect and cause global warming. The resulting fires would send a dark cloud of smoke that would block sunlight. Ryskin proposes that the resulting loss of heat from the sun could eventually cause an ice age. Ryskin acknowledges the unlikelihood of one eruption triggering global warming, an ice age, and mass extinction, but suggests that several contemporaneous methane eruptions would certainly increase the possibility of such a catastrophe. (Ryskin, 2003)

Michael J. Benton and Richard J. Twitchett proposed a second hypothesis that could explain the extinction that occurred at the end of the Permian era. They propose that, "giant volcanic eruptions" occurred in Siberia and caused the melting of methane rich hydrates and released huge bubbles of methane from the ocean floor. The methane gas triggered the "runaway greenhouse" effect by warming the planet, and in turn melting more methane rich gas hydrates. (Benton and Twitchett, July 2003) Scientists have developed a diagram that demonstrates how the proposed eruptions in Siberia led to terrestrial and marine mass extinction. (See Figure 2)

Benton and Twitchett identify global warming as the primary catalyst that led to the extinction of ninety five percent of oceanic and terrestrial life. Global warming occurs when greenhouse gases are released into the atmosphere at greater than normal amounts, which prevents the heat given off by the sun from escaping the earth's atmosphere. Many species were unable to adapt to the rapid change in temperature levels caused by global warming. These species became extinct because of their inability to adapt to a constantly changing environment. (Benton and Twitchett, July 2003)

Another theory is that a large asteroid crash caused mass extinctions. Many scientists believe this to be the cause of the mass extinction that occurred during the Triassic-Jurassic boundary and the end-Permian time. Asteroids orbit around the sun and are controlled by the sun's gravitational force. Small asteroids strike the earth frequently and do not cause disruption. An asteroid or comet with a two kilometer diameter can cause a crater with a forty kilometer diameter. Some scientists believe that it would take an asteroid with a ten kilometer diameter to devastatingly effect life on Earth. (Goldsmith, 1985) Such impacts occur, on average, once every fifty to one hundred million years.

Craters are the only evidence of an asteroid collision. Unfortunately, weathering and other changes in the Earth's surface prevent scientists from directly observing craters from the Triassic-Jurassic boundary, or the end-Permian era. For example, almost the entire present ocean floor is younger than fifty million years old.

In 1980, Luis and Walter Alvarez claimed they had found evidence of a huge impact from the Triassic-Jurassic boundary. The evidence included a worldwide layer of clay with high levels of the rare element iridium, usually the signature of an impact. In 1990, the buried remains of a 150-mile-diameter crater were discovered near the town of Chicxulub, Mexico. The Alvarez's believed the crater was caused by an asteroid or comet with a ten mile diameter and a velocity of fifty thousand miles per hour. (Paine, 1999)

Conclusion:

The lack of evidence of large asteroid impact during the end-Permian era along with the growing evidence for a "runaway greenhouse" effect of the time, it was concluded that the Siberian Trap Eruptions were responsible for triggering the mass extinction that occurred during those periods. The eruptions of the Siberian Traps initiated major atmospheric changes, and caused events such as global warming and methane driven oceanic eruptions, which ultimately destroyed most land and marine species on Earth millions of years ago.

In conclusion, scientists have come up with many different explanations for the mass extinctions that took place throughout history. These theories vary from an asteroid impact to the chain reaction of volcanic eruptions. Many of these hypotheses have valid evidence and proof; however, concerning the specific periods of the Late-Permian time and Triassic-Jurassic boundary, it was found that the "runaway greenhouse" effect not only affected lives

in the past, but it also has potential damages for our future. While Benton claimed that the "runaway greenhouse" effect was triggered by a 6-degree global warming, which was caused by the volcanic eruptions millions of years ago, today, a 6-degree global warming is caused by the increase in fossil fueling burning and also the various man-made creations like cars. If this persists, scientists are predicting another 6-degree increase over the next hundred years, in other words, another mass extinction could be in sight in the foreseeable future. If that were the case, men could very likely be the victims of one of the biggest crises on Earth during its existence.

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