Global warming led to atmospheric hydrogen sulfide and permian extinction

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Volcanic eruptions in Siberia 251 million years ago may have started a cascade of events leading to high hydrogen sulfide levels in the oceans and atmosphere and precipitating the largest mass extinction in Earth's history, according to a Penn State geoscientist.

"The recent dating of the Siberian trap volcanoes to be contemporaneous with the end-Permian extinction suggests that they were the trigger for the environmental events that caused the extinctions," says Dr. Lee R. Kump, professor of geosciences. "But the warming caused by these volcanoes through carbon dioxide emissions would not be large enough to cause mass extinctions by itself."

That warming, however, could set off a series of events that led to mass extinction. During the end-Permian extinction 95 percent of all species on Earth became extinct, compared to only 75 percent during the K-T when a large asteroid apparently caused the dinosaurs to disappear.

Volcanic carbon dioxide would cause atmospheric warming that would, in turn, warm surface ocean water. Normally, the deep ocean gets its oxygen from the atmosphere at the poles. Cold water there soaks up oxygen from the air and because cold water is dense, it sinks and slowly moves equator-ward, taking oxygen with it. The warmer the water, the less oxygen can dissolve and the slower the water sinks and moves toward the equator.

"Warmer water slows the conveyer belt and brings less oxygen to the

deep oceans," says Kump.

The constant rain of organic debris produced by marine plants and animals, needs oxygen to decompose. With less oxygen, fewer organics are aerobically consumed.

"Today, there are not enough organics in the oceans to go anoxic," says Kump. "But in the Permian, if the warming from the volcanic carbon dioxide decreased oceanic oxygen, especially if atmospheric oxygen levels were lower, the oceans would be depleted of oxygen."

Once the oxygen is gone, the oceans become the realm of bacteria that obtain their oxygen from sulfur oxide compounds. These bacteria strip oxygen from the compounds and produce hydrogen sulfide. Hydrogen sulfide kills aerobic organisms.

Humans can smell hydrogen sulfide gas, the smell of rotten cabbage, in the parts per trillion range. In the deeps of the Black Sea today, hydrogen sulfide exists at about 200 parts per million. This is a toxic brew in which any aerobic, oxygen-needing organism would die. For the Black Sea, the hydrogen sulfide stays in the depths because our rich oxygen atmosphere mixes in the top layer of water and controls the diffusion of hydrogen sulfide upwards.

In the end-Permian, as the levels of atmospheric oxygen fell and the levels of hydrogen sulfide and carbon dioxide rose, the upper levels of the oceans could have become rich in hydrogen sulfide catastrophically. This would kill most the oceanic plants and animals. The hydrogen sulfide dispersing in the atmosphere would kill most terrestrial life.

"A hydrogen sulfide atmosphere fits the extinction better than one enriched in carbon dioxide," says Kump. "Carbon dioxide would have a profound effect on marine life, but terrestrial plants thrive on carbon

dioxide, yet they are included in the extinction."

Another piece in the puzzle surrounding this extinction is that hydrogen sulfide gas destroys the ozone layer. Recently, Dr. Henk Visscher of Utrecht University and his colleagues suggested that there are fossil spores from the end-Permian that show deformities that researchers suspect were caused by ultra violet light.

"These deformities fit the idea that the ozone layer was damaged, letting in more ultra violet," says Kump.

Once this process is underway, methane produced in the ample swamps of this time period has little in the atmosphere to destroy it. The atmosphere becomes one of hydrogen sulfide, methane and ultra violet radiation.

The Penn State researcher and his colleagues are looking for biomarkers, indications of photosynthetic sulfur bacteria in deep-sea sediments to complement such biomarkers recently reported in shallow water sediments of this age by Kliti Grice, Curtin University of Technology, Australia, and colleagues in the Feb. 4 issue of the journal, Science. These bacteria live in places where no oxygen exists, but there is some sunlight. They would have been in their heyday in the end-Permian. Finding evidence of green sulfur bacteria would provide evidence for hydrogen sulfide as the cause of the mass extinctions.

Source: The Pennsylvania State University