Scientists link ocean acidification to prehistoric mass extinction

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(PhysOrg.com) -- New evidence gleaned by analyzing calcium embedded in Chinese limestone suggests that volcanoes, which spewed massive amounts of carbon dioxide into the atmosphere for a million years, caused the biggest mass extinction on Earth.

In a paper published April 26 in the Proceedings of the National Academy of Sciences, a team of researchers led by a Stanford geologist said that as carbon dioxide gas dissolved in the oceans, it raised the acidity of seawater.

The research team said it was a deadly combination - carbon dioxide in the atmosphere and higher acidity in the oceans - that eventually wiped out 90 percent of marine species and about three-quarters of land species, in a cataclysmic event 250 million years ago known as the "end-Permian extinction."

Back then, the ocean teemed with corals, algae, clams and snails. Soon after, however, there was an abrupt change to a thick layer of bacteria and limestone, a "slime-world," dominated by bacteria.

Lead author Jonathan Payne, an assistant professor of geological and environmental sciences at Stanford, said the calcium found in limestone from Guizhou Province in southeast China helps answer a question scientists have been debating for decades: What caused the mass extinction?

Scientists have proposed many possible reasons for the extinction, including asteroids, volcanoes, and low levels of oxygen in seawater. Payne and his colleagues earlier thought that carbon isotope evidence pointed to volcanoes, but they couldn't definitively distinguish between that and the other possibilities.

Two years ago, they realized that the calcium in limestone could hold the answer, because the types of calcium present in the ancient rocks would be different for each extinction scenario.

By looking at changes in the ratio of heavy to light calcium isotopes in fossils from different time periods and determining their "calcium signature," the team could infer the chemical changes - and their origin - that occurred in the environment.

The scientists ground up the limestone deposits, which spanned the pre- and post-extinction periods, and analyzed them to determine the relative presence of calcium isotopes. They found that the changes in the ratio matched the calcium signature predicted for ocean acidification, and the matching carbon dioxide signature pointed to carbon release from volcanic eruptions.

"Our best geologically supported idea is that the carbon dioxide release is related to the Siberian Traps volcanoes," Payne said.

Payne calculated that the eruptions, which lasted upwards of a million years, released 13,000 to 43,000 gigatons (1 gigaton equals 1 billion tons) of carbon in the atmosphere. By comparison, scientists estimate we would release an estimated 5,000 gigatons of carbon if we used up all the fossil fuels in the Earth.

During the eruptions, huge amounts of carbon dioxide and molten rock burst through the earth's crust, burning through coal and limestone, and releasing carbon dioxide into the atmosphere. That made oceans and rainwater more acidic, and dissolved more calcium from rocks into the ocean.

Payne said humans may not ultimately release as much carbon dioxide as the Siberian traps, but we may be doing it at a faster rate. The end-Permian extinction could be viewed as a "worst case scenario" for what we could be facing as we burn more fossil fuels and increase ocean acidity, he said.

"We won't necessarily end up with a world that looks as bad as it did after the end-Permian extinction, but that event highlights the fact that things can go very, very wrong," Payne said.

The National Resource Council recently reported that the ocean's chemistry is changing faster than it has in hundreds of thousands of years, because carbon dioxide is being released into the atmosphere and absorbed into the oceans, making them more acidic. Studies have shown increased ocean acidity decreases photosynthesis, nutrient absorption, growth and reproduction of marine organisms.

He said the next step as his research continues is to look at rock deposits in other locations from the same time period to make sure the samples they used represent a global event, as opposed to a local event. The team has already started analyzing rock deposits in south central Turkey, southern Japan, and eastern China.

More information: 'Calcium isotope constraints on the end-Permian mass extinction,' April 26, 2010, Proceedings of the National Academy Sciences www.pnas.org/content/early/201 … /0914065107.abstract

Provided by Stanford University