SCIENCE
PALEOBIOLOGY

Ocean Mix Blamed in Ancient Loss of Marine Life

By Alan Jay Kaufman
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NEW ORLEANS

Researchers earlier this month reported that the greatest of all mass extinctions in Earth's history may have resulted from the catastrophic mixing of an ancient Paleozoic ocean. They compared this great dying event—which killed more than 90 percent of all marine animals around 250 million years ago—to a 1986 disaster in the African country of Cameroon that caused the asphyxiation of more than 1,700 people. The buildup of carbon dioxide in deep waters led to both disasters, the researchers believe.

One of many theories for this extinction event, the new model suggests that the toxic effects of carbon dioxide bubbling up through shallow ocean waters would have asphyxiated most of the marine animals then alive. The fossil record shows that many major groups of animals were lost in this mass extinction, such as the tentacled crinoids, related to modern starfish; the lacy bryozoans, known as "moss animals" due to their plant-like appearance; and the clam-like brachiopods. The theory suggests that when a violent belch of carbon dioxide gas from the deep ocean ended extensive marine life, it also ushered in the world of the dinosaurs. The Lake Nyos disaster may be a modern-day echo of this ancient biological crisis.

The researchers presented the new hypothesis here at the annual meeting of the Geological Society of America.

"This is one form of natural disaster that we don't have to worry about today," said Andrew H. Knoll, the paleontologist at Harvard University who led the research team. While isolated lakes have the potential to build up and store carbon dioxide, modern oceans do not. This ancient global crisis happened when the continents, now widely separated, were massed together, resulting in patterns of ocean circulation much different from those that exist today. Because "continents are widely dispersed and there are ice caps at the poles, modern oceans are well mixed," which keeps carbon dioxide from building up in deep waters, said Knoll.

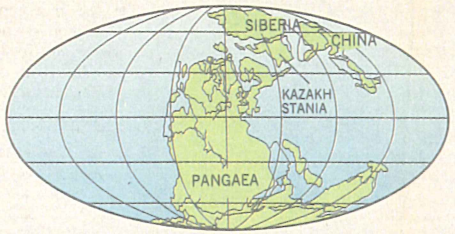
'An Interesting Hypothesis'

The scenario presented by the researchers "is an interesting hypothesis which may grow and develop into a contender," said David Bottjer, a paleontologist at the University of Southern California. Of numerous possible causes proposed for this mass extinction, the most recent range from extensive volcanic activity to a meteor impact comparable to the one that may have doomed the dinosaurs 65 million years ago.

While the people living around Lake Nyos were suffocated by a cloud of carbon dioxide, marine animals living at the time of the late Paleozoic crisis most likely perished due to chemical changes in ocean surface waters. "Elevated levels of carbon dioxide in surface waters . . . would have severely disrupted [animals'] ability to metabolize, build shells, and carry oxygen in their blood," said Knoll. Significantly, in this greatest of all mass extinctions, organisms with sedentary lifestyles, the couch potatoes of the Paleozoic era, were preferentially eliminated, while more mobile organisms survived.

The new model explains why. Animals that move around produce more carbon dioxide and can tolerate more in their blood than animals that live most of their lives in one place. Thus, the researchers reason that mobile Paleozoic animals would have been more likely to survive a sudden increase in external carbon dioxide. Organisms attached to the sea floor, which passively feed by filtering seawater, normally have very little carbon dioxide in their blood and can withstand only slight increases before falling asleep and, eventually, dying. In fact, marine biologists anesthetize animals for study by bubbling carbon dioxide through sea water.

The evidence for a late Paleozoic buildup of ocean-stored carbon dioxide is preserved in the rock record—in reefs exposed in West Texas and several other localities around the globe. The discovery of unusually textured limestones in these reefs has led John Grotzinger, a sedimentologist at the Massachusetts Institute of Technology, and Knoll to suggest that deep ocean water, saturated with carbon dioxide, suddenly mixed with shallow ocean water after a long interval of poor circulation.



At the time of the Permian extinction, all of Earth's major land masses had merged into one large unit known as Pangaea.

In response to the large increase in carbon dioxide, limestone literally sprouted from the shallow sea floor, like tufts of grass. The source of the gas was probably deep-ocean bacteria, which can excrete both carbon dioxide and hydrogen sulfide during metabolism. The buildup may have been caused by poor ocean circulation, possibly related to relatively warm global temperatures. Following a warm period, rapid global cooling and an increase in ocean circulation associated with a late Paleozoic glaciation may have caused the catastrophic mixing and the resulting increase in surface water carbon dioxide, said Knoll.

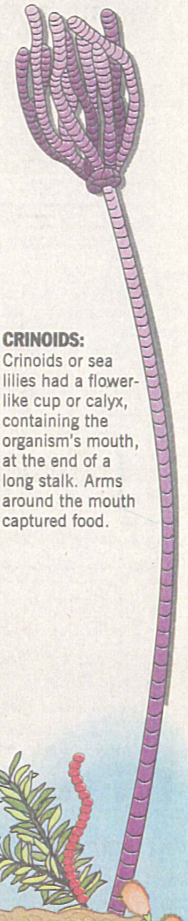
Without an efficient way to remove the carbon dioxide, marine species could not survive. "By altering pH balance, excess carbon dioxide would shut down metabolism. It would be curtains for animals who could not deal with the added stress," said Richard Bambach of Virginia Polytechnic Institute, a member of Knoll's team.

An alternative theory for the late Paleozoic crisis was recently published in the journal Science. In this report, a different group of researchers claim that a million-year-long series of volcanic eruptions in Siberia may have caused the mass extinctions 250 million years ago. While the fossil record does show that some groups of animals died off during the Siberian eruptions, Knoll and his colleagues believe that the most severe extinctions actually happened millions of years earlier—which is consistent with the proposed timing of the catastrophic ocean-mixing event.

'One of Those Messy Events'

Douglas Erwin, a paleontologist at the Smithsonian Institution and author of "The Great Paleozoic Crisis," is skeptical of the ocean-mixing theory. Erwin points out that the fossil data base does not have the resolution necessary to show whether mass extinctions occurred as a single or even as a double event. He believes that the extinctions were a long, drawn-out affair. "Paleontologists are funny," said Erwin. "Everyone wants to find a single cause for the mass extinction. But killing 80 to 90 percent of all organisms at the same time is tough. Earth history is messy . . . and I think this mass extinction is one of those messy events."

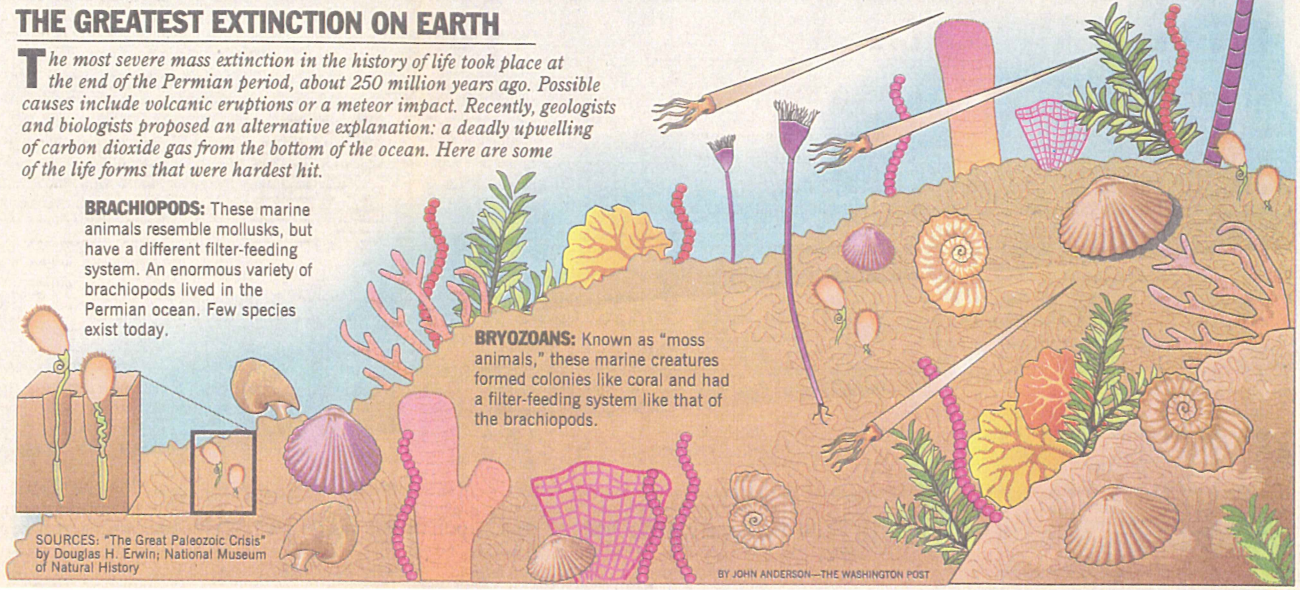
The researchers recognize that more work is needed before the scientific community accepts their theory. "We are at a point today [in studies of the late Paleozoic mass extinctions] equivalent to 1979 just before the publication of the impact hypothesis for the [dinosaur] extinctions," said Knoll. Just as it has taken years for most scientists to accept that a meteor impact led to the mass extinction of the dinosaurs, it may take as many years of research before this new theory is accepted, he suggested. Next summer, Knoll and Erwin will study late Paleozoic rocks in China.



CRINOIDS: Crinoids or sea lilies had a flower-like cup or calyx, containing the organism's mouth, at the end of a long stalk. Arms around the mouth captured food.

THE GREATEST EXTINCTION ON EARTH

The most severe mass extinction in the history of life took place at the end of the Permian period, about 250 million years ago. Possible causes include volcanic eruptions or a meteor impact. Recently, geologists and biologists proposed an alternative explanation: a deadly upwelling of carbon dioxide gas from the bottom of the ocean. Here are some of the life forms that were hardest hit.



BRACHIOPODS: These marine animals resemble mollusks, but have a different filter-feeding system. An enormous variety of brachiopods lived in the Permian ocean. Few species exist today.

BRYOZOANS: Known as "moss animals," these marine creatures formed colonies like coral and had a filter-feeding system like that of the brachiopods.

SOURCES: "The Great Paleozoic Crisis" by Douglas H. Erwin; National Museum of Natural History

BY JOHN ANDERSON—THE WASHINGTON POST