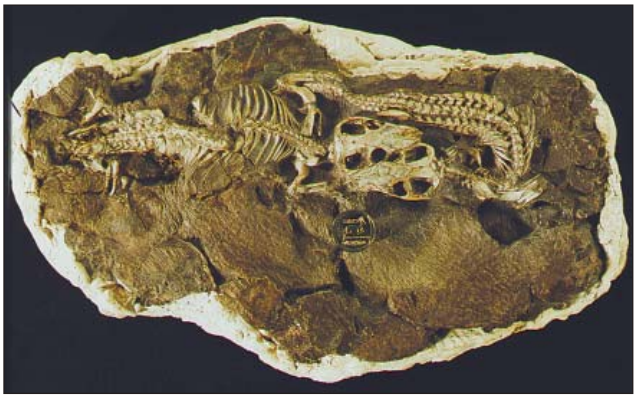
PALEONTOLOGY

# Ancient Weapon of Mass Destruction: Methane Gas?

The demise of the dinosaurs may grab all the headlines, but paleontologists have long pondered an even bloodier murder mystery: What wiped out the vast majority of species on land and in the ocean 186 million years before *Tyrannosaurus* and company bit the dust?

Now, two papers argue that methane gas did the dirty work—although they disagree about how. In the September issue of *Geology*, chemical engineer Gregory Ryskin of Northwestern University sketches an apocalyptic scenario in which methane erupted from the sea floor and incinerated land dwellers as it exploded. Meanwhile, in *The Geological Society of America Bulletin*, three paleontologists suggest that the gas attack would have essentially suffocated its victims. "They're exciting and spectacular ideas," says marine geologist Paul Wignall of Leeds University, U.K. But he and other experts aren't ready to embrace them just yet.



**Hunkered down.** Burrowing animals, such as these *Thrinaxodon*, seem to have survived the end-Permian extinction better.

Scientists have long tried to pin the Permian-Triassic extinction on global warming, perhaps spurred by erupting volcanoes. Methane, $CH_4$, played a supporting role in that scenario, helping account for a shift in carbon isotopes found in rocks from that period. As the oceans warmed, the story went, they seeped methane into the atmosphere, where it turned into carbon dioxide and exacerbated the warming trend over 10,000 years. But many researchers doubted that climate change alone could have so devastated life on land.

Ryskin's theory puts methane front and center. The idea came to him while he was lecturing to his engineering students about Lake Nyos in Cameroon, where clouds of lethal carbon dioxide had suddenly bubbled out of the deep waters, forming a cloud that killed 1800 villagers in 1986. About 10,000 gigatons of methane would be needed to account for the carbon-isotope shift, Ryskin reckoned—a whopping amount, yet easily dissolved in the oceans. An earthquake or submarine volcanic eruption could have created bubbles that would have lowered the density and pressure of the water as they rose, causing the ocean to release even more dissolved gas. Over a few days, massive amounts of methane would have entered the atmosphere and, detonated by lightning, fueled widespread fires whose products could have triggered either a nuclear winter or global warming, Ryskin says.

Some scientists have trouble imagining such a conflagration. "I just don't find compelling evidence that the methane levels needed were present in the Permian ocean," says geochemist Lee Kump of Pennsylvania State University, University Park. He says bacteria would have degraded the methane before it could reach dangerous levels. Also missing, he and Wignall note, is any sign of vast conflagrations at the boundary.

Enter the second theory, which does not require a firestorm. Studying Permian-Triassic soils from South Africa, Gregory Retallack of the University of Oregon in Eugene and colleagues saw no evidence of climate change drastic enough to explain the extinctions. They, too, thought of oceanic gas. Other researchers had suggested that the voluminous release of carbon dioxide could have harmed marine animals. Methane, Retallack's team concluded, could have affected land animals as well, by lowering the relative amount of oxygen in the air enough to trigger pulmonary and cerebral edema. "The reptiles died of mountain sickness," Retallack says.

Retallack—along with Roger Smith of the South African Museum in Cape Town and Peter Ward of the University of Washington, Seattle—points out that many survivors of the extinction were built to cope with low oxygen levels. The most abundant one, a dog-sized creature called *Lystrosaurus*, was a burrower with thick ribs and a barrel chest for efficient breathing. Smith notes that amphibians, which survived the extinction relatively well, also could have dealt with the changing air by burrowing into lakebeds.

"I think it's a really neat story," says Christian Sidor, a paleontologist at the New York College of Osteopathic Medicine in Old Westbury. "It's very imaginative." He notes that other survivors are also found in burrows, such as a group of possible turtle relatives called the procolophonoids. Michael Benton of Bristol University, U.K., on the other hand, suspects that it may just be chance that *Lystrosaurus* survived the crisis. And Sidor points out that the evidence so far only comes from part of the Permian world: "It's going to take more work to show it's worldwide."

Retallack and his team hope that a trip this fall to the Trans-Antarctic mountains will bolster their case. "I don't think the atmosphere caught fire, but it was pretty hellish," he says.

–ERIK STOKSTAD

BIODEFENSE FACILITIES

# Suit Targets Two DOE Labs

Two watchdog groups want to prevent the Department of Energy (DOE) from expanding its biodefense research. This week, Nuclear Watch of New Mexico and Tri-Valley CAREs of California asked a federal judge to halt construction of two new biosafety level 3 (BSL-3) labs, claiming that the department hasn't conducted adequate environmental and nonproliferation studies. But DOE says that its existing studies are adequate and have shown that the labs will have minimal impact.

Since the 11 September terrorist attacks, the U.S. government has been moving to expand the number of high-containment labs where biodefense researchers can work with hazardous agents. The United States now has about a half-dozen of the most secure BSL-4 facilities and dozens of less restrictive BSL-3 laboratories; but so far, DOE has had only BSL-2 labs.

The new BSL-3 spaces now under construction at Los Alamos National Laboratory in New Mexico and Lawrence Livermore National Laboratory in California would enable the agency to work with agents such as anthrax and plague. DOE gave the go-ahead to the $5.5 million project last year, after concluding that neither facility would have a "significant impact" on the environment. Both labs could open their doors next year.

But in a lawsuit filed 26 August in San Francisco, the two groups charged that DOE glossed over site-specific risks, such as how the labs might deal with an accidental spill or an earthquake, and failed to tally the potential broader impacts of its entire bioterror program. Nor did it consider whether conducting biodefense research at secretive ▶

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