Smithsonian

# Spotlight on Science at the Smithsonian

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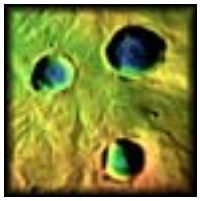






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Spotlight on Science at the Smithsonian is a bi-weekly electronic newsletter about Science at the Smithsonian. It is produced for the Smithsonian community by the Office of the Under Secretary for Science. To subscribe to the newsletter or Podcast, visit science.si.edu.

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Smithsonian Scientist Deciphers Extinction's Greatest One-Two Punch

Study of Global Warming 55 Million Years Ago Helps Illuminate the Future

Mars Orbiters Provide Clues to an Earthlike Past for the Red Planet

# Introduction from the Under Secretary for Science

In this edition of Spotlight we study the past from fossils, here on Earth, and ancient geologic features on Mars. Douglas Erwin, from the Museum of Natural History provides a synthesis of the latest scholarship on the 250 million year old Permian extinction; the largest of all extinction events which snuffed out 95% of all species. Erwin discusses the imprint of this event on the fossil record at sites around the world. Scott Wing, also from Natural History, provides insight on the Paleocene-Eocene Thermal Maximum, a mere stone's throw into past at 55 million year ago. This global warming event drastically altered the home range of plants while lowering sea level, and thus opening the Arctic land bridge to a parade of large mammal species which then entered the Americas. And finally, we travel via remote satellite imaging, to Mars, where the record of a recurrent Earthlike environment is written on the geological face of the planet. Smithsonian scientists Ross Irwin and Bob Craddock infer sudden changes in the Red planet's past from images transmitted back to Earth by the Mars Global Surveyor and Mars Odyssey orbiters. From the Earth to Mars, whether via the printed page or podcast, we once again travel far and wide to bring you the latest in Smithsonian science.

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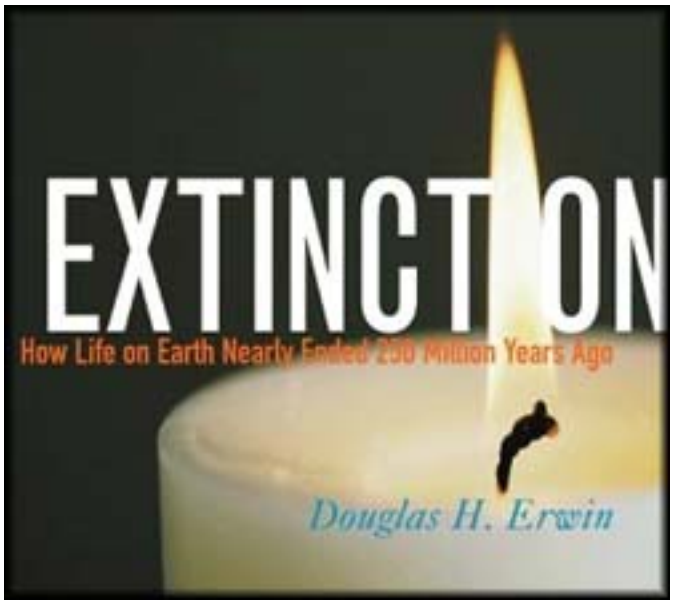


Ninety-five percent of life was nearly snuffed out 250 million years ago. A new book presents the many hypotheses of what really led to an event that has shaped life on Earth forever after.

# Smithsonian Scientist Deciphers Extinction's Greatest One-Two Punch

**Additional Resources**

Read a Chapter and Purchase the Book – Princeton University Press

Doug Erwin's website: http://www.nmnh.si.edu/paleo/curator_cvs/erwin.html

Even small children know of the great calamity 65 million years ago that ended the reign of dinosaurs and ushered in the age of mammals at the end of the Cretaceous Period. But few realize that a more serious extinction occurred almost 200 million years earlier, at the end of the Permian, wiping out around 95% of all living species in the oceans. For the dinosaurs, it is widely held that an asteroid spelled disaster, but for the varied life forms swept up in the mass extinction at the end of the Permian, the culprit is still much in dispute.

Douglas Erwin, a Paleontologist at the Smithsonian Institution's National Museum of Natural History, and the world's foremost authority on the end-Permian extinction, serves up the strongest evidence put forth by the many investigators of this mystery in *Extinction: How Life on Earth Nearly Ended 250 Million Years Ago.*

The Permian extinction, which recent evidence suggests was actually two events, changed marine life forever. According to Erwin, "If you look at a tidepool today, almost everything you see reflects the survivors of this extinction and the groups that diversified afterwards. Before the extinctions, the oceans were dominated by filter feeders and suspension feeders that were fixed to the substrate, so they couldn't move around. The complexity of the ecosystem, or at least the number of levels in the food web, was much less before the extinctions."

In fact, a seafood buffet during the Permian would have been a pretty sorry affair. "The joy of modern day cooking is much fatter than the joy of Permian cooking would have been," says Erwin, "because it is really hard to eat a brachiopod or bryozoan or most of the organisms that were around before the extinction."

Even the clam-like Brachiopods would have made slim pickings. Once the shell is breached, rather than the meaty "foot" found in today's bivalves, a diner would be faced with an unappetizing fan-like structure used to filter food particles from ocean waters.


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The marine world that we have today largely reflects who lived and who died during that massive extinction. "After the extinction, the groups that survived--crabs, sea urchins, snails, clams--were more mobile and included a lot of groups that were already predatory, and these gave rise to a greater number of predatory organisms. So there was a real changeover in the whole way ecosystems were organized between these two extinctions."

In *Extinction* Erwin delves deeply into all sides of the debate concerning the timing and intertwining causes of the Permian extinction; a debate on which he has focused his intellectual energy for the last 20 years. Traveling from the scrubby piñon pine forests of Utah to China's Yangtze River and then to the Karoo Desert of South Africa, Erwin artfully reveals the available evidence, points out the gaps, and tries to synthesize a reliable theory that incorporates data from a wide range of specialties.

In conversation, Erwin points to recent evidence that the end-Permian extinction may even have affected the battle for dominance between mammals and early dinosaurs on the land. "In the Triassic, immediately after this extinction, dinosaurs and the earliest mammals were in competition, and eventually the dinosaurs became predominant during the Mesozoic," says Erwin. "What we still don't know is how much that [outcome] really reflects the recovery from the mass extinction event at the end of the Permian."

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Fossils such as this, of a 55 million years old bean leaf, bear mute testimony to the expanded range of certain plants during an ancient global warming episode.

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An international team of scientists led by Scott Wing, of the Smithsonian's Department of Paleobiology, has used fossil leaves and pollen from Wyoming's Bighorn Basin to gain insight into the effect of a 4-8° C increase in global temperature on plant home ranges. Sifting through 55 million year old fossils in sediments laid down by the birth of the Rocky Mountains, the researchers discovered plants that until that time were known only along the Gulf Coast, 1000 miles to the south.

The plants were able to make a 10,000 year, 1,000 mile migration northward thanks to a natural global warming trend known as the Paleocene-Eocene Thermal Maximum, or PETM. The PETM started when a massive amount of carbon was released into the atmosphere leading to a 10,000 year global warming trend that took 80,000 to 100,000 years to subside. Scientists believe possible sources for this carbon include release of methane from ocean floor sediments and/or the burning of peat and coal that may have accompanied mountain building or sea level changes.

According to Wing, "The PETM carbon release appears to have been about 4500 gigatons. The current total world reservoir of fossils fuels is in the same ballpark."

As this warming trend occurred, milder climates spread north. This allowed a host of plants, including members of the bean family and warmth-loving relatives of the poinsettia, sumac and paw-paw, to creep steadily farther from their traditional homelands. Other research shows that the PETM contributed to great migrations of mammals across Arctic land bridges and the mass extinction of bottom dwelling marine organisms. This is the first study that shows plants were also affected.

How fast was the PETM compared with predicted rates of human-induced warming? Wing says, "We think the onset of the PETM took about 10,000 years, which would make it 10-20 times slower than likely rates of human-caused carbon release. But it is possible that carbon release at the PETM was quicker than we realize, we are still working to understand the onset of the event."

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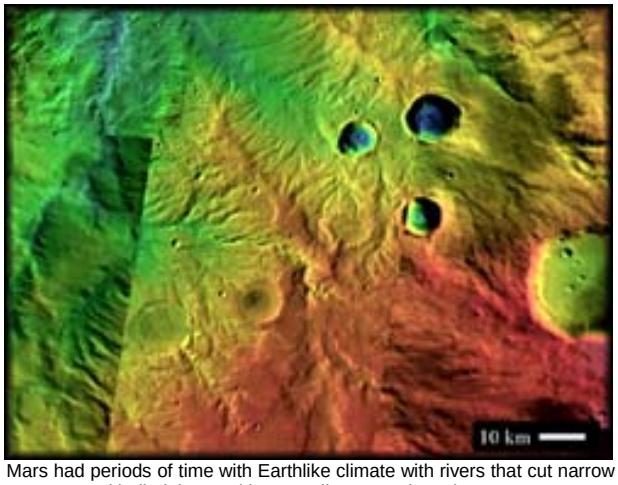


Mars had periods of time with Earthlike climate with rivers that cut narrow canyons and built deltas and large sedimentary deposits.

# Mars Orbiters Provide Clues to an Earthlike Past for the Red Planet

**Additional Resources**

Exploring the Planets: Mars
National Air and Space Museum
/www.nasm.si.edu

Mars Odyssey's Measurements Reveal a Wet, Red Planet
ScientificAmerican.com

Exploring Mars in the 1600s
ExploringMars.com

The potential for water on Mars has inspired everyone from astronomer G. V. Schiaparelli, who first charted a network of "canali" in 1877, to fantasy writer H.G. Wells, who wrote so affectingly of the Martian menace in War of the Worlds. As is often the case, the horror stories gained more popular traction than the facts. Today, scientists at the Smithsonian, studying high-resolution imaging from the Mars Global Surveyor and Mars Odyssey orbiters, have recognized geological features that point to brief and recurring periods of Earthlike conditions on the Red Planet.

The atmosphere of Mars today is too thin and cold to support liquid water, let alone rainfall, yet its surface contains many ancient, eroded impact craters and networks of dry tributary valleys that resemble river watersheds on Earth. These Martian valleys are more than 3.6 billion years old, suggesting that the atmosphere and climate were different in the planet's early history. Since the Mariner 9 orbiter first imaged these valleys in 1972, scientists have pondered how warm and wet Mars must have been for this erosion to take place.

Recent discoveries of small river channels and sedimentary deposits offer new insight into these questions. Smithsonian geologists Ross Irwin and Bob Craddock, collaborating with Alan Howard of the University of Virginia and Jeff Moore of NASA, have recognized features of these river valleys that point to one or more brief epochs of Earthlike climate on early Mars, interspersed with longer, drier periods.

During the wet epochs, rivers up to hundreds of meters wide cut narrow canyons and built deltas and large sedimentary deposits. Peak runoff in the valleys resembled yearly floods on the Earth, though storms were not necessarily severe by our standards.

Previously, researchers had speculated a long, slow decline of the Martian climate from this wet past to the modern cold, dry state. However, Smithsonian investigators instead found evidence that the change was very sudden relative to climate change on Earth.

This research suggests that some influence—maybe asteroid impacts or large outflows of groundwater—temporarily enhanced the early Martian climate for up to about 100,000 years. These conditions likely returned at intervals over a span of hundreds of millions of years, before the atmosphere of Mars finally collapsed around 3.6 billion years ago to the state we observe today.

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