SCIENCE NEWS of the week

Volcanic Suspect in Global Murder Mystery

The greatest extinction in Earth's history—a profound biological crisis that set the stage for the world of the dinosaurs—may trace to a series of massive volcanic eruptions, according to new geologic evidence.

Life on Earth has passed through several mass extinctions, including those that wiped out the dinosaurs at the end of the Cretaceous period. But the widespread die-offs at the boundary between the Permian and Triassic periods stand out above all others in the fossil record. By some accounts, 96 percent of the ocean species vanished altogether, and the dominant land animals suffered remarkably. Such drastic winnowing of Permian organisms allowed new forms to rise in prominence, ultimately leading to the ascendance of the dinosaurs. Indeed, paleontologists use the Permo-Triassic event as a dividing line to separate the Paleozoic ("old life") era from the Mesozoic ("middle life") era.

"This big extinction has long been of interest because it was so severe. But it has never been explained satisfactorily," says paleontologist Steven M. Stanley of the Johns Hopkins University in Baltimore.

Now, two scientists provide a possible answer: climate-disrupting outpourings from huge volcanic eruptions in Siberia.

Paul R. Renne of the Institute of Human Origins in Berkeley, Calif., and Asish R. Basu of the University of Rochester in New York used high-precision techniques to pin down the age of vast deposits of volcanic basalts, known as the Siberian Traps, that cover 340,000 square kilometers in the northern Soviet Union. In the July 12 SCIENCE, they report that the massive eruptions occurred within a very short geologic span some 248 million years ago — coincident with the widespread Permo-Triassic extinctions.

In previous work, Soviet researchers had dated the eruptions to well after the extinctions, precluding any relationship between the two. But Renne and Basu used a more sophisticated process, called argon-40/argon-39 dating. This technique determines age by calculating how much radioactive potassium has decayed to argon over millions of years.

"We have really nailed it down very, very precisely. It is Permo-Triassic age," says Basu. The finding reopens the possibility that the eruptions caused the extensive extinctions.

The Siberian Traps, which rank among the world's largest eruptions, spewed out roughly 1.5 million times as much rock as the Mount St. Helens blast of 1981. Gases lofted into the atmosphere by the Siberian outpourings could have devastated life at the time by altering the global climate, says Basu.

While the new work points to the Siberian Traps as a prime suspect, the biggest murder mystery in Earth's history will not yield to a solution overnight. Scientists continue to debate the age of the Siberian Traps. In the May GEOLOGY, Ajoy K. Baksi of the Louisiana State University in Baton Rouge and a coworker report using the argon technique to date the eruptions to 238 million years ago. If correct, that would rule out the Traps as the cause of the die-offs.

However, says Baksi, "the geologic pedigree of my samples is a little suspect," because he received them third-hand, years after Soviet researchers collected them. He is now checking his results for any analytical errors. Researchers with the U.S. Geological Survey are currently using the argon method to date yet another set of samples from the Traps.

The topic of eruptions and extinctions heated up this spring when scientists reported new evidence linking India's Deccan Traps with the infamous Cretaceous extinctions. Geologists have spent the last decade arguing whether that die-off resulted from a meteorite impact or from volcanic eruptions, but the latest findings suggest that both types of disaster may have hit at the same time in a double whammy of bad luck.

At the spring meeting of the American Geophysical Union in Baltimore, researchers from the USGS and Oregon State University presented argon-dating results indicating that the Deccan Traps erupted over a very short geologic span about 65 million years ago, emitting a substantial burst at roughly the same time as the purported meteorite impact.

– R. Monastersky

Hot prospects for quelling cluster headaches

A chemical that gives hot peppers their bite, activating pain sensors in the mouth, helps extinguish the pain of "cluster" headaches, a new study suggests. Researchers described this peppery paradox, along with several other novel strategies for treating cluster headaches, at last week's Fifth International Headache Congress in Washington, D.C.

"Cluster is the most excruciating form of headache known," says Ninan T. Mathew, who directs the Houston Headache Clinic and served as the conference's organizing chairman. This neurovascular disease, characterized by recurring bouts of pain concentrated around one eye, plagues an estimated 1 percent of the world's population. For unknown reasons, roughly five times as many men as women develop the condition. Each "attack cluster" brings one to 20 headaches daily for months — and sometimes for a year or longer. Between attacks, observes Mathew, "patients live in mortal fear of the next one."

Earlier research with the hot pepper compound, capsaicin, suggested it might selectively stimulate, then block, a class of sensory nerve cells responsible for recognizing or transmitting pain. Capsaicin "depletes the nerve endings of the chemicals which induce pain," Mathew explains. Repeated applications — until the treated tissues no longer "burn" on contact with the compound — eventually deaden the nerves to pain.

The new study, led by Bruno M. Fusco at the University of Florence, Italy, involved 23 men and six women suffering from cluster headaches. The researchers gave each volunteer a squirt of a capsaicin-containing solution each day, spraying the solution into only one nostril: the one on the same side as the headache pain in 16 patients, and the one opposite the painful side in 13 others. The treatment period lasted "several days," Fusco says.

Sandoz Pharmaceuticals 1990

Artist and headache sufferer Christine Lamb-Toubeau depicts eye pain in "Roger Reacts to the Light."

Throughout the 60-day follow-up period, 11 of the 16 people in the same-side group reported a total cessation of cluster headaches. Two others reported a 50 percent reduction in the number of attacks, and the remaining three reported no relief. No patient treated through the nostril opposite the pain reported any relief.

Mathew took another tack, developing

a surgical treatment to permanently deaden pain transmission in the trigeminal-nerve system involved in cluster headaches. It involves inserting a needle through a small hole at the base of the skull, advancing it into the nerve, then delivering sufficient radio-frequency radiation through the needle to thermally coagulate the nerve's small, pain-carrying fibers. The rest of the nerve remains intact, he says.

Mathew says he has performed the surgery on 70 patients, chosen because their headaches had resisted all other forms of therapy. The heat treatment helped most of these patients, halting all cluster headaches in about 75 percent of them – including several who had endured daily headaches for more than a year, he reports. Moreover, he says, the procedure can be repeated if the deadened nerve ever regenerates and the headaches return. In Mathew's view, the technique's primary drawback is a numbing around the eye on one side of the face.

Lee Kudrow, director of the California Medical Clinic for Headache in Encino, tried an even more novel approach: light therapy. Various researchers have found evidence that cluster headaches may involve a derangement of the brain's circadian "clock." Twelve years ago, Kudrow noted that some patients could get rid of their headaches by routinely sleeping a few hours later in the morning. Kudrow's new data, based on a preliminary study involving only four patients, hint that clinicians might reset faulty biological clocks in cluster-headache sufferers by prescribing two-hour stints under bright lights – beginning at dusk – for four consecutive days.

"It was very dramatic," he told SCIENCE NEWS. "We were able to break the cluster period within two weeks of the time we did the bright-light therapy." And patients didn't have to alter their sleep cycle.

If follow-up studies confirm the effectiveness of this therapy, patients might treat themselves inexpensively at the start of each cluster by sitting under a bank of 12 to 14 blue-white fluorescent lights at home, Kudrow says.

"We still haven't figured out why there is a disruption of the biological clock [in cluster-headache victims]," Mathew notes; nor do researchers know how the faulty clock might trigger the production of pain.

However, several of last week's reports helped piece together another puzzle: What generates the pain in cluster and other headaches?

For years, headache specialists assumed that the dilation of blood vessels triggered cluster-headache pain. Many headaches do occur near dilated blood vessels, and many effective headache medicines constrict dilated vessels. But lately, "we have come to realize that the [dilation/constriction theory] of headache pain is much too simple – and inaccurate," says Michael A. Moskowitz of Massachusetts General Hospital in Boston.

Pain fibers not only transmit pain but also promote inflammation in the blood vessels and other tissues they innervate. Moskowitz and others recently found that the nerve fibers have receptors for some medications effective against migraine and cluster headaches. He now reports that such drugs appear to work not by altering the diameter of throbbing vessels, but by blocking both the nerve's transmission of pain and the inflammation it fosters in nearby tissue.

His new data show how receptors for some headache drugs – and for other chemicals not yet used for headaches – appear to be "modulating the release of inflammation-provoking chemicals in the wall of [painful] vessels," he says. For example, his team prevented vessel inflammation in rats by pretreating the tissue with these drugs.

Kudrow also expresses excitement over other presentations at the meeting that appear to confirm an observation he first reported last year: that cluster-headache patients seem to suffer a temporary malfunctioning in the system that regulates the oxygen levels in their blood.

Kudrow says his work indicated that nitroglycerine, which triggers headaches in patients during an active cluster cycle, accomplishes this feat by depressing blood oxygen levels. In healthy people and in cluster-headache patients during remission, the nitroglycerine-fostered drop in oxygen lasted only 20 minutes. In patients undergoing a cluster cycle, oxygen levels stayed low three times longer – and spawned a new headache.

Two studies reported last week also indicate that active-cycle cluster headache victims have difficulty compensating for low blood oxygen levels. Together, Kudrow says, these studies may finally explain why inhaling pure oxygen – a now-standard treatment for cluster headaches, pioneered by Kudrow in 1979 – has proved so effective. *– J. Raloff*

STM scientists strong-arm silicon atoms

In the quest to build new materials one atom at a time and to create new machines with nanometer-scale components, scientists use a high-precision tool called the scanning tunneling microscope (STM). Demonstrations of the STM tip's manipulative potential have included words spelled out with xenon atoms and microscopic piles of gold deposited in the shape of the Americas (SN: 11/17/90, p.310).

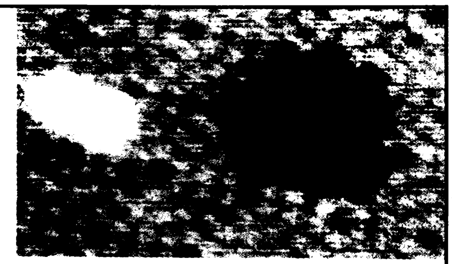
Now, two physicists have discovered that by adding a bit of electrical and chemical brawn, they can use the STM tip to pick up and reposition silicon atoms, overcoming the atoms' resistance to such maneuvering. Their results boost hopes for developing "nanoelectronic" devices, orders of magnitude smaller than today's electronic components, suggest In-Whan Lyo and Phaedon Avouris of the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y. They describe their work in the July 12 SCIENCE.

"Being able to manipulate silicon is an important first step," says physicist Daniel Rugar, who has used the STM tip to build up mounds of gold at the IBM Almaden Research Center in San Jose, Calif. "Silicon is the basis of most semiconductor technology."

In addition, the ability to pick up and move small numbers of atoms will make it easier for chemists to study the properties of atom clusters, says Avouris.

To pull atoms out of a silicon surface where they are covalently bonded, Avouris and Lyo tap chemical forces that come into play when the STM tip nears the surface. By themselves, these forces are not quite strong enough, Avouris explains, but pulsing a voltage through the tip creates a potent electrical field that can yank silicon atoms out of their places and up to the tip.

"Within one-hundredth of a second, the atoms swarm the tip," Avouris says. "The details of the motions are not known, but my feeling is that cooperative effects [between the atoms] are likely to be important."


IBM/SCIENCE

STM tip removes atoms from silicon surface, leaving a black void, and then dumps them in a pile (white spot) just to the left of the void.

The atoms gathered at the tip do not seem to diffuse into it, he adds. They hang on while he repositions the tip, then let go when he changes the direction of the electrical field. Thus, he can deposit a mound of silicon atoms wherever he wants.

By changing the tip-to-surface distance ever so slightly, Avouris can also control the amount of silicon affected by the electrical field. "As we come closer and closer," he says, "we can tune it so that eventually a single atom can be removed." *– E. Pennisi*