CHERNOBYL EXPLOSION

Inside Look Confirms More Radiation

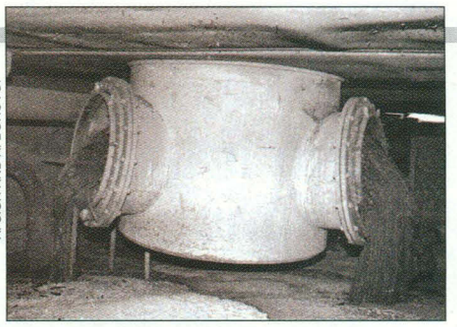
Most graduate engineering theses are quickly consigned to the dusty stacks of a library. Not so Alexander Sich's Ph.D. treatise at the Massachusetts Institute of Technology. Last month, Sich's opus won him a doctorate in nuclear engineering—and promptly became front-page news in *The Boston Globe*. The reason: Sich, after spending 18 months in the Ukraine and working inside the Chernobyl nuclear reactor, provided an unprecedented look at the aftermath of the reactor's explosion on 26 April 1986. "I went there on a whim and a prayer. I had some pretty amazing access to people, places, and data," says Sich.

That access has produced the first extensive onsite analysis of the radioactivity released from Chernobyl. Sich concludes that attempts to douse Chernobyl's burning core with tons of material dumped from helicopters were largely futile, and as a result, the crippled reactor released far more radioactivity than Moscow officials estimated at the time of the accident. That's no big surprise to researchers in the West, who had reached a similar conclusion based on less reliable airborne monitoring and ground deposition studies outside the former Soviet Union. While some of Sich's findings are still being debated, his overall effort is winning high praise. "He's brought some valuable new information to the table," says nuclear safety engineer Edward Warman of Boston's Stone and Webster Engineering Corp., co-author of a 1987 study on Chernobyl's health and environmental affects.

Sich, a fluent speaker of Ukrainian and Russian, gained the trust of local scientists studying the accident on his visit, which began in 1990, and convinced the research director at Chernobyl, Alexander Borovoi, to put him on staff. Working for brief periods inside the concrete sarcophagus that now encases the reactor, Sich helped analyze dozens of samples taken by drilling into the lava-like material that resulted from the core melting through its containment vessel and flowing into lower regions of the plant. There its heat dissipated and it solidified.

Those samples held a wealth of information. Soviet officials had claimed, at a 1986 conference in Vienna, that only 13% of the cesium and 20% of the iodine from the core was released into the atmosphere. But by looking at the remaining cesium-137 and other radioisotopes in the core samples, Sich computed a release of more than 65% and 85% of these elements, respectively. In what he calls a conservative guess, Sich concludes that the accident released more than 185 million curies—four to five times higher than the Soviet estimate. Sich's numbers are in line with current Western thinking about the accident, says Warman. Borovoi, however, still thinks Sich might be overly "pessimistic," suggesting that a lot of the vaporized radioactive particles were reabsorbed by surrounding reactor material and never reached the atmosphere.

The core samples had other news, too. They revealed almost no trace of sand, neutron-absorbing boron, lead, or any other portion of the 5000 tons of helicopter-dropped material that Soviet officials claimed had effectively quenched the fire in the 10 days after the explosion. The pilots, says Sich, were largely ignorant of the reactor design and were merely told to aim for a "red glow" presumed to be the burning core. Yet later analysis of photographs showed that the red glow, which may have been a small ejected core fragment, was more than 50 feet from the reactor; it is now covered with a 4-story mound of dumped material. "I strongly contradict the Soviet claim that the core was covered with the material," says Sich, asserting that an observed large dropoff in radiation release nearly 10 days after the accident was simply because the core had spread itself thin and cooled off.



A. SICH AND A. BOROVOI

Chernobyl lava. Portions of the molten core spread through the plant and froze.

Calling it "tricky to believe" that none of the material hit its target, Harvard University's Richard Wilson, who has studied Chernobyl extensively, is still cautious. "I would like to withhold judgment" pending a closer look at the data, he told *Science*. He and other Chernobyl followers will get their chance in May, when portions of Sich's thesis hit the press in the journal *Nuclear Safety*.

–John Travis

ASTRONOMY

Gloomy Picture for Photo Astronomers

On his next trip to Argentina, William van Altena fears he may run out of film—a frustration for any tourist, but for Van Altena, a Yale University astronomer touring the cosmos, the situation is much more serious. Since 1987, he has been taking photographs of the southern sky using his discipline's version of film: glass plates covered with a highly sensitive photographic emulsion. But last fall Eastman Kodak, the primary supplier of almost all astronomical plates, told Van Altena that it had stopped producing the type he needed. "With no warning, they dropped the bomb," recalls Van Altena, who needs 600 more plates to finish his research on the motion of stars.

JON CHASE/HARVARD NEWS OFFICE

Fading plates. Harvard astronomer Martha Hazen looks at a photographic plate, a technology that may be on the way out, taking some astronomers with it.

Van Altena is not alone. Kodak's recent move to discontinue more than a half-dozen types of plates, which were bringing in little money, has caused photographic astronomers to wonder if their discipline has any future. And last month at the American Astronomical Society (AAS) meeting in Alexandria, Virginia, these worried scientists confronted a Kodak representative, Gordon Brown, who tried to explain his company's actions and dispel rumors that other plates would be next. From Kodak's perspective, he said, there just isn't a lot of business to be had. "They may be selling only $1,000 a year [of a particular plate]. It's just not cost-effective," says astronomer Eric Craine, who convened the special session at AAS.

In large part, the astronomers' crisis stems from a digital revolution, which has, over the past decade, replaced glass plates with light-sensitive chips known as CCDs. But there is still a small community doing traditional photographic astronomy, and many of them have decades-long, wide-field sky surveys under way and other projects that depend on comparing current plates to those taken many years before.

Moreover, these scientists argue that plates are still superior to CCDs for some projects. "There are things we can do with a

photographic plate that you cannot do any other way. We have to be careful about discarding an old technology," warns Craine, who chairs the AAS's Working Group on Astronomical Imaging Technology (which, 6 years ago, was still called the Working Group on Photographic Materials). For example, plates, unlike CCDs, can capture a huge swatch of the sky in a single exposure because they can be cut into large sizes, such as 17 inches by 17 inches. Mosaics of the much smaller CCDs may be able to accomplish the same task, but experimentation with them is just beginning. And for smaller observatories, a forced shift to CCDs is also "an expensive proposition when you already have a working system," says Kyle Cudworth of the University of Chicago's Yerkes Observatory, explaining that one CCD can cost $50,000—and that doesn't include modifications to make it work with the telescope.

Photographic plates are also considered a great archival material and many observatories maintain extensive, scientifically valuable libraries. When the discovery of the first quasar was announced, for instance, two astronomers rushed to the stacks at Harvard College Observatory and pulled out dozens of historical survey plates, and made the important find that its brightness varies over the years. In contrast, the flood of data from CCDs often prompts astronomers to discard information that doesn't directly concern their object of study. And that data is lost forever. "One hundred years from now, one can always pick up a photographic plate and see a picture of the night sky," notes Robert Brucato of Palomar Observatory.

At last month's AAS meeting, Kodak's Brown explained that most of the plates used in the wide-field sky surveys would still be made for the foreseeable future and that the company hoped to adapt less specialized—and thus cost-effective—emulsions such as T-MAX 100, which is used for general black and white photography, to the stringent requirements of astronomical plates. "The plate business will be around for a while," he promised.

But with such a small market for Kodak to sell to, astronomers wonder how long "a while" really is. And Van Altena is still in desperate straits. He is now testing plates made by a small company in St. Petersburg, Russia, but he is unsure whether he can depend on their quality. Such scrambling has brought out gallows humor among the scientists, and the University of Virginia's Philip Ianna, who has a dwindling supply of his own discontinued plates, grimly joked that, "I'm considering auctioning them off to the highest bidder. They may be the last ones in existence." For Ianna, Van Altena, and other astronomers, that's not really a laughing matter.

–John Travis

GREENHOUSE CHEMISTRY

Methane Increase Put on Pause

Whatever their view of the threat from greenhouse warming, scientists are agreed on one thing: They'd like to see the inadvertent experiment in global change put on hold while they get a better grip on what is going on. Well, they just got their wish, or part of it. The rise in a key greenhouse gas, methane, which had been increasing at a disturbing rate until 1991, has stopped dead in its tracks, at least in the Northern Hemisphere. But nobody knows why.

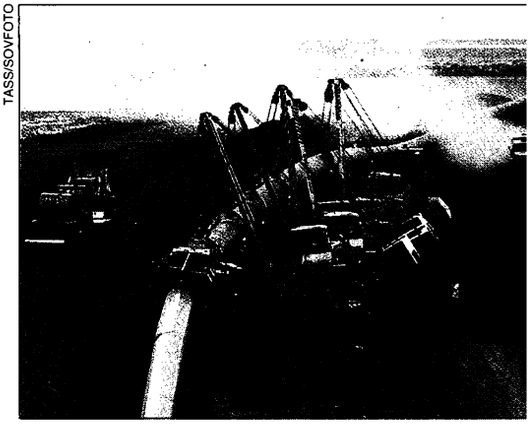
The possible explanations range from the optimistic—humans plugged enough leaks in natural gas pipelines to staunch methane's rise for good—to the disconcerting. Mother Nature may be up to some new tricks that researchers have not fathomed, sending tremors through the web of processes that control the amount of methane and other gases in the atmosphere. "The measurements are first-rate, but [atmospheric methane] is a system with a number of unknowns and equations," says atmospheric chemist Ralph Cicerone of the University of California, Irvine, "and I'm rather sure that there are more unknowns than equations."

The evidence in the great methane mystery of '92 is laid out in the 1 January issue of *Geophysical Research Letters* in a report from Edward Dlugokencky of the National Oceanic and Atmospheric Administration's Climate Monitoring and Diagnostics Laboratory (CMDL) in Boulder and his colleagues. They compiled methane measurements from 28 CMDL sites around the world and along two shipping routes to determine recent trends in methane concentrations. Previous studies had shown that the rise in methane had been slowing gradually in the 1980s (*Science*, 14 June 1991, p. 1496). But beginning in mid-1992, according to the new analysis, the rate of increase dropped sharply in the Southern Hemisphere and plummeted to zero in the Northern Hemisphere.

That doesn't mean that all methane sources in the Northern Hemisphere were suddenly choked off. The end of the rise simply means that methane supply and its removal by chemical reactions in the atmosphere had come into balance at levels more than double those of 200 years ago. Dlugokencky and colleagues believe the most likely explanation is that one or more of the eight or so major sources, which range from digestion by termites and cattle to decomposition in wetlands and landfills, slowed by some 10 million tons a year. Their leading candidate is a drop in the amount of methane escaping from Russian natural gas systems. Dlugokencky points out that the huge Siberian gas fields and distribution system have been notoriously leaky. After a disastrous gas explosion in 1989, efforts began to reduce leaks in the Russian system, and by 1992 engineers might have plugged enough leaks to have ended the methane rise, says Dlugokencky.

That's an optimistic interpretation, because it could mean that the threat of rising methane is over for good—welcome news, because so far methane accounts for one-quarter as much warming effect as carbon dioxide. But Cicerone isn't convinced. "What they say is plausible and may well be the cause," he says, but he argues that the magnitude of the Russian leaks is too poorly known to be sure they caused much of the earlier rise.

TASS/SOVFOTO



Leak prone. Laying a Siberian gas pipeline.

As a suggestion of where else to look, Cicerone points out that methane wasn't the only gas that began acting strangely in 1991. At the same time, analyses by Charles Keeling of the Scripps Institution of Oceanography showed, the decades-long rise in carbon dioxide slowed abruptly. And according to measurements by his son Ralph Keeling, also of Scripps, oxygen took an unusual jump. A surge in the storage of carbon by plants on land or in the ocean might account for the signals, and the biological change might in turn have been driven by climate. There's even a possible driver of climate change: the eruption of Mount Pinatubo in June 1991, which lofted a climate-cooling sunscreen of debris. Methane could fit neatly into this scenario, for example, if the cooling slowed production of the gas by wetlands.

So far, no one has calculated whether a climate shift could have thrown all three gases off track at once, by the observed amounts. But if climate does turn out to be behind the observations, researchers might learn more about how climate change could interact with greenhouse gases to amplify the warming in the next century. That way, even a temporary pause in the greenhouse experiment might yield a lasting benefit.

–Richard A. Kerr