sustain damage that impairs their ability to conduct neural impulses.

One of myelin's jobs is to cover channels that would otherwise allow potassium ions to flow out of neurons. This prevents current from leaking from the cells and impeding conduction of the neural impulse. Acorda has developed a drug called fampridine (chemically, 4-aminopyridine, or 4-AP) that helps compensate for gaps in the myelin by directly blocking the potassium channels at those gaps. Blight and his team, then at New York University, showed that giving 4-AP to cats with spinal cord injuries restored the ability of surviving neurons to conduct electrical impulses and stimulate a normal pattern of electrical activity in the cats' muscles. In 1991, they showed that the treatment could improve standing and walking ability as well as bladder and sensory function in pet dogs that had become paralyzed in car accidents or after ruptures of their spinal discs.

Acorda began trials in humans about 5 years ago and has since treated more than 200 patients. Fampridine improved the patients' sensory and motor functions only modestly. But the drug significantly decreased spasticity, or stiffness and involuntary jerking of limbs, in some patients. It also improved bladder, bowel, and sexual function in treated individuals compared to controls. So far, the only significant side effect is a small risk of seizure, presumably because the compound also increases the excitability of healthy neurons. Large-scale human trials of the drug began in early June.

In the future, Cohen hopes his company will help develop new medications that provide more than partial benefits. Acorda has now constructed what he says is the biggest animal facility in the world for testing treatments for spinal cord injury. There, researchers can test compounds on several hundred rats at a time and get clear, statistically significant answers about whether to pursue a possible remedy.

The right combination

Most researchers in the field believe that no single therapy will be up to the job of treating spinal cord injuries. Instead, they propose that it will take a combination of different remedies to overcome the multiple barriers to neural regeneration that scientists believe exist in the injured spinal cord. "Clearly, we're not looking for one best treatment but a combination of treatments," Olson says. For example, a clinician might build a cellular bridge across the damaged area, administer protein growth factors to boost a neuron's intrinsic capacity for growth, and deliver enzymes that digest scar tissue. Antibodies or small molecules to neutralize the effects of inhibitory factors such as Nogo might also be added to the mix.

Bregman and her colleagues at Georgetown University have done some of the most promising studies combining a scaffold, in this case made of fetal spinal cord tissue, with infusions of growth factors. Together, they found that this combination produced more complete neural regeneration than either growth factors or fetal tissue transplants do alone. Furthermore, last December in *The Journal of Neuroscience*, Bregman's team reported that delaying this combination treatment 2 to 4 weeks after an injury in rats produced even better recovery than administering it immediately. The delayed treatment enabled the rats to walk on treadmills and climb stairs, whereas immediate treatment did not.

Such combination therapies are likely to reach the clinic later, after each individual treatment has been carefully tested alone. Indeed, given the potential dangers of such approaches, some researchers recommend extreme caution before trying any of the current experimental strategies in humans. They worry that some of the more invasive strategies might end up doing more harm than good. "It's very exciting stuff we're doing," says W. Dalton Dietrich, scientific director of the Miami Project to Cure Paralysis at the University of Miami, "but we need to spend a couple more years [doing research] before we're ready to push something into people."

However, many researchers and patients do not want to wait for the perfect treatment if there is a more immediate possibility of a beneficial one. And many argue that without human tests, one will never really know whether something that improves function in rats will be of any use whatsoever in the clinic. After all, humans and rats are dramatically different—from the way they walk to the size of their spinal cords.

For his part, Cohen is betting that his new facilities for escorting early research to human trials will attract many of the creative minds in this rapidly ripening scientific field. "It's like *Field of Dreams*," Cohen says. "If you build it, they will come."

–INGRID WICKELGREN

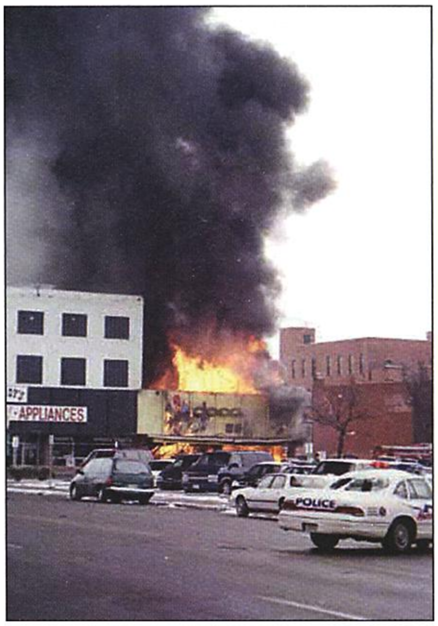
GEOSCIENCE

Data Dilemma: Stow It, Or Kiss It Goodbye

As storehouses burst with bulky samples, an NRC committee proposes a temporary cure for geology's down-and-dirty case of information overload

When Woody's Appliance Store in Hutchinson, Kansas, blew up 17 January last year, the 20-meter-high flames immediately got it pegged as a natural gas explosion. Firefighters shut off the city supply, yet the gas and flames still roared. That night, geysers of natural gas and water began to erupt a few kilometers east of downtown. One exploded under a mobile home, killing two people.

Suspecting that the gas had leaked from underground storage caverns, the Kansas Geological Survey (KGS) went in to figure out how the gas was moving. Within hours, survey scientists had created maps of the local geology from digitized records of thousands of wells drilled over past decades for energy exploration. Once they had fingered a particular layer of rock, the geologists went back to the survey's warehouse and dug out a continuous core of rock drilled some 40 years earlier. With this and other information, they quickly advised the gas company where to drill holes to vent the leaked gas.



To the rescue. A warehoused rock sample helped geologists solve a mysterious fire.

CREDIT: HUTCHINSON, KANSAS, FIRE DEPARTMENT

It was a dramatic step into the limelight for a dusty cylinder of rock. To geoscientists, such archived cores—bored out of rock and sediment by hollow drill bits—are standard reference tools for assessing hazards, searching for oil and other resources, and gathering an array of basic geologic information. Yet across the United States, many collections of cores and other samples are threatened by improper storage or simply being sent to the dump. The vast storehouses of data owned by oil and gas companies are especially vulnerable as industry giants wind down their exploration of the United States. Much of the data would be expensive or impossible to replace. "It's just a crime if we don't find a way to capture these data for general public use," says Marcus Milling, executive director of the American Geological Institute (AGI) in Alexandria, Virginia.

The problem is a "critical shortage of space for current geoscience collections and data, let alone those gathered in the future," according to a National Research Council (NRC) report released in April.* While recognizing that not everything is worth saving, the report recommends three new $50 million government-funded centers that would rely on scientific advisory committees to figure out what should be kept. "It's a huge issue," says paleontologist Chris Maples of Indiana University, Bloomington, who chaired the NRC committee. "I'm just stunned by how much has been lost."

Cold storage. Ice samples, used in climate studies, are well kept. But other samples similar to this rock core (*inset*) from Hutchinson, Kansas, face an uncertain future.

Up to the rafters

It's difficult to gauge the amount of geoscience data scattered among museums, state geological surveys, universities, federal agencies, and industry. The NRC committee estimates a total of 24,100 kilometers of solid rock cores and the rock chips, called cuttings, that come out of other wells. To that, they add 100 million boxes of fossils, as well as 560 million kilometers of paper logs, such as records from seismic experiments. The committee believes a quarter of these data are at risk, enough to fill the U.S. Geological Survey's (USGS's) Core Research Center in Denver, Colorado—one of the largest such facilities in the country—20 times over.

Exactly how much is already gone? "We tried really hard to answer that question, and we failed," says committee member Warren Allmon, director of the Paleontological Research Institution (PRI) in Ithaca, New York. "No one wants to admit that they pitched a collection." Yet, anecdotal evidence suggests that a considerable amount is missing. "We hear stories all the time of companies hauling cores to the dump," says KGS director Lee Allison.

Confirmed losses include the core from the deepest well ever in the United States—9583 meters—drilled by an oil company between 1972 and 1974 in Oklahoma. Thrown out after a merger, the core would cost up to $16 million to replace today. And cores belonging to state geological surveys have been damaged or destroyed by earthquakes in Alaska, a collapsing building in Maine, flooding in Kentucky, and collapsed shelving in North Carolina, the committee found.

That's a pity, geoscientists say, because old samples often find new uses. For instance, seismic records from Los Angeles, taken for oil exploration, are now used to assess earthquake hazards. And techniques such as cathode luminescence with scanning electron microscopes can coax old cores into revealing how best to extract remaining oil from reservoirs or how groundwater flows. Industry data are also a boon to academic scientists who can't afford to gather the information themselves. "This kind of material has all sorts of new science left in it," says AGI's Milling. "That's why we've got to save it."

Out of room

The trouble is finding a place to put it. Almost two-thirds of state geological surveys polled by NRC have 10% or less of their storage space available for new collections. Nearly 25% are already full. "We are bursting at the seams," says Allison of the KGS, which just received a donation of 15,000 boxes of core from BP Amoco. "There's no money out there to build new facilities to expand." Instead, Allison is juggling space, converting some labs to storage.

With limited shelf space, something must get tossed for every new item added. Petroleum geologist Wayne Ahr of Texas A&M University in College Station has accepted large donations of core from oil companies. But the only place he has to put them is in a wooden barracks on a World War II airfield that's already full to the brim. In fact, it's been filled up three or four times, which brings painful choices. "Whatever we had to throw out, it's gone forever," Ahr says. "It's heartbreaking."

Natural history museums are filling up, too. PRI has doubled its holdings in the past 10 years, almost exclusively by adopting collections from universities and other institutions. Now director Allmon says he turns away everything except spectacular specimens and special collections that the museum needs. "If it's a large general collection, it pains me, but we don't have any place to put it," he says.

So scientists do the best they can. Allmon has a barn of his own filled with overflow from PRI, including samples he took from pits in Florida that were later flooded for a housing development. Consulting geologists fill up self-storage units with file cabinets discarded by mining companies that went bust. Many retired geologists keep samples in their basements and garages, says Susan Landon, an exploration geologist affiliated with Thomasson Partner Associates in Denver, Colorado. "They hold out hope that eventually it will find a home … where it will be useful to the community," she adds.

In the past decade, the problem has gotten worse, notes Edith Allison of the U.S. Department of Energy's Office of Fossil Energy. As oil companies—which hold much of the data—merged and moved their exploration overseas, they shed cores and other data gathered in North America. "There are billions of dollars' worth of data in the private sector in danger of being lost," says AGI's Milling. "They have data from areas where you'll never be able to drill another well." The same trend hit the mining industry.

USGS is also feeling the pinch. Since 1995, the survey has given away almost two-thirds of its fossil collections. Staff at its core research facility, which houses more than 300,000 meters of core, has fallen from eight in 1994 to three, and storage space was reduced by 40% in 1995 to cut rent costs.

There are a few success stories. The NRC panel holds up the National Ice Core Laboratory (NICL) in Lakewood, Colorado, as a model facility. Funded by USGS and the National Science Founda-

* *Geoscience Data and Collections: National Resources in Peril.*

CREDITS: (TOP TO BOTTOM) LYNN WATLEY/KGS; NSF/USGS NATIONAL ICE CORE LABORATORY tion, the lab has a Web-based catalog, well-documented cores, and a clear policy for removing materials from the collection so that little core is wasted.

The private sector also boasts examples of good practice. When Shell donated 670,560 meters of core to the Texas Bureau of Economic Geology (BEG) in 1995, it threw in a warehouse and $1.3 million for operating costs. In return, the company received tax write-offs. "It's a good model," says BEG director Scott Tinker, "but it has to be customized for each company." Tinker expects to announce another major donation of a facility and 400,000 boxes of core shortly. The NRC panel suggests further incentives to encourage this kind of donation.

Such measures, however, address just a fraction of the problem. To make a bigger impact, the NRC panel recommends that the government fund three new centers to hold core and other materials, modeled after the NICL and the core repository of the international Ocean Drilling Program. At $35 million to $50 million, each facility would cover 16,000 square meters, about the size of a Wal-Mart Supercenter. The centers would relieve the problem of data loss for 10 to 20 years, Indiana's Maples estimates.

Mustering support for such a major investment will be difficult. "Storing rock isn't sexy," Landon says. "It's long-term housekeeping that's always going to have trouble competing with other scientific expenditures." Yet proponents say such large, unglamorous efforts are the only way to avert every scientist's nightmare: losing irreplaceable samples. "It's a sobering thought, and it's not hard to imagine," Allmon says. "Even with just benign neglect, all these data could slip away."

–ERIK STOKSTAD

RESEARCH MANAGEMENT

Big Facilities Account Is Big Headache for NSF

Legislators are pressuring NSF to explain its procedures to researchers with large projects that have been approved but not funded

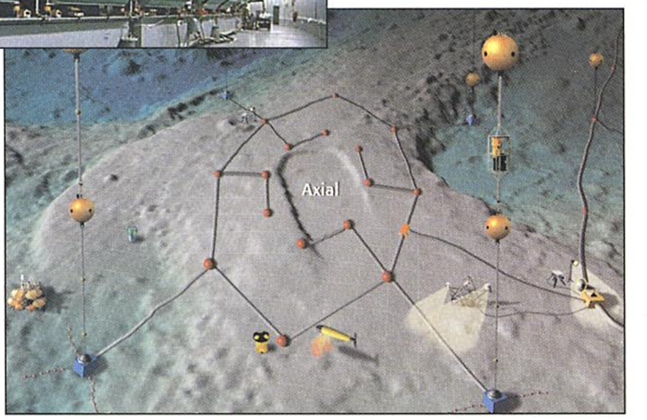
In 1994 the National Science Foundation (NSF) wanted to find a way to keep new and expensive facilities from eating into its regular research budget. So it created a separate account and used it to fund a handful of projects, from a new South Pole station to mountaintop observatories. But less than a decade later, a growing portfolio is forcing NSF to face management challenges that it never imagined—and to defend itself against criticism by Congress, scientists, and its own internal auditor.

In the past couple of years, big facilities have become a big headache for NSF. One problem is a backlog of projects approved for funding by the National Science Board, NSF's governing body, that haven't made it into the agency's budget. Researchers whose projects have been passed over complain that NSF has kept them in the dark about why they didn't make the cut while others did, and some have convinced members of Congress to do an end run by ordering NSF to fund specific experiments. Last month several influential U.S. senators asked the National Academy of Sciences (NAS) to review how NSF makes those decisions. If that were not enough, NSF's own inspector general (IG) recently issued a report questioning how the agency manages existing projects. NSF hopes to blunt the criticism by naming a well-regarded facilities construction chief to a new office, but so far it has been unable to hire anyone on a permanent basis.

To NSF officials, most of the headaches could be cured with money. Its approach, using what's known as the Major Research Equipment (MRE) account, worked reasonably well when the number of projects approved by the science board roughly equaled the number that could be funded. But last year, President George W. Bush sent Congress an NSF budget that included no new starts. This year, the foundation's budget request includes $126 million for the MRE account, enough to start two projects and continue building five others. That has left four projects in limbo—approved, but unfunded—and several others close to approval, with backers wondering if they will ever get off the ground. Climate modeler Warren Washington, who chairs the science board, says that NSF needs to "double or triple" the current level of MRE funding to satisfy the community's growing hunger for cutting-edge instruments. "We're all working toward a common end, and that end is an increased budget," says NSF deputy director Joseph Bordogna.

The excess demand has, however, exposed flaws in the system. The science board doesn't prioritize the projects it approves. Until Congress last year demanded the names of all approved projects (*Science*, 14 September 2001, p. 1972), NSF had never publicly identified individual projects until they appeared in the agency's budget request. That secrecy bred discontent. The process appears "ad hoc and subjective," wrote six senators in a letter to NAS president Bruce Alberts last month that also complains about NSF's failure to explain how the system works. The senators, the chairs, and ranking members of NSF's spending and oversight committees asked Alberts to appoint a committee to review NSF's priority setting.

NSF officials bristle at such criticism. "Every project goes through an extensive review, and we are totally transparent about how this takes place," says Bordogna. "But we'll certainly listen carefully to what the academy has to say and act accordingly." NSF and academy officials are negotiating the terms of the study, which could be completed by early next year.



Concrete ideas. NSF hopes to get money to build new research facilities at (clockwise from upper left) Brookhaven, the South Pole, and the Pacific Ocean floor.

CREDITS: (CLOCKWISE FROM TOP) ICECUBE/UNIVERSITY OF WISCONSIN; NEPTUNE PROJECT AND THE CENTER FOR ENVIRONMENTAL VISUALIZATION, UNIVERSITY OF WASHINGTON; BROOKHAVEN NATIONAL LABORATORY