PERSPECTIVES

FALL 2005

RESEARCH AND CREATIVE ACTIVITIES

SOUTHERN ILLINOIS UNIVERSITY CARBONDALE

MADE IN BANGLADESH

Globalization and Women's Lives

ALSO: TOUGHER THAN TOUGH ✠ SHAKEN AND SHOCKED ✠ FREELOADERS

Nature and *Science*, the world's top two science journals, recently featured research and commentary by two SIUC geologists. Scott Ishman and Nicholas Pinter both work in various places around the globe. Both have had funding from the National Science Foundation for their research. And both have been featured in *Perspectives* before. We return to them in this issue's Research Survey section because their scientific concerns—climate change and river flooding, respectively—have compelling implications for public policy.

So does our cover story. The 1990 issue of *Perspectives* contained an article on women and work that featured several SIUC faculty, including sociologist Kathy Ward. Sixteen years later, our cover looks at Kathy's recent focus on how globalization has affected the lives of women in one of the world's poorest countries. This work, funded by the National Science Foundation and several other agencies, has economic policy implications for Third World and industrialized nations alike.

Other projects with, we hope, high potential for public benefit include continuing research on helping Alzheimer's patients function better, and a promising new composite material to greatly extend the life of drill bits and other tools.

Whereas the last issue of *Perspectives* emphasized the regional impact of SIUC research, this issue describes several projects with worldwide implications. Besides their other benefits, such research activities better prepare the graduate and undergraduate students who take part in them to work in a global economy and live in a global society. I hope you enjoy reading about these diverse projects.

John A. Koropchak
Vice Chancellor for Research
and Graduate Dean

Southern Illinois University Carbondale

www.siuc.edu

Chancellor
Walter V. Wendler

Vice Chancellor for Research and Graduate Dean
John A. Koropchak

Associate Vice Chancellor for Research and Director, Research Development and Administration
Prudence M. Rice

Perspectives • Fall 2005

Perspectives: Research and Creative Activities at Southern Illinois University Carbondale is published twice a year, in spring and fall, by the Office of the Vice Chancellor for Research/Office of Research Development and Administration.

To be added to our mailing list, obtain back issues, or request permission to reprint material, contact Marilyn Davis, Editor, Office of Research Development and Administration (ORDA), mailcode 4709, SIUC, Carbondale, IL 62901, 618-453-4540, mdavis@siu.edu. Back issues also may be found at www.siu.edu/~perspect.

For information about the research program at SIUC, visit www.siu.edu/~ovcr, or contact John A. Koropchak, Vice Chancellor for Research and Graduate Dean, 618-453-4551, koropcha@siu.edu, or Prudence M. Rice, Director, Office of Research Development and Administration (ORDA), 618-453-4531, pmrice@siu.edu.

Editor: Marilyn Davis, ORDA

Contributors: Paula Davenport, K. C. Jaehnig, and Pete Rosenbery, Media & Communication Resources

Designer: Jay Bruce, Media & Communication Resources

Photography: Media & Communication Resources, except where noted.

Cover: Women make up most of the workforce for Bangladesh's garment industry, thanks to global economic restructuring, but most are still struggling to make ends meet. *Photo illustration by Rusty Bailey, Media & Communication Resources.*

PERSPECTIVES

FALL 2005 | RESEARCH AND CREATIVE ACTIVITIES

SOUTHERN ILLINOIS UNIVERSITY CARBONDALE

CONTENTS

DOWN THE DRAIN

Chicago's thirst for water will escalate a whopping 30 percent over the next 20 years—and the rest of Illinois will demand 28 percent more water than it soaked up in 2000, according to a new report by SIUC water-use experts.

By 2025, thermoelectric power plants will need 17 billion gallons per day—nearly 85 percent of the state's projected water use, says Benedykt "Ben" Dziegielewski, an SIUC geography professor and lead author of a comprehensive report predicting future water needs in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

The first such study of its kind, it was a joint project by researchers from SIUC's Department of Geography and Environmental Resources and the Illinois State Water Survey (ISWS).

The study projects a 7.3 percent increase in combined publicly supplied water use for the six-state region over the next 20 years, despite an overall decline in per-capita water use. Illinois and Ohio account for the majority of the projected increase.

Study totals show Illinois will need to pump about 20 billion gallons of water a day in 2025, up from the daily total in 2000 of 15.8 billion gallons. The state's population is expected to grow to nearly 14 million residents in 2025, and its per-capita water demand is predicted to jump 14 percent, to 1,450 gallons a day—a 178-gallon increase over 2000 usage.

▲ **Water resources expert Ben Dziegielewski: Conservation and careful planning will be key to avoiding local water shortages in Illinois over the next two decades.** ***Photo by Steve Buhman, Media & Communication Resources.***

About 16.9 billion gallons of water a day will be needed in 2025 to cool Illinois' power plants, the report predicts. (Although thermoelectric use declined between 1995 and 2000, it has since rebounded and is growing rapidly.) Another 3.3 billion gallons will be needed to meet the remaining needs of the public, commercial and industrial entities, irrigation, mining, and livestock.

Cook County alone will demand 2.4 billion gallons of water daily, half of which will go to cool power plants. And the burgeoning metro areas southwest of Chicago and east of St. Louis will be under tremendous pressure to provide water.

"Although we live in a water-rich state, with Lake Michigan and the major rivers, we should not take our present and future water supply for granted," says Dziegielewski, who also directs the International Water Resources Association, based at SIUC. "Local water shortages are likely to happen in Illinois, especially in the heavily urbanized parts of the state."

The research team predicts that 70 of Illinois' 102 counties will need more water in the future.

For instance, daily water demands in Cook, DuPage, Will, Lake, and Kane Counties are projected to climb by more than an additional 25 million gallons above their 2000 totals. Obtaining more water for these counties from Lake Michigan would require permission from the International Joint Commission, which monitors water withdrawals from the Great Lakes. Will, Grundy, and Madison Counties also will experience acute water needs, due to increasing thermoelectric demands.

"There will be areas where additional water supplies will not be readily available and their development may be costly and controversial," Dziegielewski says. "On the up side, new water supplies may be easier to obtain in the McHenry County area and some east-central parts of the state where there is abundant groundwater."

The report is broken into two documents: "County-Level Forecasts of Water Use in Illinois: 2005-2025," available at **www.sws.uiuc.edu/hilites.asp,** and "Countywide Projections of Community Water Supply Needs in the Midwest," available at **mtac.sws.uiuc.edu.**

Dziegielewski urges that developers and planners take the projections into consideration in order to avert future water shortages. Conservation and careful management will be key. For example, he says, power plants could construct

cooling towers that recycle water (called closed-loop cooling), which reduces a plant's water needs by 95 percent.

"We have to act on this information and draw appropriate plans," he says, "to ensure that future water needs are met without undue pressures on the environment."

For more information: Dr. Ben Dziegielewski, benedykt@siu.edu or 618-453-6021. The research was funded by the U.S. Environmental Protection Agency's Midwest Technology Assistance Center, the Illinois Department of Natural Resources through the ISWS, the Illinois Board of Higher Education, and SIUC. Dziegielewski's research on water-use modeling was reported in the Fall 2003 issue of Perspectives.

—Paula Davenport

IN HARM'S WAY

When it comes to building on flood-prone land, no place does it like St. Louis.

"The St. Louis area is the epicenter of floodplain encroachment nationwide," says Nicholas Pinter, an SIUC geologist whose article on the subject appeared in an April 2005 issue of the journal *Science*.

"Because of the extent of human development on the floodplain, our research suggests that the next [flood] may well be bigger than the last," he says.

"More than any other place, the greater St. Louis metropolitan area is allowing its floodplain to turn into new strip mall development. It has $2.2 billion in new development on land that was under water in 1993—18,000 acres either in construction behind levees or in the planning stages. It's unprecedented."

The Federal Emergency Management Agency (FEMA) spent $56 million to buy out floodplain properties in Missouri and Illinois after the great Midwest flood of 1993. But subsequent floodplain development, which has been concentrated in the St. Louis metropolitan area, is "counterbalancing" the good that FEMA did, Pinter asserts.

FEMA guidelines specify that no floodplain construction should cause more than a one-foot rise in flood level. Many states have established a stricter threshold than FEMA's. Missouri, however, passed legislation prohibiting its counties from setting stricter limits.

Pinter has studied flooding on the Mississippi and Missouri Rivers and on major rivers in Europe. Analyzing such factors as water height, flow, and volume; channel width and depth; land-use changes; and engineering structures reveals how and why river behavior changes over time. A fixed amount of rainfall can cause dramatically different flood levels, depending on these factors.

To get a fix on floods along the middle Mississippi, from just north of St. Louis to Cairo, Ill., Pinter and his students analyzed the detailed measurement record from St. Louis (which goes back to 1861) and other locations. That work was described in the Fall 2001 issue of *Perspectives*. Among other things, the team confirmed that levees have made floods higher and more frequent along this stretch. The phenomenon is called "human forcing" of floods.

With funding from a National Science Foundation grant, Pinter and his students are now working to provide better tools for planners to assess how new engineering structures in the Mississippi River system, such as new or raised levees, would affect flood levels.

"Levees make floods higher when they come through because areas that would convey and store the flood flows are blocked," Pinter explains.

"Before 1900, there were very few levees in most areas (along the middle Mississippi). For example, along a portion of the Mississippi floodplain in St. Charles County (Mo.), there was only one low levee as recently as 1930, but by 2000, they're all over the place, and they're enormously higher—in some places as much as 10 times higher." Developers in the St. Louis metro region also have been granted wetland fill permits to raise parts of the Missouri and Mississippi floodplains, says Pinter.

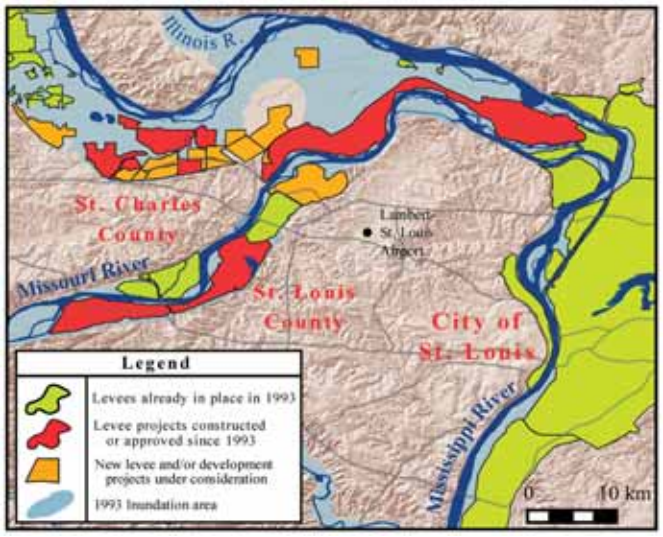
"When you look at what was there before (in terms of enclosed or raised floodplain), what's been added since 1993, and what's being proposed, it's a huge amount," he says.

But since levees force floodwaters higher than they otherwise would be, the newly enclosed or raised floodplains are not necessarily safe from major floods—and there are many more structures on them now.

Taxpayers will be the one to pay the price, says Pinter. Records show that the St. Louis area's 10 highest floods in the historical record all occurred in the last 65 years. The next severe flood, he says, is "just a matter of time."

For more information: Dr. Nicholas Pinter, npinter@siu.edu or 618-453-7375.

—K. C. Jaehnig; Marilyn Davis



▲ Recent floodplain development in the St. Louis area. ***Graphic courtesy Nicholas Pinter.***

▲ Left: Snakemouth orchid. Right: Orange-fringed orchid. *Photos by Michael Jeffords, Illinois Natural History Survey.*

Illinois' plants will get a helping hand

when three SIUC plant biologists complete a comprehensive database on those in need of conservation.

To collect information about the state's approximately 400 rare plant species, assistant professor Sedonia Sipes, professor David Gibson, and doctoral student Drew Minnis have combed through journal articles, existing databases, and government reports and talked to biologists, land managers, and conservation agents across the state.

Their rare-plant database, scheduled to be finished in 2006, will complement the state's recently completed "Comprehensive Wildlife Conservation Plan," which currently includes information only about vertebrate animals.

As a frame of reference, Sipes, Gibson, and Minnis are using criteria that affect plant population size and growth trends, such as habitat needs and means of pollination, to identify the primary threats to each species. Such threats can range from habitat destruction to invasive competitor species. The three researchers are providing information about management requirements to help conserve these species, and they are spotlighting gaps in knowledge where more research is needed.

The project is being funded by the Illinois Department of Natural Resources.

—Marilyn Davis

LISTEN UP

Otolaryngologist Leonard Rybak, a surgeon who has spent much of his career studying inner ear injuries and hearing loss, was named SIUC's Outstanding Scholar for 2005.

A faculty member with the SIU School of Medicine's Departments of Surgery and Pharmacology, Rybak is known worldwide for his work on ototoxicity (harm done to organs or nerves related to hearing and balance).

Much of his work has focused on understanding why many drugs commonly used to treat other ailments can wind up damaging the inner ear and causing hearing loss. He was the first to find that cisplatin, a common anti-cancer drug, causes the production of free radicals—atoms or groups of atoms with free, or unpaired, electrons—in inner ear tissues. When free radicals react with cell membranes, they can damage or even kill the cells.

Rybak theorized that this happened because the inner ear's normal detoxification system failed. He then began trying to understand how the free radicals were produced and what might be done to protect the inner ear.

"Dr. Rybak's contributions are leading the way toward developing new therapies to prevent hearing loss," said Edwin Rubel, a professor with the University of Washington's Virginia Merrill Bloedel Hearing Research Center, in supporting the Outstanding Scholar nomination.

Rybak also has looked at how inner ear cells are normally "remodeled" or replaced in subjects of varying ages, finding that these cells are far more active in mature subjects than was previously thought.

The National Institute on Deafness and Other Communication Disorders, part of the National Institutes of Health, has funded Rybak's research since 1985 and has tapped him to serve in various capacities, including on its Board of Scientific Counselors.

Rybak has received the Jacob Javits Neuroscience Investigator Award (given by the NIH for excellence in research), has served as president of the Association for Research in Otolaryngology, and has received the Distinguished Service Award of the American Academy of Otolaryngology–Head and Neck Surgery. ✪

—K. C. Jaehnig

▲ Leonard Rybak. *Photo courtesy SIU School of Medicine.*

SOMETHING OLD, SOMETHING NEW

Recent work by SIUC archaeology students suggests a well-known prehistoric mound site dating back nearly 1,000 years is larger and possibly more complex than originally thought.

The investigation at Kincaid Mounds, bordering the Ohio River in Southern Illinois, shows a new platform mound about 250 yards outside of known defensive walls around the site. "At some moment in its history this site was considerably larger than we had expected, or it is considerably more complex, with distinct parts of it in different locations," says Paul Welch, an associate professor of anthropology.

Kincaid was one of the two major political centers of the Mississippian culture (A.D. 900-1500) in the lower Ohio Valley. Located near Brookport, which is on the Ohio about 75 miles southeast of Carbondale, it is one of the largest prehistoric Native American sites in Illinois, and the seventh or eighth largest site of its time period in the eastern United States.

Native Americans occupied the site beginning around A.D. 1000 but abandoned it for still-unknown reasons by about A.D. 1450, several hundred years before French explorers arrived.

The Illinois Historic Preservation Agency owns about two-thirds of the Kincaid Mounds site, which it leases for no-till farming; the remainder is privately owned. SIUC proposed to the agency to determine whether a "bump" in the current cornfield was a prehistoric mound that dates to the same time period of the site's occupation, was built much later, or is a natural land-form.

After last fall's harvest, a scan of the area with a magnetometer—which measures minute variations in the earth's magnetic field—indicated the possible existence of numerous houses buried under alluvium. Fieldwork done to this point has confirmed the existence of two prehistoric houses as well as the platform mound itself. The IHPA provided a small grant to help fund the research.

A group of 11 undergraduate and graduate students—participants in this past summer's annual field school run by the Department of Anthropology and Center for Archaeological Investigations—did most of the excavating.

The project has greatly expanded on work done in the 1930s and early 1940s by the University of Chicago, says Brian Butler, the center's director and an adjunct anthropology professor. That work was "very good and extremely important in the development of American anthropology," he says—but the new work, aided by technology unavailable 70 years ago, indicates there is a "whole series of lesser mounds that is part of the complex on state land that Chicago never looked at."

As a student himself in the 1970s, Butler did intensive survey work and excavations that documented satellite settlements near Kincaid Mounds. "We felt it was time to go back to the Kincaid site itself and start doing some new work," he says.

▲ **Bridgett Williams, a junior majoring in anthropology, sifts through dirt from an excavation site at Kincaid Mounds to search for pottery fragments. *Photo by Jeff Garner, Media & Communication Resources.***

The now-confirmed settlement on the western side of Kincaid Mounds seems to "balance off" the eastern part of the complex, he says. Radiocarbon testing of burned grass thatch uncovered in the excavations will give a close date—within five to 10 years—for the beginning of mound construction on the western side.

It will now be up to the IHPA to determine if it wants to take the land out of cultivation for further research.

"We hope we are in the early phases of work," Butler says.

For more information: Dr. Brian Butler, Center for Archaeological Investigations, 618-453-5031 or bbutler@siu.edu, or Dr. Paul Welch, Dept. of Anthropology, 618-453-4740 or pwelch@siu.edu.

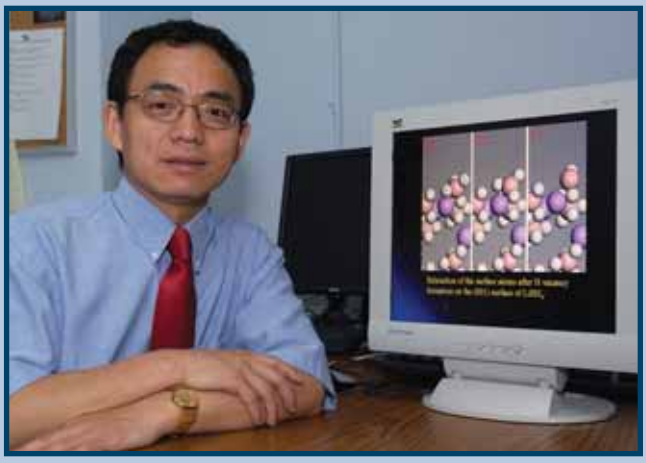
—Pete Rosenbery

KUDOS

• Siva Balasubramanian, the Henry J. Rehn Professor of Marketing in the College of Business and Administration, has been awarded a research chair appointment through the Canada-U.S. Fulbright Program. He will hold the position in spring 2006 at the University of Alberta at Edmonton's School of Business, where he will do research with Canadian colleagues and help them develop expertise in marketing strategy. Although SIUC has had dozens of Fulbright scholars over the years, Balasubramanian is the **first SIUC faculty member ever named a Fulbright research chair.**

• Haibo Wang, an assistant professor of electrical and computer engineering, has won a $400,000 award from the National Science Foundation's CAREER Program, the fifth SIUC faculty member in recent years to receive the prestigious award. The NSF grant will support Wang's work on developing mixed-signal computer chips (those that can read both digital and analog signals) that can figure out on their own if they are damaged and then repair themselves. A **self-repairing chip** would be especially useful in places where routine maintenance is difficult, such as in space or on battlefields.

• The U.S. Department of Energy (DOE) has awarded a three-year, $600,000 grant to assistant professor of chemistry Qingfeng Ge (below) for research into **hydrogen storage.** Ge's work, based on computer models, is designed to find a material that can carry hydrogen that is inexpensive, has maximum capacity, is highly efficient, and is easy to use. The DOE's goal is to make hydrogen fuel cell vehicles and refueling stations "available, practical, and affordable for American consumers by 2020."



• Associate professor of zoology Karen Lips (right) was among a select group of 20 North American environmentalists chosen to receive a **2005 Aldo Leopold Leadership Fellowship.** An expert on amphibian declines in Latin America, Lips is known internationally for helping to detect a previously unknown fungus that appears to play a part in population crashes of some frog species.

• Boyd Goodson, an assistant professor of chemistry, was recently named one of only 13 Cottrell Scholars nationwide for 2005. The $100,000 awards, made by Research Corporation, a foundation for the advancement of science, are given to faculty expected to make **significant fundamental advances in science.** Goodson's research involves techniques to improve studies of molecular structure and dynamics in thin-film materials.

• Kounosuke Watabe, a professor of medical microbiology, immunology, and cell biology at the SIU School of Medicine in Springfield, was awarded a three-year, $425,887 grant from the U.S. Army to study **a gene that blocks the spread of breast cancer cells in the body.** The research will look at how these cells spread from the primary tumor to distant organs and may lead to new treatments for the metastasis of breast cancer.

• Two faculty members received prestigious **stipends from the National Endowment for the Humanities** to support their work on book projects. Jyotsna Kapur, an assistant professor of cinema and photography, is working on a book looking at how globalization is affecting child labor in India. Kevin Dettmar, a professor of English, is writing about the use of irony in public communication in Britain and the United States over the past century and a half.

Photos by Media & Communication Resources.

COLD CASE

A pair of recent high-profile articles co-authored by an SIUC geologist report a new type of Antarctic deep-sea ecosystem and provide further evidence that the global warming going on today is attributable mainly to human activity rather than natural climate cycles.

Paleobiologist Scott Ishman, an associate professor of geology at SIUC, is one of about a dozen highly respected U.S. experts on Antarctica. He and his students have been part of a team led by Eugene Domack, a geologist at New York's Hamilton College, that has made several trips to study the breakup of parts of the Antarctic Peninsula's Larsen Ice Shelf in recent years.

They have wanted to determine whether the breakup is a unique event in recent geological history—implicating human causes for the current warming—or if it fits into a recurring pattern. Their findings were reported in the Aug. 4, 2005, cover story of *Nature*.

The article, under the headline: "A Long Shelf Life: Larsen-B Collapse Follows 10,000 Years of Stability," indicates that today's global warming is unnatural, is escalating at an unparalleled rate, and surpasses every such documented trend since the last great ice age some 10,000 years ago.

In mid-February 2005, Ishman and two undergraduate students in geology, Paul Dixon and Stephanie Dulgar, joined Domack and 14 other colleagues aboard the research vessel *Lawrence M. Gould,* which plied northwest Antarctica's Weddell Sea for a month during polar summer. It was Ishman's third expedition to this part of Antarctica and his seventh overall.

The scientists pulled cores of Antarctic seafloor sediment from an area formerly capped by the huge middle section of the shelf, labeled Larsen-B. (Larsen-A, the northernmost section, melted in the mid-1990s.) A sprawling, nearly 600-foot-thick sheet of ice, Larsen-B began shrinking in the late 1990s and collapsed in 2002, when a section the size of Rhode Island broke off and disintegrated.

"Recent warming in the Antarctic has really accelerated in the last 50 years," Ishman notes. "In that time, we've seen an average increase of 6.5 degrees Fahrenheit in the Antarctic ice shelf area, which is startling."

Ishman and his students determined what the region's environment was like in the past—and how to interpret what's happening with climate today—by studying fossilized shells of forams, single-celled marine creatures that are preserved in the sediment cores.

They have collected forams from various ecosystems to understand what environmental conditions are required by particular species. Identifying the species found in the sediment cores from Antarctica told them a lot about what the climate there was like when the fossilized specimens were alive.

Also, says Ishman, "In the cores we had—sediments deposited over the past 10,000 years—the forams were the same types of species throughout until very near the top." This indicates that the recent melting was not a cyclical occurrence.

▲ **A view of the Larsen-B ice shelf before its breakup.** ***Photo courtesy Scott Ishman.***

"The global warming we're experiencing today is a matter of great concern because it's not part of any natural cycle we've observed in the last 10,000 years," he concludes.

Ice-pack conditions on the 2005 trip permitted the research team to get farther south along the peninsula than any ship had been able to get before. As a result, the team got a scientific bonus: their submersible video camera, which was photographing a glacial trough in an area formerly covered by Larsen-B, found a type of marine ecosystem previously unknown in Antarctica.

In this sunless habitat more than half a mile deep, mats of bacteria and populations of clams are thriving in near-freezing water that until recently was covered by the ice shelf. The organisms are apparently fueled by methane from underwater vents.

The surprising find was reported in the July 19, 2005, issue of *Eos,* a scientific journal published by the American Geophysical Union.

The team's discovery will enable biologists to learn more about life in extreme environments. They may need to hurry, though.

Without the protection of the ice shelf, the deep-water communities are now vulnerable to disturbance. Sediment is already beginning to cover some of the organisms, the team reports.

For more information: Dr. Scott Ishman, Dept. of Geology, 618-453-7377 or sishman@geo.siu.edu. The National Science Foundation's Office of Polar Programs provided funding for this research.

—Paula Davenport; Marilyn Davis

GOOD DAY SUNSHINE

Special lighting and window glass can help calm Alzheimer's patients, improving their quality of life and making life easier for their caregivers, according to a recent yearlong SIUC study.

Melinda LaGarce, an associate professor of interior design, conducted the research, a follow-up to a preliminary study she did with two other SIUC researchers. (*Perspectives* reported on that pilot work in spring 1997.)

The research was designed to see if the effects of so-called "sundown syndrome" in Alzheimer's patients could be moderated. As the sun declines in the afternoon, the agitation, aggression, and anxiety shown by many people afflicted with Alzheimer's tends to worsen, sometimes dramatically. The effect begins as early as 2 p.m.

LaGarce designed two identical activity rooms in a local adult services center that provides day care for Alzheimer's patients. Both rooms faced south, were furnished identically, had the same door and window placement, and had similar exterior views.

To the room's users, including the staff, there was also no apparent difference in the lighting and window glass in the two rooms. One of the rooms, however, had full-spectrum rather than standard lighting and special window glass.

Full-spectrum light is a white light similar to noontime sunlight, whereas incandescent light is considerably yellower. Angled microslats in the window glass, which are detectable only on close inspection, blocked direct sunlight during the afternoon, letting in only reflected light.

Throughout the afternoon, a sensor progressively boosted the lighting in this experimental room to maintain a constant level of noontime-intensity light. The lighting/window combo removed any cues, such as shadows, light slant, or color of light, that the sun was setting.

The Alzheimer's patients arrived at the center at noon and stayed until about 4 p.m. year-round. Unbeknownst to them, they were alternated every few weeks between the control room, without the special lighting conditions, and the experimental room. Hidden cameras in both rooms videotaped the group.

A team of specially trained undergraduate and graduate students watched the tapes and recorded instances of agitated or disruptive behaviors common to Alzheimer's patients. They monitored 10 behaviors in all, including anxiousness, wandering, combativeness (such as hitting or throwing things), verbal disruptiveness (such as yelling), and repeating the same action obsessively.

As a quality control check, two members of the caregiving staff also recorded data as observers in the rooms. To ensure objectivity, neither the student team nor the day-care center staff was told how the two rooms differed or what the focus of the study was.

On average, agitation and disruptive behaviors dropped by half during the weeks when the patients were in the experimental room. The greatest reduction—55 percent—occurred in the fall, when the days are getting markedly shorter and the switch to standard time takes place.

Better yet, patients who had the highest levels of agitation in the control room experienced the most dramatic improvements in the experimental room.

The day-care center staff who worked with the Alzheimer's patients also recorded their impressions every day. When the room with the special lighting was being used, they reported that patients were "more calm, content, alert, slept longer during naps, and gave better verbal responses."

The study's findings were published in the autumn 2004 issue of the *Journal of Architectural and Planning Research.*

LaGarce thinks that nursing homes and elder care centers could put Alzheimer's patients more at ease fairly inexpensively, by using full-spectrum bulbs for lighting and placing louvers or trellises outside of windows to control afternoon light and shadows. Costly microslat glass is probably not necessary.

LaGarce suspects the key to helping Alzheimer's patients lies more in the color of the

Work with Alzheimer's patients indicates that full-spectrum (very white) light in the afternoon may reduce agitation and other symptoms of so-called "sundown syndrome."

ambient light than in light intensity or in removing shadow cues. To begin testing that theory, she did a small pilot study in summer 2004 looking at the effect of specific wavelengths of light on two people with Alzheimer's disease.

Each subject spent five 3-hour sessions with an attendant in a room with no windows. LaGarce used color gels to change the room's lighting to different colors for the five sessions—red light for one session, blue light for another, and so forth. The study tested the effect of blue, green, yellow, and red wavelengths, as well as a pure white.

While blue light was very calming to the Alzheimer's patients, LaGarce found that white light allowed them to be more attentive, alert, and relaxed and to function better. But when the ambient light was yellow or red, the patients' agitation grew markedly worse and their functioning declined.

Sharon Smaga, a professor of family medicine at SIU's School of Medicine, served as a medical consultant for the study. Physiologist Luciano Debeljuk, a professor of health care professions, tested subjects' blood before, during, and after the lighting intervention to measure the levels of certain chemical substances.

"There are certain neurotransmitters and hormones, such as melatonin, that we know are susceptible to light-induced changes and influence behavior," says LaGarce. "We want to see how our behavioral observations correspond with something we can measure in a test tube."

Levels of some substances did change depending on the lighting. But the pilot study's medical goal was to work out the methodology for blood assays for a larger, long-term wavelength study that LaGarce, Debeljuk, and Smaga hope to do.

For this project LaGarce plans to use a computer-controlled bank of LED lights that will allow her to easily produce any color of light. "With the software, you can pull up more blue, or more red, or whatever you want," she explains.

LaGarce also plans to include a second group of subjects in this long-term project: children who have attention deficit/hyperactivity disorder (ADHD). A colleague familiar with her work told her of parents' anecdotes suggesting that ADHD behavior also might be influenced by light. So undergraduate researcher Kandace Fisher, a student in interior design who assisted with the pilot study, tabulated the effects of the different lighting schemes on a boy with ADHD. The boy was significantly calmer and more "on task" with pure white and yellow light than with red or green light, Fisher found.

"There was a huge difference," LaGarce says—enough for her to plan to expand her research to this group as well.

Since LaGarce began her Alzheimer's research several years ago, a number of other researchers have begun investigating the Alzheimer's/light connection. But most are looking at light levels, not light wavelength, which LaGarce believes is the "real secret" to alleviating sundown syndrome.

"If we can define which wavelengths are having the greatest effect," she says, "we can 'prescribe' lighting to help these patients."

Small SIUC grants have funded Melinda LaGarce's research to date. Several companies donated products to furnish and equip the patient rooms, including the special lighting and window glass. Kandace Fisher, who now is in graduate school at the University of Wisconsin at Madison, had financial support from the federal Ronald E. McNair Postbaccalaureate Achievement Program through the SIUC McNair Scholars Program.

For more information: Melinda LaGarce, 618-453-3734 or mlagarce@siu.edu.

—Marilyn Davis

A new interdisciplinary center at SIUC will draw on the talents of faculty and students across campus to develop and commercialize new products. The Center for Innovation, housed in the College of Business and Administration, will focus on research in innovation, education in entrepreneurship and technology commercialization, and regional economic development. The center will initially draw on SIUC faculty and student expertise in business, engineering, science, and law.

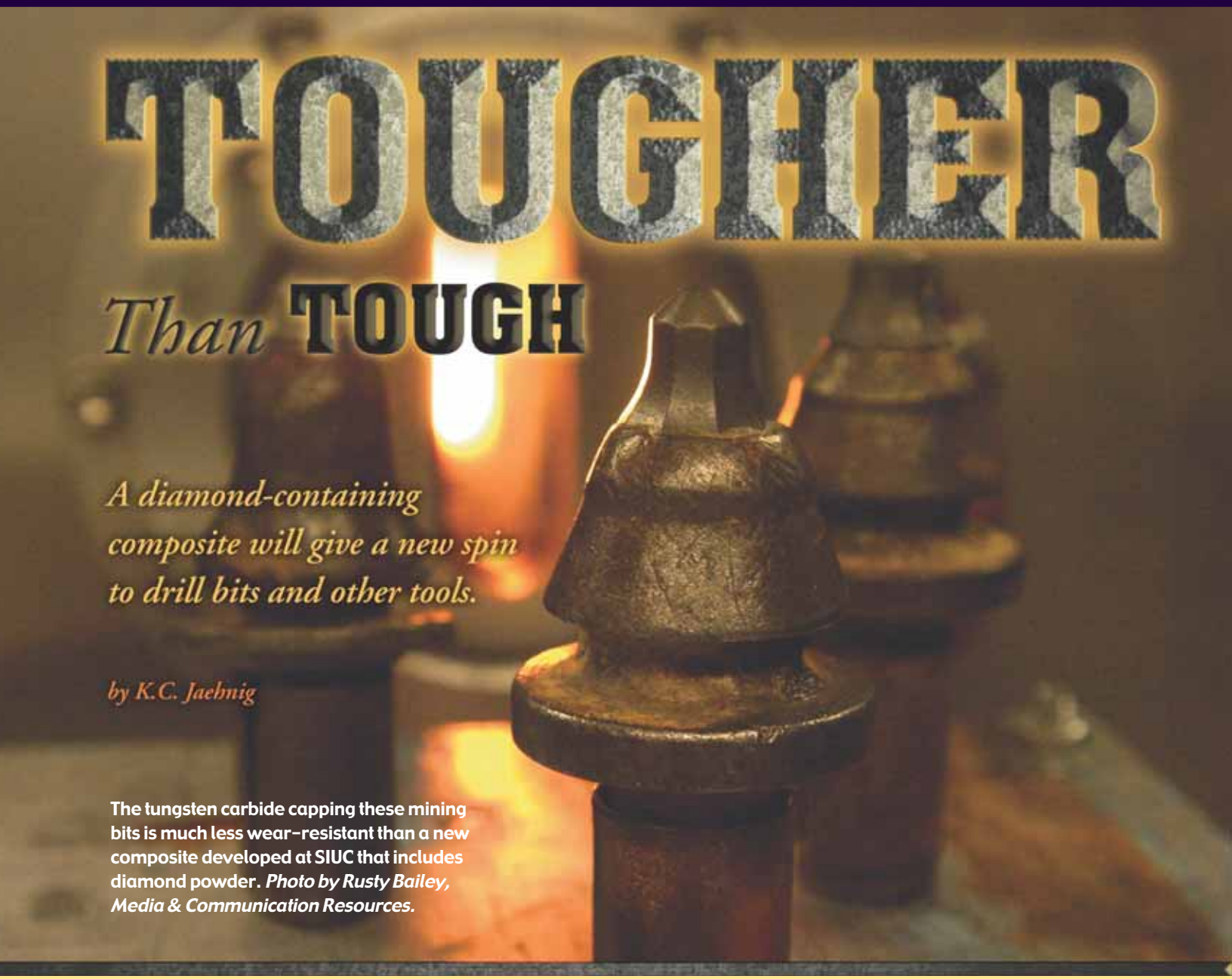
A second new center, the Center for Ecology, will involve faculty and students in the Colleges of Science, Agriculture, and Liberal Arts. The center will facilitate interdisciplinary, collaborative research in ecological systems and will foster information exchange between plant biologists, zoologists, agriculture and forestry experts, geographers, and microbiologists at the University.

Also up and running is the School of Law's Center for Health Law and Policy. This new center will address such issues as health care regulation, patient safety and medical liability, bioethics, public health, mental health, and food and drug law. It will focus on research and education, including collaborative interdisciplinary programs with the School of Medicine and the Paul Simon Public Policy Institute. The center complements the School of Law's longstanding health law program.

TOUGHER *Than* TOUGH

A diamond-containing composite will give a new spin to drill bits and other tools.

by K.C. Jaehnig



The tungsten carbide capping these mining bits is much less wear-resistant than a new composite developed at SIUC that includes diamond powder. ***Photo by Rusty Bailey, Media & Communication Resources.***

A new material so sharp and tough it can cut through cast iron and granite without wearing out could make coal mining safer, cheaper, and more productive.

Developed by SIUC materials scientists Dale Wittmer and Peter Filip, the composite consists of a mixture of nickel, aluminum, metal carbide, and industrial diamond powders processed at temperatures over 1,400°C. Engineers at the Robert Bosch Tool Co., a manufacturing plant in Louisville, Ky., found this composite to be 800 times more wear-resistant than the company's toughest carbide now used commercially in making mining tools, drill bits, ceramic tile routers, and other such items.

"It's a material unlike any that have been used in the manufacture of cutting tools," says Wittmer, a professor of mechanical engineering.

"It could be used in mining coal, machining metal, drilling for oil, cutting rock, masonry, or ceramic tile. It has numerous applications, but because we are funded by the Illinois Clean Coal Institute, we're focusing on mining. With bits made from our material, maybe coal companies could mine seams they'd shied away from before because it would have been too hard on their equipment."

Most drill bits used in mining coal consist of tungsten carbide and cobalt. They can wear out in as little as 20 minutes, depending on the type of mining being done, the coal's make-up, and the presence of rock. When worn, these bits can fall out of the drill.

"If a tool lasts longer, a miner can continue mining without interruptions, which saves

money, but there's also a safety issue," Wittmer says. "If the drill is going at 6,000 rpm and the tip comes flying off at that velocity, it could create a lot of damage."

Traditional bits also create more dust than a sharper diamond tip would make. "It gets into everything—lungs, equipment—which relates to both safety and productivity," Wittmer says.

Because industrial diamonds, like their engagement ring counterparts, rank among the world's hardest substances, manufacturers have for years mixed them with soft metals, epoxies, and organic resins to make polishing and grinding wheels. They have not, however, been able to find a way to incorporate that hardness in super-tough cutting tools.

They can't use the same materials used for grinding wheels, because with heavy pressure or high temperatures—factors involved in both making and using a cutting tool—the diamonds readily pop out, and the materials themselves lose their shape. In addition, at high temperatures, the diamonds in the materials either vaporize or turn into graphite, another form of carbon.

"When they change their crystal structure, they're no longer hard—and once they turn to graphite, that's irreversible," Wittmer says.

Wittmer and Filip, who directs SIUC's Center for Advanced Friction Studies, got into the game about two years ago. That's when Benton, Ill., resident Ken Burkett showed up at the University with a small jar containing roughly a teaspoon of industrial diamonds and the conviction that the two scientists could somehow make a coal-mining tool that contained diamonds.

After Burkett left, Wittmer and Filip tossed some ideas around, but it wasn't until the next morning, when Wittmer was in the shower, that inspiration hit.

Wittmer had a lot of previous experience working with nickel aluminide, a metal compound formed by the reaction of nickel and aluminum. He knew that when the compound heats, it expands a great deal, whereas diamonds do not. He thought the heated compound might expand enough to wrap around the diamonds—then, as it cooled, might shrink enough to clamp them into place so they wouldn't pop out. This "shrink-wrap" might also protect the diamonds from the heat's effects.

"The first composites we did were made by 'shake and bake,'" he says. "I put [the ingredients] in a plastic zippered bag, shook them up to mix them, and then pressed them into four pellets in a steel die we have. Then I put them in ceramic boxes and sent them through my furnace (a unique, continuous-belt furnace capable of reaching temperatures as high as 2,400°C).

"I was as amazed as anybody that the diamonds didn't disappear or convert to graphite—typically a scientist doesn't expect something to work the first time it's tried. But we dared to be bold, to try something we thought might not work. That's American ingenuity!"

At this point, the Illinois Clean Coal Institute got into the picture. Funding from the Illinois Department of Commerce and Economic Opportunity via the institute paid for the production of 53 different composite formulations made with differing proportions of elements and diamond sizes, allowing Wittmer and Filip to search for the combination that would produce the densest—and therefore hardest—material. It also paid for wear-testing of the best formulations at SIUC.

The two best composites easily cut through cast iron and granite with hardly a sign of wear. In fact, when testers cranked up the power in the granite test, the granite exploded, while the composites, though red-hot, remained intact. Mounted face-down under 50 pounds of pressure for 30 hours on a diamond polishing wheel running at 400 rpm, the new composites wore out the disk.

"That's how we found out how tough our material really was," Wittmer says. "These wheels typically last for months in a machine shop but only lasted for a few hours in contact with our diamond composite."

In Louisville, where Bosch company officials agreed to run wear tests of their own, engineers used a diamond-bladed saw to try to cut through both the diamond composites and the firm's toughest grade of tungsten carbide. It took a little over a minute to slice through the tungsten carbide, but even after 20 minutes, they failed to cut through the diamond composites—though they wore out the saw blades trying.

"Tungsten carbide tools have been the standard for over 50 years in the mining industry because nothing else has been able to improve on the abrasion resistance and performance, but those engineers said our materials may be the next step in the evolution of better and longer-lasting materials," Wittmer notes.

SIUC has filed a provisional patent application on the new composite materials. Meanwhile, Wittmer and Filip are still tinkering with formulations of the original ingredients—they now have 84—searching for the best possible mix. They also are working on bonding other metals to the diamonds and looking at the effects of various temperatures on density. "Our goal is to make a fully dense diamond composite material," Wittmer says.

By this time next year, they hope to have made and tested some sample tools in an actual coal mine.

"We have the hardness and the wear resistance," says Wittmer, "but the main issue will be proving that these tools are tough enough not to fracture under the kinds of stresses present in such an aggressive environment as a coal mine." ✠

For more information, contact Dr. Dale Wittmer, Dept. of Mechanical Engineering and Energy Processes, 618-453-7006 or wittmer@engr.siu.edu, or Dr. Peter Filip, Center for Advanced Friction Studies, 618-453-7932 or filip@siu.edu.

MADE IN BANGLADESH

An expert on work, gender, and the global economy tries to improve women's lives and livelihoods in a desperately poor nation.

by Marilyn Davis

These days, it's hard to find a shirt, skirt, or pair of shorts made in the United States. Check the labels in your dresser or closet; most likely you'll find items assembled in Pakistan, China, Guatemala, Vietnam, or any number of other developing nations.

The hands attaching those labels almost always belong to women, says SIUC sociology professor Kathryn Ward, who studies women's work and lives in the global economy. Her recent research has focused on Bangladesh, one of the world's poorest nations. Bangladesh's economy hinges upon garment manufacturing, which brings in three-quarters of the nation's export earnings. (Tellingly, says Ward, "Wal-Mart is the biggest buyer in Bangladesh.")

The trade agreements that effectively ended the garment industry in Southern Illinois in the 1980s gave Bangladeshi women their first decent work opportunity outside the home. The garment industry there employs about 2 million workers, mostly women who work as seamstresses 10 to 12 hours a day doing piecework. Many earn only the equivalent of $16 per month, however. Few are given the higher-paid jobs usually held by men, such as fabric cutting or managing factories. Some have lost their jobs due to more recent trade policies and have no other good options for making money.

Ward's interest in Bangladesh was sparked when she spent two weeks in 2000 consulting with Dhaka University about its women's studies program.

"I saw all the different types of formal and informal work that women were doing," she says, as well as the hardships these women faced. Dhaka sociology professor Mahmuda Islam also told Ward about the problems with domestic violence in Bangladesh, which is a highly patriarchal society. It's estimated that up to 60 percent of Bangladeshi women have experienced domestic violence, ranging from beatings to rapes and acid burns (a common punishment by husbands or by in-laws angered if they cannot extract continuing dowry payments from the wife or her family).

Women's work and domestic abuse are connected issues, says Ward. In general, the more money Bangladeshi women earn, the more independent they are and the less likely to suffer abuse. (Few women—or men, for that matter—are able to live on their own in Bangladesh. "You need multiple incomes to support a household," says Ward.)

Work and women's status

How are Bangladeshi women's work options affected by global economic restructuring—and how do those options affect their social status and welfare?

Ward began exploring these issues in 2001 with two SIUC graduate students from Bangladesh, Shyamal Das and Fahmida Rahman. The trio interviewed 44 women in Dhaka, the nation's capital, about their work histories and the degree of control they had over their lives. This pilot study was funded by a small SIUC grant.

A fellowship from the American Institute of Bangladesh Studies allowed Ward to continue her field-work while on sabbatical. Then, with a $200,000 grant from the National Science Foundation, she launched a much larger project in 2003 to see how global restructuring was affecting the work choices of women in Dhaka.

Housed at the Independent University of Bangladesh, the project relied on a team of Bangladeshi field-workers and supervisors to survey some 300 garment workers, sex workers (not surprisingly, they prefer the term to "prostitute"), domestic servants, and housewives. Although some Bangladeshi women have small businesses or work on construction crews, most work in one of these sectors. After two years and

Background: A Dhaka slum. Inset: Most Bangladeshi women with formal jobs do piecework in garment factories. This young woman is learning the more lucrative trade of tailoring. ***Portrait by Syeda Farhana. All photos courtesy Kathy Ward.***

▲ **From left, this page and facing page: Women workers in a Dhaka sweatshop; workers in a garment factory certified by an international corporation to meet certain standards; the Nari Jibon office; Kathy Ward (in red) and Saleha Parveen (with glasses) visit a food shop run by a women entrepreneur; a computer class at Nari Jibon.**

eight rounds of interviews, nearly 90 percent of the women are still participating in the study—an extraordinary follow-up rate.

"No one else has done this kind of longitudinal research in developing countries," Ward says. Other scholars have studied specific work sectors, she explains, but not the overall picture for women over time.

The fieldworkers asked the women about their families, education, and income; their work histories and preferences; how much say-so they had over household finances, child rearing, birth control, and health care; and their exposure to violence in the home or workplace.

The team found that garment workers and some groups of sex workers—those based in hotels or houses rather than in brothels or on the streets—have more control over the circumstances of their lives than other Bangladeshi women do. They usually have more education. They have more income: garment workers make about twice what maids do; sex workers make five or six times what garment workers do. They have better access to health care and education for their children. They are more independent and more mobile, able to go out by themselves in society.

Garment workers (though not sex workers) are less likely to be abused by husbands or in-laws, and they take a more equal part in household decisions. They are, to use a buzzword, more empowered.

In contrast, servants and "floating" sex workers—those who work on the streets—have little to no education, were likely to have been trafficked into their jobs, and are at high risk of violence.

To survive, women tend to move often between the "formal" and "informal" work sectors. Many work in both at the same time, holding a factory job, working as a maid or running a little business, and doing their own household chores. And recent changes in international trade agreements have pushed many female factory workers into self-employment or domestic service. (Some of these findings were published in *Critical Sociology* in 2004.)

A wake-up call for governments

Researchers must take the complexity of women's work into account, Ward says, to understand how globalization is affecting women's lives and Third World economies. Policy makers must take it into account to improve women's lot.

Globalization has both helped and hurt women in Bangladesh and other Third World nations, Ward and University of Massachusetts economist Jean Pyle argued in a 2003 article in the journal *International Sociology*. "Many multinational corporations prefer lower-cost women workers, who they believe are unlikely to resist adverse conditions," Ward and Pyle wrote. Women depend on those wages but often don't earn enough to make ends meet—and don't dare demand better conditions.

"They may be in the formal sector, but they're paid so little they have to work in the informal sector too," Ward said in a 2003 interview. "If you ignore women's labor in these informal sectors and the forces that push them there, then you generate policies that harm not just women but households and families."

Ward has argued that much global economic growth and restructuring has depended on the women who are willing to take low-paying factory work and to do informal-sector work as well. Many nations

whose policies make it possible for multinational corporations to pay low wages rely on those economic contributions by women without promoting women's welfare or rights, she says. In addition, Bangladesh and other developing nations have had to put funds toward debt repayment rather than establishing "safety nets" to help women and their families.

Despite its shortcomings, factory work allowed Bangladeshi women to make inroads into the mainstream of society in a country where women often are secluded in the household. When factories close, women lose more than just income.

And they do close, just as they have in the United States, as a result of trade agreements. For example, the 2000 U.S. Trade Development Act, which gave certain export advantages to African and Caribbean nations, spurred a number of multinationals to move clothing factories from Bangladesh to countries such as Lesotho, in a race to the rock bottom of the wage scale.

Ward was particularly concerned about what would happen in Bangladesh after the World Trade Organization's Agreement on Textiles and Clothing expired at the end of 2004. This pact, in effect since 1995, had given Bangladesh some advantages in the garment trade. When the agreement expired, says Ward, "Bangladesh now had to compete against powerhouses like China."

Some feared the collapse of the garment industry in Bangladesh. That has not happened, but many smaller factories have closed. "Unemployment went from zero to thirty in our sample group," says Ward.

Former factory workers have had to remain unemployed, take jobs as servants, incur debt in order to open tiny businesses, or even resort to sex work. Women still doing garment work often find their paychecks shorted or go for long periods without pay. Where they once changed jobs frequently in a (mostly fruitless) effort to get better wages, most are now too afraid of losing their job to attempt switching factories.

Expanding women's employment

Microcredit—the making of small loans that allow poor women to start their own small businesses, such as tea stalls, tailoring shops, or rickshaw rentals—has been widely touted as a solution to the problem of women's poverty in the Third World, and it has become a big business in Bangladesh. These tiny amounts are all a Bangladeshi woman has access to: although women there have a much lower loan default rate than men do, banks seldom lend to them.

Ward is a critic of NGOs (nongovernmental organizations) that have gone into the microcredit business. "NGOs provide education, training, health care, and so forth," she says. "There are some good people doing good things. But many have gone into microcredit because money can be made there. They have lots of overhead—large staffs and huge buildings built on loan interest from these women."

Interest, combined with surcharges and savings provisions mandated by the NGOs, can eat up a third of the loan amount. Borrowers must start repaying loans almost immediately. And women often hold multiple loans from one NGO, or from several, overburdening themselves with debt.

"Microcredit doesn't seem to bring many women out of poverty," says Ward, whose surveys for the NSF project show that women in Dhaka generally don't want these loans. "The women don't want to be

▲ **From left: Sheila Simon (in tan blazer), Michelle Miller (back), and Bangladeshi lawyers discuss strategies to fight domestic violence; the poster on this truck advertises a reward for the arrest of a man who burned his wife to death; Rifat Akhter talks to a Bangladeshi worker; Saiful Islam reader-tests information about resources for abused women.**

indebted," she says. "What they've been telling us is that they'd rather have a job."

Nor does she see the typical NGO training program as much of a solution for women, especially better-educated women. Most of these programs, she says, teach them to make handicrafts, such as candles or embroidered goods, that don't pay well or have a large market.

"We need to generate other types of employment for women," Ward says. To do just that, she launched a school, funded principally by herself and her mother, Patricia Ward, called Nari Jibon ("women's lives," in Bangla). Saleha Parveen, a Bangladeshi woman, is its coordinator.

The idea for Nari Jibon was born when Ward, in Bangladesh doing fieldwork, was introduced to a group of sex workers who'd gotten together to talk about shared problems. Most wanted to do something else with their lives; many had families to support. But "society doesn't give these women alternatives," Ward says.

Geared initially to helping sex workers find other ways of supporting themselves, the school is now attended by between 50 and 70 women and girls from various walks of life, including garment workers and servants. Those who cannot read and write begin with classes in Bangla (only about a third of Bangladeshi women are literate). Some of these women also take classes in tailoring, which is much more lucrative than doing piecework in a sweatshop. Those literate in Bangla take English classes, then may go on to computer or business classes.

The idea is to enable the women to qualify for some jobs traditionally held by men. Some of the students receive stipends for a combination of study and work, such as office or outreach work. Some have already gone on to get office jobs, work as tailors, or open their own businesses—with solid business plans in place.

"I feel we're having a big impact on their lives," says Ward, who hopes the school will serve as a model for NGOs. "Mothers are bringing their daughters. There are some really dedicated young women with progressive attitudes."

Fighting domestic violence

Another of Ward's research projects has tackled the problem of domestic violence head-on. A grant from the U.S. Agency for International Development through the Association Liaison Office for University Cooperation in Development allowed a U.S./Bangladeshi team to survey men and women about attitudes toward domestic violence and to work on strategies to fight the problem.

Ainon Mizan, a researcher with SIUC's Center for Rural Health and Social Service Development, co-directed the project. Originally from Bangladesh, she says that women's organizations offering domestic violence programs face many obstacles.

"The domestic violence problem is not out in the open, and their services are not well publicized," she says. "They worry that if they were more visible, they'll be inundated with cases they have no resources for. They are competing for the same funding.

"One objective of the project was to compile information about existing services in one brochure that NGOs could use. Another was to create a central web site to start linking Bangladeshi programs with programs in the United States serving South Asian women."

The web site is up (www.siu.edu/~narijibon), and the brochure has been distributed to advocacy groups, legal organizations, crisis centers, and grassroots activists, who will work to share the

information with women who can't read. The Bangladeshi media "have only recently started talking about domestic violence," says Rifat Akhter, a graduate student in sociology from Bangladesh who worked on the project, "but they never talk about where women can go for help."

Bangladesh currently has no laws against domestic violence, so Ward and Mizan enlisted SIUC law professor Sheila Simon to consult with Bangladeshi attorneys working for such legislation. Sociology professor Michelle Miller visited shelters for abused women. Saiful Islam, another doctoral student in sociology from Bangladesh, interviewed staff at women's organizations to learn about their operations. And Mahmuda Islam (the Dhaka University sociologist mentioned earlier) visited U.S. programs for abused South Asian immigrants to see how they work with Bangladeshi women.

"Gender role attitudes are very much related to domestic violence rates," says Akhter, who presented the team's survey findings at the American Sociological Association's 2005 international conference. Most Bangladeshi men—and women—condone wife beating as "discipline" for wifely "failures" (such as not serving meals on time, or disobeying husbands). Of all groups interviewed, the team found, female garment workers held the most progressive attitudes about domestic violence, although they still held traditional views about gender roles—perhaps because many of them are young and unmarried.

Saiful Islam, whose dissertation is on the anti–domestic violence movement in Bangladesh, discovered that effective partnerships aren't in place to combat the problem, either within Bangladesh or between Bangladeshi and international organizations. That's a real handicap.

"The movement against domestic violence is still in its infancy," he says. "This is such a major issue, one or two organizations alone can't handle it. In many cases victims are suffering needlessly because there aren't enough resources to help."

Another problem, both Islam and Mizan point out, is that available resources are very urban-based. "Almost no domestic violence services exist in rural areas at all," Mizan says.

Akhter's dissertation, funded by an SIUC Dissertation Research Award, will examine how domestic violence rates relate to women's representation in the work force, education levels, and economic indicators in 45 developed and developing nations. When either women or men lose their jobs as a consequence of economic restructuring, domestic violence rates increase, she notes. Violence rates also are high where globalization creates labor inequities—where women work long hours for less pay than men get, or are concentrated into low-paying, less-desirable jobs.

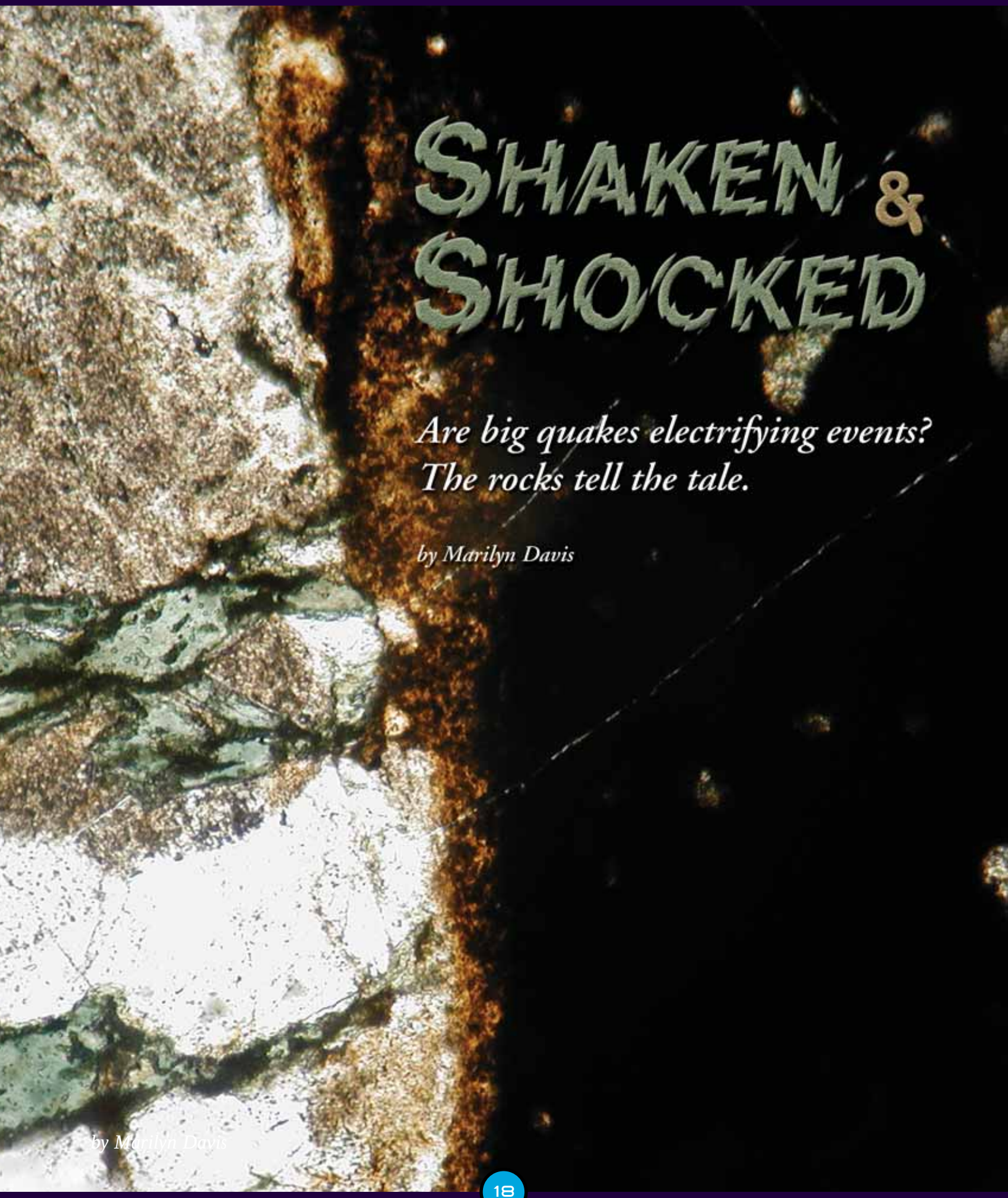
"The global economy empowers some women and disempowers others," she says.

Over the past few years, not just Akhter and Saiful Islam but a number of other students from Bangladesh have come to SIUC to work on master's or doctoral degrees. A grant from the Research Institute for the Study of Man enabled Ward to take several students back to Bangladesh to do fieldwork for their master's and dissertation projects.

Ward herself plans to continue studying women's work histories and developing more job alternatives for disadvantaged women. Despite the summer heat, the periodic flooding, and other hardships, she keeps returning to Bangladesh.

"The people I meet and work with there are incredible human beings," she says.

Dr. Kathryn Ward held a 2004-05 Fulbright Senior Scholar Award to teach and do research in Dhaka. For more information, contact her at the Dept. of Sociology, 618-453-7626 or kbward@siu.edu, or see www.siu.edu/~narijibon. K. C. Jaehnig contributed to this article.



Shaken & Shocked

Are big quakes electrifying events? The rocks tell the tale.

by Marilyn Davis

by Marilyn Davis

It sounds like a paranormal phenomenon: people reporting an unexplained glow, lasting up to several minutes, near the epicenter of a major earthquake that takes place at night.

Such reports have come for decades from far-flung, seismically active places—from California and Oregon, Turkey, Chile, Japan. The tantalizing anecdotes suggest that big quakes generate brief but intense electrical currents that can create what amounts to a "spark" along a ruptured fault. The phenomenon, associated mainly with quakes over magnitude 6.0, gained some short-lived scientific attention in the 1970s, as well as a name—"earthquake lightning." But most scientists have not taken it very seriously.

Eric Ferré does. If earthquake lightning exists, it may open possibilities for an earthquake early-warning network based not on seismic waves, which travel at about the speed of sound, but on electrical currents, which travel at the speed of light. Such a network, he says, could give near-real-time warning of a quake whose waves are still many minutes away from a big city.

Scientists in the United States, Europe, and Japan have scrutinized electrical data after the fact and have detected minute increases in electrical activity just before or during big quakes. They've suggested various alternative explanations for these findings, such as earthquake-triggered shifts in the water table or failure of power grids. So Ferré, an assistant professor of geology at SIUC, has gone to the rocks for answers.

The best evidence for earthquake lightning, he says, is locked up in dark veins that are often found cutting through rocks in quake-prone areas. The thin, sheet-like veins resemble a glassy black volcanic rock called tachylite—hence the name "pseudotachylites." Ferré calls them the "black boxes" of earthquakes because, he says, they record information crucial to understanding catastrophic seismic events.

The origin of pseudotachylites was a mystery until the early 1970s. "They thought that these had to do with magma from volcanoes," Ferré says, "but then they figured out that they're very often associated with faults and with breccia [crushed rock]. They're formed by frictional melting—the same type of process that is used industrially to weld two surfaces together without solder."

▲ A pseudotachylite vein cuts across a granite boulder.

◀ The dark half of this granite sample, seen here through a microscope, melted during an earthquake and then recrystallized to form a pseudotachylite.

When two blocks of rock on opposite sides of a fault suddenly slip past the sticking point, the friction creates heat that melts the rock along the plane of the fault. The molten rock acts as a lubricant, allowing the two slabs of rock to slip as far as necessary to release built-up stress. Once the rock melts, incidentally, its ability to conduct electricity soars.

As the molten rock rapidly solidifies into a glassy material, iron bonds with oxygen to form magnetite crystals—the same material that records information on your credit card. Over millions of years, other minerals in the glass crystallize, making the veins darker.

Pseudotachylites can be formed in almost any kind of rock, by quakes of about magnitude 4.0 or higher. The presence or absence of these veins can reveal much about a region's earthquake history. But they may have more to say than scientists had imagined.

Pseudotachylites frequently are much more highly magnetized than the surrounding rock, meaning that they were exposed to a strong magnetic field when they formed. This fact suggested to Ferré that reports of earthquake lightning aren't so farfetched: electrical currents generate magnetic fields. He believes that, in their molten phase, pseudotachylites act as conduits—essentially, lightning rods—for electrical currents generated by earthquakes. They are, he says, "very conducting for a very short period of time." And the magnetite preserves the "memory" of this event.

In 2003 the National Science Foundation awarded Ferré a $110,000 grant to test his hypothesis, with an additional $80,000 going to his chief collaborator, John Geissman, a geologist with the University of New Mexico (UNM).

The first order of business was collecting pseudotachylite samples. Ferré and his students, Geissman, and scientists from Japan and France collected samples in the Italian Alps, near Palm Springs, Calif. ("just back of the PGA golf course," Ferré says), and from the Japanese island of Kyushu. They're three of the world's most earthquake-prone regions, and all are heavily populated areas.

Pseudotachylite veins are formed at a fault's point of rupture, often several kilometers below ground. They can extend all the way up to the surface—provided that solid rock extends to the surface, rather than the fault being covered by layers of sediment. To be sure of getting sufficient

▲ **From top: A large pseudotachylite outcropping in the Santa Rosa Mountains near Palm Springs—evidence of a massive ancient earthquake; Navani Mathanasekaran, Aiming Lin, Eric Ferré, and Matthew Zechmeister hunting samples in California; frictional melting experiments to produce artificial pseudotachylites. *Photos courtesy Eric Ferré.***

pseudotachylite samples, the team chose to work with old faults, where uplift and weathering over millions of years has raised an abundance of pseudotachylites up from the depths. In California, for example, they worked not on the San Andreas fault but on a parallel "fossil" fault active 60 million years ago.

Geologically, that's still recent. The continental plates were bumping and grinding in pretty much the same places then as now, so Ferré's results will have implications for these same regions today.

At SIUC, geology master's student Matthew Zechmeister and several undergraduate students prepared samples in various shapes and sizes for advanced measurements of their magnetic properties. Some of the measurements were done on campus, some at UNM, and some at the University of Minnesota's Institute for Rock Magnetism. Ferré recently won additional funding from the NSF for equipment to double the capabilities of SIUC's rock magnetics lab, so more analyses will be done here in the future and students will gain better training.

"We spend a lot of time in the lab trying to make these rocks talk to us," says Ferré. "Anything that happens in an earthquake is potentially recorded in or near the pseudotachylite. The problem is, how do you read this information?

"The information we retrieve is not only due to the seismic slip event. There are things that happen after the earthquake. The rocks have recrystallized after they were molten. They may have been exposed to groundwater, or to weathering at the surface. All of these changes potentially affect the magnetic properties."

The arduous part is separating out the clues. But what's clear, says Ferré, is that the pseudotachylite samples "were exposed to magnetic fields 40 times higher than the earth's magnetic field." Their magnetic properties are similar to those of rocks struck by lightning bolts, he says.

Could pseudotachylites have been formed by atmospheric lightning? No, says Ferré, rocks hit by such bolts don't magnetize in a vein formation. Furthermore, some of the team's samples were collected from quarries, where the rocks had never been exposed to the surface.

Is there any explanation other than a large electric current? No plausible one that Ferré knows of. "There's still room for other hypotheses," he says, "but the fact that [pseudotachylites occur] along the fault plane limits possible explanations."

More evidence is accumulating. Matthew Zechmeister, who graduated in spring 2005 and is now doing doctoral research on mining-induced quakes in South African gold mines, relayed an interesting report to Ferré in June. During a recent magnitude-3.0 quake in one of these very deep mines, an engineer close to the quake's focus described seeing a glow along the fault plane.

Other hints come from far above the earth's surface. In August 2004 the European Space Agency launched Demeter, a satellite designed to see if variations in the atmosphere's electromagnetic field were linked to seismic activity. "The first results, which were reported in December 2004, indicate that the big anomalies observed in the electromagnetic field coincide perfectly with the boundaries of the continental plates," says Ferré.

Pseudotachylites can reveal a lot about the mechanics of earthquakes. By analyzing the variation in magnetic flux along pseudotachylite veins, it's possible to pinpoint the earthquake focus—the point of rupture. "We can get a better understanding of how big these ruptures are," Ferré says.

Scientists, he says, have historically conceptualized quakes as single ruptures. But sensitive instrumentation has found that in California, for example, often two or three major ruptures happen simultaneously. "With magnetics, we might be able to help understand these processes in fossil faults," Ferré says—knowledge to improve earthquake modeling and prediction.

Much more needs to be done to understand earthquake lightning itself. "Timing is the most

unknown issue," says Ferré. "For example, it's important to find out how long the current might last, which may tell us about the source."

There are two competing explanations for earthquake lightning: triboelectricity (basically static electricity), in which friction between two surfaces shears off electrons, and piezoelectricity, in which electrons escape their bonds as quartz crystals are skewed under pressure. Ferré and Navani Mathanasekaran, an SIUC master's student in electrical engineering, have done computer simulations of the electrical properties of fault rocks to explore these issues. But Ferré thinks that rock deformation experiments will be needed to get solid answers.

Japanese colleagues Aiming Lin and Toshi Shimamoto have done some work in that direction by making pseudotachylites in the lab. When two rock samples are rotated together at high speed under carefully controlled conditions, the frictional melting at the interface creates a pseudotachylite that bonds the samples when it cools. As part of the NSF project, the SIUC team analyzed some of these experimental pseudotachylites to help them understand the properties of naturally occurring ones.

Ferré is an advocate for the development of an earthquake early-warning system based on electrical currents. Currently, experimental warning systems are based on early-arriving seismic waves called P waves, which precede the more-damaging S waves of quakes. Both types of waves spread out from the fault rupture like ripples on a pond. Both are sluggish compared to electromagnetic waves.

Producing measurable electrical currents may take a quake of at least magnitude 6.0, Ferré thinks—right around the level where earthquakes become seriously damaging. So a warning system based on these currents could give a city valuable extra minutes to prepare for a major quake. Seismic-wave experiments in Mexico and Chile have given warnings of offshore quakes that have ranged from a few minutes up to half an hour; Ferré says electric-current monitoring could double or perhaps even quadruple that.

Because seismometers are fragile and can't be placed directly on faults, a grid of seismometers is required to monitor an entire region. But electrical receivers, which cost far less than seismometers and wouldn't be disabled by quake activity, need be placed only along major active faults.

"The electrical signal has to travel along the fault plane because it has the best electrical conductivity," Ferré says. "Any current, even if it's faint, can be intercepted with one station almost instantaneously."

So what's the hitch? "We haven't invested in electrical warning systems mainly because nobody has believed in it," Ferré says.

True, there are obstacles to be overcome. Big quakes disturb the power grid, which can create ground leaks of electrical current. To have a reliable detection system, says Ferré, "you have to know how to filter out those industrial signals."

A Greek team of engineers has developed an earthquake warning system that is attempting to do just that, he adds, "and they've been laughed at by most of the rest of the world. But we think that now the tide is changing."

Ferré suggests employing a dual-sensor setup, with one of each pair of sensors on the fault and the other some distance away. By measuring the differential between the two, you could separate seismic electrical currents from industrial ground leaks.

That sort of work will involve other specialists. Ferré sees his role as decoding the messages of pseudotachylites so that engineers can apply that knowledge.

"There's a lot of information encapsulated in these rocks," he says, "and it's important to translate it in terms useful for others." ✠

Findings from Dr. Eric Ferré's project have been presented at the Geological Society of America and published in Tectonophysics. For more information, contact him at the Dept. of Geology, 618-453-7368 or eferre@geo.siu.edu, or see his web site at www.science.siu.edu/geology/people/ferre/index.html.

A major earthquake threat to Southern Illinois comes from the New Madrid fault zone, which runs from northeastern Arkansas to the southern tip of Illinois. Three of the largest earthquakes in U.S. history, all estimated to have exceeded magnitude 8.0, occurred along this fault in 1811 and 1812. The biggest was centered near the town of New Madrid, Mo., about 80 miles southwest of Carbondale as the crow flies.

Did those quakes form pseudotachylites? We can't know for sure, says Ferré, because thick layers of sediment still cover the places where the fault ruptured. "But if we drilled down through the fault zone, I am confident that the drill hole would intersect pseudotachylites," he says.

Unfortunately, because the fault is covered by those layers of sediment, it isn't very suitable for the type of early-warning system that Ferré envisions: engineers would have to drill down to the fault in order to place instruments. But faults in other places, such as California, would be good candidates.

Freeloaders

Parasitic plants, which rely on other plants for their own sustenance, are an SIUC botanist's passion.

by Marilyn Davis and Paula Davenport; photos by Dan Nickrent

Dan Nickrent's "garden" boasts some of the most bizarre plants in the world. Like the enigmatic *Rafflesia*, whose enormous red-and-white-freckled flower smells like road kill. And *Hydnora*, which begins flowering underground, eventually producing flowers so powerful they can push up through concrete.

Nickrent, a professor of plant biology, works at the molecular level to unravel the mysteries of plant evolution. He delights in many kinds of flowers, but it's the "weirdest of the weird"—parasitic flowering plants—that stoke his scientific curiosity. He has trekked to Borneo, New Guinea, South Africa, Central America, and other places to gather and photograph these fascinating plants, and his lab contains the world's largest and most diverse collection of parasitic plant tissue and DNA samples.

He also tends the "Parasitic Plant Connection" (www.parasiticplants.siu.edu), a fertile, award-winning web site with more than 1,700 images, representing 224 genera or 82 percent of all parasitic flowering plants—plus links to scientific articles, DNA data, and more. It is now the most comprehensive online collection of its kind, a valuable resource for botanists.

Parasitic flowering plants have a peculiar lifestyle. When their seeds make contact with a suitable host, they germinate and produce a modified root that drills its way into the tissue of the host plant, siphoning out nutrient-rich water. Some parasitic plants, called holoparasites, don't carry out photosynthesis and must load up on sugars from the host as well.

A few of the 4,000 species of these freeloaders are pathogenic, such as witchweed, the main cause of corn crop failure in Africa. But most are relatively innocuous. Take the sandalwood tree, for example. Or Indian paintbrush, common on Midwestern prairies. Or *Rafflesia arnoldii*, which boasts the world's largest flowers: three-foot-wide, waxy-looking reddish blooms that mimic the stench of rotting meat, hug the forest floor, and tip the scales at 25 pounds.

◀ ***Rafflesia pricei*** **flowering in Borneo.**

Sandalwood, Indian paintbrush, and *Rafflesia* are parasites that attach to the roots of host plants. Other parasites, such as dodder and mistletoe, are called stem parasites; they tap aboveground portions of plants. Mistletoe, for example, usually grows in the branches of trees.

Parasitic plants "represent unique evolutionary experiments," says Nickrent, who focuses on understanding their evolutionary history and the molecular mechanisms driving that evolution. Although parasitism has evolved several times among flowering plants, scientists "don't have a good handle" on why most of these species developed parasitism as an evolutionary strategy, he says.

Nickrent was one of the first scientists to begin using gene sequencing to understand the evolutionary relationships, or phylogeny, of parasitic plants. Comparing specific gene sequences across various species allows scientists to tease out how those species are related and which groups are ancestral to other groups. The more differences, the farther back in time the groups shared a common ancestor. The findings are often depicted in graphic form as a sort of "family tree."

Plants have genes in three places in the cell: in the nucleus, in energy-producing structures called mitochondria, and in chlorophyll-producing structures called chloroplasts. Early on, most plant biologists using genetic information to determine evolutionary relationships were focusing on a particular gene found in plants' chloroplasts. But there's a hitch with parasitic plants: some of them, over millions of years, have lost the ability to produce chlorophyll. As a result, they have only a remnant of chloroplast genetic material.

Nickrent, then at the University of Illinois, was among the first scientists to show that genetic material from the nucleus could be used instead. In his case, he was extracting a particular sequence of RNA and seeing how it varied in certain parasitic species. (RNA is DNA's "companion" molecule, various types of which translate DNA's instructions and assemble proteins.)

In collaboration with other scientists, Nickrent and his students proved the validity of this RNA sequence for analyzing evolutionary relationships not just among parasitic flowering plants, but among flowering plants in general. Many plant scientists have since adopted the use of nuclear genes, not just chloroplast genes, for such research.

Nickrent has worked for many years on determining the "family tree" for Santalales, the sandalwood order. This huge group of plants comprises more than 2,200 species, most of them parasitic, including the more than 1,500 species of mistletoes. His lab also has published extensively on holoparasites and how they

▲ ***Hydnora africana*** **flowering in South Africa. This species and** ***Rafflesia*** **(left) are holoparasites, meaning that they lack chlorophyll.**

From top: The mistletoe *Amyema artensis* in New Guinea; the holoparasite *Cynomorium coccinieum* in Spain; *Pilostyles thurberi,* a holoparasite native to the American Southwest, blooming on a host shrub; Dan Nickrent (left) and some of the students who have worked on the parasitic plant research: Romina Vidal-Russell, Josh Der, Katherine Speicher, and Lecretia Akines.

are related to other groups of plants.

"We're fascinated with some of the processes going on in these plants at the genetic level," he says. "They're challenging a lot of 'set' biological ideas."

Nickrent and his students discovered, for example, that some genes mutate at an accelerated rate in these plants—up to three times as fast as in most other plants. The rate of genetic change, and the degree of genetic diversity, in holoparasites are so great that it is devilishly difficult to trace their evolutionary relationships. To check the reliability of their data from nuclear genes, Nickrent's team compared certain gene sequences from the mitochondria as well, since these plants have no chloroplasts. They succeeded in constructing family trees for three holoparasite families, including the one to which *Rafflesia* belongs.

"For 150 years we haven't known where they fit among angiosperms [flowering plants]," Nickrent says. Now botanists do.

Several labs, including Nickrent's, also recently discovered that gene swapping—technically called "horizontal gene transfer"—goes on between *Rafflesia* and its host. "Parasitic plants are getting genes from their hosts, and hosts are getting genes from their parasites," says Nickrent. Given such gene exchanges, scientists need to be especially cautious about the genetic methods they're using to determine the relatedness of organisms, he warns.

Plants' evolutionary history can be related to their physical features and to the fossil record to determine where certain plant groups grew many millions of years ago. Historical biogeography—the study of how plants and animals have been geographically distributed through the ages—began when 19th-century scientists noticed that very similar plants grew in widely separated parts of the Southern Hemisphere. These plant studies helped scientists understand that present-day Africa, India, South America, Australia, and Antarctica were once part of a supercontinent, Gondwanaland, back in the days of the dinosaurs.

In a recent project funded by the National Science Foundation, Nickrent proposed to study whether continental drift had affected the evolutionary history of a large family of Southern Hemisphere mistletoes (Loranthaceae). What his team found was that all the main groups of these mistletoes were already represented on Gondwanaland, rather than developing after the breakup of the supercontinent.

That means their lineages go back farther in time than many scientists had thought.

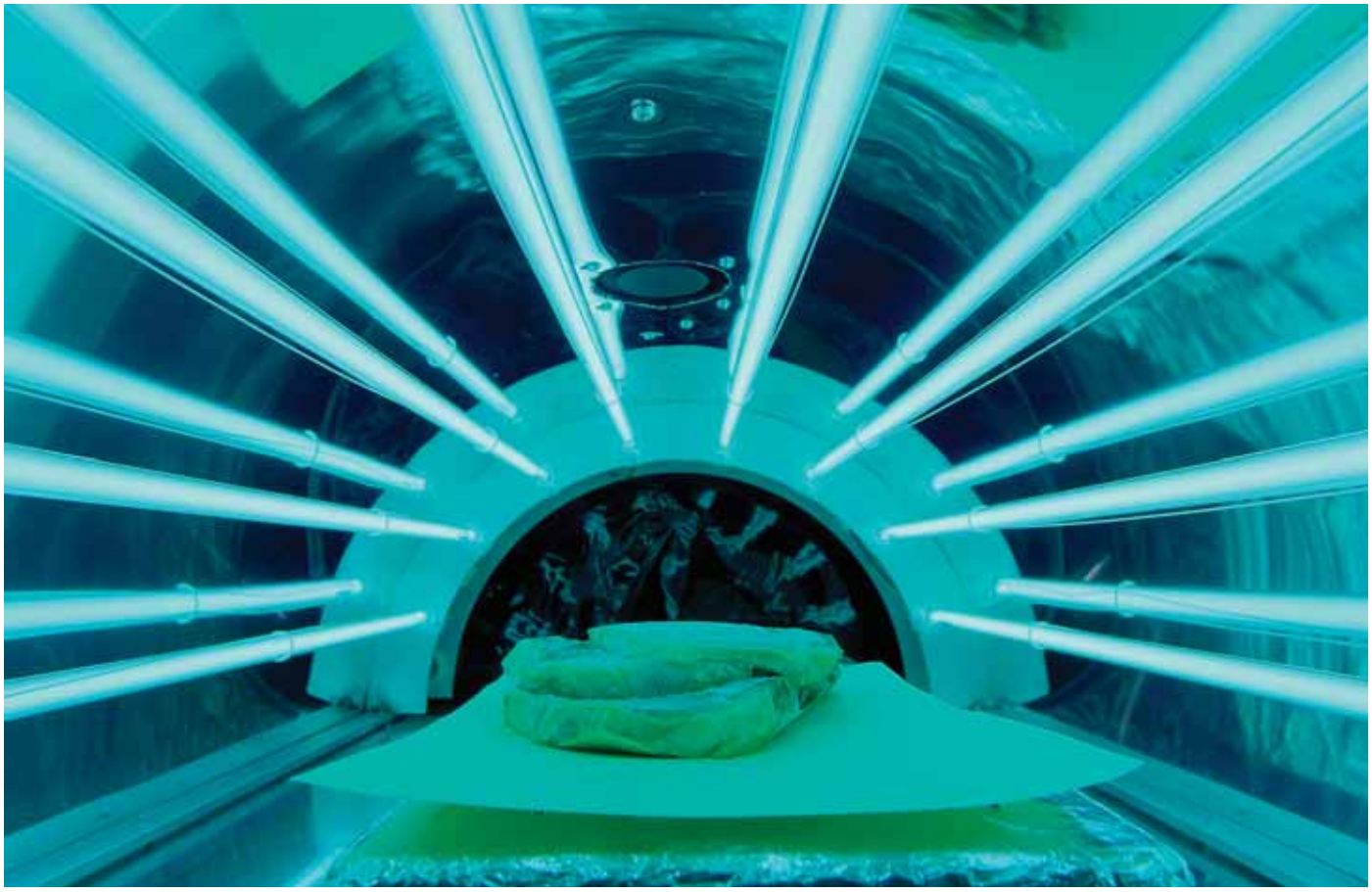
The finding "fits well with some previous hypotheses" based on chromosome data, Nickrent says, adding, "Our estimate of the age of angiosperms keeps going farther back in time—at least to the Jurassic."

It's a strange and wonderful botanic world out there, with much left to discover.

"There is still so much to learn about plants," Nickrent says.

Dr. Daniel Nickrent's work on parasitic plants has been funded in part by the National Science Foundation. For more information, contact him at the Dept. of Plant Biology, 618-453-3223 or nickrent@plant.siu.edu.

Pork Barrel



▲ **A UV sterilization tunnel.** ***Photo by Rusty Bailey, Media & Communication Resources.***

Open a package of pork that you've had for three months and if the smell doesn't kill you, the bad bugs will. But David Shoup, an SIUC professor of agricultural systems, is experimenting with a mix of techniques for turning pork into a longer-lasting, possibly even nonperishable food.

The key is ultraviolet light. "UV sterilization can kill viruses, bacteria, molds, and yeasts—all the things that cause food to spoil," Shoup says.

Most food irradiation at present is done with high-energy wavelengths such as powerful X-rays. UV light is much safer, but takes more time to kill the nasty critters. That extra time has been a real drawback to adoption of the technology.

"The UV tubes got quite hot, so they were actually cooking the food, just like a microwave," Shoup says. With funding from the Illinois Pork Producers Council, he and his graduate students modified a UV tunnel design so that it kills bacteria without retaining enough heat to cook or degrade the pork.

Shoup also uses lasers to trim fat from the pork before it's treated—a cleaner cut leaves fewer rough edges where bacteria like to hang out—and vacuum-packs the treated product to prevent oxidation. His data suggest that these three steps together can extend the refrigerator life of pork from a few days to three or four months.

He's now experimenting with a mix of UV and food preservatives to see if pork can be made truly nonperishable "without salting it to death," he says. Such a product could be useful for military operations overseas or in developing nations where refrigeration is not widespread.

For more information: Dr. David Shoup, Dept. of Plant, Soil, and Agricultural Systems, dshoup@siu.edu or 618-536-2333. Shoup is also working to see if UV sterilization could prevent the need for chemical preservatives in various other food products.

—K. C. Jaehnig

Office of Research Development and Administration
Woody Hall C206 - Mail Code 4709
Southern Illinois University Carbondale
900 S. Normal St.
Carbondale, IL 62901

ADDRESS SERVICE REQUESTED

NON-PROFIT ORG.
U. S. Postage
PAID
Permit No. 15
Carbondale, IL

Southern Illinois University Carbondale

Visit us on the web at: www.siuc.edu

SOUTHERN 150