CenterPiece

Research Scholarship, Collaboration, and Outreach at Northwestern University

SPRING 2011

IN THIS ISSUE

Optimism seems the appropriate emotion for spring, especially after enduring the long Chicago winter. In this issue of *CenterPiece* we address the solutions to the problems of energy and climate change being worked on in labs, offices, classrooms — and even rooftops — across Northwestern's campuses.

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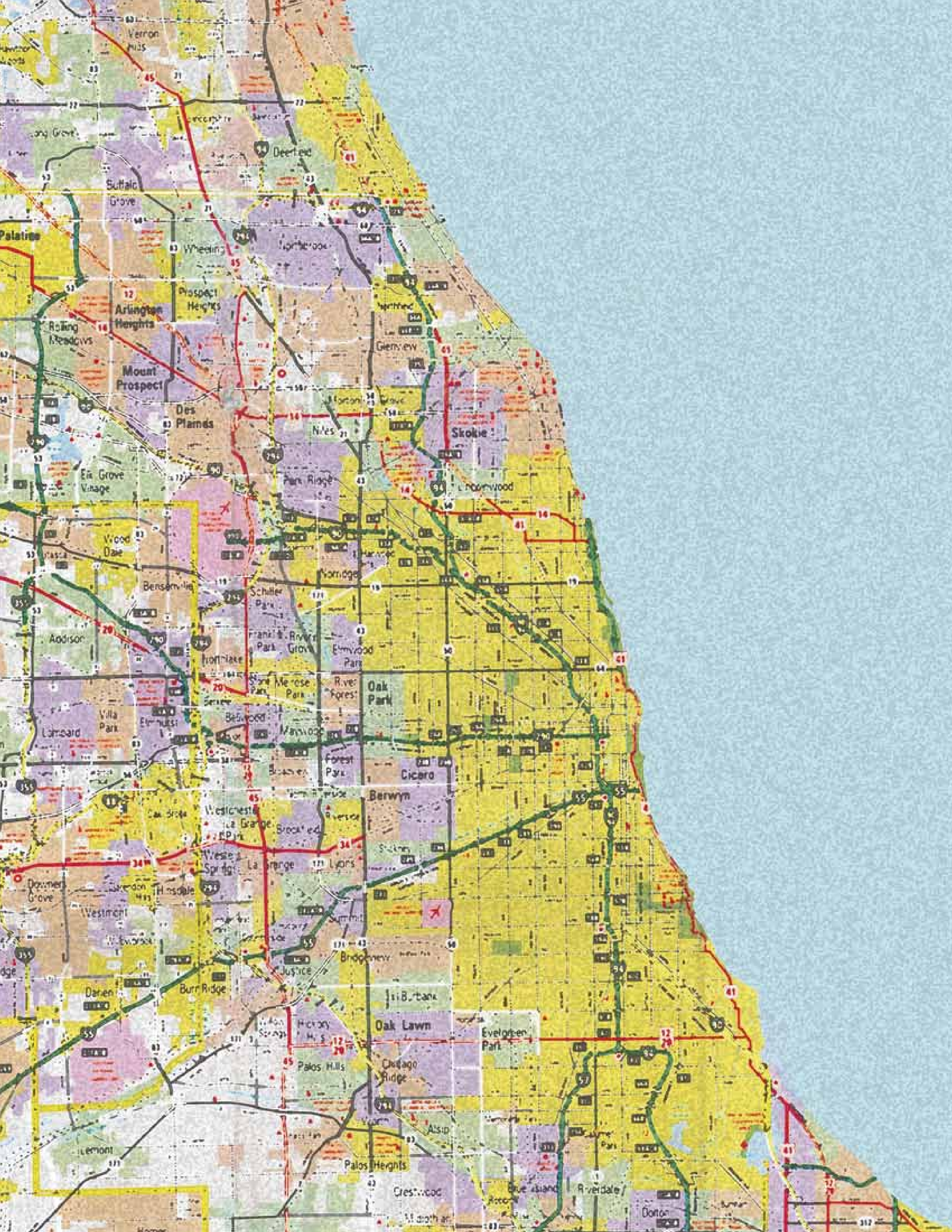
cover – The red stripe across the landscape in Bighorn Basin, Wyoming is known to geologists as "Big Red." It marks the global warming event 56 million years ago that Francesca McInerney studies. See article on p. 10. Photograph ©Thomas Nash 2011 | nashpix.com.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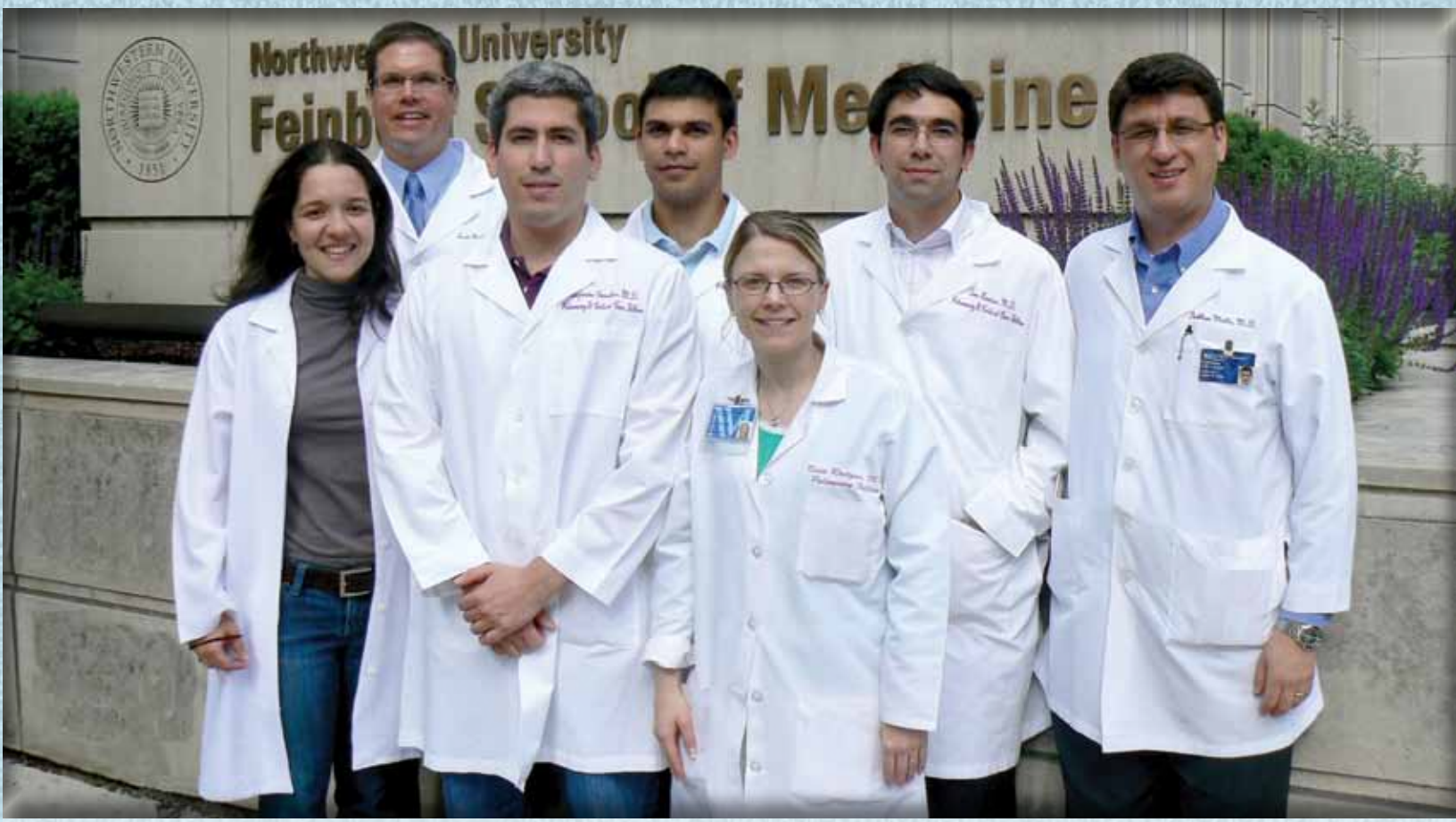
THE AIR WE BREATHE



From left to right: Daniela Urich, Scott Budinger, Sergio Chiarella, Angel Gonzalez, Kathryn Radigan, Recep Nigdelioglu, Gökhan Mutlu. All are members of the Mutlu lab, medicine, pulmonary division at Feinberg School of Medicine except for Dr. Budinger, who is a collaborator with the lab.

The US Environmental Protection Agency documents the threats that air pollution presents to the health of Americans. In fact, their data tell us that Chicagoans face some of the highest risks in the country for cancer, lung disease, and other health problems linked to industrial pollution. Based on 2005 data, Cook County is ranked worst in the nation for dangerous industrial air pollution. Chicago is said to be among the worst cities in the United States.

Under consideration and some contention these days is a new rule proposed by the EPA that would require 31 states (including Illinois) and the District of Columbia to reduce air pollution and attain clean air standards. This rule, known as the Clean Air Transport Rule, would require the reduction of power plant emissions that contribute to ozone and fine-particle pollution in other states.

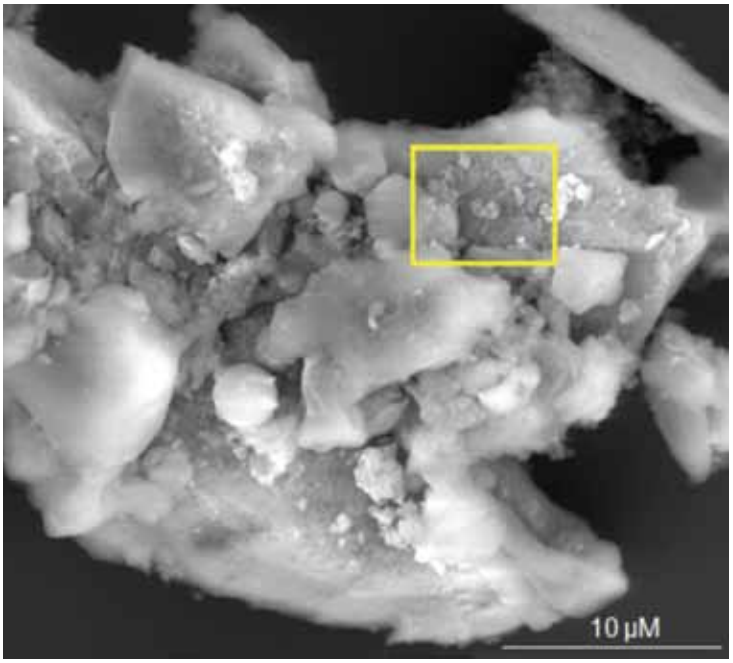
This proposal would require significant reductions in sulfur dioxide and nitrogen oxide emissions that cross state lines. These pollutants react in the atmosphere to form fine particles and ground-level ozone and are transported long distances, making it difficult for other states to achieve national clean air standards.

By 2014 the rule and other state and EPA actions would reduce sulfur dioxide emissions from power plants by 71 percent from 2005 levels; nitrogen oxide emissions would drop by 52 percent.

Fine-particle pollution is in the air we breathe every day, no matter where we live. These small particles — 2.5 micrometers and less in diameter — can get deep into the lungs and cause serious health problems. Exposure to such particles can affect both your lungs and your heart. Research being conducted at Northwestern is helping to explore the mechanisms at work that cause often-fatal diseases.

Gökhan Mutlu, pulmonary and critical care medicine, studies the link between air pollution and the development of heart disease or stroke. He has found a correlation between particulate pollution and blood clots in the lungs known as pulmonary embolisms. He and his collaborators, Scott Budinger, pulmonary and critical care medicine, and David Green, hematology and oncology, have found that lungs inflamed by particulates secrete a substance, interleukin-6, that causes a greater tendency for blood to coagulate or clot. This increases the risk of a fatal heart attack or stroke in people with cardiovascular disease such as coronary artery disease, congestive heart failure, or a history of stroke.

Mutlu is finalizing a manuscript examining how the use of inhaled medications used to treat asthma and chronic obstructive pulmonary disease (COPD) might worsen



Electron microscopy of the particulate matter collected from air in Washington, DC. The yellow box marks an area used for chemical analysis. Image courtesy of Vinayak Dravid, materials science and engineering and director of NU*ANCE*.

air-pollution-induced inflammation and thrombosis. His findings suggest that individuals at risk from pollution-induced tendency to form blood clots may benefit from the use of readily available therapies that can counteract the unwanted effects of these inhaled medications prior to exposure to particles.

Mutlu says his research is not designed to develop new drugs. Instead he is more concerned about the public health impact of his results. "My research should help convince the EPA to lower the acceptable levels of particulate pollution in the air," he says.

Working with Mark Hersam, material science and engineering, Mutlu also has published research into the lung toxicity of single-walled carbon nanotubes. Their results indicate that the potential health risk of these carbon nanotubes depends mostly on the aggregation of the nanomaterials. Purified preparations of single-walled carbon nanotubes show minimal toxicity and appear to be safe to use in commercial and biomedical applications.
—by Joan Naper

Aiming High: Andrew Jacobson (right) and his postdoc Joel Moore sit with the Picarro G1101-i, an instrument they will use to measure the concentration of carbon dioxide in Evanston's atmosphere. The instrument station took measurements from the roof of the Northwestern Main Library (as seen here) as a part of the testing process. Photograph by Amanda Morris.

Measuring Chicago's Urban Metabolism

With cars navigating through bumper-to-bumper traffic on busy weekday commutes and acres of tall apartment buildings surviving the frigid winter months on gas heat, cities are notorious for chugging tons of exhaust and smog into the atmosphere. But as of today, there are few data showing exactly how individual cities contribute to global atmospheric trends. Andrew Jacobson, Earth and planetary sciences, has embarked on a new project to discover the numbers involved in Chicago's "urban metabolism."

Using state-of-the-art instrumentation, Jacobson is setting up a carbon dioxide-measuring station on Northwestern's Evanston campus to measure the levels and sources of CO_2 in the local atmosphere. The long-term goal is to set up stations throughout Chicago to generate an urban atmospheric CO_2 record akin to the Keeling Curve, a scientifically significant graph that illustrates the increase in atmospheric CO_2 concentrations based on measurements from the Mauna Loa Observatory in Hawaii.

"Long-term, high-resolution records of urban atmospheric CO_2 concentrations are sparse," Jacobson says. "We're one of the largest cities in the United States, so Chicago offers a prime opportunity to study urban carbon cycling and its role in global trends. Having this information may help strengthen and expand the city's efforts to green itself."

The instrument, a Picarro G1101-i, is inconspicuous, about the size of a desktop computer. To establish procedures and test the equipment, Jacobson and Joel Moore, a postdoctoral student in Jacobson's lab, took measurements atop of the Main Library and Locy Hall, which houses the Department of Earth and Planetary Sciences. The Picarro uses a vacuum pump to draw air through a manifold and a series of drying tubes that expel water vapor. The instrument then "sips" off this airstream and takes a measurement approximately every eight seconds, using a novel, laser-based technique called wavelength scanned-cavity ring down spectroscopy, or WS-CRDS.

CARBON DIOXIDE'S FINGERPRINT

WS-CRDS is so sensitive that it can quantify differences in the carbon isotope composition of CO_2, which Jacobson says is like revealing CO_2's "DNA or fingerprint." By analyzing the isotopic composition of CO_2 in Evanston's atmosphere, Jacobson can determine where it originated. As the climate crisis heats up, such a technique might help resolve questions in the public domain as to whether global warming is a natural or manmade phenomenon.

"When carbon dioxide is emitted, it has a unique isotopic composition that's diagnostic of its source," he explains. "If you burn methane, then the CO_2 produced has a different isotopic composition than burning coal or gasoline. All of these fossil fuel sources yield CO_2 that is distinct from natural sources, such as soil and plant respiration. Globally, the isotopic composition of CO_2 has begun trending toward the fossil fuel signature."

The challenge for Jacobson is to find the best position for the station in Evanston, so the air samples are representative of the local atmosphere. "One goal is to avoid large obstructions, such as tall buildings and trees, that affect air flow," he says. "Rooftop air handling infrastructure presents another obstacle. That equipment vents CO_2 from inside buildings and may emit CO_2 itself. While this CO_2 contributes to the composition of the local atmosphere, we don't want to measure point sources."

THE RIGHT SPOT

Despite the challenges of finding the ideal spot for the station, initial results have revealed valuable trends — some consistent with common assumptions, others more surprising. For example, Evanston's atmospheric CO_2 concentrations are consistently elevated above the global atmospheric level, with the highest concentrations observed when wind speeds are low. Not surprisingly, CO_2 concentrations increase between the hours of six and eight in the morning, corresponding with the daily rush hour. The isotopic composition is consistent with gasoline combustion, but Jacobson was amazed to observe that the trend is superimposed on a large background consistent with methane burning, perhaps the result of winter home heating. "It will be interesting to see what happens as we transition into summer," he says.

Once a permanent spot is found, Jacobson wants to keep the station working for as long as possible to establish a long-term, high-resolution record. Joel Moore is working with Northwestern's Information Technology office to design and develop a website that will display the instrument's feedback in real time. The site will go live as soon as the final station location is chosen.

GRIDDING THE CITY

Jacobson is already in talks with the mayor's office in Chicago to set up multiple stations around the city. One idea is to place them on top of Chicago public schools to give students the opportunity to work with an ongoing scientific experiment and also have more interaction with the University.

"The city is definitely interested," Jacobson says. "Our task is to demonstrate potential. It's an exciting opportunity because there are few cities doing anything like this."

A more concentrated grid of stations will allow Jacobson to measure various locations simultaneously, resulting in a more accurate measurement of Chicago's carbon footprint. By analyzing data in a way that shows exactly where CO_2 is coming from, he hopes his project will help policymakers make more informed decisions about energy and sustainability. Moreover, other researchers have demonstrated that high local atmospheric CO_2 concentrations cause local temperature increases that lead to higher concentrations of ground-level pollutants and particulates that impact human health.

Jacobson's project is mainly funded by ISEN (the Initiative for Sustainability and Energy at Northwestern). Other sponsors include the David and Lucile Packard Foundation, the Office for Research, Weinberg College of Arts and Sciences, and McCormick School of Engineering and Applied Science.

—by Amanda Morris

Stephen Anzaldi

NEW PLASTIC FACILITY FOR STUDYING CLIMATE CHANGE

When Andrew Jacobson, Earth and planetary sciences, walks into his lab, the only metal present is a part of his eyeglasses. The new clean laboratory, which is located on the third floor of Hogan Hall, is made primarily of plastic. Even the "glass" windows and sink faucets are 100-percent plastic.

With a main goal of better understanding climate change, it's a place where he can analyze radiogenic isotopes without running the risk of contaminating his samples with metallic particles.

"Some of the elements we plan to measure are or occur in metallic materials, so the facility needs to be metal-free," he says. "For example, when analyzing low-level lead isotopes to study urban pollution, you can't measure samples confidently when you're constantly fighting background contamination."

By examining the isotopes of various elements present in soil, rock, water, vegetation, and even extraterrestrial samples, researchers can better understand the co-evolution of the Earth and life through time.

Funded by the National Science Foundation and supported by Northwestern, this metal-free clean lab was designed by a former geochemist in Germany who specializes in building laboratories of this nature. There are only three other labs of this kind in the United States — at Brown, Stanford, and Yale universities.

In addition to the metal-free environment, the lab has a remarkably high-level of cleanliness. Air is pulled from the outside into a duct and filtered four times before entering the lab. The air is measured regularly with a particle counter to ensure there are less than 100 particles per cubic foot (of size 0.5 nanometers or higher). Specialized areas of the laboratory have less than five to ten particles per cubic foot. Jacobson calls it "the Cadillac of clean labs."

Jacobson will primarily focus on the analysis of calcium and strontium isotopes to support climate-change research in locations throughout the world, including New Zealand, northern Alaska, and Greenland. In the laboratory, he separates calcium and strontium from other elements and analyzes their isotopic composition with a thermal ionization mass spectrometer, also contained in the facility.

"There are so many unknowns in science — especially when dealing with nature," he says. "Nature is extraordinarily messy. By working in a clean laboratory, I can measure small isotope abundance variations that may have big implications."

The lab is a part of the new Integrated Labs for Earth and Planetary Sciences (ILEPS), the department's new facility that houses advanced instrumentation for research in biogeochemistry and high-pressure mineral physics. ILEPS will be fully up and running soon.
—by *Amanda Morris*

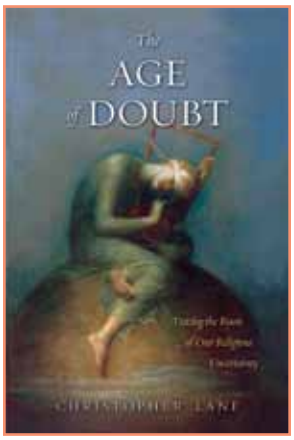
ON THE BOOKSHELF

The Age of Doubt: Tracing the Roots of Our Religious Uncertainty

Yale University Press, 2011

Christopher Lane, English

The Victorian era was the first great "Age of Doubt" and a critical moment in the history of Western ideas. Leading nineteenth-century intellectuals battled the Church and struggled to absorb radical scientific discoveries that upended everything the Bible had taught them about the world. In *The Age of Doubt*, distinguished scholar Christopher Lane tells the fascinating story of a society under strain as virtually all aspects of life changed abruptly.



In deft portraits of scientific, literary, and intellectual icons who challenged the prevailing religious orthodoxy, from Robert Chambers and Anne Brontë to Charles Darwin and Thomas H. Huxley, Lane demonstrates how they and other Victorians succeeded in turning doubt from a religious sin into an ethical necessity.

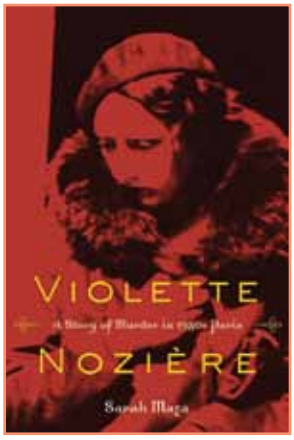
The dramatic adjustment of Victorian society has echoes today as technology, science, and religion grapple with moral issues that seemed unimaginable even a decade ago. Yet the Victorians' crisis of faith generated a far more searching engagement with religious belief than the "new atheism" that has evolved today. More profoundly than any generation before them, the Victorians came to view doubt as inseparable from belief, thought, and debate, as well as a much-needed antidote to fanaticism and unbridled certainty. By contrast, a look at today's extremes — from the biblical literalists behind the Creation Museum to the dogmatic rigidity of Richard Dawkins's atheism — highlights our modern-day inability to embrace doubt.

Violette Nozière: A Story of Murder in 1930s Paris

University of California Press, 2011

Sarah Maza, history

On an August evening in 1933, in a quiet, working-class neighborhood in Paris, eighteen-year-old Violette Nozière gave her mother and father glasses of barbiturate-laced "medication," which she told them had been prescribed by the family doctor; one of her parents died, the other barely survived.

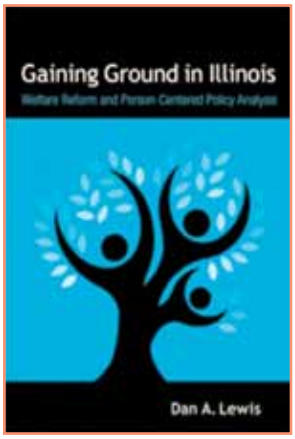


Almost immediately Violette's act of "double parricide" became the most sensational private crime of the French interwar era — discussed and debated so passionately that it was compared to the Dreyfus Affair. Why would the beloved only child of respectable parents do such a thing? To understand the motives behind this crime and the reasons for its extraordinary impact, Sarah Maza delves into the abundant case records, re-creating the daily existence of Parisians whose lives were touched by the affair. This compulsively readable book brilliantly evokes the texture of life in 1930s Paris. It also makes an important argument about French society and culture while proposing new understandings of crime and social class in the years before World War II.

Gaining Ground in Illinois: Welfare Reform and Person-Centered Policy Analysis

Northern Illinois University Press, 2010

Dan A. Lewis, human development and social policy, IPR fellow



In 1997, then state Senator Barack Obama sponsored legislation in the Illinois General Assembly to study the newly passed federal welfare reform and how it would affect the citizens of Illinois. He believed that a sound piece of research assessing how the new law affected the poor of Illinois would give lawmakers a way to come together and improve the law and the lives of the poor. In the highly charged times of the 1990s when ideology often trumped pragmatism, the assumptions and values of policy makers often shaped their work much to the detriment of those affected by the policies.

Dan A. Lewis was selected to direct the study and report back to the legislature. For four years, Lewis and his team of researchers tracked a random group of 1,000 people who were on welfare when the new law went into effect. He reported on their income, their general well being,

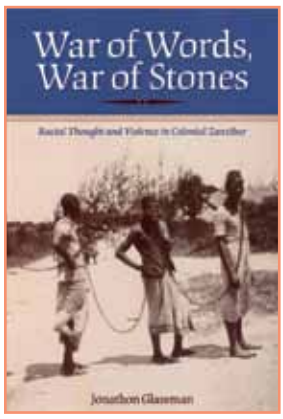
and the lives of their children under the new system. *Gaining Ground in Illinois* illuminates the findings of the study and offers advice for future policy makers. Lewis uses quantitative and qualitative data to draw clear conclusions but also to make the real experiences of the people he studied as vivid as possible. The reports allowed the legislature to debate the issue with the facts at hand.

Lewis seeks a middle ground to give us a picture of how welfare reform affected the poor and to give policy makers some direction in how to improve the lives of the poor moving forward. As the current economic crisis leads to more discussion of public aid and entitlements, Lewis's work offers a starting point for the discussion about the welfare of the people of Illinois.

War of Words, War of Stones: Racial Thought and Violence in Colonial Zanzibar

Indiana University Press, 2011

Jonathon Glassman, history

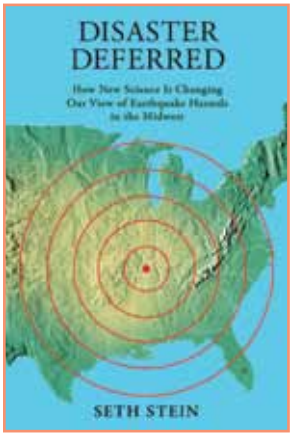


The Swahili coast of Africa is often described as a paragon of transnational culture and racial fluidity. Yet, during a brief period in the 1960s, Zanzibar became deeply divided along racial lines as intellectuals and activists, engaged in bitter debates about their nation's future, ignited a deadly conflict that spread across the island. *War of Words, War of Stones* explores how violently enforced racial boundaries arose from Zanzibar's entangled history. Jonathon Glassman challenges explanations that assume racial thinking in the colonial world reflected only Western ideas. He shows how Africans crafted competing ways of categorizing race from local tradition and engagement with the Atlantic and Indian Ocean worlds.

Disaster Deferred: How New Science Is Changing Our View of Earthquake Hazards in the Midwest

Columbia University Press, 2010

Seth Stein, Earth and planetary sciences



In the winter of 1811-12, a series of large earthquakes in the New Madrid seismic zone — often incorrectly described as the biggest ever to hit the United States — shook the Midwest. Today the federal government ranks the hazard in the Midwest as high as California's and is pressuring communities to undertake expensive preparations for disaster.

Coinciding with the two-hundredth anniversary of the New Madrid earthquakes, *Disaster Deferred* revisits these earthquakes, the legends that have grown around them, and the predictions of doom that have followed in their wake. Seth Stein clearly explains the techniques seismologists use to study Midwestern quakes and estimate their danger. Detailing how limited scientific knowledge, bureaucratic instincts, and the media's love of a good story have exaggerated these hazards, Stein calmly debunks the hype surrounding such predictions and encourages the formulation of more sensible, less costly policy. Powered by insider knowledge and an engaging style, *Disaster Deferred* shows how new geological ideas and data, including those from the Global Positioning System, are painting a very different — and much less frightening — picture of the future.

Comparative Secularisms in a Global Age

Palgrave Macmillan, 2010

Edited by **Elizabeth Shakman Hurd, political science**, and Linell E. Cady, religious studies, Arizona State University, Director of the Center for the Study of Religion and Conflict

Comparative Secularisms in a Global Age explores the history and politics of secularism and the public role of religion in France, India, Turkey, and the United States. It interprets the varieties of secularism as a series of evolving and contested processes of defining and remaking religion, rather than a static solution to the challenges posed by religious and political difference. It features essays from leading scholars from across disciplines, secular and religious traditions, and regional expertise. The volume illustrates a new approach to the hotly contested relation between political authority and religious tradition.

The sun beats down on Francesca McInerney as she takes a break on the project site just south of Old Tensleep Highway. Her team continues to dig a new quarry in the background. Pictured on the right: "Big Red" Paleocene Eocene Thermal Maximum (PETM) soil layer sequence.

THE CLIMATE SECRETS OF ANCIENT PLANTS

Fifty-six million years ago, north central Wyoming was a balmy, green garden of redwoods and sycamore trees, flowering poinsettias and sumac. It bathed in the warmth of a sudden temperature increase. Animals, including cat-sized horses and the ancestors of modern primates, migrated vast distances and settled in the area. Its landscape was undergoing massive changes associated with the world's first abrupt carbon-driven global warming, which increased temperatures by 5 to 8 degrees Celsius (9 to 18 degrees Fahrenheit).

Francesca McInerney, Earth and planetary sciences, has visited this area every summer for the past seven years. She pays particular interest to Wyoming's Bighorn Basin, a geological depression nestled among four mountain ranges that loom over each side. Filled with 20,000 feet of sedimentary rocks, the basin is a time capsule packed with information about Earth's past climates.

"When the mountains were going up, the sediments were filling in at just the right time," McInerney says. "It's probably the best site to look at terrestrial ecosystems during this time in a more complete way. There's an incredible vertebrate fossil record, the only preserved fossilized plant record, and great soils and sedimentary records. It's one of the very few places on Earth where you can get all of those things preserved during this period of global warming."

That time of rapid and extreme warming was a geologically short-lived period in the Cenozoic era known as the Paleocene Eocene Thermal Maximum, or PETM as most scientists call it. It took less than 20,000 years to start and 200,000 years to complete, which is a flash in the pan on the geologic timescale. The warming was caused by a natural carbon release, possibly as the result of gas hydrates at the bottom of the ocean floor, magma intruding into organic-rich rocks, peat- and coal-burning wildfires, or permafrost melting in Antarctica. The cause of the carbon release is much debated, but one thing is certain — the temperature increase led to profound changes for many ecosystems.

History inside plant wax

McInerney examines plants to reconstruct these changes to the ecosystem. When a plant is alive, it produces wax that covers the leaves and retains moisture. The lipids in the wax are still present in the fossilized plants that

The camp at sunset.

McInerney collects from the Bighorn Basin. She extracts these lipids using microwaves, and then separates them into different components to be analyzed with a gas chromatograph isotope ratio mass spectrometer at Northwestern's new stable isotope facility in Hogan Hall. The individual compounds are combusted and analyzed separately.

"The idea is that we can use those chemical or isotopic signatures to reconstruct how terrestrial communities change with climate change, and how the climate changed itself," she says.

Discovering how plants responded to the PETM can tell scientists how ecosystems will respond to the current climate change. The difference is the warming that took place 56 million years ago took thousands of years to begin. The warming the Earth is undergoing now due to human-induced carbon emissions is much faster and will take mere centuries.

A Hard Day's Work

While McInerney is project leader on the grant, her work is part of a larger project in collaboration with Scott Wing, a paleobotanist from the Smithsonian Institution; Mary Kraus, from University of Colorado, who studies sedimentology; and Jon Bloch, of the University of Florida and Florida Natural History Museum, who studies vertebrate paleontology. Each summer, the researchers and their teams gather at the Bighorn Basin and camp on land owned by the Bureau of Land Management. The conditions are hot and dry. The only thing that accompanies their tents is a large water tank.

After waking from the morning's hot sunbeams, each research group heads in a different direction. McInerney's group hikes through the parched terrain to dig trenches and quarries and unearth the secrets of the past. Quarries are for finding plant samples. The trenches are used to look for sediments for isotopic samples. Around noon, the groups head back to the trucks, where lunches are kept in coolers. It's much too hot to keep food outside. Then it's back to digging. At night, the desert air cools. The groups come back together and stay warm around a campfire where they talk about the day over dinner before heading back to their tents for a much-needed rest.

One of McInerney's goals is to determine how precipitation patterns changed during the PETM. She says that people would expect a warmer Earth to cause a more vigorous hydrological cycle with more rain. However, her group's research indicates that the climate first became more arid followed by increased precipitation during the warming event.

The collaborative research also indicates a reshuffling of the entire ecosystem as plants and animals migrated. The animals that migrated to North America during the PETM were here to stay and are now considered modern fauna

(Left) Scott Wing looks on as Mary Kraus examines insect burrows from fossil soils in the west side of the North Butte. (Right) Plant fossils from the PETM quarries.

for North America. Plants actually migrated north and then retreated back to the Gulf Coastal plain.

"Current and future climate change are likely happening at a much faster rate," McInerney says. "Another big difference between past and current change is that there weren't the barriers to migration that human settlement has imposed now. That could become an issue with plants' and animals' ability to adapt to climate change."

The Vast Experiment

The amount of carbon that was released during the PETM is comparable to the amount that is available in the fossil fuel reserve. Although carbon dioxide is being released at a faster rate, it's a similar amount.

"One of my colleagues calls this 'the vast experiment,'" McInerney says. "And we're just trying to reconstruct the manual for the experiment that was run. It's incredibly important because, while we can try to model what's going to happen in the future, unless we have reason to believe it's a realistic scenario, then we're potentially modeling ourselves into a fictional space. We need this empirical information on past climate change to ground-truth our models."

This summer, McInerney will be part of an NSF-funded project that will drill a core through terrestrial rocks of the Bighorn Basin from the Paleocene and Eocene epochs. The core will provide fresh, unweathered rock for geochemical, sedimentological, and palynological analysis.

McInerney contends that reconstructing the geological archive of information can tell scientists how different atmospheric and ice-sheet conditions and ocean circulations influenced the climate and ecosystems.

In addition to her research on ancient plants, McInerney and her students work with the Chicago Botanic Garden to collect modern plants. By understanding the relationship between the environment and the cycling of carbon and hydrogen isotopes in the leaf waxes of modern plants, she can calibrate these isotopic proxies for paleontological samples. She also received funding from ISEN (the Initiative for Sustainability and Energy at Northwestern) to examine the waxes of leaves from the Cretaceous period to reconstruct past CO_2 conditions in the atmosphere during the PETM.

McInerney's research is funded by collaborative research grants from the National Science Foundation Division of Earth Sciences. —*by Amanda Morris*

WHEN ATTITUDE IS EVERYTHING

As the world faces a global climate crisis, evidence suggests that if we want to stabilize carbon dioxide levels for the future, then we should have acted 10 years ago. That begs the question: What are we waiting for? Northwestern's social scientists are using surveys to analyze the attitudes that hold us back and move us forward.

Growing Concern

Yael Wolinsky-Nahmias, environmental policy and culture and political science, thinks a significant shift has been occurring in public attitudes toward environmental issues, sustainability, and climate change. Her research examines trends in public attitudes toward these issues over the past 20 years based on international opinion surveys of 40 to 180 countries. The research project, joint with So Young Kim of Korea Advanced Institute of Science and Technology, shows that levels of public concern have grown over time but variation of concern from nation to nation remains high.

The highest level of concern registered in Brazil where 90 percent of the population is very concerned about climate change. The countries with the lowest levels of concern report that only 30 percent of their populations are highly concerned. Earlier studies suggested that the public in more developed and more democratic countries might show higher concern. After several types of analysis, Wolinsky-Nahmias found that neither development nor democracy offered statistically significant explanation for cross-national variation in public concern.

"It seems like people in less-developed countries are as likely to be concerned about climate change as people in more-developed countries," she says. "And when the question is put more succinctly, you find that people in less-developed countries are more concerned."

Yael Wolinsky-Nahmias

She also found that people in less-developed countries were more willing to pay higher taxes to combat climate change. Among more-developed countries — even those most concerned where citizens want their governments to do more to address the climate crisis — there is a sharp drop in the willingness to pay taxes.

"Taxes are a more politicized issue in developed countries, and people are sensitive toward change," Wolinsky-Nahmias says. "In some less-developed countries, there might be less public debate about taxes, so people have less polarized opinions on that issue."

In either case, the United States tends to be an outlier when compared to similarly developed societies. While there is some concern, the division between the concerned and unconcerned is unique.

"If you look internationally, one of the indicators of whether people are concerned about climate change is how interested they are in politics," Wolinsky-Nahmias

says. "In the United States, the best indicator is actually party identification. If you are a Republican, then you are far less likely to support climate policies than if you are a Democrat. We don't see this type of ideological division elsewhere."

Partisan Polarization

Jamie Druckman, political science and Institute for Policy Research (IPR) faculty fellow, and Fay Lomax Cook, education and social policy and director of IPR, also found party divisions matter when conducting research on Americans' knowledge, attitudes, and policy preferences about traditional energy sources, such as oil and coal, and alternative energy sources like solar, wind, and nuclear.

Funded by ISEN (the Initiative for Sustainability and Energy at Northwestern), Druckman, Cook, and former Northwestern PhD student Toby Bolsen conducted multiple opinion surveys, in which they presented a single energy policy to different groups but changed the policy's sponsor in order to see how that would affect support for the policy. They found that respondents, particularly when reminded about partisan divisions, supported the policy when told it was sponsored by their political party of choice but then rejected the same policy when attributed to another party. "We're currently experiencing the most polarization we've ever seen," Druckman says. "People tend to focus on political party more than on the content of the policy."

Druckman, Cook, and Bolsen began their work three years ago by conducting a search of all questions that were asked in opinion polls since 1974 to examine the extent to which attitudes changed over time. They continued their work on opinions about energy policy in summer 2010 by conducting the first-ever, integrated survey of members of the public, energy scientists, and policymakers. They are analyzing the data now and plan to present their conclusions in the fall.

"Scholars don't know much about the extent to which energy scientists, policymakers, and the public agree," Cook says. "Where there's agreement, policy can build on that agreement."

The team also conducted surveys around the topics of the energy behaviors of individuals and the politicization of

Andrew Campbell

Jamie Druckman

Jim Ziv

Fay Lomax Cook

Courtesy of David Dana

David Dana

science. They are interested in seeing how politicization affects research and the development of new technologies. For example, they administered surveys in which the questions were framed differently to different groups. Sometimes the questions were asked after a discussion of the virtues of science and other times after a discussion that politicized science.

"Even if there is great science, new policies only survive with public support," Druckman says. "It's important to see how people think."

Adaptation vs. Mitigation

David Dana, law, researches how people value the potential benefits of climate change investments. In other words, are they worth it? His first project analyzes climate laws in the United States. Dana says that most assessments for lawmaking focus only on America.

"There is normally an insular view," he says. "Policies typically only address the impact on the United States and not how the rest of the world is affected."

An expert in environmental law, Dana's corresponding project examines public opinions toward climate-change adaptation versus mitigation. Adaptation includes activities like erecting walls to guard against rising sea levels and engineering drought resistant crops. Mitigation is the prevention of further global warming from occurring. For example, switching from fossil fuels to alternative forms of energy to prevent more carbon dioxide from entering the atmosphere.

Dana conducted Internet-based surveys to see how solutions for adaptation affected individual attitudes toward mitigation. He was curious to see how opinions changed in the United States from region to region. Are people in the Midwest as concerned with rising sea levels as those on the coast? Are people in the Southwest more concerned about drought than the rest of the country?

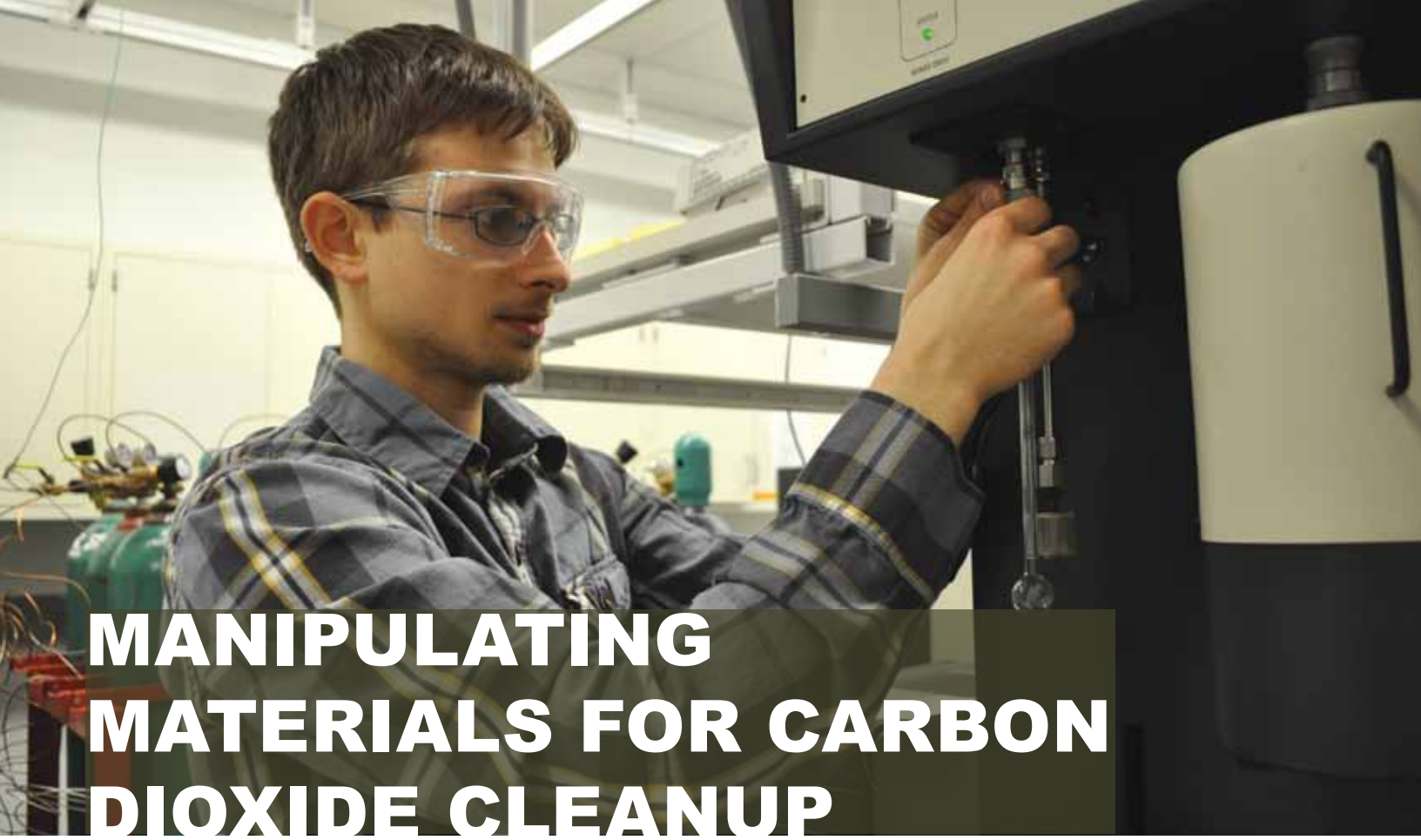
"This information has policy implications," Dana says. "It lets us know what kinds of laws we need on the federal, state, and local levels."

Dana completed his first survey on adaptation versus mitigation in March. His paper, "Learning about Climate Change Adaptation and Its Effects on Support for Climate Change Mitigation," contained the initial results of his work and was presented at the Research Roundtable on Climate Change, Adaptation, and Environmental Law held at the School of Law in April. He plans to revise the survey and conduct it again over the summer.

The Fuller Picture

When Druckman and Cook started their research into energy opinions, they were surprised that the area had not been widely studied. Druckman says that having a social science component to the study of climate change and energy policies is important. "If you don't understand opinion and opinion formation, then you won't have a full view," he says.

With discussion about climate change and energy policy becoming increasingly politicized, this research is particularly critical. The success of energy initiatives ultimately depends on public acceptance. According to Druckman and Cook politicians rarely pass new policies in the face of public opposition, and public policies, even when implemented, seldom succeed if the public disregards them. *—by Amanda Morris*



MANIPULATING MATERIALS FOR CARBON DIOXIDE CLEANUP

In the world of climate change, the work of Northwestern chemistry PhD Charles David Keeling is well known. He's the scientist who first sounded the alarm about the dangers of carbon dioxide and temperature change. The Keeling Curve is still used to describe the progressive atmospheric buildup of carbon dioxide, the main greenhouse gas driving climate change.

In the future it's quite possible the name of another Northwestern graduate may be synonymous with one of the solutions to that buildup of carbon dioxide. That class of 2011 student is Aleksandr Zhukhovitskiy, whose research for his senior honors chemistry thesis, "Synthesis and Characterization of Porous Organic Polymers with Tunable Nucleophilicity and Pore Width for CO_2 Sequestration," has positive implications for the facile and low-energy-cost removal of carbon dioxide from the atmosphere. Zhukhovitskiy will present his research at the Undergraduate Research Symposium in May and plans to submit it for publication in a peer-reviewed journal.

WORKING ON THE NANOSCALE

Zhukhovitskiy is synthesizing porous organic polymers (POPs), materials with nanometer-sized rigid pores that can capture or absorb atmospheric gases. "As the pores of this material are made smaller, their surface-to-volume ratio increases," he says. He is manipulating the size and structure of the pores in the newly created polymers to determine their potential for the capture of toxic gases. "This way you can get a pore small enough to interact more specifically with what you are trying to capture." The geometry and chemical composition of the pore dictate that specific interaction.

Zhukhovitskiy sees potential for his materials to capture the emissions from electricity-generating power plants, the largest man-made contributor to the buildup of greenhouse gases. The current methods, where strong chemical adsorbents are used, are inefficient, requiring a significant amount of additional energy to remove the gases and recycle the adsorbent. A porous organic polymer, like the ones that Zhukhovitskiy is making, would use up fewer resources, he says.

INDEPENDENT RESEARCH

"The project that Alex submitted for the 2011 Undergraduate Research Grant was entirely his own idea," says SonBinh Nguyen, who is Zhukhovitskiy's adviser in chemistry. "He thought up this class of porous organic polymers on his own as a sensing application. I just needed to give him the hint that CO_2 capturing would also be an exciting application for these polymers before he launched himself wholeheartedly into an investigation of their synthesis and application."

Zhukhovitskiy's project is one of the first Academic Year Undergraduate Research Grants (URGs; sponsored by the Office of the Provost) to be funded through the Initiative for Sustainability and Energy at Northwestern (ISEN). According to

Photographs in this article by Amanda Morris except where noted.



Opposite page: Graduating senior Aleksandr Zhukhovitskiy replaces a sample of one of the porous organic polymers in an instrument that measures the pore surface area. This page, left: A sample of the porous organic polymers. Middle: Omar Farha, Zhukhovitskiy's current mentor in chemistry (photo courtesy of Omar Farha). Right: SonBinh Nguyen, Zhukhovitskiy's advisor in chemistry (photo courtesy of Department of Chemistry).

URG coordinator Peter Civetta, an ISEN representative sits on the committee that reviews and adjudicates undergraduate research grant proposals, and ISEN may then choose to fund URGs if they are in line with ISEN's mission.

Zhukhovitskiy, who graduated at the top of his class at Maine East High School in Park Ridge, Illinois, was admitted to Northwestern through the Integrated Science Program (ISP), a highly selective program for students with unusual aptitude and interest in science and mathematics. Only about 25 to 30 students enter ISP each year from a total of approximately 2,000 first-year students. ISP is a highly rigorous program, with a curriculum consisting of 23 required honors and accelerated courses, most of which are open exclusively to ISP students. These courses cover a large amount of material, often more than twice as much as regular courses, and resemble graduate-level courses. Nguyen is the director of ISP.

STRATEGIC AND TACTICAL HELP

After spending the summer of his freshman year doing research in organic electronics, Zhukhovitskiy asked to work in Nguyen's lab so that he could explore another area of materials research. Nguyen agreed and had him collaborate with Emily Pentzer, a graduate student mentor, on a polymer synthesis project.

"The adviser is there to help you with strategy and the mentor with tactics," Zhukhovitskiy says. "The mentor is typically a graduate student or postdoc who guides a new student through the early stages of research. He or she is in the lab almost every day and is responsible to make sure you learn proper techniques, stay on track with your research, work safely, and make good progress."

Zhukhovitskiy's current mentor for this research project is Omar Farha, research assistant professor in chemistry — though he also credits earlier mentors such as Pentzer and graduate student Hakan Usta in the lab of Tobin Marks, chemistry. His research experience with Marks convinced Zhukhovitskiy that he wants to dedicate his career to the synthesis of new organic molecules and materials. "The chemistry department here is awesome," he says. "We have access to tons of resources like Argonne National Laboratory and the huge shared facilities that few others can match."

A BRIGHT FUTURE

Zhukhovitskiy has had an outstanding Northwestern career, winning awards in both the chemistry and mathematics departments in his freshman year. He also is a winner of a Goldwater Scholarship, the Illinois Chemical Foundation's Undergraduate Scholarship Award, as well as the Department of Chemistry's 2009 MathCAD Award for junior-level physical chemistry. In 2010 he was inducted into Phi Beta Kappa as a junior — one of only 20 students so honored. He recently was awarded both a 2011 NSF Graduate Research Fellowship and a 2011 National Defense Science and Engineering Graduate Fellowship, prestigious awards that recognize and support outstanding students who are pursuing research-based graduate degrees in science and engineering.

After triple majoring in chemistry, integrated science, and mathematics, Zhukhovitskiy will graduate with both a BA and MS in chemistry in June after only four years in college. He had entered Northwestern with 20 Advanced Placement credits in several subjects, the only freshman in ISP who achieved junior status in his first year.

Zhukhovitskiy has decided upon the Massachusetts Institute of Technology for graduate studies. His love of both teaching and research points him in the direction of academia. He appreciates the amount of freedom he's found in research, especially the ability to apply his creativity to the design of his own research.

—by Joan Naper

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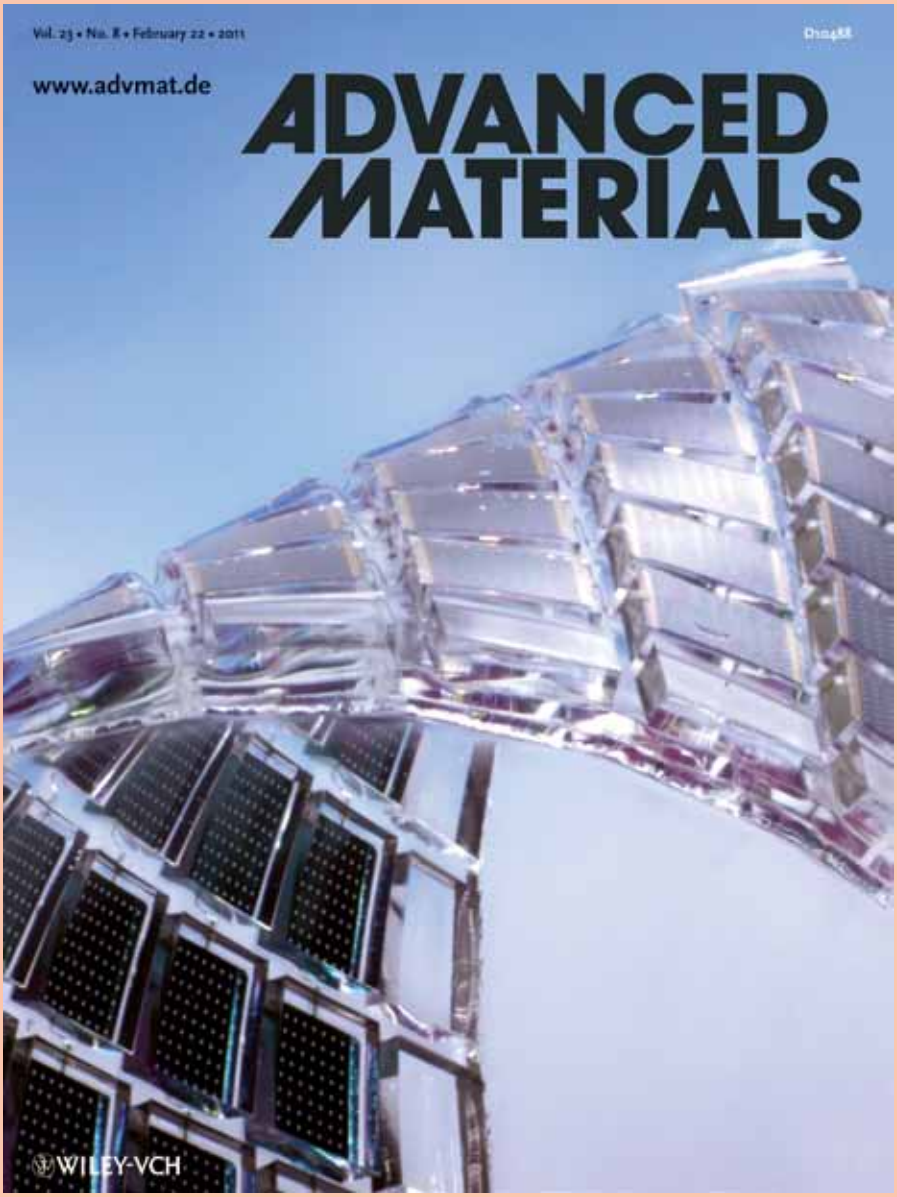

Ever wonder why solar panels are seen only on rooftops? One reason is that there are fewer obstructions to block the sunlight up there. But another, lesser-known reason is that those glimmering panels are so brittle that it's best to keep them out of reach.

Featured on the cover of the February 2011 issue of *Advanced Materials* is a flexible solar cell developed by a research group including Yonggang Huang, civil and environmental engineering and mechanical engineering. His goal is to make cells so flexible that they can be put most anywhere — including clothes.

The most prevalent material for constructing photovoltaics is silicon. It's highly efficient, lasts for years, and is so abundant that it's relatively inexpensive. The one disadvantage is its incredible frailty.

"If you stretch or bend silicon a little — just a little — it will break," Huang says. "We made silicon that is more than 150 percent more stretchable, so you can stretch and twist it."

The secret behind the product is in the size of the silicon panels. Rather than using one sheet of silicon, as seen in a typical solar panel, Huang used very small pieces of silicon, set atop a soft and stretchable material. The silicon pieces are connected with thin, wavy wires that have enough slack to move and stretch.

"You can put it in other places besides a roof," Huang says. "There is even solar fabric, so you can put on a solar coat to go jogging and charge your electronics."

Funded by the Initiative for Sustainability and Energy at Northwestern, Huang is also creating user-defined transparent solar panels that could be put on surfaces like windows and walls. "We would like to use more solar energy," he says. "Part of that is to significantly expand the area that absorbs the solar energy."

With flexible and transparent solar cells, we are well on our way. —*by Amanda Morris*

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