groundwater in such areas, arsenic release can be triggered." He has observed a similar pattern in Vietnam.

Elsewhere in Bangladesh, however, other factors appear to be more important in releasing arsenic than irrigation pumping. Geochemist Alexander van Geen of the Lamont-Doherty Earth Observatory in Palisades, New York, and his colleagues have found high levels of arsenic in water that's more than 40 years old, suggesting that irrigation pumping hasn't been involved. And arsenic contamination is less of a problem in the northwestern part of the country, where much farm water is pumped, adds John MacArthur of UCL. Harvey chalks up the inconsistencies to different sediment chemistry and says that his study area in Munshiganj is typical of southern Bangladesh: "I see no reason why the same process can't happen in other places."

Arsenic levels at the study site begin to pass muster at about 160 meters, which suggests that deeper wells could reduce the arsenic problem. But that's an expensive option in one of the poorest countries in the world. Other near-term strategies include developing filtration techniques and trying to persuade villagers to switch to more distant shallow wells that are still safe.

–ERIK STOKSTAD

ENERGY RESEARCH

Industry Invests Big in Stanford Project

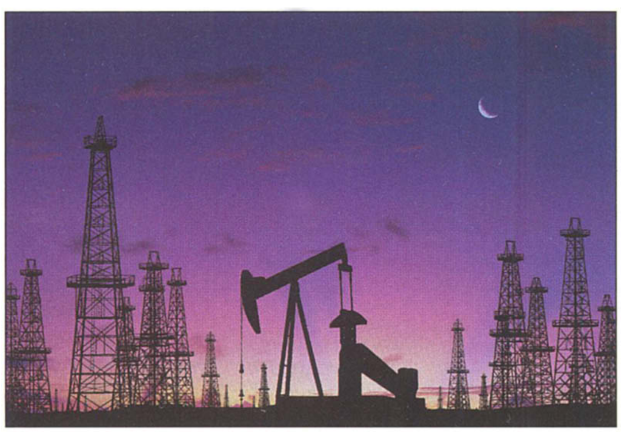
An international consortium of energy companies intends to pump up to $225 million over the next decade into a climate change and energy project led by Stanford University in Palo Alto, California. Researchers say they are stunned by the size and scope of the effort to study ways to reduce global warming, which will examine everything from carbon sequestration to the economics of substituting hydrogen fuel for oil, coal, and natural gas. "This is one of the grand challenges of the century," says Lynn Orr, a petroleum engineer at Stanford, who will lead the project.

Although energy companies have long funded academic research programs, the scale and structure of the effort are unprecedented. Stanford and industry officials say that the data derived from the effort will be publicly available and that an independent advisory board will help chart the project's direction. "Absolutely nothing is off the table; we want all areas addressed," says Frank Sprow, vice president for safety, health, and environment at ExxonMobil, which will provide the single largest chunk of funding. Even skeptics of industry welcome a broad research effort. "This is an acknowledgement that global warming is a problem they can no longer ignore," says Dan Lashof of the Natural Resources Defense Council in Washington, D.C.

ExxonMobil will contribute $100 million to the project, and General Electric and E.ON, an energy provider based in Düsseldorf, Germany, will provide $50 million each. Schlumberger, a global oil-drilling equipment company, will pitch in $25 million. University officials will be in charge of handing out $20 million during the project's first 3 years, roughly half to Stanford researchers and the remainder primarily to other academic scientists; company researchers are not eligible. The university will hold title to any patents, although the funding sponsors will have a short period to negotiate licenses before the discoveries are up for grabs. The first funding likely won't begin flowing until the end of next year.

The project grew out of discussions between Stanford and Schlumberger about geological sequestration, or the injecting of carbon into the ground to prevent its release in the atmosphere. "This could be a big operation, potentially almost the same size as the oil industry today," says Philippe Lacour-Gayet, a physicist and chief scientist at the Schlumber-Doll Research division of Schlumberger. The project's scope grew as other corporations became involved.

Orr says that the scientific and engineering agenda has yet to be finalized but that the focus will be on ways to lower greenhouse emissions in the short run while exploring how to convert the world's energy system to less polluting fuels and technologies. That includes cheaper methods of generating hydrogen, more efficient burning of hydrocarbons, and other alternatives ranging from solar to fusion energy.



CREDIT: BILL ROSS/CORBIS

Clearing the air? An oil-industry consortium hopes Stanford research on ameliorating global warming will also stimulate the next generation of energy production.

Companies were attracted to Stanford because of its strengths in earth sciences and engineering and its tradition of interdisciplinary work, say industry representatives. Outside energy experts add that the university's stature should ease fears that the project will be tilted toward a hydrocarbon-biased approach. "If you wanted to buy a university to do your bidding, you wouldn't pick Stanford," says John Holdren, an environmental science and policy professor at Harvard University. Orr agrees: "We will never give up the right to decide what we work on. We're not at all concerned about undue influence."

ExxonMobil managers say they hope the research lessons can be applied to developing as well as developed countries. But Sprow adds that the project doesn't mean oil has no future. "This is a terrific opportunity to see if oil can be used in a way that's more benign," he says. Whatever turns up, Sprow and his consortium colleagues are betting big bucks that the research will help them cope with changes in their business as well as in the global environment.

–ANDREW LAWLER

NATIONAL SCIENCE FOUNDATION

Congress OK's Budget Doubling, At Last

Some straightforward political horse-trading paved the way for the National Science Foundation (NSF) to achieve one of its most cherished goals last week: a congressional promise to double the agency's budget in 5 years.

Science lobbyists have spent years arguing that the recent ramp-up for the National Institutes of Health should be balanced by a similar boost for NSF. Last month Congress appeared ready to sign off on the idea as part of a reauthorization of NSF's programs, but then Senator Jon Kyl (R–AZ) applied a last-minute hold on the bill as it was about to go before the full Senate (*Science*, 25 October, p. 719). The real objection, however, came from the White House Office of Management and Budget (OMB), which felt that doubling was a crude budgeting tool and clashed with its efforts to hold down domestic spending. The parliamentary maneuver infuriated Senate Democrats, who complained that they had been blind-sided.

But House members who had passed a similar bill in June didn't give up. They spoke with OMB officials, who quickly offered a compromise: a 5-year bill that made the last 2 years contingent on a review by OMB of NSF's progress in meeting a series of management goals that are part of a presidential goodgovernment initiative. That allowed the White House to maintain that it hadn't handed NSF a blank check and to enshrine the concept that bigger budgets were a reward for good management. At the same time, congressional supporters of doubling could say that they had taken a big step toward raising NSF's budget from its current $4.8 billion to $9.8 billion in 2007.

The bill (H.R. 4664), now awaiting the president's signature, doesn't actually give NSF a dime, however. Annual spending is set by appropriators, who have yet to complete action on any domestic spending bill for the 2003 fiscal year that began 1 October. But "we think it's great," says NSF's David Stonner, head of legislative affairs. "It demonstrates strong congressional support for NSF." The bill is loaded with congressional demands, too, including more than a dozen reports on topics ranging from improving math and science education to building big research facilities.

—JEFFREY MERVIS

CELL BIOLOGY

Chaos Reigns in RNA Transcription

The critical job of transforming raw genetic information into proteins seems to call for a well-oiled machine. But one research team, pushing the boundaries of imaging technology and computer modeling, argues that this machine is the picture of inefficiency. Rather than smoothly assembling on a gene, the proteins that form a major transcription tool, called RNA polymerase I, collide without sticking and zoom off if their companions are seconds behind schedule.

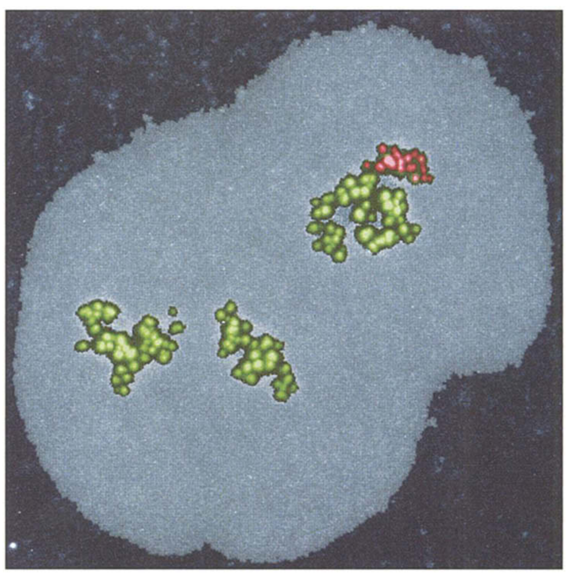
The research, reported on page 1623, is not without critics, who contend that the technology used in the study has not advanced enough to support such a model. But the work reflects an increasingly sophisticated effort to delineate the dance performed by transcription machinery. Two papers analyzing the other main transcription tool, RNA polymerase II, will be published next month. Although the three home in on different aspects, all find similar chaos.

"What they're saying is that things are just flying around, and they happen by accident to come together," says Joseph Gall of the Carnegie Institution of Washington's branch in Baltimore, Maryland, of the *Science* paper. "That's an extreme view ..., [but they're] such good data that you have to sit up and listen."

To gather these data, Tom Misteli and his colleagues at the National Cancer Institute (NCI) in Bethesda, Maryland, first conducted imaging experiments on animal cells. RNA polymerase I consists of at least a dozen different proteins; Misteli's group focused on nine of these that together make up the bulk of the polymerase. Using in vivo microscopy, they tagged one at a time with a fluorescent marker and followed each through the nucleus to the DNA. By watching how long each protein loitered by the gene and then overlaying that with the behavior of the eight others, the researchers could begin tracing polymerase assembly.

But imaging technology reveals only so much. The biologists were curious about a protein's chance of being welcomed into the polymerase if it surfaced in the right place at roughly the right time. For that, they turned to Robert Phair, a computer modeler at BioInformatics Services in Rockville, Maryland. The team plugged imaging data into a model Phair built to simulate the known stages of polymerase assembly. The model suggested that joining the polymerase was quite a challenge: A polymerase protein would wait for only 2 seconds for another to show up and bind to it before darting off.

Furthermore, the team discovered, a polymerase breaks apart once it has transcribed a gene, forcing reassembly to start from scratch. Despite this stunning inefficiency, the group found, a polymerase assembles every 1.5 seconds. Misteli theorizes that the system works because the polymerase proteins are so abundant.



Confused choreography. Tagging components of RNA polymerase I (red) revealed a jumbled transcription process in the nucleus (light blue).

But several researchers question whether imaging and mathematical models can provide such an unambiguous picture of assembly. NCI's Gordon Hager wonders whether the polymerase always comes together the way the model predicts. And other researchers point out that it's tricky with imaging to tell whether a protein is joining the polymerase. Misteli agrees that imaging and modeling a living cell isn't foolproof, but he still considers it superior to previous in vitro work.

Although Hager questions some of the details of protein motion reported by Misteli's team, his own paper, which will appear in December in *EMBO Reports*, supports the general theory that "everything is dynamic." It examines regulatory proteins for RNA polymerase II; although not part of the polymerase, these enzymes help launch transcription. His group reports that these proteins spend just seconds in transcription locales.

Another paper, by Oxford University's Peter Cook and his colleagues, will be published in the December *Journal of Cell Biology*. Cook's group studied a subunit of RNA polymerase II and saw many of the same inefficiencies as Misteli. This growing body of evidence might shift the debate about polymerase assembly and the stability of whole polymerases, says Cook: "A lot of what's driving everything is random chance events." The purpose scientists seek in cellular machinery, he adds, might be nowhere to be found.

—JENNIFER COUZIN

EVOLUTIONARY BIOLOGY

Bacteria Shared Photosynthesis Genes

Historically, sun-loving microbes that convert solar energy to biomass, it seems, were quite promiscuous: They readily swapped DNA. Since then, they have been basking in the light for hundreds of millions of years, adding life-supporting energy and oxygen to the environment and making possible the variety of organisms on Earth today. Early on, these species were remarkably free, as researchers explain on page 1616, in sharing the photosynthesis genes that enable them to draw energy from sunlight—so free that it's hard to use these genes to trace the microbes' ancestry. "There's been massive horizontal gene transfer" among these organisms, says co-author Robert Blankenship, a biochemist at Arizona State University in Tempe.

Until about 5 years ago, researchers considered the transfer of genetic material from one species to another an oddity. Since then, genome studies have shown that some genes have moved around quite a bit. Even so, microbiologists assumed this would not be true for genes involved in translating DNA to RNA, for example, or sunlight to biomass; they couldn't see how genes of such mixed ancestry could possibly coordinate these

CREDIT: MIREK DUNDR AND TOM MISTELI/NATIONAL CANCER INSTITUTE