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*Chevron Technology

Chevron

Deep Seething Sea

Unlocking oil that lies beneath menacing forces of nature

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On the Cover

As the search for oil and gas expands into more challenging environments, Chevron must build facilities that withstand the forces of nature. Beneath the ocean's surface, currents as powerful as hurricanes pound and batter pipelines and platform installations. But Chevron's talented people can face any challenge—whether it's above or below the earth's surface.

Next*
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Welcome *

Our industry and the world's energy consumers face unprecedented demands. Global energy consumption continues to rise. International energy companies have extremely limited access to easily produced resources. Global markets and consumers are struggling to absorb sustained higher energy prices, and societal expectations for our industry are increasing in number and complexity. And there is growing momentum toward carbon management in some form. Looking to the future, we can be certain of one thing: the world will need all the energy that can be produced from every potential source. But producing that energy has never been more challenging.

People everywhere depend on a vast global energy infrastructure that both interconnects and powers the world. Resources and markets are separated by great distances. Hydrocarbon molecules are recovered from ever-more-difficult environments—deeper, more remote and increasingly complex fields and underground reservoirs with more challenging characteristics, such as extreme pressures, extreme temperatures and high concentrations of toxic gasses.

Overcoming these challenges will depend on collaboration, innovative partnerships and technology breakthroughs. Though many consider Chevron to be an oil company, we think of ourselves as an energy company; it may be more accurate to say we are a technology company that produces energy, including oil, gas and renewables. We use a business-driven strategy to manage our technology portfolio and sourcing. This is a powerful competitive advantage for Chevron.

According to the International Energy Agency, "There is no single technology solution that can lead to a sustainable energy future—all energy technologies must contribute."

Within this third issue of *Next**, we offer examples of the diverse solutions that will be critical to meeting the world's future needs.

This issue includes examples of Chevron's innovative approach to technology applied around the world. From a challenging natural gas field with high levels of toxic hydrogen sulfide in China's Sichuan basin to the massive, hurricane-strength underwater waves threatening oil production platforms in the Gulf of Mexico's ultra-deep waters, Chevron solves problems across the energy spectrum.

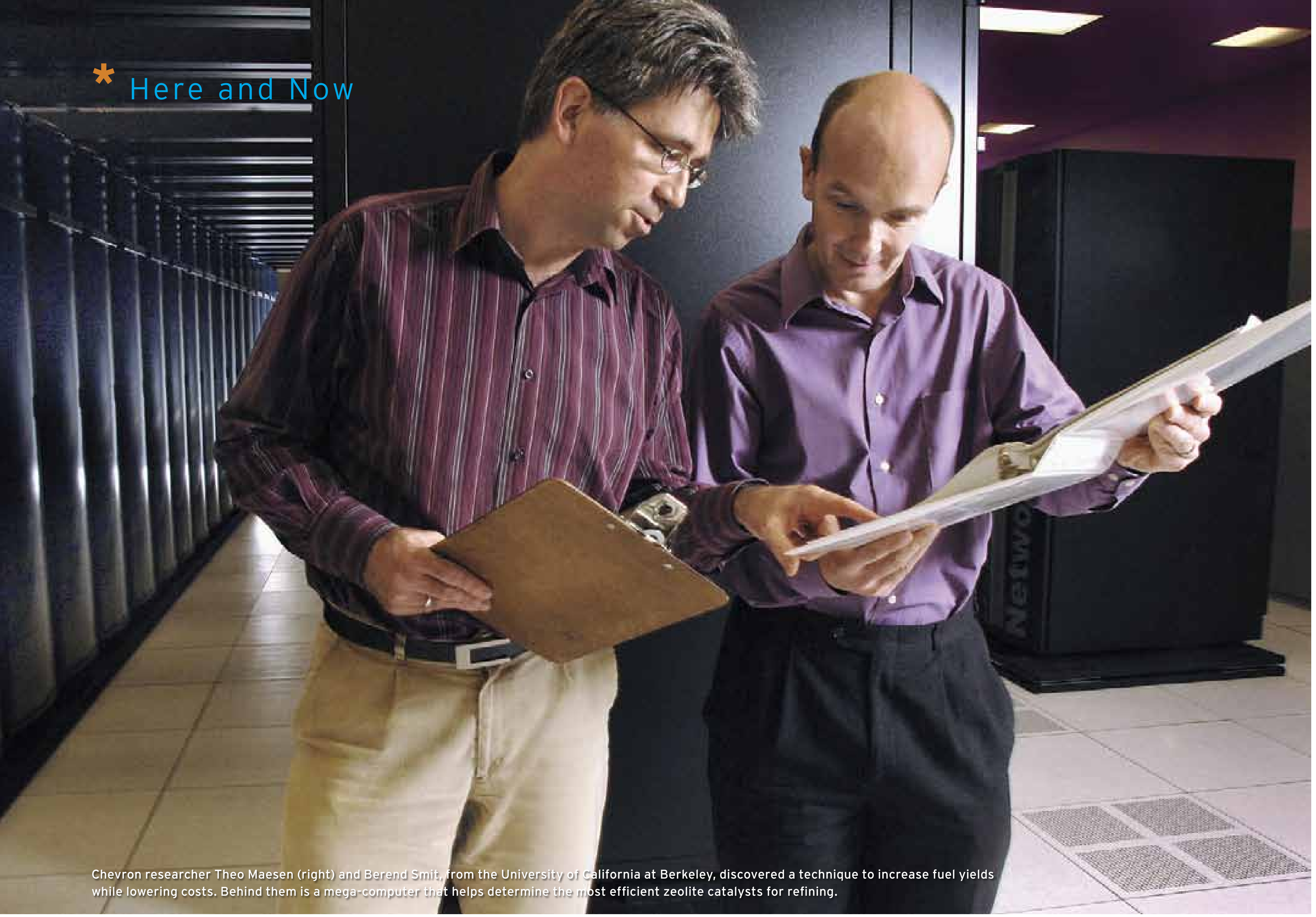
In the ultra-deep waters that cover some of the world's most promising resource areas, a unique collaboration with earth scientists is bringing greater accuracy to our industry-leading exploration program. Paleontologists and geologists are examining microfossils from well cuttings to paint a more accurate picture of the formations into which our explorationists are drilling, increasing our success rate.

In a century-old field in California's Central Valley that has already produced 2 billion barrels of crude oil, three-dimensional reservoir models and sophisticated heat management tools are helping us recover the next billion barrels.

I hope you enjoy learning more about all of the ways the people of Chevron are developing and deploying technology to help produce the world's energy from an increasingly challenging slate of resources.

Sincerely,

John W. McDonald, Chevron Corporation
Vice President and Chief Technology Officer



Chevron researcher Theo Maesen (right) and Berend Smit, from the University of California at Berkeley, discovered a technique to increase fuel yields while lowering costs. Behind them is a mega-computer that helps determine the most efficient zeolite catalysts for refining.

PHOTO: MARILYN HULBERT

Breakthrough in Designing the Perfect Catalyst

Significant study, published in *Nature,* crowns 10 years of scientists' work

As the world clamors for more energy, Chevron researcher Theo Maesen and Berend Smit, his partner from the University of California at Berkeley, have discovered a technique with the promise to increase fuel yields and to lower costs. For the first time, it is possible to use computer simulations to design more efficient catalysts.

Catalysts, key to the refining process, accelerate the chemical reaction required to crack—or break—large, low-value hydrocarbon molecules, such as heavy oil molecules, into smaller, higher-value hydrocarbons, such as gasoline. The more efficient a catalyst is at cracking hydrocarbons, the more product it yields.

The achievement has profound significance. Instead of fine-tuning catalysts by observation or trial and error—which are painstakingly slow—powerful computers can sift through a huge number of catalyst configurations to find the best.

Ironically, Maesen and Smit's breakthrough in catalyst simulation was the byproduct of their initial work: understanding how the internal pore shapes of zeolites—minerals that are commonly used as refining catalysts—determine, or "select," the type of product made. The phenomenon is called "shape selectivity."

"Most of the constituents of many everyday substances, from gasoline to a plastic bottle, have seen the inside of a zeolite catalyst and experienced the effect of shape selectivity," write Maesen and Smit in the science journal *Nature.* "Yet despite the enormous economic importance of shape selectivity, we have only recently gained the insights needed to fully understand the molecular mechanisms that give rise to it."

Here's how zeolite catalysts work: Large hydrocarbons adsorb onto the catalyst, bonding with certain sites. These sites add or subtract hydrogen. This causes large molecules to be susceptible to bond-breaking attacks by zeolites. The relationship between the fate of the large molecules under attack and the details of the zeolite structure has long been shrouded in mystery.

Maesen and Smit's simulations effectively turn a zeolite's three-dimensional structure into a free-energy landscape. Much like pouring water on a landscape to see how the water runs and pools, this thermodynamic energy map shows how hydrocarbons will interact with the particular contours of the zeolite.

While it's still impossible to monitor experimentally how individual molecules move and react inside the pores of a zeolite under operating conditions, Maesen and Smit's achievement maps these processes through simulation. For catalysts currently used in refineries, their simulations perfectly match reality.

The computer-intensive process would have been impossible 20 years ago, requiring "many millions of years of computer processor time," the authors write.

The simulations not only predict which zeolites will work best, they provide mechanistic explanations for the product distributions of zeolites currently used in refineries.

Says Maesen, summarizing the significance of the 10-year study: "Now you not only can explain the past, you also can predict the future."

Research Excellence

A university partnership nets results

As John Dewey, an American philosopher and educator, once said, "Every great advance in science has been issued from a new audacity of imagination." The business of science is to resolve the great challenges of the future—such as supplying energy to meet the rapidly increasing demand, developing production technology for hard-to-reach locations and cultivating industry talent for the future.

Chevron has been building alliances with some of the finest institutions in the world to meet these challenges. One such alliance is with the University of Tulsa in Oklahoma.

Called the TU Center of Research Excellence (TUCoRE), this partnership is cultivating talent by training scientists and engineers to tackle energy challenges. One specialty of the TUCoRE research program is dispersions. Common dispersions are mists, emulsions, foams, sands, and anything added to oil and gas streams that may hinder production.

At TUCoRE, researchers use a customized dispersion characterization rig to study these production interferences. They have an engineering flow loop that enables them to study the separation of oil, gas, water and solids mixed together. The results of these studies benefit Chevron because dispersions interfere with production processes and solids in pipelines sometimes hinder the flow of oil and gas.

"This research has widespread application within the energy industry," explains Melody Meyer, president of Chevron Energy Technology Co.

For example, in the design of pipelines coming from deep seabeds to shallower water, modeling of sand transportation is an essential factor. At the Greater Gorgon Area off the northwest coast of Australia—the site of a Chevron project—a TUCoRE dispersion characterization flow loop with a model for solids transport was used to model sand transportation in order to optimize pipeline design.

One TUCoRE professor, Mengjiao Yu, is a leading expert on water-based mud, which is used to circulate cuttings out of a well during drilling. He and his students built a portable well-site cuttings tester to study the effects of water-based muds on the shale portions of wellbore walls.

"Projects that use oil-based mud have fewer drilling issues, but oil-based mud is much more expensive, and it's difficult to dispose of the oily cuttings. Water-based mud, however, reacts to and weakens shale. So we're studying these wellbores, identifying the variables and running tests through our flow loops to improve shale stability."

Another TUCoRE focus is high-viscosity multiphase flow. "Multiphase" refers to more than one fluid at a time in a production system. For example, oil, gas and water may all be mixed together, and in deepwater production, very low temperatures can change the thickness and flow properties of these fluids. At TUCoRE, researchers are designing computer models on flow properties of high-viscosity and heavy oils. They send oil mixed with other fluids through flow loops and use the acquired data to design computer programs simulating the production system behavior of high-viscosity oils.

"Since heavy oil constitutes approximately 30 percent of Chevron's portfolio," says Ben Bloys, Chevron strategic planning and business manager for drilling and completions, "this TUCoRE research has widespread application for our upstream business, especially for our deepwater and heavy oil production systems. These models will allow us to design less-expensive and more-optimized production systems."

The Chevron-operated tanker *Northwest Swan,* shown, carries liquefied natural gas from Western Australia to markets in Asia-Pacific. The gas was cooled to minus 260 degrees Fahrenheit (–162° C), condensing it into a liquid one six-hundredth of its original gaseous volume.

PHOTO: CHRISTIAN SPROGOE

Predicting the Weather—and More

CELTIC, Chevron's simulation model, handles the variables

Sometimes talking about the weather just isn't good enough. That's what a Chevron project team found when it developed the Chevron Extend LNG Transportation and Inventory Control (CELTIC) event-driven simulation model. This sophisticated model provides operational insights into the complex liquefied natural gas (LNG) business in which decisions must be made in a dynamic and uncertain environment involving liquefaction production and regasification facilities, shipping, and natural gas marketing.

Doing something about the weather entails factoring in how it and other key variables could affect operations at potential LNG receiving facilities. "Converting LNG into natural gas, sending it to the pipeline grid amid an environment of finite LNG storage capacity, and planning for LNG ship arrivals from multiple supply locations are some of the factors to consider when developing a reliable long-term view of a regasification terminal's probable output," says Garry Flanagan, regional manager of LNG shipping.

The model was developed with Chevron's math modeling team, which created algorithms based on a prototype that drew upon many variables, including weather and wave data, the patterns of hurricanes and El Niños, and the operational variables.

CELTIC also factors in potential upstream LNG supply disruptions that might cause a terminal to run out of natural gas. "The bottom line is to determine the mix of firm and variable natural gas volumes that can be marketed from the facility over a 12-month period," says Flanagan.

An effective blending of technology and business, CELTIC supports decision-making needs in a fluid, often changing environment. The tool also demonstrates Chevron's capability in mathematical modeling.

And it yields practical, money-saving results in a number of different applications. Chevron applied the model as it developed plans for a proposed regasification facility—Casotte Landing—in Jackson County, Mississippi, adjacent to the company's Pascagoula Refinery. Main business objectives were to identify the terminal's storage requirements, throughput capacity and send-out reliability and to assist in the development of a natural gas marketing strategy for the facility.

Frank Cassulo, development manager for the proposed terminal before becoming advisor to the president of Chevron Pipe Line Co., says: "This is an excellent example of collaboration across Chevron's business units, with participation from information technology, shipping, natural gas marketing and trading, and gas commercialization. We tailored CELTIC to meet the design parameters, and the data-driven discussions improved decision making in a very uncertain environment."

The model has been subsequently adapted for use with Cheniere Energy Inc.'s Sabine Pass LNG terminal, an onshore LNG regasification facility recently constructed in Cameron Parish, Louisiana, at which Chevron will have access to LNG terminaling services beginning in 2009. Again, weather is a factor, since the terminal is located in a channel where fog frequently causes delays and build-ups of ship traffic.

Adding what Flanagan calls "another layer of complexity" is the fact that Chevron is one of three companies with the right to use the terminal. CELTIC has proven useful for resolving such issues as shared storage and overall cooperation among capacity holders, yielding positive results through expected increases in utilization and efficiency.

* Here and Now

Getting More From What You Have

The science of coaxing out stubborn oil

As Chevron explores for oil in ever-more-remote locations and uses emerging technology to extract crude from deep and challenging fields, the era of easy oil is over and the era of enhanced oil recovery (EOR) has begun.

"EOR will play an increasingly important role," says Jairam Kamath, Chevron's team leader of well performance and recovery mechanisms. "You can't just go out there and get it. So you're going to have to try to get more out of what you already have."

Thermal EOR, also known as steamflooding, has helped Chevron coax more than 2 billion barrels of heavy oil from mature Chevron fields, such as 50-year-old Duri in Indonesia and 109-year-old Kern River in California. At those fields, steam is injected into the reservoir and heats up the sticky oil, making it less viscous so it flows more easily into production wells. While thermal is thus far the most successful form of EOR, Chevron is re-evaluating using chemical and miscible gas EOR technology—techniques that had been tried decades ago then were largely abandoned—to move resources to reserves.

There are basically two kinds of chemical EOR technologies. The first uses a surface active agent, or surfactant. When it is mixed with water and flooded into a reservoir, the surfactant acts as a detergent, reducing surface energy between water and oil, thus causing oil droplets to flow more efficiently through rock formations deep in the reservoir. The second chemical method involves flooding reservoirs with a water/polymer mix. The polymers essentially bunch up and, like a squeegee, push individual oil droplets together into oil "banks" that are swept toward production wells. Sometimes both surfactants and polymers are used together in a chemical flood. But unlike steamflooding, chemical floods must be specifically formulated for each reservoir.

None of this technology comes cheap. "The surfactants are expensive molecules to make, and even if you optimize them, you have to use quite a bit," says Ed deZabala, leader of Chevron's EOR team. "Although it adds to the cost, this is oil you wouldn't get otherwise."

For some reservoirs, a chemical method known as alkaline surfactant polymer is showing even greater promise. In this process, a chemical such as sodium carbonate is added to the surfactant/polymer mix and pumped with water into the reservoir. The alkali interacts with acid in the oil, and during that chemical reaction, extra surfactants are naturally created. "That way you have surfactant that's very effective, but you use quite a bit less," says deZabala.

Initial surfactant trials have been performed at Chevron's vast Minas Field in Indonesia, and an expanded operation is in the planning stages. Polymer flooding may soon be tested at the Captain Field in the U.K. North Sea, which would make it the first U.K. offshore reservoir experience of chemical EOR.

The Captain Field, approximately 68 miles north of Aberdeen, Scotland, in the Inner Moray Firth, was discovered in 1977 and has been producing oil since 1997. Chemical-enhanced oil recovery techniques could significantly increase the heavy oil field's ultimate recovery rate.

PHOTO: CHEVRON EUROPE

"For chemical flooding, we know we can technically make it work—we can displace large amounts of oil—we know that," deZabala says. "The key to making the project work is to make it economical."

One of the biggest challenges with EOR is that it is very difficult to scale. "You might spend half a million dollars developing something in the lab, field testing may cost $20 million to $30 million, and implementing it on a large scale could cost hundreds of millions," says Kamath.

Each of the surfactants is being studied through Chevron's partnership with the University of Texas at Austin's Center for Petroleum and Geosystems Engineering, where enhanced recovery methods have been tested for decades. Chevron provides funding for research on enhanced recovery methods on company assets.

While chemicals hold new promise in recovering hard to reach oil, so too does injection of various miscible gasses, such as natural gas, into reservoirs. While gas flooding is a proven technology, natural gas is usually considered too precious a resource to simply inject back into the earth and is often piped out and sold instead. There are exceptions to this, most notably the reinjection of sour gas brought up during oil production at Kazakhstan's Tengiz Field.

Natural sources of carbon dioxide (CO_2) are rare and mostly spoken for, with the notable exception of the Permian Basin, which straddles a tiny swath of the western United States. Because of its close proximity to the basin, the McElroy Field near Midland, Texas, is targeted for future CO_2 flood optimization.

"When we run out of the natural sources, where do we get CO_2?" deZabala asks. "The idea would be to capture CO_2 from various sources like power plants and other industrial sources and then use that CO_2 for EOR. CO_2 capture and storage—or sequestration—as an EOR source is currently very expensive and is in its infancy and will need technological and policy breakthroughs, which are being actively pursued."

Wonder Chemical Revolutionizes Deep-Sea Drilling

MMA can handle the pressure

A common chemical that displays bizarre behavior when it is heated has become a surprising star in the quest for oil trapped deep undersea, thanks to an extraordinary partnership spearheaded by Chevron engineers.

As oil exploration expanded into ever-deeper waters, Chevron engineers had a vexing and expensive problem: equipment crushed by powerful forces deep underwater. To help tackle this issue, Chevron turned to its research partners at the U.S. Los Alamos National Laboratory, hoping experts outside the oil industry might offer some fresh ideas to solve this stubborn problem.

As engineers drill, they go as far as the physical nature of rocks and pressure will allow them to go; then they stop, run casing, cement the casing in place and drill ahead.

"We drill a telescoping series of holes and cover them up with casing," says Ben Bloys, Chevron strategic planning and business manager for drilling and completions. "However, as we do so, we end up with a fluid-filled gap between the top of the cement and the wellhead at the seabed that seals all the pressure into the well."

Fluid trapped in that gap exerts no pressure when it is about 39 degrees Fahrenheit (4° C), the average temperature of seawater at the drill site. But once the well starts producing, hot oil, gas and water from deep underground—often topping 200 degrees Fahrenheit (93° C)—surge upward, causing the trapped fluid to forcefully expand.

"That expansion creates tremendous pressure, 10,000 to 12,000 pounds per square inch (703 to 844 kg/sq cm) or more," Bloys says. "And those pressures are more than enough to start crushing some of the other hardware in the well."

When energy companies first began drilling deep underwater, engineers did not fully appreciate how harsh an environment their equipment would face. In one of the first deepwater wells drilled by another energy company, the casing and production tubing was completely crushed in less than 24 hours and cost millions to fix. It was a lesson the entire industry learned from.

Although there were a number of different technologies available to combat the pressure, most were expensive, often adding millions of dollars to each well. Having exhausted existing solutions to the deep-sea dilemma, Chevron senior drilling advisor Manny Gonzalez turned to his research contacts at Los Alamos, who brainstormed potential solutions in just a couple of weeks.

One of the most promising was a fluid that would basically shrink in response to temperature instead of expand. Years earlier, one of the Los Alamos scientists had been designing plastic rods that guide laser light using a chemical monomer, a liquid called methyl methacrylate, or MMA, that turns into a solid polymer/plastic when heated. Every time the researcher heated his MMA liquid to make rods, to his frustration, the volume would shrink by 20 percent.

"It was a fact of life that people who make the plastics fight every day. It's a pain in the neck," Gonzalez says. "But it was precisely what we needed to solve our problem."

When heated, MMA transformed from liquid into tiny solid beads, consistently shrinking by 20 percent. The hope was the shrinkage of MMA mixed into spacer fluid in the casing annuli would prevent liquid expansion and subsequent collapse of the casings.

"We took this long-standing problem of plastics shrinkage and turned it to our advantage," Gonzalez says.

Spacer fluid is a complex mixture of water, detergent, weighting materials and other ingredients. By tossing MMA into the mix, the chemistry became far more complex. Now scientists had to add even more chemicals to prevent the polymerization of MMA into its solid, shrinking self until the exact moment the temperature in the casing annulus was just right. Then another chemical that would initiate polymerization (and thus shrinkage) would become active.

Baker Hughes Drilling Fluids provided its expertise to take this from the lab to the real world; and Lucite International, the United States' largest MMA producer, secured an adequate supply of the monomer and provided valuable guidance on safely dealing with the materials in the field.

Testers at Baker Hughes' 500-foot-deep (152-m) test well simulated the heat and pressure experienced in deepwater conditions.

"When we got to the target temperature, the reaction started taking place. The MMA began polymerizing, causing the expected 20 percent shrinkage. The pressure dropped down to zero; and no matter how much longer we aggressively heated that annulus, the pressure stayed at zero," says Bloys.

Now that the team knew the science worked, they had to turn it into a safe, reliable commercial product. The challenge was that MMA, the miracle ingredient that promises to prevent deep-sea damage to drilling equipment, was extremely flammable.

"To ensure safety, the MMA never sees the open air during mixing," Bloys says. "By emulsifying it into the water-based fluid, the flammability is removed."

Over the following two years, an exhaustive series of testing and retesting was carried out, including an active land well test. Having aced these first tests, the MMA team is planning its first actual deep-sea operation at Chevron's St. Malo No. 4 well in the Gulf of Mexico.

"We've been able to get this to the front lines in just three years," Bloys says. "This could become an industry-standard solution to the problem."

INFICOMM will be installed later this year at Chevron operations in Colorado's Piceance Basin, which holds 3 trillion cubic feet of natural gas.

PHOTO: TIM THOMSON

Military Technology Performs "Well" for Chevron

Seeing the unseen

It may be unusual to take a communication technology originally used by the military and make it apply to oil field production. And developing the first prototype in a home garage sounds even more fanciful. Yet that is exactly what happened with the INFICOMM system—one of Chevron's most promising new technologies. Six retired scientists, who were originally part of Chevron's alliance with the U.S. Los Alamos National Laboratory, took this technology and made it into a super-efficient "down hole" (in the well) transmission system.

Project manager Don Coates explains how it works: "Without wires or cables, an electronic box above the ground sends an electromagnetic signal to the bottom of the well. This signal powers up a wireless sensor that reads its environment. The sensor, now transformed by the well's conditions, sends a signal back to the electronic box, which relays the information to a computer where an operator receives real-time communication about conditions in the well."

Last fall, the new transmission system sailed through tests at a Chevron well in Bakersfield, California. It performed reliably at extremely high temperatures. After this test, Manny Gonzalez, senior drilling advisor for Chevron, says, "INFICOMM's real-time communication could revolutionize oil reservoir management. For the first time, we can economically measure critical indicators of the health of all types of wells."

To better understand how INFICOMM helps engineers manage oil reservoirs, compare the traditional management process to a patient with an illness not easily diagnosed. The doctor listens to the patient's description of symptoms, runs a few tests and then begins the process of elimination.

Until now, oil reservoir management has followed a similar process. Large reservoirs include many wells, and engineers aren't completely sure which are the big producers. New information is constantly fed into the system for re-evaluation. With INFICOMM, this troubleshooting process comes to an end. Engineers can put the system into all of the wells on a reservoir and have real-time, exact data about conditions in each one.

Having minute-by-minute information about every well every day is a huge benefit. With INFICOMM, engineers can know the mix of oil, water, sand and other products. Engineers also have discovered an interesting side benefit that has potentially widespread implications: they can listen to the sounds wells make during production. Geologists have not previously studied acoustical data from wells. INFICOMM may reveal significant differences in the sounds that high- or low-producing wells make and open up a whole new avenue of reservoir diagnosis.

As soon as the Bakersfield test was completed, the development team was bombarded with requests to install the technology at operations elsewhere in the United States and in such far-flung locations as Angola, Indonesia, Kazakhstan, Nigeria and Venezuela. In one region, Chevron plans to install INFICOMM in all of its new wells.

Pioneers in Solar Technology

Chevron offers solar solutions to universities, post offices and other customers

Solar power is an old idea whose time has come. Driven by tight supplies of crude oil and natural gas, solar energy is finding a growing market—particularly in meeting the need for a clean, available source of electricity.

Chevron subsidiary Chevron Energy Solutions Co. is demonstrating its ability to pioneer new applications of solar technologies and use technologies with a track record in the marketplace. This effort is helping universities, school districts, post offices and other institutions both use less and pay less for energy while ensuring reliable, high-quality power for critical operations.

Chevron's solar projects to date use photovoltaic cells made from silicon alloys—principally crystalline silicon—to collect and convert sunlight into other forms of energy. Typically, flat-plate solar photovoltaic modules are mounted either on roofs or parking shades. The modules consist of semiconducting materials that convert sunlight directly into electricity. The materials are covered by transparent glass or plastic that protects the conducting cells while allowing the sun's rays to pass through.

In one project, Chevron completed the largest solar power and energy efficiency installation for the U.S. Postal Service at its mail processing center in Oakland, California. The 910-kilowatt solar power system spans a rooftop area nearly 200 yards (182 m) long and will help meet electric demand during peak periods. Inside the mail facility, Chevron installed motion-sensor technology and other conservation systems.

Chevron also is building the nation's largest solar power and energy-efficient facilities program in primary and secondary education at the San Jose (California) Unified School District. The project includes a total of 5.5 megawatts of solar arrays to be installed on rooftops and on parking-lot shade canopies at various district schools.

"The standard photovoltaic technology uses crystalline silicon," explains Bob Redlinger, Chevron director of renewable and distributed energy. "It's used in most of the installations around the world, including 90 to 95 percent of Chevron's projects. It's a mature technology, very reliable but relatively expensive."

Another option involves thin-film technology, which can use amorphous—or noncrystallized—silicon or other more exotic materials. "The advantages of thin films are twofold: they tend to use less expensive raw materials, and they often have more advanced, scalable manufacturing processes," says Redlinger. "But because thin film tends to be less efficient than crystalline silicon, it requires more space and additional support structures and wiring. It's a trade-off. Thin-film panels take up to twice as much area to collect the same amount of energy as the standard technology. But there's more future upside in thin film."

In 2001, Chevron explored the qualities of thin-film technology to broaden the commercial application of flexible solar-electric roofing materials and other technologies. Chevron worked with affiliates and partners to develop photovoltaic systems that produced electricity in a variety of climate conditions. This was achieved by using a unique, flexible, durable thin-film technology that was manufactured and installed as a building-integrated roofing material.

Chevron successfully applied thin-film technology in 2003 when the company installed the first solar photovoltaic facility to help power oil field operations. At 500 kilowatts, the Midway Sunset oil field demonstration project was one of the largest photovoltaic installations in the United States at the time and the largest array of flexible amorphous-silicon solar technology in the world. The facility consists of 4,800 flexible current-producing solar panels, each about 1.3 feet (0.4 m) wide by 18 feet (5.5 m) long and mounted on metal frames that resemble car ports.

Chevron currently is finding ways to capture the benefits of various materials through recent projects that use hybrid technologies. For example, at the University of California at San Francisco, the company used three different solar module applications at the same location. Two use crystalline silicon: one on a parking shade structure on the top level of a garage and the other integrated into the roof of the campus's marquee building. The third system, which uses amorphous silicon, is completely vertical and is integrated into the facility as an architectural facade.

At a U.S. Postal Service mail processing center in San Francisco, Chevron installed a crystalline silicon parking shade that tracks the sun and a separate amorphous silicon rooftop photovoltaic system.

"Metallic blue solar cells made from a thin, flexible film stretch across part of the building's roof," wrote the *San Francisco Chronicle*. "Another solar array covers parking stalls below, the panels moving once an hour to track the sun. Inside, a new industrial-strength air cooler ramps up and down depending on need. Its predecessor only ran at full blast."

The improvements will help the postal service cut its local power purchases nearly in half.

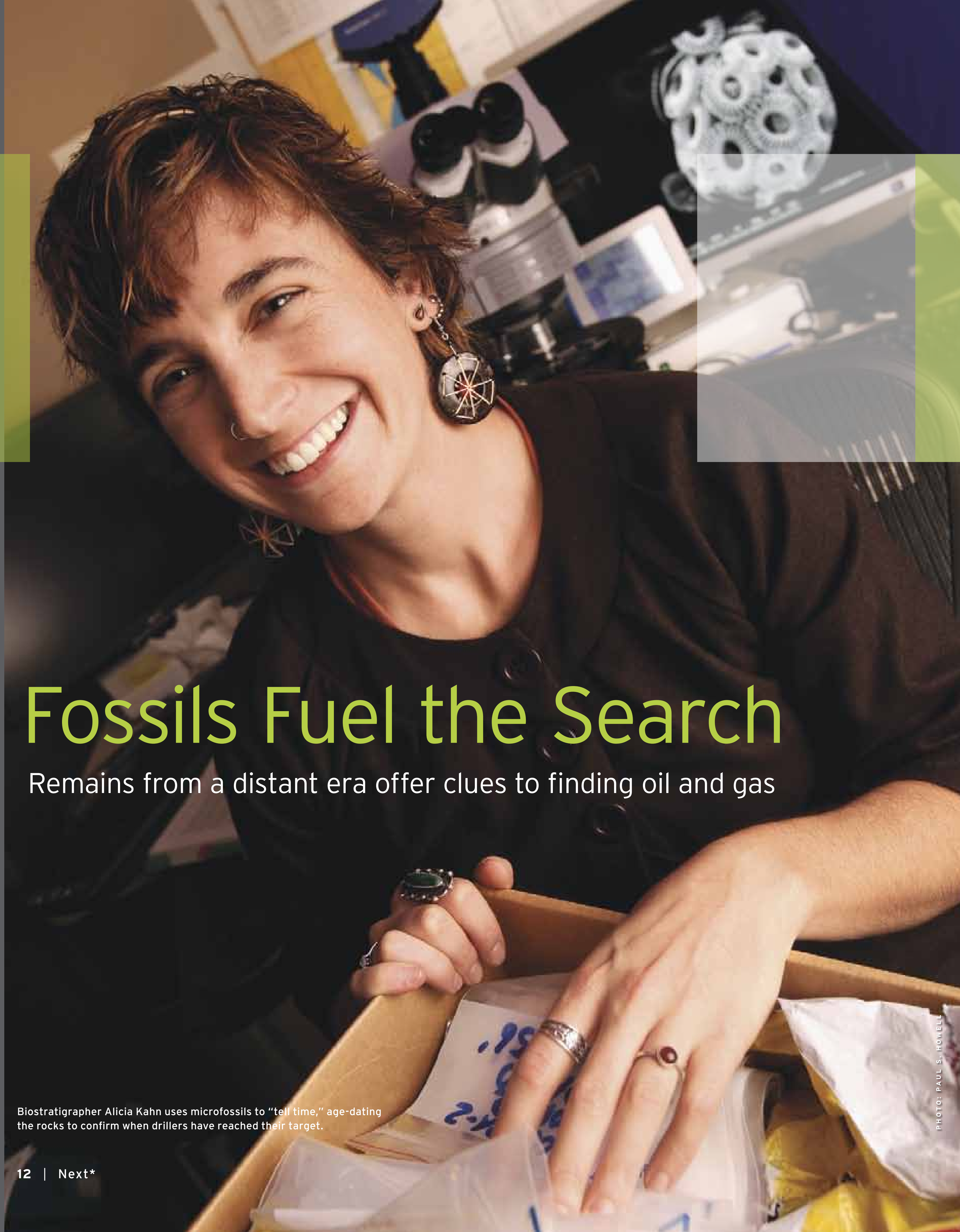
These cost savings, along with lower emissions, are driving the demand for Chevron's solar energy technology. For instance, the company provided California's Contra Costa Community College District with, among other improvements, a 3.2-megawatt solar energy installation, the largest of its kind at an institution of higher learning in North America.

Meanwhile, Chevron continues to explore projects that would use a range of promising exotic materials and technological advances, such as concentrating photovoltaics with curved mirrors or lenses to focus the sun. The goal: lowering material costs and helping differentiate Chevron in the increasingly competitive solar marketplace.

Information on specific Chevron solar projects can be found at www.chevron.com/solar.

PHOTO: PAUL S. HOWELL

Turning a face to the sun: In 2007, Chevron Energy Solutions installed two different types of photovoltaic cells at the new Mission Bay campus of the University of California at San Francisco. The cells reduce demand for electricity from the local utility and the state's power grid. The system is expected to generate 350,000 kilowatt hours of electricity annually, enough to power 55 homes. The clean energy generated by the system prevents nearly 470,000 pounds of carbon dioxide emissions each year.



Fossils Fuel the Search

Remains from a distant era offer clues to finding oil and gas

Biostratigrapher Alicia Kahn uses microfossils to "tell time," age-dating the rocks to confirm when drillers have reached their target.

PHOTO: PAUL S. HOWELL

PHOTO: MITCH COVINGTON, BUGWARE, INC.

As explorationists drill deeper into ocean waters at ever-increasing rig costs, they're getting help from scientists trained in digging through time. Paleontologists, who study the fossilized remains of life, increasingly have been joining drillers, engineers and geologists aboard Chevron drillships and drilling rigs. As the drillers drill, paleontologists use fossils to date each rock layer.

They, and the whole drill crew, are looking for reservoir sands of a particular age, buried miles beneath the seabed, that may contain petroleum. The tiny microfossils–formed from microscopic plants and animals that were buried millions of years ago–are time markers for finding those sands.

"I use fossils to tell time," says Alicia Kahn, a Chevron biostratigrapher–a scientist who uses fossils to date and correlate strata.

"I work while the crew drills," explains Kahn. "Geologists on board ask me where we are in terms of age, and the only way to know for sure is through the fossils."

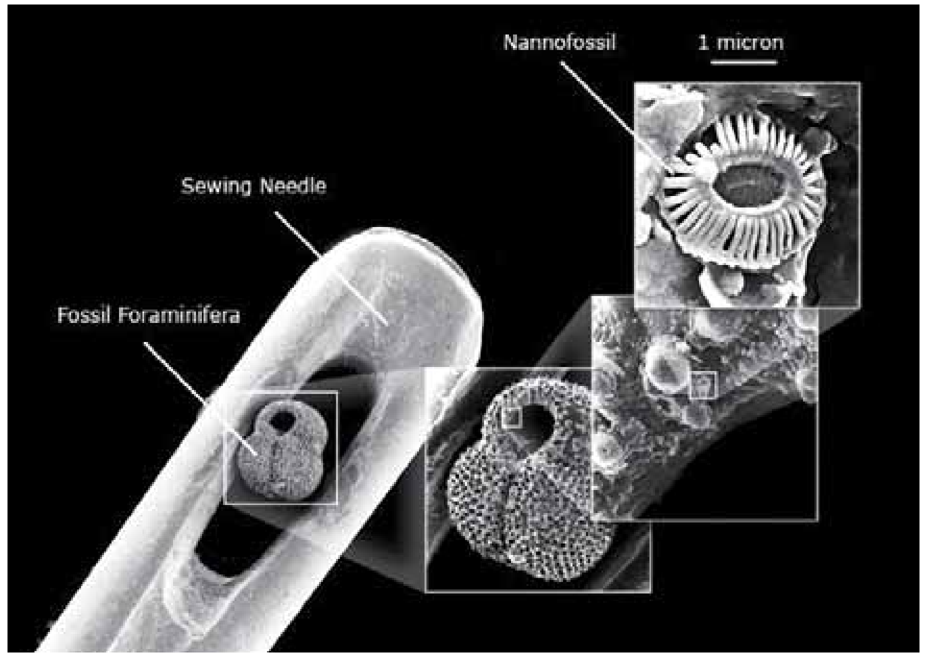
In real time, Kahn and Chevron's other paleontologists examine microfossils in the cuttings, the rock fragments that break free as the well is drilled. By age-dating these fossils, they confirm when drillers have reached the well's target horizons, key zones of potential oil and gas reservoirs, and the total depth of the well.

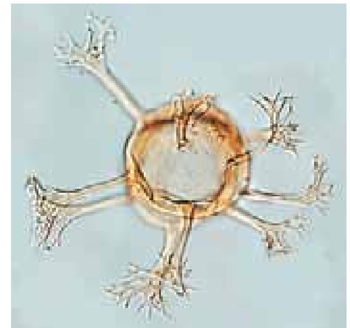
The paleontologists identify fossils that were deposited at the same time to correlate points from well to well across wide areas. They use fossils to reveal information about original environments, including the water depths in which organisms lived and died. Paleontologists also provide critical data for determining where to best set casing points–that is, the depth to stop drilling an interval of a particular diameter hole so that casing of a given size can be run and cemented.

Microfossils are the earth's most abundant and easily accessible fossils, occurring in huge numbers in sedimentary rock. The pyramids of Egypt, for instance, are made of sedimentary rocks composed of the shells of foraminifera, a major microfossil group. England's white cliffs of Dover are thick accumulations of calcareous nannofossils–extremely tiny marine algae.

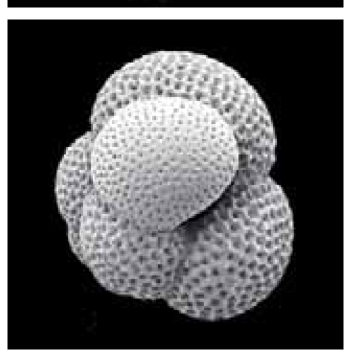
In addition to forams and nannofossils, which are routinely analyzed in Chevron's wells around the world, a third group of microfossils is used by paleontologists: fossilized marine algal cysts called dinoflagellates and land-based pollen and spores–collectively known as palynology.

Background: Calcareous nannofossils, greatly magnified by a scanning electron microscope, are tiny marine algal remains no larger than clay particles.





Upper cluster: Foraminifera *(Globigerinoides ruber),* pictured for scale in the eye of a needle. With additional magnification, shown in increasing stages from left, the nannofossil *(Emiliania huxleyi)* is visible. **Top right:** Dinoflagellate microfossil *(Oligosphaeridium pulcherimum)* from Early Cretaceous rocks (about 100 million years old). **Lower right:** Plant spore microfossil *(Leschikisporites sp.)* from Triassic rocks (about 200 million years old).



Top: Clay-sized marine algal microfossil *(Eiffelithus eximius)* from Late Cretaceous rocks (about 75 million years old). **Bottom:** Sand-sized, floating foraminifera microfossil *(Catapsydrax unicavus)* from Early Miocene rocks (about 20 million years old).

While microfossils don't reveal oil or gas, they do confirm when drillers have hit their target. And with drilling rig rates at $500,000 a day, drillers want to hit that target as quickly as possible.

Chevron employs about a dozen paleontologists or biostratigraphers and hires more on a contract basis. They work on wells all over the world–Angola, Australia, Brazil, Canada, Libya, Nigeria and the United States–wherever Chevron is exploring. Many of the wells Chevron is drilling today are in the open ocean. But before the oil and gas formed from bacteria and algae millions of years ago, these sites may have been in open marine settings, very near shore or even onshore in lakes or swamps.

Many of the marine sections of rock contain thick salt layers that distort seismic imaging. That makes fossils all the more important in identifying the age of strata below the salt.

Paleontologists working in the U.S Gulf of Mexico have amassed an enormous amount of microfossil data through the years. One Chevron paleo team reached a major milestone recently by recoding and integrating all Chevron, Texaco and Unocal paleo data into one online database, called ePaleo.

"Chevron appears to be the only corporation that has fully integrated all of its own and merged-companies' data into one workable system," says Roger Witmer, a biostratigrapher who manages ePaleo. Witmer intends to expand the database beyond the Gulf of Mexico.

This desktop system allows geoscientists to quickly access paleo data for more than 22,000 onshore wells in the U.S. states of Louisiana and Texas and 20,000 offshore wells. Geoscientists can search the database for individual wells or groups of wells in a number of ways. It also plots age-versus-depth curves for up to 10 wells at a time, enabling quick comparisons of rock accumulation-rate histories across regional wells. "We can get a lot of critical information in seconds," says Witmer.

And that is good news for paleontologists. Better news still is the work that lies ahead for them. "When I was in school," says Kahn, who earned her Ph.D. in micropaleontology in 2006, "I never thought I'd be able to work in my field in the petroleum industry."

PHOTOS, CLOCKWISE FROM BOTTOM LEFT: SEV KENDER; MITCH COVINGTON, BUGWARE, INC.; CHEVRON EXPLORATION; HEIDI HOWE; HEIDI HOWE

Geoscientist Matthew Johnson (left) and biostratigrapher Rome Lytton examine data from a deepwater Gulf of Mexico drilling well.

PHOTO: PAUL S. HOWELL

An Explorationist's Best Friend

In the search for oil and gas, biostratigraphers are good friends to have

Take Rome Lytton, one of Chevron's senior-most paleontologists. Years ago, Lytton was going over a paleo report on a well that had just been drilled in Louisiana's Caillou Island Field in Terrebonne Parish. Drillers had reached total depth only to find a dry hole. "I looked at the paleontology and said to the team, 'Wait a minute. See this zone above the reservoir sand? We haven't penetrated it yet. We have the wrong correlation.'" Six months of persuasion later, Lytton convinced the team to go back in and drill the well deeper.

It hit big–that one Caillou Island well produced 9.1 billion cubic feet of gas and 66 million barrels of condensate before the field sold in 2004.

Sometimes paleo research succeeds by forewarning of failure. That's what happened in a deepwater U.S. Gulf of Mexico partner well. The sands below the salt layer and near the intended total depth were much younger than everyone expected. They were Pleistocene sands (less than a million years old) instead of Miocene sands (about 17 million years old) like those in Chevron's huge Tahiti Field, now in development. Paleo data enabled partners to stop drilling the well several thousand feet short of total depth, potentially saving millions of dollars in drilling costs.

Deep Seething Sea

PHOTO: ©ISTOCKPHOTO.COM/FELIX MÖCKET

Unlocking oil that lies beneath menacing forces of nature

Years from now, when you're filling your car with gasoline from one of the most menacing corners of the deep seas, use every drop wisely. And thank dozens of Chevron scientists and engineers. They will have unlocked a vast treasure of oil guarded by ocean currents so fierce, they pluck and pick steel pipes like they're nylon guitar strings.

That's the situation Chevron faces in the deepwater U.S. Gulf of Mexico. Three of its oil discoveries–Big Foot, Jack and St. Malo–lie under a part of the gulf prone to furies of nature called loop currents and Rossby waves.

Chevron's offshore facilities for these discoveries are a few years off and "involve engineers and earth scientists evaluating the most efficient and reliable ways to produce the oil," says Brian Smith, general manager of major capital projects for Chevron's deepwater Gulf of Mexico operations.

While design and engineering continue, the company's lead in a number of metocean (meteorology and oceanography) studies will improve not only the strength and safety of these future facilities but those of the whole industry.

The time is ripe. As the worldwide search for oil and gas pushes into the deepest seas, understanding metocean phenomena such as loop currents and Rossby waves takes on a whole new urgency.

Underwater Hurricanes

Loop currents are the hurricanes of the underwater. These swirling masses of warm water can extend from the sea surface to 3,000 feet (900 m)–as deep as three stacked Eiffel Towers.

Loops form when trade winds blowing west from Africa pile water against Mexico, Guatemala and Colombia. That water funnels between Cuba and the Yucatan peninsula, shoots north into the Gulf of Mexico, then loops east and south before flushing through the Florida Straits. There it becomes the Gulf Stream, the well-known ocean current that warms Europe.

Not only are loop currents powerful–they can swirl for months on end and generate currents of nearly 6 mph (10 km/h)–they are fertile, too. Loops randomly spawn eddies, some as big as Iceland.

Chevron leads the industry in tracking metocean phenomena to protect its assets, like the Tahiti platform in the deepwater Gulf of Mexico. Here, the massive Tahiti hull is being hauled from Corpus Christi, Texas, out to sea for installation.

Chevron's Metocean Edge

Chevron's metocean research is breaking ground in several ways:

- Chevron led the American Petroleum Institute's creation of the first stand-alone protocol for determining metocean conditions for offshore platforms and pipelines in the gulf.
- Chevron is managing the CASE (Climate and Simulation of Eddies) joint-industry project, an effort among 20 oil companies to understand little-known metocean phenomena. Recently, CASE uncovered unexpectedly strong subsurface currents caused by hurricanes passing over a loop and alerted engineers of this hidden danger. The project's findings have broad application outside the gulf.
- Chevron is leading an initiative to establish the first cooperative effort to routinely forecast ocean currents. The project partners are Chevron, the U.S. Department of Energy, industry project DeepStar, the U.S. Navy, and the National Oceanic and Atmospheric Administration. Cort Copper, Chevron metocean specialist, says, "Once we prove the concept," which he expects will occur in 2010, "we hope the U.S. government will take the reins. There are so many potential applications, from more efficient deepwater drilling to better forecasts of red tides that close gulf oyster beds and beaches. This effort can yield a lot of common good."

When either the loop or an eddy churns under an offshore facility, two things can happen: it can shut down drilling and cause relatively slender vertical members such as risers to vibrate.

"For some offshore facilities, loops and eddies create a force that's stronger than hurricanes," says Cort Cooper, Chevron metocean specialist.

Loops have cost the industry several hundred million dollars in drilling downtime. Chevron has largely avoided that fate–as well as structural damage due to loops and eddies–by monitoring the currents, planning around them and designing facilities to withstand them.

"We've generally designed and managed our installations well through good forecasting and awareness of the dangers," says Cooper. "But like others in the industry, we've had to work around major loop currents."

Chevron operates facilities in the deepwater gulf that are exposed to loops and eddies 20 percent of the time. Some companies have facilities sitting in the loop 30 percent of the time. Future production may come from platforms with a 50 percent exposure.

Huge, Menacing Waves

A potentially greater challenge looms when eddies morph into little-understood Rossby waves–300-mile-long (500-km) subsurface waves that stretch the equivalent distance from Houston, Texas, to New Orleans, Louisiana.

Rossby waves form when the loop or an eddy hits the U.S. outer continental slope. But the real trouble begins when Rossby waves get trapped in a steep, rugged undersea slope about 100 to 200 miles (160 to 320 km) southwest of the Gulf Coast, called the Sigsbee Escarpment.

When a Rossby wave gets trapped in the escarpment, its energy focuses and intensifies like a light beam hitting a magnifying glass. The resulting currents can etch trenches 20 feet (6 m) deep in the sea floor. More important, they can impose powerful forces on pipelines and risers, the pipes that carry oil from the sea floor to the surface platform.

PHOTO: MCNEE PRODUCTIONS

Deep-Sea Trifecta

Chevron's challenge? Its Big Foot discovery sits directly on the escarpment, and its Jack and St. Malo discoveries lie just north of it. All live in Eddy Alley.

That puts Chevron in the unenviable position of designing and building platforms to withstand the deep sea's trifecta: loops, eddies and Rossby waves. And while Chevron is not the first company to design and build platforms near the escarpment, it is the first to fully consider Rossby waves in the design of its platforms.

Designing a deepwater platform to operate for 20 to 30 years in the Gulf of Mexico is an engineering balancing act. The platform must be strong enough to withstand hurricane waves as high as 90 feet (27 m), yet its slender, submerged limbs must resist vibrating in the strong currents driven by loops, eddies and Rossby waves.

Design advances sometimes come the hard way. The classic spar platform–a hollow, vertical, cylindrical structure like a giant buoy–was initially considered a breakthrough in the deep water for its tremendous stability in hurricane-size waves. But the industry soon learned that classic spars are prone to large movement in loops and eddies.

That sent engineers back to the drawing board. They emerged with truss spars, which use a more skeletal or latticelike framework to maintain stability in big waves while producing less drag when the loop hits.

A 6,500-Foot Guitar

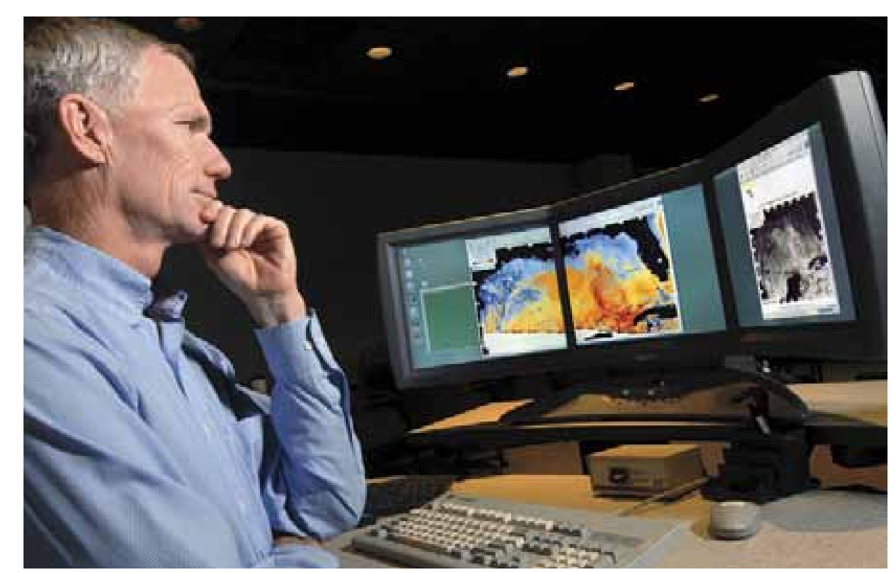
The biggest issues in designing around Rossby waves are the relatively slender risers that descend from the platform.

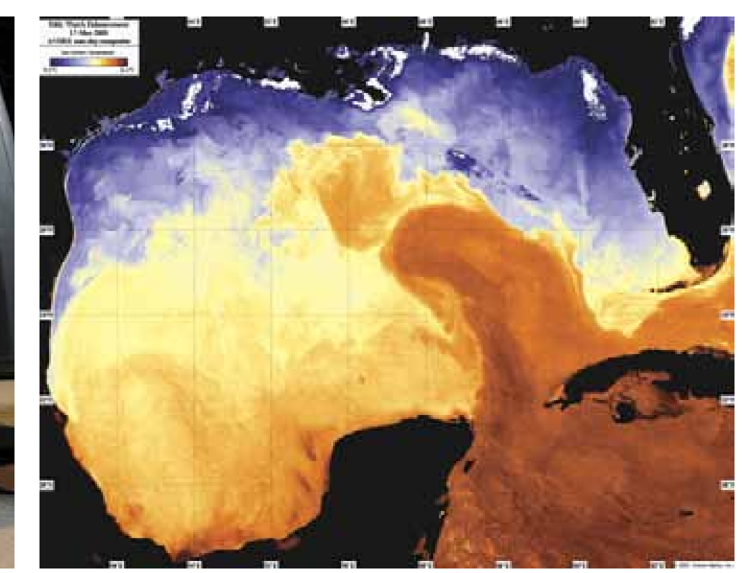
"Imagine stretching a 3-foot-diameter (1-m) pipe from the sea surface to 6,500 feet (2,000 m) below, then trying to pull it through the water at 3 mph (5 km/h)," says Cooper. "That force makes the pipe act like a guitar string that wants to make music. Unfortunately, the music–or vibrations–can cause fatigue. If it's not engineered properly, it can even cause cracking and possibly a broken 'string.'"

Coping with the movements–called VIV, or vortex-induced vibrations–is a riser engineer's focus. And between now and the day motorists fill up with fuel from Eddy Alley, Chevron's engineers will be busy.

"We'll evaluate diverse engineering options over the coming years," says Smith. "Eventually, our solution will combine safety, reliability and sound economics. Of course, consumers won't see any of that. What they'll see is an uninterrupted and safe supply of fuel."

Cort Cooper, Chevron's metocean specialist, tracks dangerous currents such as the swirling Gulf of Mexico loops in the infrared satellite image at right. The large red features in the eastern gulf are caused by the loop's hot water and a newly spawned eddy.





PHOTOS, FROM LEFT: SUZIE SAKUMA; HORIZON MARINE INC.

On the Road to Chuandongbei

About an hour's drive outside the small town of Nanba in southwestern China's Sichuan basin lies the Luojiazhai Field, one of China's largest onshore natural gas fields. The area is surrounded by fish, chicken and corn farms and rice fields that form steps into the hills. Along the rocky dirt road and up the hill toward Luojiazhai are natural gas wells that are currently shut in; an old gas plant is visible in the distance.

Gas from the field has relatively high levels of hydrogen sulfide (H_2S), a toxic gas that is also highly flammable. Sour gas, as it is known, must undergo extra processing to remove sulfur before it can be used as an energy source. Like other unconventional resource types, such as heavy oil, sour gas is sought after more and more as conventional, or so-called easy, energy sources are becoming harder to find and develop.

"Sour gas requires special handling equipment and drilling and production technology to ensure safe operations," says Isikeli Taureka, Chevron country manager for China.

So when PetroChina parent company China National Petroleum Co. recently sought help to develop the Chuandongbei project (of which the Luojiazhai Field is a part), Chevron's expertise in sour gas made it a natural partner.

After being invited to bid on the project in late August 2006, Chevron moved quickly to assemble a cross-functional team and develop a proposal. "Traditionally, business development efforts on such scale take several years because it takes time to pull in all the required experts to do the evaluation, reach a satisfactory conclusion and progress negotiations," says Oleg Mikhailov, business development manager for Chevron Asia South Ltd. "In our case, we were able to access top Chevron people from around the world very quickly."

Adds Tim Galvin, manager of Chevron's business unit responsible for the evaluation and proposal: "Having access to subject matter experts from Tengiz operations in Kazakhstan and from exploration, energy technology, gas and business development was clearly one of the keys to successfully reaching an agreement."

"Our sour gas expertise within the company is extensive, with large projects in the United States and Kazakhstan," says Taureka. "By building and operating several major projects, we have become a leader in understanding how to design and operate facilities safely and effectively."

"Any field with a sulfur content above 2 percent is classified as high sulfur. The Chuandongbei fields average around 10 percent sulfur," explains Dave Nelson, vice president and general manager of the Chuandongbei project. "Chevron has decades of experience in safely operating fields with sulfur levels north of 20 percent."

Since the 1980s, Chevron has been safely operating a high-sulfur natural gas field in Carter Creek, Wyoming. The H_2S content there varies from approximately 1 percent to 22 percent depending on the geologic formation. Since 1993, the company has processed sour gas from the massive Tengiz Field in Kazakhstan. Tengizchevroil, in which Chevron has a 50 percent interest, is operator of the field, whose reservoir gas contains 13 percent H_2S. The Tengiz project team developed an injection system expected to meet technology challenges while maintaining safety.

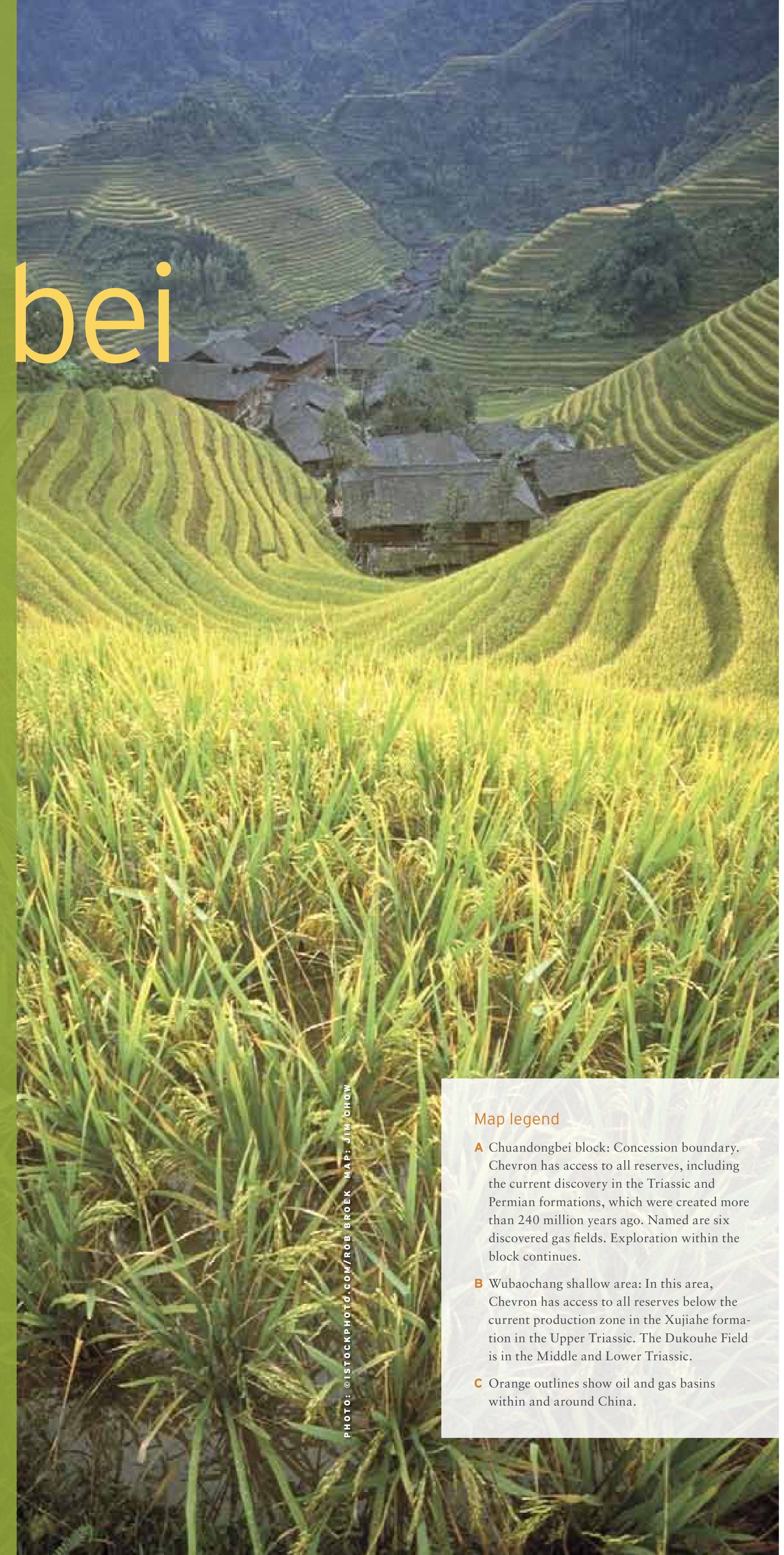


PHOTO: ©ISTOCKPHOTO.COM/ROB BROEK MAP: JIM CHOW

Sour gas requires special corrosion-resistant materials. During operation, there has to be very close tolerance–attention to detail–and avoidance of any unplanned releases of gas to the atmosphere. To be successful, Nelson says, the combination of specialized design criteria and very rigorous operating practices is needed.

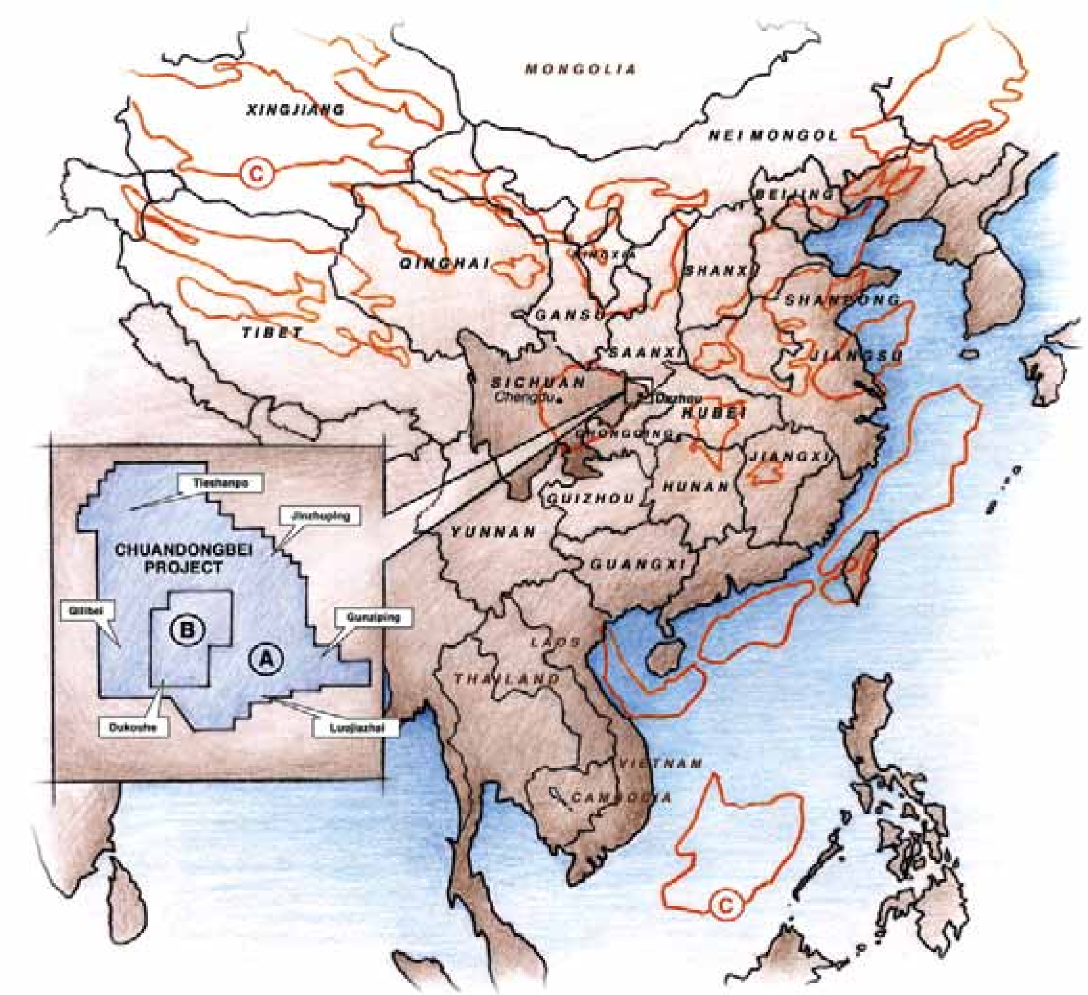
The Chuandongbei gas development area covers nearly 772 square miles (2,000 sq km) in the Sichuan province and has an estimated resource base of 5 trillion cubic feet of natural gas. Design capacity at the proposed gas plants is expected to be 740 million cubic feet of natural gas per day. Chevron has the option of exploring for more gas that has yet to be proven in the area.

"Part of the challenge and the opportunity here is that from a surface-facility design perspective, we really have a blank sheet of paper," Nelson says. "While the resource has been proven, a substantial amount of drilling lies ahead. It's a fantastic opportunity to get it right from the start."

PetroChina scientists are spending several weeks working with Chevron partners, sharing data such as seismic images and three-dimensional maps showing where gas reservoirs are likely located in the field so that drilling teams can precisely plan where to begin operations.

"PetroChina is keenly interested in understanding our methods of project execution, our operational excellence program and how we pursue incident-free operations," Nelson says. "So part of what we're bringing to the table are our safety processes and effective project execution."

There is a sense of urgency to produce first gas as quickly as possible because of China's strong demand for energy fueled by explosive growth. But there is a commitment to taking the time to do it right. "We are going through a very rigorous and detailed front-end engineering design that will determine when the gas will flow," Nelson says. "It's a question of construction schedule, it's a question of safety, and it's a question of receiving all the permits from the government. The gas will flow when it's safe to flow."



Map legend

A Chuandongbei block: Concession boundary. Chevron has access to all reserves, including the current discovery in the Triassic and Permian formations, which were created more than 240 million years ago. Named are six discovered gas fields. Exploration within the block continues.

B Wubaochang shallow area: In this area, Chevron has access to all reserves below the current production zone in the Xujiahe formation in the Upper Triassic. The Dukouhe Field is in the Middle and Lower Triassic.

C Orange outlines show oil and gas basins within and around China.

Chevron's Computer Chief Says: Click Here for Energy

A conversation with Louie Ehrlich

Next*: Oil doesn't look much like an information technology–savvy business. How does Chevron use computers?

Louie Ehrlich: Oil is actually one of the most data-intensive industries. In 1982, Chevron became one of the first oil companies to process seismic data with a Cray supercomputer. We've continued to rely on the most powerful computers, especially to process our huge volumes of seismic data. Today, of course, clusters of desktop machines can easily do what the big Crays did back then. We continue to rapidly grow in all information technology (IT) arenas: servers, networks, internal Web sites, desktops. IT has become pervasive and today represents the fundamental underpinnings of the energy industry.

Next*: How does IT help you find and develop new energy supplies?

Ehrlich: We rely on it, literally, everywhere—drilling, reservoir modeling, facility design. For example, IT allows us to simulate multidimensional images of the earth's crust, which we view in 3-D visualization rooms to pinpoint the best places to explore. IT also supports our global process of ranking hundreds of prospects for risk and potential, so we've improved our discovery rate.

Next*: How does IT help you in the older fields? Aren't they running dry?

Ehrlich: IT is critical to keeping these foundation fields alive by helping us flatten decline curves and add new reserves. A whole basket of IT technologies is allowing us to better model the reservoirs and understand mature areas where we've developed computer "dashboards" of real-time information. Sensors and computers tell us exactly how each well is doing and, in some fields, exactly when to inject steam to stimulate production. This trend, which reflects the automation aspect of our field integration initiative—i-field™—has huge promise. Historically, the industry captures less than half of the oil it finds, so just a 5 percent improvement would add billions of barrels to world supplies.

Next*: What about IT in fuels manufacturing?

Ehrlich: The trend in refineries is automation using sensors and controls to optimize the different processes. These are very complex facilities—IT systems at our Pascagoula, Mississippi, refinery, for example, regulate about 60,000 valves per second.

Next*: So does all of this make Chevron a good place for an IT career?

Ehrlich: Yes, and it's an even better place for IT-empowered careers of all kinds. We like people with "hybrid" degrees or skill sets—half professional or technical, half IT. To help these professionals, we founded the Center for Interactive Smart Oil Field Technologies at the University of Southern California.

Next*: Beyond earth science, what are some other uses of IT at Chevron?

Ehrlich: IT supports every aspect of our industry, from exploration, extraction and transportation to processing, transactions and delivery. For example, e-procurement has streamlined purchasing while getting us the best deals from suppliers. And as alternative energies advance, IT will play a similar role.

Next*: How are you taking advantage of wireless capability?

Ehrlich: We use handheld terminals in our refineries and oil fields. But the big gains come from thousands of cell phones, wireless laptops and handheld devices. In the early 1970s, we had about 40,000 people running a much smaller business. Today we have about 60,000 people running a huge, global business using a standardized network of desktop computers, our Global Information Link. IT is the great connector, allowing us to leverage our workforce like never before.

Next*: How much does Chevron invest in IT?

Ehrlich: Currently, we invest about $300 million a year, but what really matters is how we're spending it. Our IT focus historically was to automate for efficiency. That has paid off, but now we see a much bigger opportunity to integrate data and systems to optimize our business performance. We are linking our IT investments more closely than ever before to our global business strategies to drive what we call "IT-enabled business processes."

Next*: For example?

Ehrlich: We have one project that is standardizing all our business processes in oil refining and fuels marketing. Another is improving our oil and products trading capability. And our People Hub database is giving us an unprecedented capability to globally mix and match our people to best-fit jobs.

Next*: What are some other key IT trends at Chevron?

Ehrlich: Virtualization—the science of optimizing the use of all our systems. And it's tied to "green computing," because virtualization reduces power use and makes us more efficient. Since 1992, when we began tracking the efficiency of our energy use across all our operations, we have increased energy efficiency per unit of output by 27 percent. IT helps enable that efficiency. For example, we have the green tools of global teleconferencing and telecommuting, which save jet fuel, gasoline and time as well. There is also the potential for social computing, such as Facebook, and virtual worlds similar to capabilities from the game industry to play important roles in enabling business in the future.

Next*: What's the next big thing in IT for Chevron?

Ehrlich: We want to dramatically improve our internal search capability. This is a fundamental focus of the new Global Information Link 3 system we're rolling out this year. With IT's advancements have come huge volumes of data and information to store and manage, and it's a big challenge. With an improved search capability, our scientists and engineers can be even more productive.

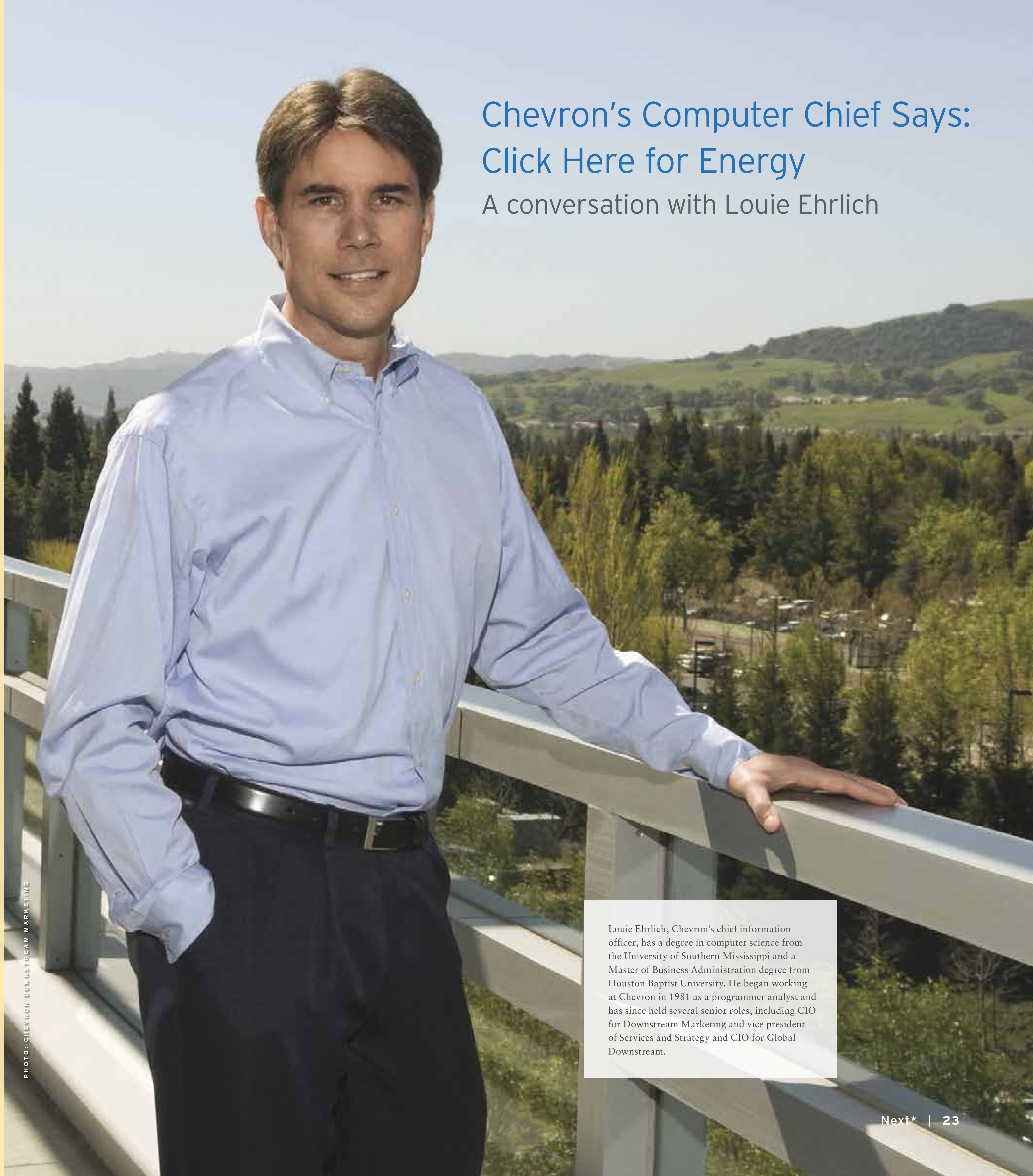


PHOTO: CHEVRON DOWNSTREAM MARKETING

Louie Ehrlich, Chevron's chief information officer, has a degree in computer science from the University of Southern Mississippi and a Master of Business Administration degree from Houston Baptist University. He began working at Chevron in 1981 as a programmer analyst and has since held several senior roles, including CIO for Downstream Marketing and vice president of Services and Strategy and CIO for Global Downstream.

The eProspect database helps identify top exploration prospects. Chevron's investments in those prospects lead to drilling—such as in Canada's Orphan Basin (beneath this drillship), northeast of St. John's, Newfoundland and Labrador.

PHOTO: GREG LOCKE

Exploration's Secret Weapon

Not so long ago, explorationists of large oil companies acted more like they worked in retail–and on commission–than for energy companies.

"You used to be judged by whether or not you could get your proposal through to drill a well," recalls Steve Evans, Chevron exploration general manager for North America. "It was a kind of sales job. Success may ultimately come, but in a business where only one in four wells hits, you could always claim dry holes were expected three out of four times."

Fast forward to today, when industry analysts have singled out Chevron for its track record in finding oil and gas. "Since the merger [with Texaco in 2001], Chevron has achieved a marked turnaround in its exploration performance, outperforming by a wide margin on a number of key exploration indicators," reports Wood Mackenzie, an energy consulting and research firm.

What changed? Chevron's entire exploration philosophy. Instead of evaluating projects regionally, projects are compared globally. Instead of using local methodologies to assess risks, one global methodology is used. And instead of investments going to the best salesman, they go to the best prospects.

The approach wouldn't be possible without the eProspect database.

eProspect catalogs more than 2,600 Chevron prospects–areas the company thinks might contain oil or gas that haven't been drilled. Regional scientists quantify each prospect's potential economics, volumes and geologic risks on eProspect's template. Whether those scientists are in Angola, Australia or Argentina, they use one standardized methodology to quantify their prospects' potential. An independent exploration review team works with the regional scientists to validate the data.

Because the entire process is collaborative and driven by a dispassionate methodology, final investment decisions are seldom contested. Says Evans: "It's the emotional driver we've tried to take out. We take a disciplined approach."

Adds Steve Larkin, Chevron North America exploration advisor, "Because of its high risk, exploration can sometimes become less of a business game and more of an instinctual game. But if you just trust your instincts rather than the data, in the long run you'll probably lose."

Since adopting a global portfolio approach and a strong technical review process, Chevron's exploration effort has been industry-leading. Six years of consistent exploration success have resulted in new resource additions averaging more than 1 billion barrels of oil-equivalent per year and an exploration drilling success rate of 45 percent, high for the industry.

The eProspect database has been a work in progress. Its first iteration, following the merger, consisted of 20 separate databases maintained by business units around the globe. But because they were built from desktop databases that weren't intended for enterprisewide systems, they occasionally corrupted or crashed.

Then, over six months in 2005, Chevron information technology specialists, who immersed themselves in the needs of their exploration colleagues, built one eProspect application to replace the 20 databases. The new system added valuable search capabilities. "We could compare prospects we were considering to those we own or used to own," says Danielle Carpenter, who worked on the rebuild. "In one easy click, it gave us institutional memory."

The rebuild also improved security and reliability. "Today, the only downtime we have is associated with maintenance windows. Those are planned with customers before we bring our server down for patches, hardware upgrades or replacements," says Kiet Tran, leader of the information technology team that rebuilt eProspect.

By the end of 2008, Tran's team plans to morph eProspect into eXPLORE, adding volumetric simulation and processes for assessing risk and uncertainty.

Can Chevron build upon the exploration success it's enjoyed for years? Stay tuned.

In It for the Long Haul

The massive Kern River reservoir near Bakersfield, California, was discovered in 1899 by a father-son team digging the first well by hand. Little did Jonathan and James Elwood know that technology would ensure that the field would still be producing a century later and, in late 2007, would celebrate 2 billion barrels of oil extracted.

"It's a story of technology, of perseverance," says Warner Williams, Chevron's former San Joaquin Valley vice president and now Gulf of Mexico vice president.

During the field's first year of production, Kern River produced more oil than the state of Texas. Still, many predicted a limited life for the field. One industry executive said, "The field will not last. It will only be a year or two at most until Kern River will be numbered with last year's snows and forgotten." The year was 1904.

In fact, the massive petroleum basin sparked an oil boom that catapulted Bakersfield from a sleepy agricultural town to a regional metropolis. But that boom looked more like a bust by the mid-1960s, when Kern River was producing fewer than 10,000 barrels of oil a day even though only about 15 percent of the field's reserves had been produced. The challenge was how to lift the heavy oil trapped in the reservoirs.

"We're fortunate to have a field with a lot of oil in place, and through technology, we're able to get the recovery factor pretty high," says Gary Piron, Kern River area manager.

Now the overall recovery rate stands at 53 percent, with some parts of the field having recovered 70 percent, thanks to ever-evolving steamflooding technology.

PHOTO: DAN ESGRO

Kern River Cogeneration—a joint-venture partnership between Chevron and Edison Mission Energy—uses natural gas to generate electric power for Southern California Edison and steam for Chevron's Kern River Field. The steam is used for enhanced oil recovery.

But even though 2 billion barrels of oil have thus far been recovered, Chevron scientists look forward to an ultimate recovery of 74 percent of the original oil in place for the entire reservoir.

That's where creative redeployment of existing technology coupled with innovative use of new technology is breathing new life into this old field. For example, Chevron earth scientists are using detailed 3-D reservoir models at Kern River to determine where to drill horizontal wells, which now produce some of the highest rates at the field. These wells produce up to 10 times more than the more typical vertical wells. In addition, older injection wells that once injected steam into the ground have been converted to production wells because the crude oil in those areas is now thermally viable to pump out.

"We've had a very strong commitment to surveillance," says Greta Lydecker, San Joaquin Valley general manager of asset development. "It's a big field, and the well spacing is very close, so to have this high volume of data about reservoir conditions has enabled us to make a very detailed 3-D model of the reservoir and in turn continue to drill new wells and increase the oil recovery."

New technology to visualize the wealth of reservoir data and cutting-edge i-field™ technology are coming online to help Kern River continue production over at least the next decade.

One tool, the i-field™ Master Schedule Visualizer, pinpoints where each crew is working in real time, allowing schedulers to optimize maintenance work flow and increase the efficient use of people, time and equipment. Another tool that will soon be used, the i-field™ Steam System Optimizer, will allow engineers to make the best decisions possible to manage heat use by analyzing extremely accurate information on what's happening with steamfloods and thermal conditions below ground.

At Kern River and other heavy oil fields Chevron operates around the world, heat management is critical to forcing clumpy petroleum out of the labyrinth of the reservoir and into nearby production wells. Bottom-hole heaters and cyclic steaming had brought only minimal success, but in 1963, a breakthrough technology that continuously injected steam into San Joaquin sandstone brought production levels back to life.

Today, in addition to several steam generation plants that have been in use for decades at Kern River, two massive cogeneration facilities produce the vast majority of steam at the field. With four modified jet engines each, the plants churn out about 250,000 barrels of steam every day to be injected below ground as well as produce more than 300 megawatts of electricity that powers Kern's nearly 9,000 oil pumps at the 23-square-mile (60-sq-km) complex and provides electricity to homes and businesses in the area.

With Chevron's International Heavy Oil Center located at Kern River, researchers work hand in hand with operations staff to apply the best technology in this legacy field.

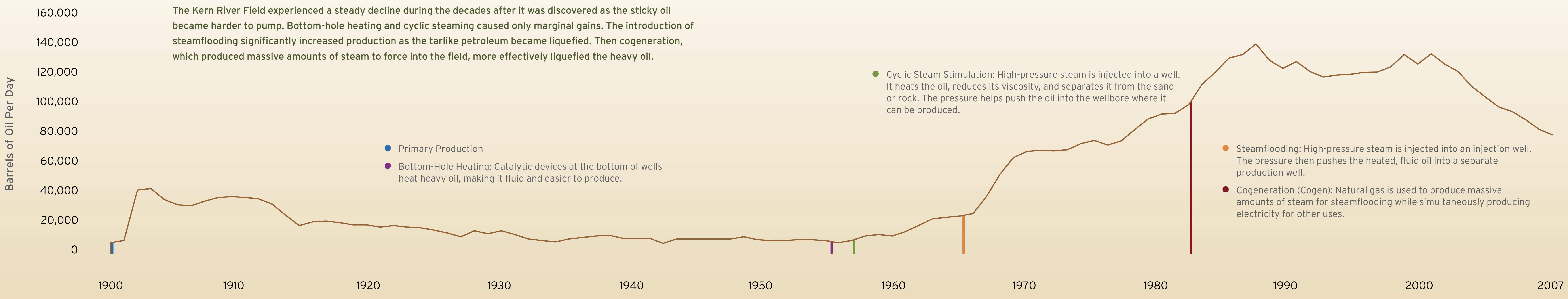
"The intracompany collaboration allows us to pilot and test new technology in a kind of laboratory environment and quickly apply it elsewhere Chevron has similar operations," Williams says. "This is a real key in our ability to improve recovery worldwide."

CHART: SHANNON MAGEE

PHOTO: SUZIE SAKUMA

From left: Chevron project manager Graham Cambrice, operations supervisor Jeremy Sosa and general manager of asset development Greta Lydecker join the celebration of the 2 billionth barrel of oil produced at the historic Kern River Field in Bakersfield, California.

Patience and Perseverance Reap Rewards



Managing Technology for 21st-Century Energy Security

Vantage Point with Melody Meyer

Melody Meyer is president of Chevron Energy Technology Co. and is responsible for managing the company's technology services and research and development. She began working for the company in 1979 after graduating from Trinity University with a Bachelor of Science degree in engineering science–mechanical. Throughout her career, Meyer has been involved in major projects as well as upstream exploration and production operations in the United States and internationally.

Picture the perfect energy future, a balance of abundant supplies from multiple sources, from renewable to conventional—clean, secure, available and affordable for all.

To achieve this vision of energy security, we need to invest in every kind of energy, encompassing conventional, unconventional, alternatives and renewables, plus make a big new push in energy efficiency.

We know crude oil and natural gas resources will be harder to find, recover and process—and we must continue to protect people and the environment, conserve energy, and reduce emissions of all kinds.

Fortunately, we have an old friend on our side: technology.

Advancing Core Technologies

Here at Chevron, the group I head, Chevron Energy Technology Co., supports global energy and products businesses by combining several separate technology service groups. This vital part of our corporation has grown significantly in recent years, reflecting new opportunities, a huge wave of new developments and a host of new challenges.

We invest a lot of time and energy doing more of what we've always done: advance core oil and gas technologies. This ensures that our technical efforts are closely tied to business needs, both to drive new projects and for greater reliability and efficiency in current operations.

Using Our Subsurface Advantage

In our view, it all starts with subsurface characterization and reservoir management—visualizing the subsurface geology with new and advanced tools to help drill more efficiently, discover new fields, find new hydrocarbons in and around established fields, and steadily improve rates of recovery. Striving for subsurface advantage supports our business in multiple ways. For example, combined with our global exploration management process, our subsurface capability helped deliver a 45 percent average annual success rate in exploration for 2002 through 2007, making Chevron a strong industry performer. Notably, Chevron's ability in subsalt seismic processing technology was fundamental to discovering our Tahiti deepwater field in the U.S. Gulf of Mexico.

PHOTO: CHEVRON NORTH AMERICA EXPLORATION AND PRODUCTION

PHOTO: CHEVRON AUSTRALASIA

At Chevron's Global Technology Center in Perth, Australia, senior geologist Joao Keller (left) and business manager Alex Sutiono are part of a growing team delivering technology and research initiatives in the Asia-Pacific region.

Building on Downstream Heritage

Looking downstream, we need to create innovative applications and new kinds of processing technologies to make the fuels of the future. For example, we may be able to produce new diesel formulas using future feedstocks such as oil shale, coal liquids and extra heavy oils. We believe our direct coal-to-liquids technology approach, which produces fewer greenhouse gases, may give us a long-term competitive advantage.

Leveraging Research and Development

Of course, no company should tackle technology invention, qualification and deployment on its own. We emphasize a leveraged R&D investment strategy, sharing costs and ownership of intellectual property with industry, university and government partners.

For example, Transocean Inc. is constructing a next-generation deepwater drillship, the $650 million *Discoverer Clear Leader,* secured by a five-year service contract with us beginning in 2009. With a 20,000-ton variable deck load, it will support drilling in 12,000 feet of water and 40,000 feet of total depth while a parallel drilling system promises ultimate speed and efficiency.

Managing Technology

But technology itself is only half our challenge today. The other half is managing the technology effectively. The fact is, our energy developments are becoming more complex and more costly, so we need more technology per barrel to make them viable. We need everything to be more efficient and reliable within highly complex systems. And we need to address opportunities globally.

One of the biggest issues in technology management is the need for a stronger focus on integration—a "wells to wheels" perspective. At Chevron we incorporate all of our technology services into one organization, from upstream to future fuels, and we were the first in the industry to adopt this structure. Also, we recently established new Technology Centers in Perth, Australia, and Aberdeen, Scotland, to help us find new research and development opportunities, increase our access to technical talent worldwide and deploy technology solutions faster.

Teaming with Universities and Government Laboratories

Working with national laboratories, research centers and universities gives us access to great minds and helps us find technologies adaptable to oil and gas operations. In recent years, we have established the Chevron Centers of Research Excellence with several institutions—including the University of Tulsa, which is working on advanced production systems, and the University of Southern California, where our Center for Interactive Smart Oil Field Technologies is helping build a new generation of information technology–savvy oil and gas professionals.

In other alliances, we recently created a remote and ultra-deepwater research program at the Massachusetts Institute of Technology, while a new partnership with the University of Texas at Austin will advance the science of enhanced oil recovery.

Partnering with governments is also essential. In 2004, Chevron announced a new R&D relationship with the Los Alamos National Laboratory, which is already helping us find new ways to master the extremes of deepwater production. Internationally, we added a scientific and technical cooperation agreement with the Russian Academy of Sciences and with the Western Australian Energy Research Alliance.

Mentoring Talent

But nothing happens in the energy game without human innovation. One of our primary tasks is executing the "big crew change," hiring and training new global talent as older professionals retire. I'm happy to report that this is well under way at Chevron. One of our proudest efforts is the Mentoring Excellence in Technology program: handpicked senior scientists and engineers provide structured guidance to our technical professionals with five to 15 years experience.

Meanwhile, we're placing hundreds of new technical hires into our structured Horizons career-track program, and we're rolling out a new Pathways career track for experienced technical professionals.

At Chevron, our goal is to reach out to our young colleagues and make sure our industry's new generation is ready to give to this century the same level of energy security we gave to the last one.

National Renewable Energy Laboratory researchers Kimberly Christensen and Eric Knoshaug process algal cultures in a temperature-controlled, illuminated growth room. This room provides the necessary light intensity for algae to grow by allowing them to convert light energy into chemical energy through the process of photosynthesis.

PHOTO: PAT CORKERY, NREL

Algae, Anyone?

Green slime or future transportation fuel?

Last fall, Chevron announced an agreement with the National Renewable Energy Laboratory (NREL) to collaboratively research technologies to produce transportation fuels from algae. It is part of a strategic alliance the two formed in 2006 to study and advance the development of biofuels.

NREL, a laboratory of the U.S. Department of Energy, conducts widespread scientific and engineering research on biofuels, renewable electricity and energy systems. As the need for diverse sources of energy continues to grow, Chevron is looking at a number of different biofuel options. Algae, which feed off carbon dioxide, have a chemical makeup well-suited for developing fuel.

Unlike many other potential biofuel sources, algae are not a source of food for humans. NREL, a world-class leader in the study of algae, has a huge body of research on these simple plantlike organisms. Working together, NREL and Chevron are using each other's core strengths to develop these simple organisms into renewable transportation fuels.

Collaboration is at the heart of this research alliance. For almost two decades, NREL scientists have patiently identified many known naturally occurring species of algae, carefully noting the unique qualities of each one. Today these scientists are searching for robust, prolific strains to understand what each strain does and to determine how to best process it.

"We are extremely pleased to join Chevron in this path-breaking research," says NREL director Dan Arvizu. "Our scientists have the advanced tools and the experience to rapidly optimize yield and productivity of key species of algae. In Chevron, we have found an ideal research partner with the skills and knowledge to transform these species into cost-competitive fuels and distribute those fuels to customers."

The ball is passed to Chevron at the processing stage. Chevron scientists and engineers are focusing on three things: identifying the most advantageous algae strain, determining how to extract oil from algae and developing processes to refine that oil into a fuel. To achieve these goals, they have many hurdles to overcome. In addition to developing a cost-effective way to transform algae into fuel, they must also study how and where to grow it contaminant-free.

"We have a number of challenges in trying to develop these new sources of energy," says Steve Miller, the Chevron researcher managing the alliance. "If we are successful, algae have the potential to be a valuable raw material for manufacturing biofuels."

Underwater Explorers

Transmitting data through water

Chevron and the Massachusetts Institute of Technology (MIT) have teamed up on a $5 million research agreement primarily to develop remote ultra-deepwater—to 10,000 feet (3,000 m) and beyond—exploration and production technologies. One research project under way perfects ultra-deepwater robots, known as autonomous underwater vehicles, or AUVs. It tailors AUVs for the rigors of ultra-deepwater exploration, equipping them with capabilities that should reduce costs by minimizing the use of remotely operated vehicles (ROVs) for simple ultra-deepwater tasks. Chevron and MIT are teaching these AUVs to swim around the inky black ocean floor and provide feedback to engineers about the conditions of the oil field infrastructure there.

A research team led by two MIT professors, Chryss Chryssostomidis and Milica Stojanovic, is conducting the AUV and acoustic communication research.

"Our alliance with Chevron will enable us to learn more about the deep-sea environment as it pertains to propagation of acoustic signals. More important, we will test communication algorithms I have been developing over the past several years," says Stojanovic, principal scientist at MIT. "If successful, this effort will benefit Chevron by providing acoustic communication methods that may be applicable to the next generation of remotely controlled instruments for modern deep-sea oil drilling and production."

One researcher, Dylan Owens, a Chevron fellowship recipient, is studying AUV docking for offshore operations. Owens is working to enable an AUV named *Odyssey IV* to hover in place, send data to its operator and to await further instructions. Currently when deepwater equipment issues arise, Chevron hires ships equipped with ROVs to investigate the problem—at a cost upward of $100,000 a day. Chevron and MIT expect AUVs like *Odyssey IV* to cost-effectively perform tasks such as inspecting subsea equipment, retrieving samples and actuating valves.

MIT and Chevron are also working to develop a reliable high-speed communication link for *Odyssey IV*. Jim Morash, a former Chevron fellowship recipient who is now an MIT research engineer, produced the first prototype of this integrated acoustic modem last fall.

Odyssey IV transmits data wirelessly to a receiver on the ocean floor that relays this information to engineers in a control center. Those operating it can view live video from *Odyssey IV*'s onboard cameras and communicate with the AUV through this same seabed receiver, providing further instructions. Morash, who also wrote the software for transmitting the *Odyssey IV* data, explains, "We hope this acoustic modem technology will make it possible to transmit data reliably through water at very high speeds. As it is wireless, it should result in lower operating costs for maintenance and inspection tasks."

"This is an exciting time for the industry. These deepwater technology studies are pushing the boundaries of energy exploration and production, and we are drilling at depths once thought to be impractical," says Owen Oakley, a Chevron research consultant who manages this alliance. He adds, "The AUV technologies and the high-speed communication link we're developing for *Odyssey IV* are just two examples of a broad-based research collaboration we have formed with MIT."

The agreement, which calls for $5 million to be dispersed over the next five years, is part of a larger body of energy research called the MIT Energy Initiative.

Learn more about MIT's Center for Ocean Engineering at http://oe.mit.edu.

A Bridge Over the Energy Gap

Researching cleaner coal technologies

In a world in which the supply of energy is having trouble keeping pace with the rapid increase in demand, one important solution may be a very familiar source of energy: coal. For centuries, this abundant resource has been used to meet a variety of energy needs, and today, Chevron is working to develop technologies that will make coal friendlier to the environment.

Coal, which is primarily plant matter that has been in the earth for hundreds of millions of years, is readily available throughout the world, including in Australia, China, India, Russia and the United States. As Paul Allinson, vice president of Chevron Energy Technology Co., explains, "Coal is abundant and its locations are well-known. The development of more effective technologies to convert coal to transportation fuel will be beneficial to society."

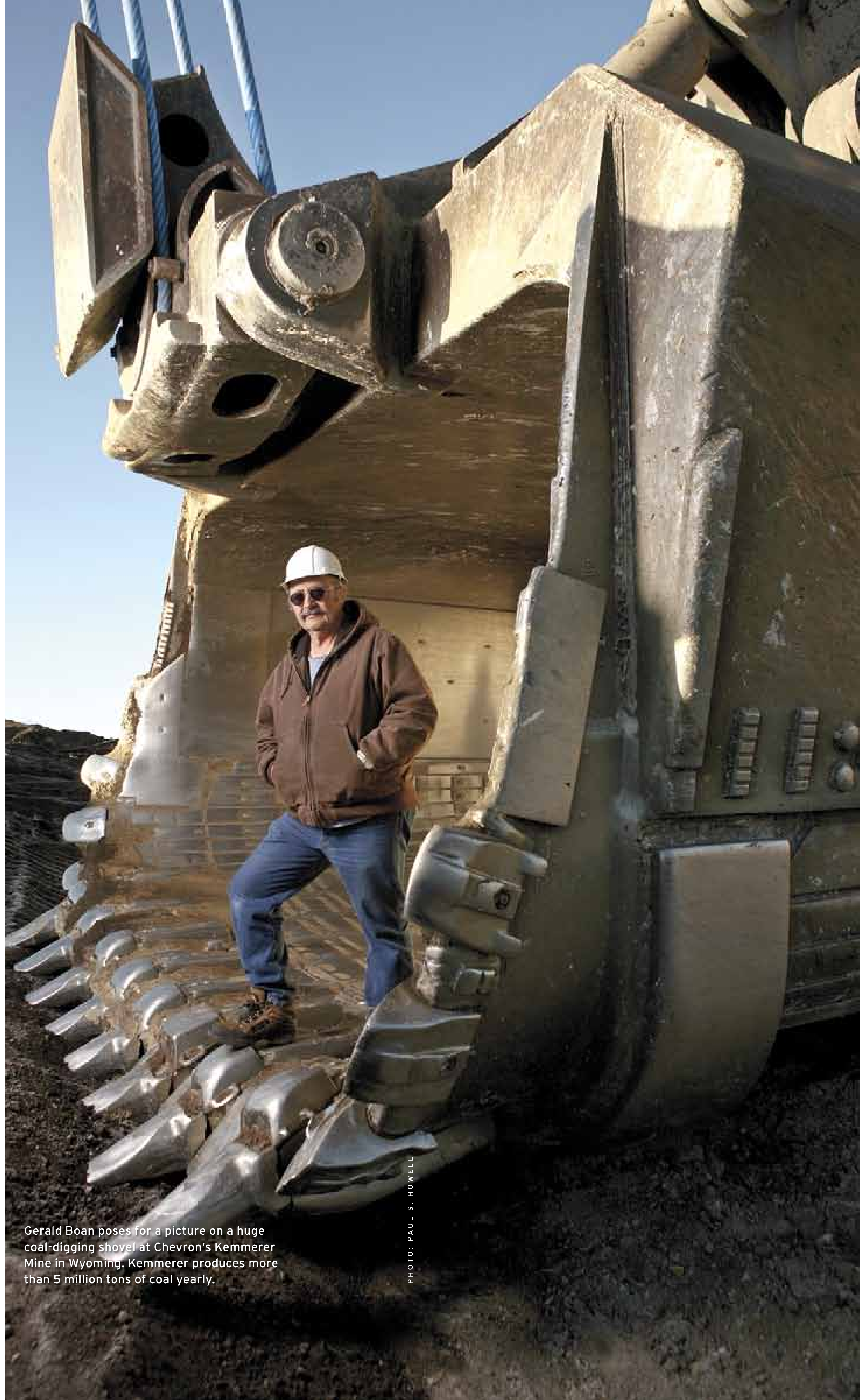
Chevron recently formed a research alliance with Pennsylvania State University (Penn State) to do just that. Over the next five years, the $17.5 million agreement will focus on ways to advance the clean conversion of coal into transportation fuels. Chevron and Penn State researchers will explore coal chemistry, catalysts for converting coal to liquids, and next-generation coal-to-liquids process technologies.

There are many pathways for transforming coal into fuel. The indirect method uses gasification to break coal into small molecules of carbon monoxide (CO) and hydrogen gas (H_2). Part of the coal is burned with pure oxygen in the presence of steam to produce a mixture called synthesis gas (syngas). Impurities must then be removed from the syngas. This process creates considerable carbon dioxide (CO_2) emissions because part of the coal is burned. The syngas is then reassembled into hydrocarbon fuels using catalysts to create a chemical reaction that converts CO_2 and H_2 into liquid hydrocarbons. This process, called the Fischer-Tropsch process, produces excellent fuel, but it is energy intensive and expensive.

"Converting coal to liquids via direct liquefaction produces fewer emissions," explains Jeff Hedges, general manager of integrated laboratory technologies at Chevron. "We need to understand how sub-bituminous coals, which are inexpensive and particularly abundant in North America, break down to liquid when they are run through a reactor, and researchers at Penn State have been studying this."

One reason direct liquefaction is cleaner is that the coal does not have to be broken down into CO and H_2 molecules as it does in the indirect method. And direct liquefaction is far more efficient than gasification because syngas does not have to be produced. Instead, coal is ground, dried and slurried in a hydrocarbon solvent. Specially designed catalysts are then used to create a reaction of the coal slurry with the hydrogen to produce high-quality coal liquids. These coal liquids can be marketed as synthetic crude or further processed into transportation fuel.

"Developing a clean process for converting coal to liquid is one of the nation's major energy challenges," says Eva Pell, senior vice president for research and dean of the graduate school at the university. "Penn State has a long history of leading energy research and education, including the study of fossil energy, renewable energy and nuclear energy, with coal research dating back more than a century. We are delighted to work together with Chevron to help meet the nation's clean energy challenges and train tomorrow's energy professionals."



Gerald Boan poses for a picture on a huge coal-digging shovel at Chevron's Kemmerer Mine in Wyoming. Kemmerer produces more than 5 million tons of coal yearly.

PHOTO: PAUL S. HOWELL

On the Lookout

Shaping future suppliers

Second to the U.S. government, which industry is the largest user of high-performance computing in the world?

The answer is the oil and gas industry, which depends on high-performance computers to map huge and complex swaths of the earth's subsurface. And Chevron has been singled out as a leading user. Readers of *HPCwire*, an online news and information service covering the computing field, voted Chevron the most innovative user of high-performance computing.

But the field of high-performance computing transforms like rapidly dividing cells. To stay apace, Chevron relies on its venture capital group within Chevron Technology Ventures (CTV) to scout out emerging companies whose technologies could give Chevron an edge.

"It's a win, win, win," says John Hanten, an executive with CTV. "The startup receives Chevron's minority equity investment, becomes our supplier and may grow to the point where it is acquired at an attractive price by another company. In return, we help shape our future suppliers, enhance our business with their products and achieve an attractive return on our investment."

Chevron's model of an in-house venture capital firm is fairly unique among the major oil and gas companies.

Here's how the model works: Chevron reviews up to 400 early-stage companies a year. While many are involved in oil field services technologies, others are developing novel information technology. Chevron looks for two types: high-performance computing that can be used for exploration, and information technology that can help employees work more efficiently.

Next, Chevron introduces the most promising startups to a company business unit having a complementary problem to solve. A "technology transfer" is made when the business unit purchases the technology. Chevron aims for at least 10 such transfers a year.

Compared with traditional venture capital firms, which finance and influence the management of startups, Chevron offers a unique resource. "We bring access to our technology system, which is large and deep and good," says Hanten. "And we bring Chevron as a potential customer and reference."

Recent examples of transfers include SilverStorm Technologies, which developed specialized technology to accelerate the communication between hundreds of computer nodes in Chevron's computer clusters to speed up seismic processing.

"We had a successful financial return," says Hanten, "and we helped generate additional business for SilverStorm."

Four years ago, Chevron evaluated IronPort Systems, Inc., an email-filtering company. At the time, Chevron employees were getting spammed to death. Chevron identified issues with the product that needed to be addressed.

After resolving the issues, Chevron adopted the product. Almost overnight, spam disappeared. Later, networking giant Cisco Systems, Inc., acquired IronPort for $830 million, netting Chevron a tidy profit.

The model's benefits speak for themselves. Since forming in 1999, the venture capital group has racked up more than 80 technology transfers. Ranked against professional venture capital firms, the group has achieved top-quartile financial returns.

What's the Alternative?

Cleaner fuels program explores biodiesel and GTL

Building on its partnership to test hydrogen as a transportation fuel, Chevron and the Alameda–Contra Costa Transit District (AC Transit) in California launched another partnership: the Cleaner Fuels Test Program to study two alternative fuels in buses traveling San Francisco Bay Area roadways.

During the six-month study, AC Transit tested a biodiesel fuel blend and GTL (gas-to-liquids) diesel in a fleet of 22 unmodified diesel buses. Chevron provided the fuels, engine manufacturer Cummins Inc. provided technical consulting, and AC Transit supplied buses and collected data. During the study, the buses transported more than 1 million passengers, traveled more than 400,000 miles and consumed more than 100,000 gallons of alternative fuels.

The pilot was unique because it provided the opportunity for an end-user, a fuel provider and an engine manufacturer collectively to learn more about the characteristics, distribution, efficiency and emissions of biodiesel and GTL diesel. Along with providing information on the potential emissions benefits, the program offered participants invaluable experience in such critical areas as fuel handling, blending and storage.

The Cleaner Fuels Test Program builds on another Chevron and AC Transit partnership—the successful HyRoad Fuel Cell Demonstration Program. For this ground-breaking program, Chevron built hydrogen production and fueling facilities that have been powering AC Transit's fleet of zero-emission fuel cell buses since January 2006.

"AC Transit and Chevron have shown how public-private partnerships can advance technological innovation through real-world demonstration," says Rick Fernandez, general manager of AC Transit. "As a public transit agency, our mission is to provide the best possible service to our communities. By exploring a range of emissions-reducing alternatives, we not only provide cleaner, 'greener' public transportation for our region, we also help advance our range of alternative fuels, potentially benefiting communities far beyond our own service area."

"Chevron supports increasing the amount of renewable and alternative fuels in the transportation fuel mix as a way to help expand and diversify energy supplies," says Mike Wirth, executive vice president of Global Downstream for Chevron.

The Cleaner Fuels Test Program studied B20, a blend of 20 percent biodiesel and 80 percent ultralow-sulfur diesel. While B20 can be used in conventional diesel vehicles, the warranties on most engines allow only for biodiesel blends up to 5 percent. This partnership provided the opportunity to study the impact of a higher-biodiesel blend on engines.

The pilot program also studied the use of 100 percent GTL diesel, a high-quality liquid fuel derived from natural gas. It is virtually sulfur-free and almost odorless. GTL diesel could help diversify supplies needed to meet the global demand for transportation fuels.

The test program is just one example of how Chevron seeks out public-private alliances that benefit from each partner's area of expertise. By working together, all partners can gain a better understanding of how alternative fuels may one day move from an emerging energy source to a conventional one.

Chevron and partner AC Transit are testing two alternative fuels for real-world transportation on San Francisco Bay Area roadways.

PHOTO: FILMSIGHT PRODUCTIONS

Here Comes the Sun

Rising from across the San Francisco Bay, the sun greets the photovoltaic cells at the University of California's San Francisco campus. Chevron subsidiary Chevron Energy Solutions (CES) developed, designed and installed the 250-kilowatt direct-current solar power system. CES has also helped post offices and other institutions use renewable energy to meet their power demands and sustainability goals. See the story on page 10.

PHOTO: PAUL S. HOWELL

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