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## News Release

April 10, 2008

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# 3 to 4.3 Billion Barrels of Technically Recoverable Oil Assessed in North Dakota and Montana's Bakken Formation—25 Times More Than 1995 Estimate—

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Reston, VA - North Dakota and Montana have an estimated 3.0 to 4.3 billion barrels of undiscovered, technically recoverable oil in an area known as the Bakken Formation.

A U.S. Geological Survey assessment, released April 10, shows a 25-fold increase in the amount of oil that can be recovered compared to the agency's 1995 estimate of 151 million barrels of oil.

Technically recoverable oil resources are those producible using currently available technology and industry practices. USGS is the only provider of publicly available estimates of undiscovered technically recoverable oil and gas resources.

New geologic models applied to the Bakken Formation, advances in drilling and production technologies, and recent oil discoveries have resulted in these substantially larger technically recoverable oil volumes. About 105 million barrels of oil were produced from the Bakken Formation by the end of 2007.

The USGS Bakken study was undertaken as part of a nationwide project assessing domestic petroleum basins using standardized methodology and protocol as required by the Energy Policy and Conservation Act of 2000.

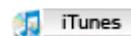
The Bakken Formation estimate is larger than all other current USGS oil assessments of the lower 48

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states and is the largest "continuous" oil accumulation ever assessed by the USGS. A "continuous" oil accumulation means that the oil resource is dispersed throughout a geologic formation rather than existing as discrete, localized occurrences. The next largest "continuous" oil accumulation in the U.S. is in the Austin Chalk of Texas and Louisiana, with an undiscovered estimate of 1.0 billions of barrels of technically recoverable oil.

"It is clear that the Bakken formation contains a significant amount of oil - the question is how much of that oil is recoverable using today's technology?" said Senator Byron Dorgan, of North Dakota. "To get an answer to this important question, I requested that the U.S. Geological Survey complete this study, which will provide an up-to-date estimate on the amount of technically recoverable oil resources in the Bakken Shale formation."

The USGS estimate of 3.0 to 4.3 billion barrels of technically recoverable oil has a mean value of 3.65 billion barrels. Scientists conducted detailed studies in stratigraphy and structural geology and the modeling of petroleum geochemistry. They also combined their findings with historical exploration and production analyses to determine the undiscovered, technically recoverable oil estimates.

USGS worked with the North Dakota Geological Survey, a number of petroleum industry companies and independents, universities and other experts to develop a geological understanding of the Bakken Formation. These groups provided critical information and feedback on geological and engineering concepts important to building the geologic and production models used in the assessment.

Five continuous assessment units (AU) were identified and assessed in the Bakken Formation of North Dakota and Montana - the Elm Coulee-Billings Nose AU, the Central Basin-Poplar Dome AU, the Nesson-Little Knife Structural AU, the Eastern Expulsion Threshold AU, and the Northwest Expulsion Threshold AU.

At the time of the assessment, a limited number of wells have produced oil from three of the assessments units in Central Basin-Poplar Dome, Eastern Expulsion Threshold, and Northwest Expulsion Threshold.

The Elm Coulee oil field in Montana, discovered in 2000, has produced about 65 million barrels of the 105 million barrels of oil recovered from the Bakken Formation.

Results of the assessment can be found at <http://energy.usgs.gov>.

For a podcast interview with scientists about the Bakken Formation, listen to episode 38 of CoreCast at <http://www.usgs.gov/corecast/>.

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March 8, 2009

FRESH STARTS

## Hiring in Hydrology Resists the Slump

By EILENE ZIMMERMAN

THE Earth may be two-thirds water, but only about 1 percent of that water is actually usable for human consumption and agriculture. What's more, as the planet warms and the population shifts, even that 1 percent is at risk.

That is why demand for hydrologists has been predicted to grow 24 percent from 2006 to 2016, much faster than the average for all occupations, according to the Bureau of Labor Statistics.

Hydrologists study the distribution, circulation and physical properties of water, with hydrogeologists focusing specifically on groundwater. (According to the United States Geological Survey, there is 100 times more water beneath the ground than there is in all the world's lakes and rivers.)

"Hydrologist is a fairly broad term, but generally, any research or problems having to do with water, there's a hydrologist working on it," said Matthew C. Larsen, a hydrologist and associate director for water at the Geological Survey.

Most hydrologists did not earn degrees in hydrology; in fact, only a handful of undergraduate and graduate hydrology programs exist across the country. It is far more common for hydrologists to come from a hard-science or engineering background. Though it is possible to enter the field with a bachelor's degree — most often as a lab technician — moving up in the career requires an advanced degree, Mr. Larsen said.

After creation of the Environmental Protection Agency in 1970 and passage of the Clean Air Act in 1977 and Superfund legislation in 1980, hydrologists' work was largely focused on water quality. Today, however, "an increasing percentage of hydrologists are interested in water quantity and supply, which is an emerging issue and where global climate change plays a big role," said Dork Sahagian, professor of earth and environmental science at Lehigh University and director of its Environmental Initiative in Bethlehem, Pa.

"But concern with water quality — which involves local, site-based issues — still drives the job market," he said. "Most hydrologists in this part of the world are still hired to cope with the availability of clean water for drinking and municipal supplies."

Hydrologists use samples of water and soil, which they have traditionally collected themselves by wading out

into a river or lake. Computers, however, have changed the nature of that field work. The Geological Survey now uses computerized samplers set up in rivers and streams throughout the nation.

**But some field work is still required, especially early in a hydrologist's career, and is often considered a perk — the ability to work outdoors and in beautiful places. That work could involve inspecting a dam, drilling a well or measuring a river's flow.**

"I used to say the worst day in the field still beat the best day in the office," said Mark Wigmosta, a hydrologist with the Pacific Northwest National Laboratory, an Energy Department research center in Richland, Wash. "I don't spend as much time out in the field, and I miss it. My work now is primarily in front of a computer."

In fact, computers have revolutionized hydrology in ways beyond sampling. Data collected in the field is now plugged into complex mathematic models that allow hydrologists to make predictions — for example, about the effect of climate change on sea levels. The models also help them develop recommendations for solving problems, like how much water can be diverted from a river to combat a drought.

"People interested in hydrology often don't understand you need to be very strong in math," said Michael Boufadel, an engineer and hydrologist and the chairman of the civil and environmental engineering department at [Temple University](#) in Philadelphia.

They also need to communicate well, because their research is often written in reports and presented to others — to policy makers, if they work in the public sector, or to clients in the private sector.

According to the Bureau of Labor Statistics, **about 28 percent of hydrologists are employed by the federal government, at the Geological Survey and the Defense Department. An additional 21 percent work for state agencies and state departments of conservation. Others work in architecture, engineering and for management, scientific and technical consulting firms.**

SCOTT D. WARNER, principal hydrogeologist and a vice president at the environmental consulting firm Amec Geomatrix in Oakland, Calif., said **demand for his firm's services had been strong since the 1980s. "Our firm is growing, even in this economic downturn,"** he said. Much of Amec's work is with municipal water districts that need to find ways to manage their water and predict their needs.

Salaries for hydrologists range from an entry level of about \$35,000 to well into six figures for the most senior scientists at consulting firms. Jobs in consulting firms generally pay higher salaries than those with the government.

But few choose the profession to become rich, Mr. Warner said. Most often, the reason is that the work is fulfilling. "We're not oil tycoons, but we feel good about the type of work we do and the problems we solve," he said. "You really learn something new every day."



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#### Hydrogeologists Tap into Demand for an Irreplaceable Resource

Robert Coontz  
United States  
8 August 2008

When hydrogeologists talk about their field, one word keeps coming up: "recession-proof." While geologists in the energy and mineral industries face roller-coaster hiring-and-firing cycles, those who study the movement and chemistry of water seeping through rocks and sediment find demand for their expertise almost as steady as the flow of groundwater itself.

"Water problems are not going away." - Richelle Allen-King, University at Buffalo

"I can't think of any unemployed hydrogeologists," says Roy Haggerty, an associate professor of hydrogeology at Oregon State University, Corvallis. It's easy to see why. Water is essential, irreplaceable, and, as populations and economies grow, increasingly in demand and endangered.

Environmental consulting companies, which employ about 80% of hydrogeologists in the United States, currently report four jobs for every qualified graduate, according to the American Geological Institute (AGI). Government regulatory agencies, national laboratories, and mining and oil companies also need them. New niches open regularly as hydrogeologists team up with scientists in other disciplines to grapple with huge environmental challenges, such as forecasting how changing climate will affect water resources and aquatic life. And signs are that the future will hold more of the same. As Richelle Allen-King, a hydrogeology professor at the University at Buffalo in New York, puts it, "Water problems are not going away."

#### A STEADY FLOW

Kurt Zeiler, 32, works in the Denver, Colorado, office of the global environmental-services company AMEC Geomatrix. After 5 years as a hydrogeologist, he says: "It's going well. I definitely love this field."

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There's a lot of opportunities to do really interesting science."

Zeiler's training--a B.S. in earth science from [Montana State University](#) in Bozeman and a double-M.S. in water resources and hydrogeology from the [University of Wisconsin](#), Madison--exposed him to the whole gamut of hydrogeologic work. He learned to monitor the water levels in wells for the differences in hydraulic potential ("head") that drive water through porous rock or sediments, analyze well-drilling cores to get a picture of underground rock and sediment layers, perform pump tests to determine how readily the water can flow through the strata, and probe water samples for their geochemistry and contamination.



**Taking data.** Kurt Zeiler logs core samples.

His forte, though, is running the computer models that hydrogeologists use to integrate their knowledge of a groundwater system and plan its future. Zeiler's modeling work has covered sites in California, Montana, Alaska, and Ghana. His biggest project is an aquifer east of Los Angeles where groundwater contaminated with fuel and industrial solvents is being pumped out and treated for use as drinking water. Zeiler says he leaves most of the data gathering to other scientists. "I enjoy being outside--working on a drill rig, getting my hands dirty, all that stuff," he says. "But modeling is where I've ended up."

Of the 15 hydrogeologists in the Denver office where Zeiler works, only three have Ph.D.s. That's typical of the field as a whole: AGI estimates that university programs graduate five times as many M.S. students as Ph.D.s. Its figures show that about 18,000 hydrologists and hydrogeologists now work in the environmental industry, a few thousand in the mining and petroleum industries, and about 850 in academia, the only sector for which a doctorate is required.

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Despite high demand, salaries for hydrogeologists in government and in the private sector remain about 15% to 20% below those of other geoscientists. Low payoffs go hand in hand with high security, Haggerty says: "I know of people in their 50s who have been fabulously successful in the petroleum industry, but there are boom-and-bust cycles. In hydrogeology, the boom and bust is not there. It's much more level. But I don't know of many multimillionaire hydrogeologists, either."

If the field doesn't surge, it does at least ebb and flow. "Ten to 20 years ago, it was all cleanup--contaminant work," Allen-King says. The profession's cleanup phase waned in the late 1990s and early 2000s as changing political priorities, soaring cleanup costs, and some noteworthy environmental successes led to cutbacks in remediation.

Now, the focus has shifted to supply, the problem of finding and managing water resources while protecting their quality. Techniques such as artificial recharge (reinjecting water into the ground for storage) and carbon sequestration (keeping carbon dioxide emissions from combustion out of the atmosphere by forcing them underground) raise new water-related environmental issues that scientists are just learning to tackle.

In the realm of research, academic hydrogeologists are broadening their time horizons to help forecast and mitigate the effects of climate change, and they're stretching the traditional boundaries of their field to explore questions such as how groundwater interacts with the surface water of lakes and rivers. Collaborations with scientists from other disciplines are proliferating. "More and more, hydrogeologists are no longer working alone," says John Wilson, a hydrology professor at the [New Mexico Institute of Mining and Technology](#) in Socorro. "The subsurface is part of it but no longer the whole thing. Other parts of the cycle--biology, chemistry, ecology, and climate--that is where research is going, I think."

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## SHADES OF GREEN

The broadening of academic research has filtered down to the training of M.S. students. Some graduate programs, such as New Mexico Tech's and the double-M.S. program at the University of Wisconsin, now require interdisciplinary courses in topics such as surface water, ecology, and economics. Some hydrologic consulting companies, however, complain that versatility isn't what they need. "We're having difficulty finding traditional hydrogeologists," says [Daniel Stephens](#), founder and head of a 110-employee environmental consulting company with offices in New Mexico, Texas, and California. "The people we're seeing are fewer in number, and their qualifications are thinner." Instead of giving students a smorgasbord of skills, Stephens says, universities should equip them to start work on real projects.

But Wilson, whose department at New Mexico Tech embraced the multidisciplinary approach a decade ago, says his students are well-prepared to learn anything they need to know. "At some point, the employer is responsible for training students in the details of the jobs," he says. Oil companies, he notes, are happy to recruit promising hydrogeologists and train them in petroleum exploration.

If money were the only lure for earth scientists, fossil fuels might be the only fluids in town. But hydrogeologists say a strong undercurrent of environmental idealism pervades the field as well. Just as many senior scientists drew their inspiration from the first Earth Day, some young water experts are pursuing activist agendas of their own--and carving out new career paths to do it.



**Pumped up.** Trayle Kulshan tests a new well north of Kabul, Afghanistan.

Trayle Kulshan is one of them. After getting her M.S. in hydrogeology from [Stanford University](#) in Palo Alto, California, in 2002, she spent 2 years in the Peace Corps in Guinea. Now, as water, sanitation, and hygiene coordinator for the humanitarian nongovernmental organization [Action Contre la Faim](#) (Action Against Hunger), she plans and oversees projects to build wells, latrines, and water networks in developing countries as far-flung as Afghanistan and the Democratic Republic of the Congo. She currently is working in Kenya.

Although she is now as much a public-health worker as an earth scientist, Kulshan says her graduate training gives her a quick grasp of hydrologic conditions as well as skill in collecting, analyzing, and interpreting other kinds of data and communicating the results. "In grad school, we are all [teaching assistants] and develop skills as teachers. Every day I am teaching," she wrote by e-mail from Nairobi. "And I have to say I am still a student learning every day as well."



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"Functionally, there's no unemployment of geoscientists right now." Cindy Martinez, American Geological Institute

### In the Geosciences, Business Is Booming

Carolyn Gramling  
United States  
8 August 2008

Geologist Amy Simonson loves her work. She spends her days in the countryside around Charlottesville, Virginia, measuring stream flow and groundwater levels for the state's [Department of Environmental Quality](#). The job, she says, is exactly what she wanted.

Simonson, 25, began her job hunt in 2007 after getting a master's degree in geology from the [University of Delaware](#), Newark. She had one condition: She wanted to spend as much time as possible in the field, not in front of a microscope or a computer. Taking a scattershot approach, she applied for jobs in geophysics, engineering, environmental consulting, and geographic information system mapping. She didn't have to wait long. "I got offered a lot of stuff," she says.

Simonson's experience isn't rare. For many young geoscientists now embarking on careers, the job outlook is very good. The current federal research funding situation means it's less rosy for those on an academic research track. But for those in industry, the number of geoscience jobs will grow by 22% from 2006 to 2016, much faster than the projected total of a 10% increase for all occupations, according to the U.S. [Bureau of Labor Statistics](#).

"In general, the market is hot," says Cindy Martinez, who analyzes geoscience workforce issues at the [American Geological Institute](#) (AGI) in Alexandria, Virginia. "Functionally, there's no unemployment of geoscientists right now."

In the petroleum, mining, and environmental consulting industries, a desperate quest for new talent has sent companies scrambling to hire new graduates. Traditionally, a master's has been the professional degree of choice for industry employers. But the need for new hires within these fields is such that even graduates with bachelor's degrees are

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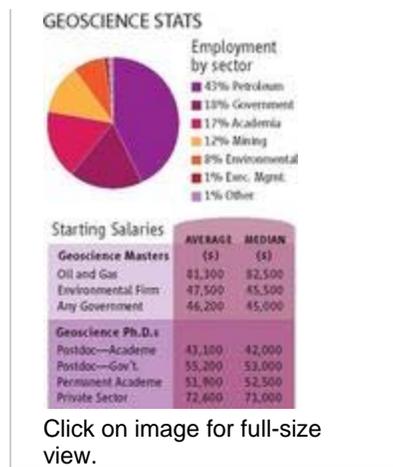
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finding jobs, particularly in environmental consulting--although a master's is generally needed to move up the ladder from fieldwork to the office.

That intense competition for new hires has raised starting salaries in these industries, especially oil: Graduates now entering the petroleum industry earn \$82,500 a year, on average, according to AGI.

Geoscience salaries generally have also been increasing, AGI data show. In 2005, the average starting salary for a geoscientist in an industry, academic, or government position was \$74,000, a 9.7% increase over 2004. For later career scientists with more than 20 years of experience, the average salary was \$139,000 in 2005, an increase of more than 23% over the previous year.



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The current hiring boom in the petroleum industry is a welcome change from the layoffs of the 1980s and 1990s; unemployment among geoscientists reached 11% in 1985. Those layoffs left a distinct gap in the oil industry workforce between new hires and senior managers, a 2007 [National Petroleum Council](#) report noted. And with many senior managers likely to retire within the next decade, there aren't enough midlevel managers ready to take the helm. This hiring and firing pattern is "totally cyclical," Martinez says. "The industry needs to work on fixing that."

Although industry jobs are readily available, the job market is tougher for students seeking careers in academia. One problem is a research-funding shortage, as primary funding sources such as the [National Science Foundation](#) have suffered from essentially flat research budgets for the past few years. That lack of research money contributes to another trend: When a venerated geology professor retires, some universities are choosing not to hire a replacement, filling the position with a scientist in a different, often environmental, field, or not at all. As of January 2008, the number of geoscience faculty members in U.S. colleges and universities was 12,354, down from 13,554 in 1999, according to a June 2008 report released by AGI.

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The lack of available academic positions has left geoscientists who aspire to faculty jobs in limbo, often stringing together several postdoc positions as they wait for openings, Martinez says. The percentage of geoscience postdocs "has really gone through the roof," with about 58% of Ph.D. graduates pursuing postdocs in 2005 compared with 40% in 1999. That trend may soon slow if a combination of strong industry salaries and weak academic opportunities pushes some students to leave graduate school early. "We're seeing geoscientists in droves going into industry with master's degrees and not staying on for Ph.D.s," Martinez says.

"My perception is indeed that there are many more applicants for jobs than there are positions," says Joseph Colgan, a [Mendenhall Postdoctoral Research Fellow](#) at the [U.S. Geological Survey](#) (USGS) in

Menlo Park, California. Colgan, who studies the geologic setting of mineral deposits in the western United States, has considered academic jobs but would like to stay in a more permanent job at USGS. However, the agency, like many universities, has tightened its belt after years of flat or declining budgets, which means fewer hires.

Geoscience graduates will have training that qualifies them for jobs outside of their home field. Scientists with training in multidisciplinary specialties such as isotopic tracers, mineral commodities, and geotechnology are successfully venturing into fields that aren't considered geologic, including medicine, law, and finance. In fact, only 50% of people with geoscience degrees currently work in the geosciences, according to AGI.

Ultimately, for geoscientists who want to work in industry, job opportunities abound. "The earth

sciences are in a somewhat unique situation at the moment because we're in one of the biggest commodity booms ever," Colgan says. So if he doesn't get a permanent position with USGS, he adds, "I'll come up with something else."

Carolyn Gramling is a geosciences writer in Washington, D.C.	Comments, suggestions? Please send your feedback <a href="#">to our editor</a> .
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June 24, 2009

## Despite Recession, High Demand for Skilled Labor

By [LOUIS UCHITELLE](#)

Just as the recession began, Chris McGrary, a manager at the Cianbro Corporation, set out to hire 80 “experienced” welders. Only now, 18 months later, is he completing the roster.

With the unemployment rate soaring, there have been plenty of applicants. But the welding test stumped many of them. Mr. McGrary found that only those with 10 years of experience — and not all of them — could produce a perfect weld: one without flaws, even in an X-ray. Flawless welds are needed for the oil refinery sections that Cianbro is building in Brewer, Me.

“If you don’t hire in a day or two, the ones that can do that,” Mr. McGrary said, “they are out the door and working for another company.”

Six million jobs have disappeared across the country since Mr. McGrary began his quest. The unemployment rate has risen precipitously to 9.4 percent, the highest level in nearly 30 years, and most of the jobs that do come open are quickly filled from the legions of seekers. But unnoticed in the government’s standard employment data, employers are begging for qualified applicants for certain occupations, even in hard times. Most of the jobs involve skills that take years to attain.

Welder is one, employers report. Critical care nurse is another. Electrical lineman is yet another, particularly those skilled in stringing high-voltage wires across the landscape. Special education teachers are in demand. So are **geotechnical engineers, trained in geology as well as engineering, a combination sought for oil field work.** Respiratory therapists, who help the ill breathe, are not easily found, at least not by the Permanente Medical Group, which employs more than 30,000 health professionals. And with infrastructure spending now on the rise, civil engineers are in demand to supervise the work.

“Not newly graduated civil engineers,” said Larry Jacobson, executive director of the National Society of Professional Engineers. **“What’s missing are enough licensed professionals who have worked at least five years under experienced engineers before taking the licensing exam.”**

While these workers might be lured away by higher offers in a robust economy, they should be more plentiful when overall business demand is as slack as it is now.

For these hard-to-fill jobs, there seems to be a common denominator. Employers are looking for people who have acquired an exacting skill, first through education — often just high school vocational training — and then by honing it on the job. That trajectory, requiring years, is no longer so easy in America, said Richard Sennett, a [New York University](#) sociologist.

The pressure to earn a bachelor's degree draws young people away from occupational training, particularly occupations that do not require college, Mr. Sennett said, and he cited two other factors. Outsourcing interrupts employment before a skill is fully developed, and layoffs undermine dedication to a single occupation. "People are told they can't get back to work unless they retrain for a new skill," he said.

None of this deterred Keelan Prados from pursuing a career as a welder, one among roughly 200,000 across the nation. At 28, he has more than a decade of experience, beginning when he was a teenager, building and repairing oil field equipment in his father's shop in Louisiana. Marriage to a Canadian brought the Pradoses to Maine, near her family. And before Mr. Prados joined Cianbro, an industrial contractor, he ran his own business, repairing logging equipment out of a welding and machine shop on the grounds of his home in Brewer.

The recession dried up that work, and last December, he answered one of Mr. McGrary's ads. "I welded a couple of pieces of plate together for them and two pipes, and they were impressed," Mr. Prados said. In less than two weeks, he was at work on Cianbro's oil refinery project, earning \$22 an hour and among the youngest of Mr. McGrary's hires, most of whom are in their mid-30s to early 40s.

The [Bureau of Labor Statistics](#) does not track how often Mr. Prados's experience — applying for a job and quickly being offered it — is repeated in America in the midst of huge and protracted unemployment. A bureau survey counts the number of job openings and the number of hires, but the data is not broken down by occupation.

[The Conference Board](#), a business organization in New York, comes closer. In a monthly count of online job openings — listed on Monster.com and more than 1,200 similar Web sites — it breaks the advertised openings into 22 broad occupational categories and compares those with the number of unemployed whose last job, according to the bureau, was in each category. In only four of the categories — architecture and engineering, the physical sciences, computer and mathematical science, and health care — were the unemployed equal to or fewer than the listed job openings. There were, in sum, 1.09 million listed openings and only 582,700 unemployed people presumably available to fill them.

The Conference Board's hard-to-fill openings include registered nurses, but the shortage is not as great as it was before the recession, particularly in battered states like Michigan and Ohio, said Cheryl Peterson, a director of the American Nurses Association.

"Until the downturn, it was easy for experienced registered nurses to find employment right in their communities, in whatever positions they wanted," Ms. Peterson said. "Now it is a little more difficult because the number of job openings has fallen and we have more retired nurses, in need of income, coming back."

That does not hold for nurses who have a decade of experience caring for critically ill people, particularly in hospital recovery rooms, said Dr. Robert Pearl, chief executive and chairman of the Permanente Medical Group, a big employer of medical professionals. "There are probably more nurses recently trained than there are jobs for them," he said, "but for those with the highest level of skill and experience, there are always openings." And at \$100,000 in pay.

That is also the case for geological engineers like Diane Oshlo, who was hired last month by Kleinfelder, a professional services firm headquartered in San Diego that takes on big projects, like the environmental

cleanup work Ms. Oshlo is doing in Corpus Christi, Tex., at the site of an inactive oil refinery. Engineers like her, skilled in petroleum, are in short supply, and those who are also professional geologists are even rarer.

That made Ms. Oshlo, 50, a hot prospect when she decided to relocate from Chicago, where she had lived for years, doing similar work for a similar firm. Margaret Duner, a Kleinfelder recruiter, spotted her résumé when it arrived in the spring in response to a job ad, and quickly brought her into the hiring process. “Diane stood out,” Ms. Duner said.

Two other firms to which Ms. Oshlo sent résumés also quickly offered work. What swayed her was not the \$65,000 salary — there will be raises and bonuses soon, Ms. Duner said — but Kleinfelder’s willingness to pay to move her to Corpus Christi.

“I told the two others I couldn’t wait,” Ms. Oshlo said. “They offered roughly the same pay, but they weren’t sure about the relocation package.”

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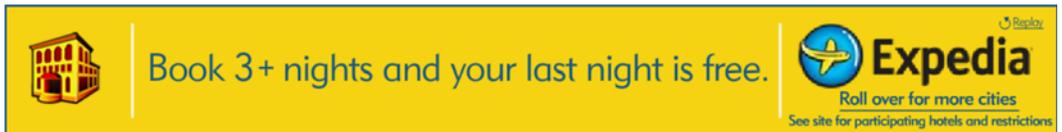
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## ENERGY

### Oxy oil discovery could spark new interest in California's energy potential

The biggest find in the state in 35 years, somewhere in Kern County, could herald new exploration in California and the U.S., experts say. But some worry it could lead to a false sense of security.

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An oil rig in the Elk Hills Oil Field near Bakersfield. Occidental Petroleum says it has made the state's biggest oil and natural gas find in 35 years in Kern County but did not disclose the site. (Gary Kazanjian / For The Times)

By Ronald D. White  
September 24, 2009

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A few years ago, Occidental Petroleum Corp. executive Stephen I. Chazen sounded like a cryptologist out of a Dan Brown novel as he told investors that an oil bonanza awaited any outfit that could "crack the code" of California's seismically fractured underground.

Occidental's engineers may have done it.

The Westwood company revealed in July that it had found the equivalent of 150 million to 250 million barrels of oil and natural gas in an undisclosed part of Kern County using techniques that the oil company's executives would rather not talk about. It was California's biggest find in 35 years.

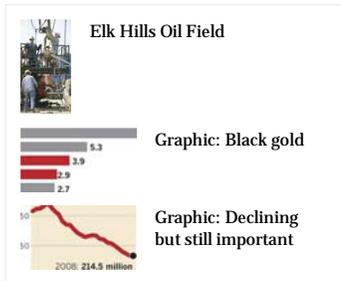
Some experts say it could herald a period of new exploration in California and the U.S.

"Certainly this kind of success will send other people back to California to rethink the geology and rethink the theories of the area," said Daniel Yergin, chairman of IHS Cambridge Energy Research Associates and author of the Pulitzer Prize-winning history of the oil industry "The Prize: The Epic Quest for Oil, Money and Power."

Joe Hahn knows firsthand the significance of finding that much crude in California.

A former oil reservoir engineer for Arco, now owned by oil giant BP, Hahn said that exploration in the state has been rife with failures and false leads.

"We had considerable acreage that turned out to be good as goat pasture," said Hahn, now a professor at Pepperdine University's Graziadio School of Business and Management. "It's very rare to have a find of this size" this late in California's oil-production history.



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Despite steady declines in petroleum output to about 214.5 million barrels last year from about 394 million barrels at the 1985 peak, California still ranks fourth in the nation behind the combined federal offshore drilling sites and Texas and Alaska.

Bruce Bullock, executive director of the Maguire Energy Institute at Southern Methodist University in Dallas, said there has been renewed interest in many old oil regions long believed to have given up most or all of their crude.

"We're seeing quite a bit of activity," Bullock said. "A: They think they can find more oil; B: They think they can get it out of the ground."

Over the last decade, Occidental has been actively acquiring leases and drilling rights in California as most other big oil companies have been selling out. But Occidental executives weren't the only people who thought that California might have a surprising amount of oil left to exploit.

The U.S. Geological Survey travels the country to assess petroleum reserves and the potential for new discoveries. In 2003 and again in 2007, its geologists said that it was likely that an additional 4 billion barrels "may be added to reserves in existing oil fields."

As Occidental's Chazen put it, "We had a small amount of production in California, historically, but we made a commitment to explore in the state. Even so, it has taken us the better part of 10 years to get where we are now."

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Photos, map and reader comments

Occidental executives have kept secret both the location of the discovery and the methods used to find the new oil and natural gas field.

"The way we found it is obviously proprietary," said Chazen, the company president, who was a vice president when he tantalized investors about code cracking in 2001. "Other people might own acreage nearby that we will want to acquire."

Chazen wasn't above dropping hints about the holdings, which were painstakingly amassed over several years.

"Most of the land was not held by individuals. Most was held by some kind of corporation or institution, some by the federal government. This wasn't a redwood forest. If you had the water for it, you might be raising cotton, at best, on it. Some of it we owned. We have the oil rights to 1 million acres there," Chazen said.

In the company's latest earnings call with analysts and investors, Chazen said that the oil find "is most similar to deep-water discovery," later adding, "There is no good analogy that we can come up with that looks like this field anywhere in the Lower 48" states.

As soon as the discovery was announced, the race was on to figure out the location of Occidental's find. A few real estate agents turned into amateur sleuths, worried about the possibility that the oil might be next to some new client's home.

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### Geoscientists in High Demand in the Oil Industry

Lucas Laursen  
United States  
8 August 2008

Six years ago, would-be lawyer Kira Diaz-Tushman heard a National Public Radio program about the impending retirement of senior [U.S. Geological Survey](#) (USGS) geologists. "I thought, 'That sounds fun. I want to do what they're doing and play around in the field.' " So she double-majored in geology and political science at [Bryn Mawr College](#) in Pennsylvania and did a summer internship at USGS.

"I joined for a bit of adventure ... [and the] opportunity to go all over the world." Sally Serenyi, Schlumberger

Watching researchers scramble for dwindling federal funding turned her away from government work. But her interest in geology persisted, so she studied for a master's degree in structural geology at the [University of Texas](#) (UT), Austin. While there, she interned with the technology group at [Apache Corp.](#), an oil exploration company based in Houston, and learned the basics of seismic mapping. She began to seriously consider a job in oil exploration.

Diaz-Tushman, now an operations geologist for [BP](#), is part of a fast-growing global cadre of scientists and engineers building careers around unlocking more of Earth's energy reserves. Those in the field repeat the mantra that the "easy oil is gone"; this new generation faces the challenge of finding oil in remote locations and of pioneering new ways to tap into unconventional reserves in existing oil fields.

### MIND THE GAP

The cyclical nature of oil prices has left a historical footprint on the existing pool of human resources. Low prices in the 1980s and 1990s meant that many major companies recruited less or not at all, leaving them top-heavy and in need of young talent.

The hiring gap "is more of a driver than the

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price" of oil today, says Laura DeMott, a Houston-based senior petroleum geologist at [ExxonMobil](#). Regardless of the cause, demand for people with geological and geophysical training is high in the oil industry, and experts predict it will stay strong for the next 5 to 10 years.

People entering the industry will have their choice of a great diversity of companies, locations, and career paths. In North America, family-owned single-drill outfits work alongside multinational exploration companies such as Schlumberger and companies that integrate the entire process from exploration to production to distribution, such as BP and ExxonMobil.



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## RECRUITMENT AND PREPARATION

Sally Serenyi (pictured at top) didn't set out to join the oil industry. But not long after she graduated with her bachelor's degree in physics from the [University of Exeter](#) in the U.K., she walked past a glossy recruiting display at a career fair with pictures of exotic landscapes. The display was for [Schlumberger](#); now, just under 2 years later, she works for the company as a field engineer. "I joined for a bit of adventure," she says, and the "opportunity to go all over the world." Serenyi works with a crew of a half-dozen engineers and equipment operators near exploration sites in Austria and Hungary, collecting and preparing data for client companies.

Recruiters generally encourage students interested in the oil industry to obtain master's degrees, and industry-sponsored scholarships provide some incentive. But the current demand for new talent means that companies are "happy to have people with a strong bachelor's," says [Charles Groat](#), former USGS director and now a professor of energy and mineral resources at UT Austin. Groat tells students that oil companies still prefer graduates who have fundamental training in geology and geophysics and who are comfortable with quantitative analysis, perhaps through classes in economics, statistics, or computer science. There are also jobs available to people in related fields including physics and engineering, as Serenyi found.

Companies use internship programs as recruiting tools and as extended interviews, says Eric Lyons, a geophysicist at BP. Lyons did three internships with [Marathon Oil Corp.](#) en route to earning a geophysics master's degree. Such programs give companies "a chance to look at the students and vice versa," Groat says. But internships are "a long way from being required," he adds.

## THE DAILY GRIND

New recruits to large companies typically spend a significant part of the first couple of years completing in-company training and gaining experience with different parts of the company. Lyons, who has worked on North American oil fields, now works on fields in the Gulf of Mexico and will be assigned elsewhere next year. For DeMott, who earned her master's degree in geology in 2007, training at ExxonMobil will involve three 8-month placements.

As companies bring in green staff, they are also trying to bring experienced staff back from retirement, or retain baby boomers as part-time consultants, to train the young recruits. Even so, the workforce is expected to be bottom-heavy--which could work to the advantage of younger employees. "In a few years, there will be the option to go up the ladder faster," Diaz-Tushman says.

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## Mines hit by a lost generation of miners

Fri Mar 30, 5:35 PM

By Pav Jordan

SANTIAGO (Reuters) - They are calling them the lost generation, the men and women who simply aren't around to staff the world's booming mining industry.

Even as metals prices pump profits for global mining companies, the industry is facing a shortage of people able to take advantage of the international mining bonanza.

"Mining lost a generation, in the 70s, 80s and 90s, when it was perceived as a yesterday's business, and young people went into other fields," said Chip Goodyear, who heads the world's largest mining company, BHP Billiton.

"And so, we're paying the price for that today," Goodyear said as he inaugurated a mine this week during Chile's 6th annual world copper conference (CRU) in the Chilean capital Santiago this week.

He said the lost generation includes professionals like engineers and geologists, tradesman, from plumbers to electricians, and technicians, like the drivers of monster trucks and other mining equipment.

Mining executives say the shortage in skilled staff and labor delays projects and raises costs as those who are around demand higher wages.

Canada's Barrick Gold Corp. has seen the development costs for its giant Pascua Lama gold property bordering Chile and Argentina nearly double amid a 65 percent rise in labor costs.

Miners are also having to modify their salary offers according to how remote the mines are, which is particularly challenging given that mining facilities are typically far removed from human comforts.

"Now they are not just interested in the salary, they want to know where they are going to have to work," said Jose Marun, chief executive of the Tintaya copper mine in a remote area of southern Peru. "Costs of hiring individuals are rising without a doubt."

Allan Trench, a consultant for copper CRU International, which hosted the 6th annual global copper conference in Chile's capital Santiago this week, said anecdotal evidence suggests a 20-30 percent rise in labor costs over the past two years.

And he said the hardest hit mines seem be those that are the most remotely located.

Trench said poaching, the act of luring away qualified workers from other miners with salary hikes of at least 15-20 percent, is clearly evident in the industry.

Big miners like Billiton and Xstrata are fighting poaching by making it more attractive for employees to stay, through internal training programs and international placement perks.

Billiton is also working to secure new skilled workers by promoting the industry in schools and universities and by casting its hiring net wider by hiring geologists and engineers from countries including Russia, China and India.

But those are medium- and long-term measures what may or may not succeed before the next generation of graduates decides whether or not to go into mining.

"I believe that we are more conscious every day about the tremendous deficit in qualified mine workers and it's a very serious problem because it is not something that can be resolved from one day to the next," said Carlos Guajardo, executive director of Chile's Center for Copper and Mining Studies (CESCO).

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## Miners Top MBAs as Metal Boom Makes Geologists Scarce (Update2)

By Rob Delaney and Stewart Bailey



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March 13 (Bloomberg) -- Brittan Jones passed up a \$100,000-a-year job at a mining company last December when he finished his degree in geology. The 24-year-old Canadian said he's confident he'll get a better offer.

"I'm lucky to have graduated when metal prices are so high," said Jones, who has traveled to the Arctic Circle, British Columbia and the U.S. on mining internships. "There's a lot you can do with this degree."

Mining companies such as **Barrick Gold Corp.**, **Teck Cominco Ltd.**, **BHP Billiton Ltd.** and **Rio Tinto Group** are paying geology grads 44 percent more than three years ago, giving them higher salaries than the average Master of Business Administration in the U.S. Demand from developing nations including

China helped gold, copper and silver prices more than double in that time. Gold reached a record \$1,001.50 an ounce today in New York.

"There is a chronic shortage of skilled people, and wages have skyrocketed," said **Bart Melek**, commodity strategist at BMO Capital Markets in Toronto. "There's no relief in sight."

Wall Street firms have fired more than 30,000 in the last seven months as prices of mortgage-related assets slumped.

Salaries for geology undergraduates in Canada, home to three of the world's largest gold producers, jumped to an average C\$90,000 (\$91,776) from C\$62,500 in 2004, according to Norman Duke, a professor at the University of Western Ontario, who has been a consultant for companies including Teck Cominco.

**Cameco Corp.**, the world's largest uranium producer, Teck Cominco, the second-largest zinc producer, and **Potash Corp. of Saskatchewan**, the largest maker of the crop fertilizer, are also based in Canada.

### More Than MBAs

Geologists' pay tops the average for new U.S. MBAs, which, according to an August 2007 survey by the National Association of Colleges and Employers, was \$86,696. Those with mining skills are also catching up with Harvard University MBAs, whose average starting salary rose 15 percent over three years to \$115,000 in 2007, according to the university. Tuition for the two-year program is \$87,600.

This year there will be about 1,200 geology grads in Canada to fill 9,000 positions in the country's mining industry, said Ryan Montpellier, executive director of the government's Mining Industry Resources Council. In the U.S., the number of jobs open to geologists will rise 22 percent in the decade ending in 2016, about double the average for all occupations, according to the U.S. Department of Labor.

### Expecting Higher Offer

Instead of taking a permanent, full-time position, Brittan Jones started a research project after completing his four-year course at Canada's provincially funded Brandon University in Brandon, Manitoba. Tuition for his undergraduate honors degree was about C\$15,000 for the program.

In June, he will start a four-month contract managing a British Columbia drilling program. Jones said he is betting the additional experience will result in a more lucrative job than the position offered by a private Manitoba exploration company in December.

Demand for his skills is unlikely to drop. Mining companies announced 1,100 new projects last year with a total value of \$308 billion, 50 percent more than a year earlier, Magnus Ericsson, an analyst at Stockholm-based Raw Materials Group, said in an interview.

The lure of higher salaries may push the annual number of graduates within the next three years to 1,800, still only a fifth of the people required, Montpellier said.

Mining companies pared hiring in the 1990s, when a decline in global demand for metals slashed prices and forced cutbacks in exploration. Now, the industry needs to expand its workforce while replacing employees who are set to retire.

#### Retiring Workers

**Teck Cominco** estimates that as many as half its workers in British Columbia will retire over the next five years. Mining companies across the world are in a similar position, said **Peter Kukielski**, chief operating officer of the Vancouver-based company.

“The industry has been understaffed for years,” said **Greg Wilkins**, chief executive officer of Toronto-based Barrick. “The mining industry has generally not been very attractive for graduates, so there is a lack of skilled people.”

The shortage of mining expertise is particularly acute in Canada, Australia and the U.S., said Frances McGuire, chief executive officer of **Major Drilling Group International Inc.** The Moncton, New Brunswick-based company, the world's second-largest mineral-drilling contractor, needs about 200 experienced rig operators, who earn as much as \$120,000 a year.

In Australia, employment in mining has jumped by almost two-thirds in five years. The Minerals Council of Australia estimates the national industry will need an extra 70,000 workers by 2015.

#### ‘Huge Demand’

“There is huge demand for skilled engineers, geologists, pipefitters, welders, technical people, right across the natural-resources industry,” said Kinross Gold Chief Executive Officer **Tye Burt**. “Everyone is enjoying high wages in our industry at the moment, and with commodity prices being high and demand strong it's hard to see that changing soon.”

Kinross, the largest gold producer in Brazil and the second-largest in Chile, is offering more responsibility to younger staff and stock options further down the management chain to retain and attract staff, Burt said.

The rising demand for their labor has given graduates unprecedented bargaining power, said John Humphreys, head of the geology and geological-engineering department at the Colorado School of Mines in Golden.

“We used to tell graduates to hang in there, that something would come along,” Humphreys said. “Now we're counseling our students on how to deal with multiple offers.”

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