Speed rocks!

For Nexen geologist Rachel Newrick, the art of fast bikes and the science of sediments makes life complete

by Andrea Lorenz
Photo: Joey Podlubny

No longer do the prolific fields hunted by Canada's early explorers still exist, and companies must employ sharp, young minds capable of thinking outside traditional parameters to find the deeper hidden treasure. One of those is Rachel Newrick, a geophysicist recently hired by Nexen Inc. after she had demonstrated she could develop more precise methods of pinpointing the location of natural gas in complex formations.

Canadian Hunter Exploration's legendary founder, Jim Gray, recalled exploring in the 1970s: "We did everything by hand, and we drilled very, very slowly, and we drilled all kinds of dry holes. When we found a well, they were great wells. We just turned on the valve and they started producing."

If only it were like that today. A report released by the National Energy Board last month titled *Short-term Canadian Natural Gas Deliverability 2006–2008* reaffirms conclusions that the flow of conventional gas from the Western Canadian Sedimentary Basin is slowing: over the next two years, it is expected to decrease to 450 million cubic metres per day from 463 million cubic metres per day.

The good news is that the decrease will be more than offset by production from unconventional gas sources such as coalbed methane (CBM) and shale gas. In the next two years, deliverability from CBM itself is expected to more than triple to 27 million cubic metres per day resulting, surprisingly, in a one per cent growth.

"All my work in the past year for Nexen has been in unconventional gas," says Newrick, a New Zealander with an enthusiastic, outgoing personality. In their search for untapped gas, exploration and production companies are pushing relentlessly west, moving from central Alberta to the more complex geology of the Rocky Mountain foothills.

Nexen's search has also focused on under-explored areas of northeast British Columbia, particularly in the Horn River Basin. "Rachel is able to see definitive ways to improve data quality which will give us better interpretation," says Mike Simpson, who heads Nexen's new growth team. "It's particularly important in areas where you've got structural environments such as the Alberta foothills, which are particularly challenging because of the difficulty of surface access."▶

AT A GLANCE

Education: Bachelor of science in geology and bachelor of science in geophysics, Victoria University, Wellington, New Zealand; doctorate in exploration seismology, University of Calgary

Awards: 2004 Outstanding PhD Thesis and Outstanding Academic Achievement awards, Department of Geology and Geophysics, University of Calgary

Quote: "I think you need an inquisitive mind to work on unconventional opportunities because we haven't fully understood how geophysics contributes to unconventional exploration."

Passion: Motorcycling

Founder: Wild West Vixens, a motorcycling club for women

Newrick's methodology is in demand in countries which have geology similar to Canada's WCSB. At the Simposio Bolivariano in Cartagena, Colombia last month, she outlined how she and her colleagues are turning old data upside down and inside out to extract more information. "My presentation was on 'What can we get out of existing data? What can well logs tell us that we haven't previously thought of?'"

To appreciate Newrick's work, one must understand that the earth is anisotropic—that is, energy does not travel through it at equal velocities. In an interview, she explains the difference in terms comprehensible to a layman.

Previous interpretations of the depth of oil and gas reserves assumed that the earth was isotropic. "But the earth is anisotropic. Since energy takes the fastest path, old isotropic processing meant we drilled close or on the flank, but not at the oil trap. We're trying to more accurately image the subsurface so we can have better drilling success."

Powerful computers enable geophysicists to synthesize individual data into reports that reveal the extent to which reservoir rock is anisotropic.

"We often put our heart and soul into our interpretation," Newrick told colleagues at the 2006 Canadian Society of Petroleum Geologists convention.

"We incorporate structural style and stratigraphy with well logs and surface geology to create a picture of the subsurface. We stand behind our interpretation and say with confidence that given the available information this is an accurate representation of the subsurface. But—and this is a large 'but'—what if the seismic image itself is flawed? The advance from isotropic post-stack time imaging to anisotropic pre-stack depth imaging has allowed geologists to make huge improvements in both defining and locating geological structures."

These days, competition between companies for talented young geoscientists is so fierce that some companies have stooped to stealing top talent from rival organizations. Yet when Newrick applied for her first job, she was turned down. WesternGeco, Schlumberger's seismic interpretation arm, told her that she lacked experience.

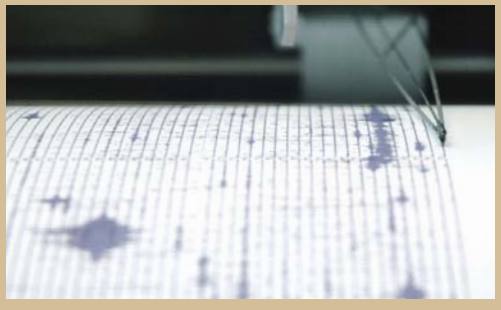
Rather than knock on more closed doors, she decided to pursue a master's degree. She found the research so fascinating that

"The interpretation of observed elastic wave velocities in the rocks of the earth's crust is our principle basis for inferring its structure at inaccessible depths." — Ide, 1936

RACHEL WRITES:

Ide's statement is as true today as it was back in 1936. He goes on to talk about the practical nature of geophysics and how the observed time differences are more important than the actual velocities in different rocks. This is no longer true. With the advent of depth imaging, there is a paradigm shift back to requiring the actual velocities of elastic waves travelling through rock.

In recent years, the focus of seismic processing has moved from time imaging to depth imaging. Time imaging is often preferred for its simplicity in determining imaging velocities to create an image of the subsurface. However, in areas of complex deformation that contain laterally varying velocity fields, depth migration is required. Instead of imaging velocities, depth migration uses interval velocities. Estimating interval velocities for depth processing is challenging but provides additional information regarding the subsurface.



AVOIDING INTERPRETATION PITFALLS

Additionally, time migration is less sensitive than depth migration to variations in the velocity model but may distort structures in areas with lateral velocity variations and introduces the possibility of interpretation pitfalls. These pitfalls may often be eliminated with the use of a precise velocity model to convert time sections to depth sections, although this will not resolve the lateral mispositioning of structures by time migration.

In the case of complex structures with steep dips, lateral velocity changes, and closely spaced folds and faults, depth migration is necessary to correctly position reflectors. However, to obtain the correct image, we ultimately require the correct velocity model. In addition, anisotropy further confounds the issue and leads to greater errors in the final image, if ignored, and therefore must also be considered in the velocity model.

In the case of isotropic pre-stack depth migration, velocity is independent of the direction of travel, and therefore, a single value is required for each subsurface location and a single-velocity model fully characterizes wave propagation. Despite the long-term success of the isotropic assumption, the Earth is, in fact, anisotropic and should be treated as such in seismic imaging. Many studies have shown that transverse isotropy, a form of anisotropy, sufficiently characterizes wave propagation through clastic strata, in which case, four parameters are required to fully characterize P-wave propagation. When Thomsen's parameters of anisotropy are utilized, the velocity model is now, in effect, four models (velocity, ε, δ, and θ) that we refer to as the $V\varepsilon\delta\theta$ model, where V represents the V0 velocity perpendicular to bedding, ε and δ are the Thomsen parameters of anisotropy, and θ is the orientation of the symmetry axis.

Presently, the $V\varepsilon\delta\theta$ model used in depth imaging is refined by selecting parameters that best flatten events on common image gathers and create the most coherent depth-migrated section. However, how this $V\varepsilon\delta\theta$ model relates to the actual geological model is often not considered. By understanding the relationship between the seismic velocity model and geology, we should be able to improve the velocity model, and subsequently improve the seismic depth image.

— From *Fundamentals of Geophysical Interpretation*, *SEG Geophysical Monograph Series No. 13*, by Dr. Rachel Newrick and Dr. Larry Lines

"New Zealand is God's gift to motorcyclists. The roads are…so twisty you're often riding as fast as you can, but you're not breaking the law."

she continued on to earn a PhD. When she decided she had had enough of studying and it was time to launch another job search, she told herself, "This time I'm going to decide which company I want to work at."

She made a spreadsheet, inputting the qualifications of her top 10 companies. "One of my requirements was that the company had to be able to think outside the box."

She telephoned the chief geophysicist at each company and asked if they were hiring. Five said yes. "I also wanted a job offer within two weeks. Only two could do that, Talisman and Nexen. I picked Nexen."

Unlike some academics who are so competitive that they would do anything rather than share their knowledge with their peers, Newrick had no qualms about assisting fellow geophysicists in learning better ways to interpret their data.

While working as a teaching assistant with Professor Larry Lines, head of the University of Calgary's Department of Geology and Geophysics, she became aware that students were spending up to $1,000 on text books while only using two or three chapters. "What I said to Larry—somewhat jokingly—was why don't we write our own?"

Lines agreed, and they decided to combine their class notes into a monograph. "I put together what I called a recipe. My work was really just how to build a model for the working geophysicist."

The Society of Exploration Geophysicists published the "practical handbook for the petroleum geophysicist" under the title *Fundamentals of Geophysical Interpretation, SEG Geophysical Monograph Series No. 13*. "It was brilliant because it followed our course and cost students only $30," Newrick says.

Proud to be a published author, she took her first book to the SEG Conference in Denver. "I found all the famous people," she said, her eyes sparkling at the recollection. She asked the celebrities to sign her book. One was Milo Backus, famed for his pioneering work in digital seismology and 3-D seismic surveying.

"Backus is a god," she says in the gushing tone of a teenager who has just snared the autograph of a rock star. The monograph, which is in its second printing, has sold more than 1,800 copies.

Newrick leads a double life: one as an academic star and the other as a self-confessed addict of speed—on the road that is. She is the founder of the Wild West Vixens, "a Naughty Gurlz Riding Club."

Newrick is as much at ease talking about anisotropic pre-stack depth imaging as she is about motorcycling at breakneck speeds around hairpin turns in her country of birth, New Zealand. "I have always been a speed demon. I am so lucky police in New Zealand are lenient," she says.

According to those who know her, her two personas rarely collide. When Newrick morphs into a Vixen, many of her riding companions have no idea of her other life as a highly educated earth scientist. "She doesn't come across as a know-it-all," says fellow Vixen Lesley Desmarais. "You'd never know that she has a PhD in geophysics."

Newrick bought her first motorcycle at the age of 25. From then on, she spent every moment of her spare time zooming along New Zealand's highways. She logged 30,000 kilometres in the first nine months of owning her bike. "New Zealand is God's gift to motorcyclists. The roads are often so twisty you're often riding as fast as you can, but you're not breaking the law."

Soon after Newrick started motorcycling in Canada, she began to wish there was a women's motorcycling club similar to the one she belonged to in New Zealand, the Women's International Motorcycle Association. Five years ago, at a motorcycle rally in Kelowna, British Columbia, she spotted a fellow enthusiast and decided to see if she was interested in the idea. "I ran over and said, 'Hi, I'm Rachel,'" recalls Newrick.

"She actually approached me," Desmarais recollects. "A lot of the Vixens are like that. She basically said, 'Hello, my name is Rachel. We have a girls' motorcycle club in Calgary.'"

The club now has about 80 members, many of whom ride together for fun whenever they can. They often invite male friends to join in their rides. "We joke about making them ride at the back."

Newrick herself is regarded as an excellent rider. "She's a really good rider. She's not afraid to ride in snow, whatever," says Desmarais, who is an instructor. Newrick now owns five motorcycles, a Kawasaki Z1000, a BMW F650, a Honda CR80, a Kawasaki Zephyr 750, and a Kawasaki KZ1000 LTD.

For the self-confessed "speed demon," Newrick is passionate about safety, a message she made sure students heard when she was a chief instructor for the Calgary branch of the Canada Safety Council. "If she saw anybody riding without gloves, she'd probably lose it," says Desmarais.

Newrick is also an inveterate world traveller—by motorcycle over backcountry byways if possible. After completing two bachelor's degrees from Victoria University in Wellington, and before moving to Canada to further her studies, Newrick took two years off to travel.

"All New Zealanders have this push to go travelling around the world," she says. After she graduated from Victoria University in Wellington she decided to follow in her compatriots' footsteps. Two places she loved were Honduras and Mali.

"One of the poorest countries I travelled to was Honduras. I loved Honduras. They could have a bowl of rice for dinner and they would invite you to share it."

In an observation astute enough to be added to the *Rough Guide* travel series, she notes, "You can often judge the mood of a country by the dogs and the kids." In one place she would not name, "the dogs cowered and hid in the dust and the kids spat at us." By contrast, "if you arrive in a country and the kids are waving and the dogs are wagging their tails, you can really judge how a country will treat you."

She described one particularly magical experience in Mali. "In 1996 we visited the Dogon people. We camped outside their village. The night sky was pitch black because there was no electricity for hundreds of miles. We were lying there counting the shooting stars. [We saw] one of the largest meteor showers in history." ■