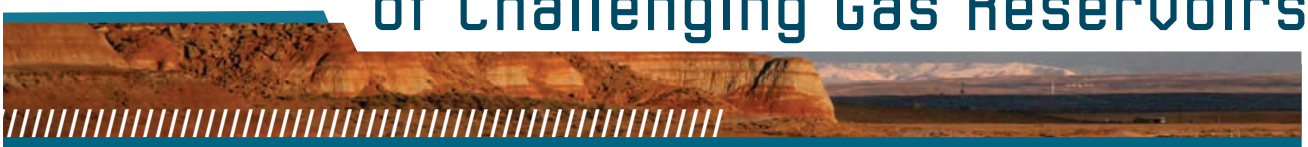
Unlocking the Potential of Challenging Gas Reservoirs



Craig Cooper, Land Seismic Project Coordinator for the North America Gas Business Unit at BP, sat down with I/O's Senior VP of Corporate Marketing, Chris Friedemann, to discuss the first FireFly field trial at Wamsutter.

By Chris Friedemann

Q: Let's start with the asset itself. Tell me about Wamsutter and how it fits into BP's portfolio within North America?

Craig Cooper // Wamsutter is located in south-central Wyoming. Most of the production facilities sit at 8,000 feet above sea level in the environmentally sensitive Red Desert area. Wamsutter is the largest contiguous block of BP-operated acreage in the United States, covering an area of about 1,700 square miles (4,400 square kilometers). We produce 135 MMscf/d from nearly 1,100 wells and hold a working equity interest of roughly 40% in the entire field. The field is one of the largest tight gas resources in North America, with more than 50 TCF gas initially in place (nearly 9 billion BOE).

Q: I read that BP intends to invest $15 billion over the next ten years in its North American onshore assets. I guess that means both land and North America are still alive and well?

Craig Cooper // Worldwide, reservoirs in which BP holds a working interest contained about 200 billion barrels of oil equivalent (BOE) initially in place. Of this amount, approximately one-third or nearly 70 billion BOE, are here in the United States, much of which is located onshore in tight reservoirs. Yet, out of the 200 billion BOE initially in place, less than 20% has been produced. I don't know the specific percentages for the U.S., but I would guess it is only slightly higher. Taken together, this means we have a sizeable resource base and a significant opportunity right here in the U.S. BP clearly expects our efforts here to contribute to the growth and financial performance of the company in their own right. But, on a broader level, the U.S. is an excellent laboratory. We hope that we can transfer whatever we learn at an asset like Wamsutter to other similar reservoirs around the world.

Q: Not too long ago, BP announced plans to invest $2.2 billion at Wamsutter over the next fifteen years. Can you give our readers some idea as to how this capital will be spent?

Craig Cooper // The investment is multi-faceted, spanning subsurface imaging, drilling, well completions, and surface facilities. The bulk of it, however, is scoped for an in-fill and step-out drilling program targeting approximately 2,000 additional well locations. If we're successful, we think we can significantly increase production and add to our reserve base.

The capital program also includes $120 million for field trials of new technologies, which we hope will enable us to further improve upon the expected results of our existing field development plans.

Q: What are the key technologies that are being trialed?

Craig Cooper // The Wamsutter field trial program is a comprehensive effort designed to investigate technologies and methods that could deliver a substantial impact on our operations. Drilling and completion technologies are attracting a good portion of the funds; our desire to protect the Red Desert region is compelling us to experiment with things like horizontal drilling in order to reduce the footprint from our well pads. Hydraulic fracturing is also important to overall well productivity, so we're looking at several new techniques in this area.

However, we haven't ignored the subsurface. Roughly $30 million is targeted at improving our subsurface images. There are three elements to the subsurface program. We're acquiring a massive 3D VSP, acquiring a cross-well tomography dataset and, of course, using FireFly to record densely sampled 3D3C seismic data.

Q: Are these three subsurface technologies synergistic with one another, or do they stand alone?

Craig Cooper // Each of the technology field trials were justified on a stand-alone basis and were designed to benchmark vertical and spatial resolution at our target reservoir levels. But we'll go to a lot of effort to integrate the seismic data with well and production data to determine how we can better predict well performance ahead of the drill bit. We'd like to be able to determine how to more effectively utilize our seismic data to optimize our drilling program in order to get the most value from the field. We've acquired a fantastically rich suite of data, so I think we have a good opportunity to do this. We're obviously at a very early stage in that effort, so it's a bit too early to state anything definitive just yet.

Q: It sounds like subsurface imaging is a big part of the technology field trial. Is the focus on subsurface imaging unique to Wamsutter or is this a general theme across BP?

Craig Cooper // While the trial is critically important to Wamsutter, improved subsurface imaging is vitally important to all of our North American assets and, really, to all of BP's assets worldwide. In North America though, much of our portfolio resides in thin, tight gas reservoirs or, as we in BP have coined them, in "challenging gas reservoirs." These are reservoirs that have permeabilities of less than a tenth of a millidarcy and in which natural and induced fractures are extremely important to the productivity of individual wells. So we need to acquire seismic data with substantially higher vertical and spatial resolution in order to better characterize these challenging reservoirs. If we're successful, we'll be able to high-grade our drilling program and improve economic performance. While our North American assets push the limits on the definition of tight gas, we do expect many of our learnings to transfer elsewhere in the BP portfolio.

Q: Transfer to places such as?

Craig Cooper // Well, beyond North America you'd have to immediately flag North Africa and Oman as prime candidates. In addition, many Russian reservoirs are some combination of tight, carbonate, or fractured, so we might have some opportunities to transfer our insights to our partners at TNK-BP.

I also should state that it's not only the imaging-related insights we hope to transfer, but the HSE-related ones as well. Operations on BLM lands and in areas possessing challenging surface conditions push us on the HSE front the same way that tight, fractured reservoirs push us on the imaging front. So we're hoping that the processes we've put in place to ensure HSE-friendly operations at Wamsutter are also transferable to our seismic activities elsewhere in North America and around the world.

Q: One of the subsurface technologies in the field trial is FireFly. Can you tell our readers how this technology fits into your imaging objectives at Wamsutter?

Craig Cooper // To optimize our investment program at Wamsutter, we need to maximize the productivity and reserves capture from every well that we drill. To target fractures and hit other subtle 'sweet spots' in the reservoir, we need seismic data that is substantially better than what we currently possess. This includes improving spatial and vertical resolution of our seismic data as well as capturing information that enables us to better characterize our target reservoirs. The most likely way to do that is to increase the source/sensor density and utilize a survey design that enables multi-azimuth, single-sensor acquisition. Accomplishing these things with a conventional land system and approach would have been cost prohibitive. It also would have imposed risks on us from an HSE and cycle time standpoint that we probably wouldn't have taken. As a result, we would have been making tradeoffs and sub-optimizing the program, which would have compromised the quality and interpretability of the data.

With FireFly, we can deploy as many sensors as necessary without being forced to make these compromises. We can achieve dense sampling, increase the fold of the seismic data, and implement powerful acquisition designs that were not previously practical. All the while, we are collecting the data in ways that have minimal impact on the environment, are safer, and are more cost effective. Crew safety and productivity both go up due to the lighter and less cumbersome equipment, while the reduction in the cabling of the FireFly system allows us to greatly reduce the equipment's footprint on the surface.

Q: The deployment of FireFly at Wamsutter was the first commercial application of this technology. What elements of FireFly lived up to their billing?

Craig Cooper // Well, all pieces of the system worked. There were no big failures, although some parts of the system performed better than others. The actual layout of both the FireFly field station units and VectorSeis sensors went pretty smoothly. I thought we had a pretty good workflow designed to charge and prep the units, put them into backpacks, and move them en masse to the field. All the gear was right where it needed to be when the field crews came along to deploy it.

I was particularly impressed with the shooting side of the operation. We were using a dynamite source and only had a five to six hour window for acquisition, primarily because of the limited daylight we had in late December and the remoteness of the operation. Though we started a bit slowly with only a couple of hundred shots per day due to weather and some other operational factors, the crew really started to hit a learning curve such that, during peak production, we achieved 1,001 shots in one five-hour period. That's a couple of hundred shots per hour, which is what you might expect in an entire day of shooting with a conventional, cable-based telemetry system. I think if we had better weather and if the crew had more experience with the system, we could have done even better

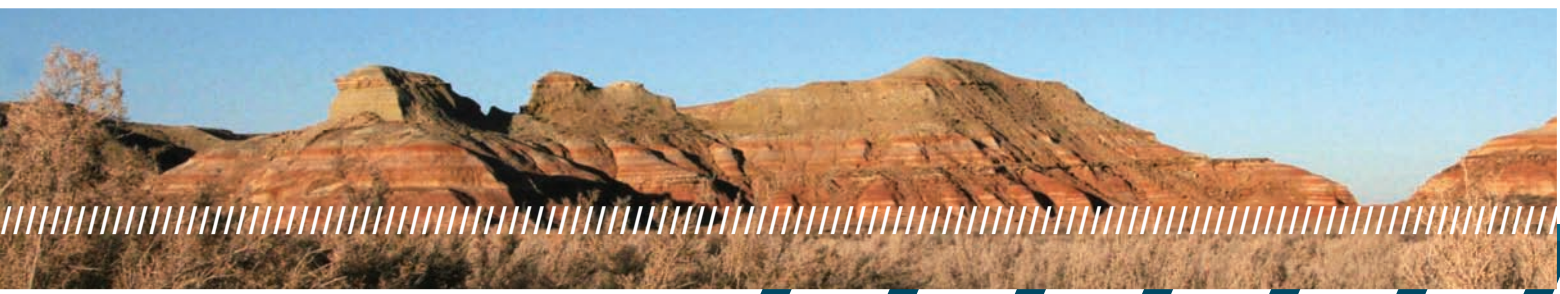
–maybe 300 shots or more per hour. If you extrapolate this to an eight-, twelve-, or twenty-four-hour operation, you're talking several thousand shots per day. That's an order of magnitude better than we see with conventional land seismic operations.

I also think FireFly will let us be more productive as we re-think the role of surveying, especially when it comes to positioning the sensors. While we'll still need conventional surveying to demark archaeological sites, pipelines, and the like, FireFly in combination with LiDAR will provide us with an opportunity to lay out the receivers and locate the source points without the traditional 'stake and flag' activities. This will not only save time during surveying but, because the positional information is written directly into the trace headers, will mean we won't have to worry about correcting human-generated errors in the merge step during processing. This is potentially a big time saver and should really increase our confidence in data integrity.

Overall, I think there was clear evidence of FireFly's potential. We saw occasional 'flashes' of brilliant performance that really have us excited about our next use of the system.

Q: Given that it was a field trial, I'm assuming certain things didn't go exactly as planned. Can you give us some idea of the shortfalls as you experienced them?

Craig Cooper // The initial deployment process was a little rough. We started out deploying the units with a two-man crew that was charged with navigating to a spot, drilling a hole for



the VectorSeis sensor, and synching up the FireFly field station unit with the GPS satellites and central recorder. The last step took a bit longer than we anticipated, which left people exposed to the elements at each receiver point for too long. We also had some issues with the power management system. As a result, some of the units didn't 'go to sleep' when they were supposed to, which drained their batteries prematurely. Lastly, we found that some of the crew relied too heavily on the handheld units for navigation in the field. Early on there was a tendency to stare slavishly at the screen of their navigation tool while walking between FSU locations. As a result, people were needlessly running into bushes and stepping into holes. On this last point, I'm confident that this tendency will go away with a little more experience in the deployment of the system.

Q: Is it safe to assume you feel confident that the shortfalls from the Wamsutter project will be resolved before the next program begins for BP?

Craig Cooper // Yes, absolutely. The encouraging part of this for me was that the sources of most of the problems were identified almost right away. Many corrections were made as quickly as possible and addressed by the time we finished up at Wamsutter. I feel certain that the ones that weren't will soon be corrected. We're hoping to conduct another field trial later this year or early next. I'm looking forward to working with the system once these modifications are fully included and Vibroseis source capability is incorporated.

Q: Where do things stand with Wamsutter at the moment? I understand that the raw data looks good and the initial processing has begun. Can you elaborate?

Craig Cooper // The data is currently being processed by your GX Technology group up in Denver. The raw data and quick-look volume appear to be pretty encouraging. While we shot this survey primarily to capture better P-wave data, the C-wave data actually looks very good. That's icing on the cake.

Processing is currently a bit ahead of schedule and we expect to have a final P-wave volume early in the third quarter. This will allow us to make some critical business decisions related to our drilling program in 2008 and about re-shooting the entire Wamsutter field. Beyond that, we'll look into processing and interpreting the converted wave data, test some interesting imaging techniques like offset vector-tile processing, and attempt to correlate the VSP, cross-well, and surface seismic datasets.

Q: Is there anything else you would like to add?

Craig Cooper // I am honestly excited about the potential impact a system such as FireFly can have on our operations. The flashes of brilliance we saw at Wamsutter make it exciting to think about how to more tightly integrate FireFly into our field development plans. Initially, we'll be able to obtain substantially better 3D data which, in many cases, will include converted wave data as well. This will give us more information and a better chance of characterizing our reservoirs. It also opens up possibilities related to the surface-monitoring of our hydraulic fracture programs and for employing 4D on more of our onshore assets.

We have an opportunity to use this technology to fundamentally change the way we perform. Now that we see what it can potentially deliver, we have to sustain our commitment to maturing the system and rolling it out to our relevant assets in a timely way. If we stay committed and deploy the technology quickly, BP can really stay ahead of the pack. OP