Best CBM D[r]illing, Completion, Production, Technologies, and Management Practices

Dennis Carlton

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I am also a geologist, so this presentation is somewhat skewed to a geologic standpoint. No one has tried to really take a look at the basics of the best practices in coalbed methane. And please understand that this is a presentation really targeted toward the Raton Basin. As you’ve all heard, each basin has its own characteristics for completions, production techniques, and the Raton Basin is no different. This was Evergreen’s primary production, and this presentation is targeted for just the Raton Basin.

Evergreen is a public company, and we’re focused on coalbed methane opportunities throughout the Rocky Mountains, primarily. And we’re a little bit different from most companies, in that we’re integrated. We do everything internally, from building locations to cleaning the wells, producing, installing the gas gathering system to marketing the gas to putting the molecules of gas in the pipeline. We also have a couple of projects in the UK and in Alaska, which are just beginning. The intent here is to show that we are vertically integrated. And to be able to have our own completion techniques has really helped in the quality control in the Raton Basin. This is a diagram that you’ve probably all seen with all the coalbed methane basins. No presentation would be complete without it.

So the Raton Basin is out here to the South. This is the estimated recoverable—excuse me, estimated resources. And this is the Raton Basin, the city of Trinidad, Walsenburg, New Mexico, I-25 comes around, makes a loop around. Evergreen is about 275 acres from the basin. The Spanish Peaks lie right here. The deepest part of the basin is to the north and comes down like this. Other operators, Barrett/Williams, I guess Williams now, Devon in El Paso. The field was discovered in 1993, based on our exploratory wells. Currently in the basin, there are 805 gas wells drilled, of which 743 wells are producing. We’re just starting to develop the Raton at this point in time. Total production is about 132 million cubic feet a day. And that’s approximately a one to one ratio. We produce anywhere from one barrel of water, from small amounts of water, to as much as 1,000 barrels of water. Total sales in the basin right now is about 120 million a day from Evergreen’s operations. The intent of this is to try to give you a whirlwind view of how we select drill sites and the best technology.

We go out and kick the rocks, because what we see on the surface can be translated to depth. We do a series of maps, and we also look at the microgeology under the microscope. We just completed a magnetic survey of 21,000 kilometers in an attempt to understand the base and structure, primarily the leaf structure and also the water limits throughout the basin. This is a satellite image of the Raton Basin. The same basics; here’s the Spanish Peaks, Sangre De Cristo Mountains, Trinidad Reservoir, and the state line is down here. We use aerial photography to try to identify fracture trends, and we also use aerial photography to look for drainage patterns, anomalies, and thus, permeability in the coals themselves. So we start from the macro and work to the micro. This interesting photo shows a stress agitation anomaly, which equates to the hot spot within the basin itself. We think the hot spot is going to be associated with the . . . or the Spanish Peaks down to the south. And this the same basic photograph of a smaller area using the infrared high area photography.

We have a complicating factor in the Raton Basin, in that we have intrusions in the form of vertical and horizontal silts. They eliminate the actual coal seams that we’re trying to produce. Little bit of the structural geology. This doesn’t quite fit, but what we look at on the surface, these coals, for instance, here, are actually lower most Raton, and approximately six miles to the north would be producing out of those same coals. So we study the coals on the surface to try to understand what’s going to happen at depth. Something that’s important to the coalbed methane success story is permeability. And one way of mapping or trying to understand permeability is to look for fracture trends. So wherever possible, we try to map the intensity of fractures on the surface. This is a vertical cut, but we map by the intensity of the permeability of depth. This is the same view, just in a horizontal view. Minor stress direction. Keep in mind, we’re doing all this geologic work with the intent of trying to pick the best drillable locations. We even look at the sedimentary geology and the non-coalbearing strata to determine what happens at different depths.
So you can imagine drilling here and saying, oops, not a good place to drill. But 50 feet away we have a good area. We look at the coal geology, as an outcrop mostly, along Highway 12. This is one-meter thick coal, if you look at the microgeology of the actual coal seams. This scale is a pocketknife scale. We try to understand the gas contents by measuring the gas contents in both cores and in samples. I mentioned before that the Raton Basin was somewhat unusual, in that we have igneous protrusions which seem to be both good news and bad news. They can induce fracturing, but on the other hand, this is a situation where about 100 feet of coal has been totally eliminated by an igneous intrusion called a dike; and then likewise, intrusion of the coal seam over here has totally eliminated the coal itself. As with other operators in the basin and other operators in the basin, we use the typical gamma ray to identify the coal seams.

In the San Juan Basin, we operate where we have multiple thin seams, anywhere from as thin as two to a maximum of about 10 feet in the Powder River Basin. So we have a multiple seam to deal with, and it’s complicated in that factor. We have a very, very low formation pressure we have to deal with. This is an example of the subsurface mapping. We take all of the log data and try to map the structure and also the thickness of the coals or the isopach. This is where total thickness of the coals are going to be the best penetrated. The correlation of the coal seams is somewhat challenging in the Raton Basin.

And finally, we look at the microgeology under the microscope. Once we have selected a drill site, we try to evaluate the surface for disturbance. We try to locate wells so they have the least amount of visual impact. Here is another example. This is a county road in the country. There’s the well site. This is the different phases of drilling techniques. All of our wells in the Raton Basin are phased for completion. So we have basically surface casing and conductor pipe, and then production casing sends it all the way back to the surface and the producing formations at depth. And then inside the casing we have a string of tubing and rods.

We use an air drilling technique using an air compression hammer. Rates of penetration are very, very rapid. Typical wells are drilled and cased to depths of 2500 feet. We run casing and logs in about 36 hours. This is a picture of the percussion or hammer bit assembly.

This is the actual drill rig. This is the actual drill bit, and this is basically a down hole jackhammer. It does regulate very slowly, this being the bit. It essentially chips away at the depth. And we use air instead of mud to bring the samples to the surface, mainly to prevent damage to the formations. We cut cores in several wells to try to keep up on the contents, permeability, and measurements, and also to give us an idea of ash contents so we can calculate recoverable reserves. This is a close-up of the coal. Some coals require hydraulic fracture stimulation to reach economic levels of production. We have a high quality nitrogen foamed fracturing fluid, which is something that looks like a shaving cream, which goes down the hole, carrying the sands and creating the actual crack at that depth.

We’re on the forefront of developing a technique called a coil tubing unit. So, it’s a $1.65 million machine that allows us to frac every single coal seam. This is a little cartoon of drilling a well. The well comes down, intersects the coal seams, and we shoot perforations through the pipe. The rig is brought in, and this is a visual account of how we isolate the individual coal seam and the coal mixed with sand and fluid and foam. It’s the same exact thing. So we have good penetration of the coals and for the frac job. This is what it looks like, in theory. We use what’s called a progressing cavity pump to actually produce the well, versus an insert pump. It looks like an Archimedes’ spiral. I’m sure everybody’s seen this type of curve also. This is a typical coalbed methane well, if there is such a thing. It has increasing methane content, production through time, with decreases in the water.

Same picture of an electrically driven gas meter. This stays like a motor on top of the well here, and the same thing, that’s a perpetual motion machine, a gas-driven unit. And then where we have a noise considerations, we put the gas drive inside of the house. This is the progressing cavity pump. It’s about 20 feet long in most cases, and looks like an Archimedes’ spiral. This is inside the pump. This is the roter, this is the stay, which is just opposite of the Archimedes. So when the pump turns, it actually brings the fluid and anything else to the surface. Typical production unit, very simple.

Two-phase gas and water sprayer. Gas comes out the side of the operator. It goes through a meter room, which in this case has an electronic metering device. So when
our guy is in here, he downloads data which is accumulated every second. So he has all kinds of information. Water data, temperature, pressures and it's recorded. He takes all that data and e-mails it to Denver every single day for all 750 wells. Because our system is—our formation is very, very under pressure, we have a very large pipe in place which takes gas of the basin. Then we have an infrastructure pipe throughout the field going to eight compressor stations. And this is a pipe that's over eight inches in diameter. Typical gathering construction crew along the highway. And this is what the right-of-way looks like when it revegetated. This one is contained within a building. That particular unit is 3,000 horse powered—it moves about 10.8 million cubic feet a day. All the compressor stations have emergency shut down for high pressure, high temperature. It's a system that shuts off the computers and then phones automatically to the field office, which sends a signal to about 15 different maintenance guys to come fix the compressor.

Water management is, of course, one of our key issues. Water quality. We test the water from COGCC earthen pits. We offer the chance to home owners to have their water wells sampled, and we give them water quality data. We test the water from the producing wells also. Colorado Department of Health, we test all the permitted outfall points.

Surface water, there's a program where we have a data base of water, samples from all the rivers and also the Trinidad reservoir. We test water using an independent laboratory, so it puts some distance between the operator and the Department of Heath and Environment. With only 700, 800 wells in production, we have well over 20,000 data points of water collected. With our current operations, we have 640 pits that are permitted with the Oil and Gas Commission and 678 out of the Colorado Department of Health and Environment. We have seven active disposal wells; two wells are being completed right at the moment. As I mentioned before, we have independent companies who collect data for us so that we have a good data base to work from.

Thank you.

**CBM DEVELOPMENT AND WATER ISSUES**

**DAVE BROWN, Environmental Specialist, BP**

I was assigned the topic of CBM development and water issues in the San Juan Basin of Colorado. I'm going to talk about this today because that's where a lot of water issues are occurring right now in terms of people's concerns.

First, here is a brief overview of BP for those who may have lost track. BP is a multinational company formed as a result of recent mergers involving BP, Amoco, ARCO, Vastar, and Castrol. So those of you who are familiar with Amoco, that's who BP is now. BP is the largest oil and gas producer in the United States, so we're quite involved here in the lower 48 states and in Alaska in terms of energy supply in the U.S.

In Colorado, we are the biggest natural gas producer, and we market quality fuels at retail service stations. The gasoline BP markets in Colorado is the same Amoco product as we've always sold.

In La Plata County, we operate 900 natural gas wells, and we have 114 employees who live and work in the area. So we have a lot of folks committed to producing natural gas in the most environmentally responsible manner possible. What I want to discuss is the potential

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