Coal-bed Methane

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RAG [Coal West, Inc.] is a successor interest to what used to be called AMAX Mining Company. In 1999 AMAX was bought by RAG [International Mining], which is a German owned company. Actually RAG is a relative newcomer to the coal-bed methane (CBM) market; we started coal-bed methane development in 1999; so we only have about 2 years of experience with CBM. We are relatively small; we have about 120 wells, so we are not like a 2500-well large company that stretches across the basin. We got into CBM mainly to protect ourselves, to be proactive and to protect ourselves from CBM development out ahead of our mining operation. But it is also an opportunity for coalmines, if you have certain mineral interests, oil and gas interests and if you acquire your property in the right way, to have another harvest of an energy source from your mining operation.

CBM, or coal-bed methane, is a natural gas that actually occurs in coal-beds. It was generated through the conversion of plant matter to coal during the coal gasification process and really is a cost competitive energy source, for industrial use, for home use, domestic use and for power generation.

About 55 million years ago during the Paleocene period, Wyoming was a series of fresh water swamps and riverbeds. A lot of plant matter was deposited, a very thick mass of plant matter and then over the course of 55 million years you had erosional sediment over that plant matter. You had sandstone, sand, clays deposited over the plant matter, which compressed it, and the plant was then coalified.

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There are 2 types of coal-bed methane gas in coal. There is thermogenic gas and that is gas that is developed at depth at temperatures about 250 to 300 degree F. There is also biogenic methane, which is basically the respiratory product of bugs [bacteria] in the gas (bugs [bacteria] that were deposited with the water in the plant matter at the time the plant matter was laid down).

The coal-bed methane in the Powder River Basin is relatively pure. It is about 98% to 98.5% methane; the other part of it is about 1 1/2% to 2% carbon dioxide that has plus or minus 1000 BTU's per cubic foot. When you hear coal-bed methaner's talk about a standard cubic foot they are looking at about a 1000 BTU's per standard cubic foot. It's free gas within the fractures of the coal, dissolved gas in the coal seams and the water and absorbed gas held by molecular attractions within the coal itself, that is absorbed gas within the molecular structures of the coal. In the Powder River Basin we have significant amounts of both free gas and dissolved gas. That's basically where the coal-bed methane in the Powder River Basin comes from.

If you look at coal deposits in Wyoming, the Powder River Basin is mostly in the Gillette area, Buffalo and Wright. You have other basins, the Hannah Basin down in the Hannah area, Green River, Rock Springs, and you have some other minor basins scattered around the state. Most of the coal mining operations that you see are in the east flank of the Powder River Basin. The reason for that is because that is where the coal outcrops. On the east flank of the Powder River Basin you only have 50 to 150 or 200 foot of overburden. So it is relatively easy to get to the coal and strip it in that area. You also have surface and some underground mining operations (that are quickly closing by the way), and some underground mining operations in the Hannah Basin. If you look at a

cross section of the Powder River Basin starting from the east side and going to the west, the coal outcrops on the east and actually dips about 1% to the west. So, as you move to the west the overburden ratio gets higher, it is more costly to mine; most of the mines just strip right along what we call the outcrop, on the east side. In the center of the Basin there is a deeper, thicker coal seam, called the Big George seam. It is in the neighborhood of 1000 to 1500 foot in depth. But people are starting to drill in that particular seam right now. On the west edge of the basin there is the Lake DeSmet coal seam. It is located a few miles north of Lake DeSmet and a few miles south of Buffalo and is about two to three miles wide and it is about 200 foot thick.

In the Powder River Basin we have approximately 578 billion tons of coal in place. If you look at the standard cubic foot, that is how many cubic feet of gas there is per ton of coal, geologists will tell you there is about 65 cubic feet per ton of coal. So, if you take 65 cubic feet of gas in place there is about 37 trillion cubic feet of gas. Out of that amount (that is in place) you can only recover a certain percentage, so the recoverable gas is about 25 trillion cubic feet. This analysis of 25 trillion cubic feet of gas is only in coal-beds that are thicker than 20 feet, based upon a 67% recovery factor and it represents only bout 80% of Wyoming's CBM reserve.

We want to look at the drilling on the ground operations for just a moment. In what we call the “fairway” which is north of Gillette and south of Gillette you can drill wells on 40 acre spacing. In all other areas within the Powder River Basin you are required to drill wells on 80 acre spacing. In 1999 there were 4,400 drilling permits issued and in 2000 there were 6,300 drilling permits issued and in 2001 I don't have a count but there was probably two times that amount.

Drilling a well, typically what you would see is, starting at the surface you would go through various layers of clay, sand, sandstone, shales and so on to get down to the coal. Basically you go down to the top of the coal when you drill a well, withdraw your bit and then you set an 8" steel casing right on top of the coal. You cement that casing in by taking a very thin cement, force it down through the casing itself, through weep holes in the bottom of the casing, it goes back up through the annulus and fills the void between the casing and the formation. This is how you cement your well.

Then you drill through that casing into the coal and you conduct an electric log [analysis]. There are many types of logs that you can do such as gamma ray logs, density logs, sonic logs, and various other logs within the formation. But what the logs do is essentially tell you about where the top of the coal and the bottom of the coal is. What happens a lot of time is you will get carbonation shale and what we call, a parting, within the coal itself. If you set your casing too far above the hard coal then you will get leakage of that carbonation material and softer material in your well bore and it will foul your pump and your well. Once you take your log you will determine where you want to develop the well. You will put on what is called an under-reading tool, a hydraulically operated tool that attaches to your drill-stem and it expands the drill-bit outward. When that bit is expanded you can increase the size of your well bore from 7-8 inches up to 12 inches in diameter. It gives you more surface area within the well bore itself which gives you more gas and water flow into your well bore. Basically what you do then is flush out the well bore with fresh water to remove all of the cuttings and contaminates to have a clean well bore. On the surface a CBM well has a wellhead, your electric monitors, counters and so forth, surrounded by a small fence that keeps animals out.

CBM is extracted by lowering a submersible pump into the core formation just like you would do in a water-well. After starting the pump it would pump for 3 to 6 months, and lowers the water pressure and the head of water within the well bore. What you want to do is get the bottom hole pressure down to about 3 to 5 feet of size, which means about 8-9 feet of water above the top of the coal. What do you do with the water? You discharge it. The water out of some of the wells is extremely fresh. We had a company from Colorado who bottles water who wanted to come up and use this water for their bottling process; it is extremely clean water.

Actually by lowering the head of water within the well bore you create a low-pressure area around your well. So, the gas out in the formation wants to migrate from the middle of the formation to the low-pressure area within the well bore. That is where you get your coal-bed methane gas. The water still goes up the tube and is taken out by the pump and goes up the pipe to the discharge point. The gas goes up the annulus of your casing to the surface. It is taken out at the top of the casing, and goes to a compressor where the gas is compressed. It is compressed in several ways, you might have a first stage compressor some place before a major compressor that will take your gas from 2-3 psi to over 100 psi (which is an intermediate stage) and then the gas will go to your main line compressor. Your mainline compressor will take your gas from 500 psi to over a 1000 psi to get it into the main transmission line.

The thing that happened in the Gillette area (and what has probably happened north and south of us; I haven't seen those fields) because you want to develop your low-pressure area some companies put on an electric blower. What an electric blower does is help reduce the gas pressure in the well bore down to a negative pressure. Essentially the

theory is the lower the pressure, the more gas you will produce and the more gas you can recover from the formation. But what happens is, because gas is a fugacious material, it is just like a wild critter, it goes where it wants to go, it goes wherever the lowest pressure is. The guy next to you has to put on a blower to protect his gas from migrating to your well bore. So, it becomes the competition of who has the best blower. Again, you spend $10,000 to $20,000 to put on a blower but you don't produce any more gas because your competition is going to take it. You may very well end up producing the gas faster but typically not any more gas.

If you look at the pipelines serving the Powder River Basin, one of the interstate gas companies predicts that there will be about 675 million cubic feet of gas [per day] passing out of the basin by November 2001. So, those of you that travel to Cheyenne or from Cheyenne to Gillette you will notice the circular pipe that is stacked in the rail yards or on the rail lines, or right at the edge of the interstate, that is the gas line that is going in. In addition, there is another plan to increase the capacity from the Powder River Basin to Glenrock in 2003. There is not enough capacity to transmit all of the coal-bed methane gas that is produced in the Powder River Basin. But this issue should be remedied soon.

Tracking back a little bit to a CBM well. Typically when you put in a CBM well, you have to pump water from 2 to 6 months. Once you get your water level down to a certain place then you can start extracting gas. A CBM-well, once it starts to produce gas, the theory is, that it will be stable from 5 to 15 years. But no one really knows at this point in time how long the coal-bed methane gas well will last. If there is any recharge it may be longer, or if it is a good location, where it has good connections with the coal, but has high permeability and so forth, it might last longer than that. Over this 5 to 15 year

plus period you will see the maximum amount of coal-bed methane production and your water production decline. In the declining life of those wells, the declining life is expected to be 18 to 24 months; you will see a decline in water production and a decline in gas production.

When is it uneconomical? That all depends on the price of gas. If you have $2 or $3 dollar gas you can probably run a well and cover your expenses at about 50 Mcf a day [Mcf is defined as 1000 cubic feet]. That is very low production, but I don't know of any major company that would keep a well on line for that long. Average daily well production in the Powder River Basin runs anywhere from around 150 to 250 Mcf a day. So, looking at $2.00 gas you take $2.00 x 150 Mcf one well will produce about $300.00 per day. Day in and day out as long as the pump is up.

A well's life is affected by a number of things (e.g. the density of the spacing) if you have wells on 40-acre spacing; your well's life is going to be shorter. How it interacts with other wells? If your well is 40 acres away and it may be a 640 Mcf a day producer it may be stealing gas from your well that is only doing 75 Mcf. The other thing is production volume. How much gas can you take out and how fast can you take it. In 1989 there were 18 wells in the Powder River Basin that were producing and in 1999 there were 3200 and to date there are in the excess of 6,000 wells. When you look at the production outlook (the billions of cubic feet of gas to be produced) in 1999 there was about 67 billion cubic feet of gas; 2006 projections are that we will be upwards of 450 billion cubic feet of gas. If you look at the top 10 gas producing states in the nation Wyoming is third. For Wyoming CBM in 2000 was about 10% of the total gas production and we think it will go upwards of 25% over the next 5 years. Wyoming has

a positive outlook for energy production and has developed a Wyoming Energy Commission (which is a positive thing in going forward and developing that production).

Gas prices traditionally have been $1.50 to $2.50. It goes up in the winter, down in the spring, gets a little bump in the summer and goes down in the fall, and the cycle just repeats itself over and over. As you all know in March of this year and in the winter months we had a peak of around $10.00 on gas prices. Gas prices today are back down in the $2.60 gas range and will probably stay in that range in the foreseeable future.

Some of the industry challenges are: drilling permits, water discharge permits, air quality permits, shortages of man power, shortages of material, and skilled labor is another one. There are some conflicts between coal-bed methane developers and the coal mining industry. For those that work in the coal mining industry you will recall that a year or so ago when there was a serious conflict between a coal-bed methane developer and Thunder Basin Coal company. I think that has since been resolved but those conflicts continue to exist. A mining company has to be very aware of what kind of mineral interest they have, what kind of oil and gas leases are out ahead of them, and what kind of surface rights they have. It becomes a very big land management, mineral management issue for mining companies.

For a coal-bed methane company again, for some of their localized issues associated with drilling (including surface rights), air quality issues are beginning to become a big issue. In Campbell county most of the county roads are graveled with scoria. Scoria is great when it is new and after it has been on the roads for a little while it beats down until it is a very fine dust. You get drill rigs, pickups, a number of pieces of

equipment traveling those roads on a continuous and frequent basis it kicks up a lot of dust. It is an issue that is coming of more importance to the mining companies.

Then of course there are water issues. If you discharge water you have to meet Wyoming water quality standards and you have to protect the quality of not only our water but Montana's. If you look at the drainage's involved in the Powder River Basin you've got the Belle Fourche River (that's where we operate), the water in the Belle Fourche is extremely good, the Cheyenne River, and the Powder River drainage. The Powder River drainage has some issues associated with it. The water that comes out of the Powder River drainage area has a high SAR ratio that once it is pumped out of the ground is has an acidity for the salt in the soil, therefore it tends to make the soil more salty. There are some treatment techniques that you can do to handle that. You can impound the water for example, you can work your discharge points so that you co-mingle the water, you can have treatment ponds that will treat the water itself, you can have evaporation ponds that will allow the water to be evaporated, you can reinject the water. Reinjection has been discussed, there may be one or two reinjection wells around (I'm not sure if any are operating), and you can blend the water. Also you can get beneficial use out of the water by letting local ranchers or farmers use the water by setting stock tanks or using it for irrigation.

The reason that we got into coal-bed methane gas production was that we wanted to be proactive and wanted to take advantage basically of the economics of the coal-bed methane at the time and also wanted to reap another harvest on our lands and our coal.

In summary, we think that coal-bed methane and coal mining can exist in harmony. The coal-mining group has to be aware of what they have. They have to

manage their assets very well. They have to be willing to work with coal-bed methane developers and at the same time the coal-bed methane developers have to be willing to work with the mining companies, not only to get surface access but also to negotiate in good faith on values of wells that might be taken out. That's the end of my presentation and if you have any questions please let me know.