Developing CBM in the Powder River Basin

William T. Brown, Jr.

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What I will attempt to do today is give you a little bit more philosophical overview from the geologic standpoint of coal and how it's produced and more of the geologic problems involved with that. First of all, I would like to express my appreciation to Jeannie and, in particular, these two people here, Ed Weber and Eric Mitchell, who did a lot of art work and basically put this together.

Below is just a very simplified view of the coal outcrop. One thing I'd like to point out is that this line here, which is labeled as a state line, is not a fault line.

Next is a generalized cross-section from west to east across Powder River Basin.

The Fort Union Formation is sitting here. We're looking at the upper part, which has the coal in it. A lot of that coal is actually a combination and merging of at least three different coal seams that split off as you move further west. The Wasatch coals, to date, have not been intensively evaluated in terms of their producibility.

They are the coals that are mined in the Sheridan area. One thing I'll point out to people who are not familiar with basic geology, we have in the Powder River Basin one of the thickest coals in the world. Around Lake DeSmet, you have about 300 feet of cumulative coal. There's no other place in the world that has that thickness of coal.

This is just a generalized cumulative thickness map of all the coal seams that exist in the basin. As you can see, the thicker coals are out in here. And as you reach the outcrop and mining, you have some very thick coals in that area, about 100 feet in thickness in many cases. As we move out into the basin, where the play is active now, you have multiple coal seams. There will be at least one seam in much of this area that has a 30-foot thickness. A 30-foot seam by itself, that's the least we want to look for to start with. If you have two seams each that are 30-feet thick, what we've done to date is drill two wells.

They're open-hole completed. One of the things that I wanted to basically acquaint you with, again not knowing quite what the demographics of my audience would be, is how coal is formed. Basically, you have a swamp or area of accumulation of organic material that will just pile up on top of itself, bury it, subject it to heat and pressure, and then you get the coal, which is a residual.

One thing here that you may not be aware of is that for every foot of coal, you started out with ten feet of organic material. We're looking at 100-foot thick coal. We actually have 1,000 feet of organic material. This is a very unusual situation in terms of coal. But every coal basin I have worked in or looked at is unique.
There are different ways to drill. There are different ways the coal is formed. There are different ways to complete wells, and they have different production characteristics. What I’ve tried to show here are the differences in the types of coal that we’re looking at. The Powder River Basin is a sub-bituminous coal, and it’s relatively immature. And initially, I did start working in the Powder River Basin, but we were using the San Juan Basin model. We took pressure cores, and our gas contents were in the 20 cubic feet per ton range, which, as you know, compared to the San Juan Basin, if you’re looking at 3 or 400 more, it’s disappointing. It makes up for it though by being thick. This coal gas is biogenetically created. The process is still going on today.

One of the important supports for the gas generation system is the groundwater. There are instances of coals in the Powder River Basin that are breached on both sides. They do not have water in them. There is no gas in that coal. That happens specifically up in Montana because you’re more heavily incised into the section as you move into that area. The Raton Basin and Utah and then Appalachia contain coals of progressively higher rank. In all of these cases, you have wells that are too deep to produce gas at an economic rate.
The gas content for the coalbed biogenically created gas in the Powder River Basin is primarily methane. There are some other constituents that will come in from time to time. This carbon dioxide, this is actually a little high because the methanogens that will create gas actually consume CO2. CO2 has not been a problem in the basins. You look at the natural gas you get out of a sand reservoir, and you have a large spread of the constituents there. Basically, what we're getting is almost pure methane out of the ground. By the way, if you don't know it, what you burn in your home is pure methane. If it has any of the heavier constituents in it, those are stripped out. And in some a cases, there's propane, or actually liquids, that can be removed from the gas itself. What runs down the street and comes into your home is, in fact, about 100 percent methane. And they put the stinky stuff in there so you know you have gas. It's colorless and doesn't have a smell. This is something intriguing to me as a geologist.

One of the things I have found is, this may be true, that the coal is rarely missing due to stream erosion where the stream channel actually cut the coal. Those are very rare.

As you know, and I'll go through this quickly, production characterizations versus conventional. You're looking at adsorption taking place in the coal. And the Powder River Basin has some unique qualities with that. You've got the adsorbed gas on the face of a cleat and microcleat in the coal. And as you take the water off, you allow the gas to escape.

This has not been discussed much in the literature—but you have another methane molecule sitting in here by itself. How far this process goes, I don't know. But what we've found consistently from basin to basin is that you get more gas than you originally thought you had. And a lot of things that cause that. But basically, that's generally a rule.

One thing we found at the Powder River Basin is that we do have, because of
the type of coal present, some primary porosity. That may, in fact, and in many cases, be interconnected to the cleat system. We have not been able to get an accurate measurement because the methodologies that we have for determining this actually destroy the coal. So we get to a point where it’s going to blow up on us, which is fun, but we don’t get a number out of it. We assume, based on the modeling and reservoir reconstruction, that we’re looking at something between 10 to 12 percent primary porosity. That’s a significant increase. Also in

the Powder River Basin, and this is probably true in many other basins, but there are several different types of traps that form here.

In one case, if you have a sand underneath the coal and the coal is actually draped over the sand due to compaction, you can get a free gas cap in the well. A relatively water-free gas cap, although nothing is water-free. One thing that’s not shown well on here is in the Powder River Basin the Fort Union coals are charged with free gas. The sands have very high porosities and very high permeabilities. This production, in many cases, is essentially water-free. Unfortunately, the size of the reservoirs are limited and very difficult to map because of the type of depositional system we’re in. So that’s not something being chased very dutifully. Then, of course, if you have faulting, you can charge the coal in those sections there. In the area around Sheridan there is faulting. We’re talking about hundreds of feet. We do find many instances where there’s basically free gas, and there’s wells that have blown in that area. There are also other

CONVENTIONAL TRAPS
IN SHERIDAN COUNTY, WYOMING

Structural Trap

Structural-Truncation Trap

Tectonic/Compaction Fault Trap
wells that have blown out, in other areas of the basin, but the drillers weren’t really equipped to handle the occurrence of free gas.

The type of completion, typically, is open-holed completion, as before. If you have a thinner zone, you don’t want to let that go. It may not justify drilling an additional well because of its thickness. So we’re looking very actively at multiple zone completions. The mechanical difficulty of this is severe in some cases. We have tried to use plastic pipe, and we end up with a bird’s nest that the drillers hate because they have to pull the plastic shavings off by hand. Also, we don’t get good adherence with cement. So in many cases, we’ve gone back to using steel and either drilling it out or perforating it. When you cement across the coal zones, you very often destroy permeability, and it’s difficult to get back. The treatment typically used on the wells is, if it’s under-reamed, it’s injected with water, the same type of water you use for drilling, and then flowed back, which you don’t have problems with. And this is really the only stimulation of any type. It’s actually called an enhancement. There’s nothing to compare it with except trying to fracture a sand without proppant.

This is for the environmentalists in the audience. We do have buffalo in the area. There are scenic views.

When we finish however, this is how things look. We chase out the buffaloes and level the buttes.

This is just a brief comparison of the different basins we’re looking at. As you see, the grade and coal in the Powder River Basin in less than in other basins. Gas content is extremely low. Areas in square miles is great. Thicknesses are wonderful. And GIP is very low. (See table on next page).

Thank you.
**COALBED CHARACTERISTICS, ROCKY MOUNTAIN BASINS**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Coal Rank</th>
<th>Gas Content SCF/ton</th>
<th>Area (sq. mi.)</th>
<th>Max. Seam Thick.</th>
<th>Gip (TCF)</th>
<th>Cum. BCF 1998</th>
<th>#CBM Wells</th>
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</thead>
<tbody>
<tr>
<td>Powder River</td>
<td>Sub-bituminous B</td>
<td>&lt;100</td>
<td>25,800</td>
<td>200'</td>
<td>30</td>
<td>55</td>
<td>1,500</td>
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<tr>
<td>San Juan</td>
<td>Bituminous Med. and low volatile Sub-bituminous</td>
<td>100–500</td>
<td>7,500</td>
<td>40'</td>
<td>50</td>
<td>5,873</td>
<td>&gt;3,000</td>
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<tr>
<td>Raton</td>
<td>Bituminous High volatile C Med. volatile</td>
<td>200–400</td>
<td>2,200</td>
<td>10'</td>
<td>32</td>
<td>38</td>
<td>-225</td>
</tr>
<tr>
<td>Utah (Ferron)</td>
<td>Bituminous High volatile B</td>
<td>200–500 (400)</td>
<td>290</td>
<td>10'</td>
<td>5</td>
<td>100</td>
<td>210</td>
</tr>
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**CBM DEVELOPMENT FROM THE PERSPECTIVE OF WYOMING COUNTIES**

**MICKEY STEWARD, Coalbed Methane Coordination Coalition Coordinator**

I am the coordinator for the Coalbed Methane Coordination Coalition, which is a unique organization developed in Wyoming for a purpose that is different depending on who you talk to. So today, to start my description of the coalbed methane coordination coalition, I brought the memorandum of understanding that created the coalition. The coalition was constructed between the state of Wyoming and a joint powers board that is made up of five county commissioners and two conservation district supervisors. And if I had been smart, when I found out the constituency of the board, I would have known right away that this was a job that was going to have controversy associated with it, because I have five government people and two technical information transfer people, and that accurately reflects the purpose of the Coalbed Methane Coordination Coalition. And let me read to you exactly how we were constituted.

*The purpose of this memorandum of understanding is to provide for participation between the parties in addressing coalbed methane issues. The participation will be facilitated through communication,coordination, and cooperation between the State and the board for the common goal of reasonable and responsible coalbed methane development and protection and preservation of water supplies in Wyoming.*

*The board will employ a coalbed methane coordinator (you can switch that phrase to sacrificial goat). The board will employ a coalbed methane coordinator to facilitate participation including participation in the preparation of the Powder River Basin oil and gas development, environmental issues and environmental assessment.*

So we were created for the specific purpose of assisting in the reasonable and responsible development of coalbed methane and also to review the environmental impact statement. We are also unique in that our board has some industry advisors and participants who have been very brave and very helpful in furthering our cause, but early on, we recognized a split role was a difficult one for the industry, legislatively. So, to wholeheartedly support this, we have a very dynamic interaction there.