

## MEMORANDUM

**DATE:** October 26, 2009

**TO:** Frank Walles, President, AAPG Energy Minerals Division

**FROM:** Andrew R. Scott and Jack C. Pashin, Co-Chairmen,  
Coalbed Methane Committee

**SUBJECT:** Coalbed Methane Commodity Report

### **EMD Coalbed Methane Activities:**

Coalbed methane continues to be a topic of great interest to the membership of AAPG and EMD. EMD is co-sponsoring the Gulf Coast SEPM Bob F. Perkins Research Conference, which will be held in Houston, Texas from December 6 through December 8, 2009. This conference is entitled, “Unconventional Energy Resources: Making the Unconventional Conventional,” and includes presentations on numerous EMD commodities, such as coalbed methane, shale gas, gas hydrates, tight sands, oil shale, and tar sands. Further information is available online at <http://gcssepm.org/>.

Coalbed methane is being featured in oral and poster sessions at the upcoming AAPG Annual Meeting in New Orleans, and abstracts are currently under review. Jack Pashin, Richard Carroll, Marcella McIntyre, and Rashmi Grace of the Geological Survey of Alabama will be leading a post-meeting field trip called “Unconventional Gas Plays of the Southern Appalachian Thrust Belt,” which is being co-sponsored by EMD and SEPM. This trip will be run out of Birmingham, Alabama, and will feature coalbed methane and shale gas reservoirs. Participants will visit outcrops of deformed Cambrian shale masses, which host Alabama’s first shale gas field, Devonian shale, which is productive along the Appalachian frontal structures, and Pennsylvanian coal-bearing strata, which host major coalbed methane reserves in the Black Warrior and Cahaba coalfields.

### **Coalbed Methane Activity:**

The U.S. remains the world leader in coalbed gas exploration, booked reserves, and production. Currently, there is commercial coalbed gas production or exploration in approximately 12 U.S. basins and several basins in Canada, although activity has slowed in response to low gas prices. The major producing areas are the San Juan, Powder

River, Black Warrior, Raton, Central Appalachian, and Uinta (Ferron and Book Cliffs) basins. Other U.S. areas with significant exploration or production are the Cherokee, Arkoma, Illinois, Hanna, Gulf Coast, and Greater Green River basins. Exploration continues in all major U.S. basins, and the principal environmental issue confronting development is water disposal. Production operations are maturing in U.S. coalbed methane basins, and the U.S. Department of Energy has sponsored a series of pilot tests for CO<sub>2</sub> storage and CO<sub>2</sub>-enhanced coalbed methane recovery in coal. Injection has been completed in the Illinois, San Juan, Appalachian, and Williston basins, and additional injection tests are scheduled for the Black Warrior and Appalachian basins.

Annual coalbed methane production in 2008 increased significantly to 1,966 Bcf and was approximately 12.2 percent higher than 2007 coalbed methane production (1,753 Bcf)(Figure 1). Coalbed Methane reserves decreased from 21,874 Bcf in 2007 to 20,798 Bcf in 2005 representing a decrease of 1,076 Bcf or (4.9%) (Figure 2). Coalbed methane now represents 9.6 percent of 2005 dry-gas production and 10 percent of proved dry-gas reserves in the US. Coalbed methane now represents 9.6 percent of 2008 dry-gas production and 8.1 percent of proved dry-gas reserves in the US.

Most of the coalbed methane activity in the eastern U.S. is focused on the Appalachian Basin of Southwestern Virginia and the Black Warrior Basin of Alabama, with several companies actively developing joint CBM and CMM projects. At least 2,267 coalbed methane wells have been drilled to date in southwestern Virginia and production has increased from 85 Bcf in 2007 to 101 Bcf in 2008 (Figure 1). West Virginia had more 290 coalbed methane wells and coalbed methane production of 28 Bcf as of the end of 2008 representing a 12.0% increase from 2007 (25 Bcf). The number of wells in Pennsylvania is undetermined, but production nearly doubled from 5 Bcf in 2007 to 11 Bcf in 2008. This represents a 547% increase from a 2002 production rate of 1.7 Bcf. The advent of pinnate horizontal drilling has resulted in a significant expansion of the coalbed methane industry in the Appalachian basin by providing access to large volumes of gas in low-permeability coal seams. There are over 4,800 coalbed methane wells currently operating in Alabama with cumulative production of nearly 2 Tcf. Coalbed methane reserves in Alabama declined from 2,126 Bcf to 1,727 Bcf (or 18.9% decrease ) where as reserves in Virginia increased slightly from 2,738 to 2,781 (or 1.6% increase)(Figure 2). Reserves in other Eastern States (which include West Virginia, Ohio, Pennsylvania) declined from 393 Bcf to 390 Bcf (Figure 2).

Year	Alabama	Colorado	New Mexico	Utah	Wyoming	Virginia	E. States	W. States	Others (a)	Total
1989	23	12	56	NA	NA	NA	NA	NA	0	91
1990	36	26	133	NA	NA	NA	NA	NA	1	196
1991	68	48	229	NA	NA	NA	NA	NA	3	348
1992	89	82	358	NA	NA	NA	NA	NA	10	539
1993	103	125	486	NA	NA	NA	NA	NA	18	732
1994	108	179	530	NA	NA	NA	NA	NA	34	851
1995	109	226	574	NA	NA	NA	NA	NA	47	956
1996	98	274	575	NA	NA	NA	NA	NA	56	1,003
1997	111	312	597	NA	NA	NA	NA	NA	70	1,090
1998	123	401	571	NA	NA	NA	NA	NA	99	1,194
1999	108	432	582	NA	NA	NA	NA	NA	130	1,252
2000	109	451	550	74	133	NA	58	4	269	1,379
2001	111	490	517	83	278	NA	69	14	444	1,562
2002	117	520	471	103	302	NA	68	33	506	1,614
2003	98	488	451	97	344	NA	71	51	563	1,600
2004	121	520	528	82	320	NA	72	77	NA	1,720
2005	113	515	514	75	336	NA	90	89	NA	1,732
2006	114	477	510	66	378	81	24	108	NA	1,758
2007	114	519	394	73	401	85	31	136	NA	1,753
2008	107	497	443	71	573	101	40	136	NA	1,966
<b>TOTAL</b>	<b>1,980</b>	<b>6,594</b>	<b>9,069</b>	<b>724</b>	<b>3,065</b>	<b>267</b>	<b>523</b>	<b>648</b>	<b>2,250</b>	<b>23,336</b>

Figure 1. Historic coalbed methane production. Data from the Energy Information Administration (EIA)

Year	Alabama	Colorado	New Mexico	Utah	Wyoming	Virginia	E. States	W. States	Others (a)	Total
1989	537	1,117	2,022	NA	NA	NA	NA	NA	0	3,676
1990	1224	1,320	2,510	NA	NA	NA	NA	NA	33	5,087
1991	1714	2,076	4,206	NA	NA	NA	NA	NA	167	8,163
1992	1968	2,716	4,724	NA	NA	NA	NA	NA	626	10,034
1993	1237	3,107	4,775	NA	NA	NA	NA	NA	1,065	10,184
1994	976	2,913	4,137	NA	NA	NA	NA	NA	1,686	9,712
1995	972	3,461	4,299	NA	NA	NA	NA	NA	1,767	10,499
1996	823	3,711	4,180	NA	NA	NA	NA	NA	1,852	10,566
1997	1,077	3,890	4,351	NA	NA	NA	NA	NA	2,144	11,462
1998	1,029	4,211	4,232	NA	NA	NA	NA	NA	2,707	12,179
1999	1,060	4,826	4,080	NA	NA	NA	NA	NA	3,263	13,229
2000	1,241	5,617	4,278	1,592	1,540	NA	1,399	41	4,572	15,708
2001	1,162	6,252	4,324	1,685	2,297	NA	1,453	358	5,793	17,531
2002	1,283	6,691	4,380	1,725	2,371	NA	1,488	553	6,137	18,491
2003	1,665	6,473	4,396	1,224	2,759	NA	1,528	698	6,209	18,743
2004	1,900	5,787	5,166	934	2,085	NA	1,620	898	-	18,390
2005	1,773	6,772	5,249	902	2,446	NA	1,822	928	-	19,892
2006	2,068	6,344	4,894	750	2,448	1,813	273	1,030	-	19,620
2007	2,126	7,869	4,169	922	1,948	2,738	393	1,709	-	21,874
2008	1,727	8,238	3,991	893	1,851	2,781	390	927	-	20,798

Figure 2. Historic coalbed methane reserve trends. Data from Energy Information Administration (EIA).

The mid-continent region, consisting of the Cherokee, Forest City, Arkoma, and Illinois Basins has recently been one of the more active regions in the U.S., but production and reserves appear to be declining. Exploration in the Cherokee basin in Oklahoma and Kansas has spread northward to include the southern part of the Forest City Basin. The Arkoma Basin continues to produce CBM and there are multiple prospects being developed in this basin. As in the Appalachian Basin, horizontal drilling is proving to be an effective development strategy. Production for Kansas increased from 38 Bcf in 2007 to 47 Bcf in 2008 (a 23.1% increase), whereas production decreased in Oklahoma from 82 Bcf in 2007 to 69 Bcf in 2008 (a 15.9% decrease).

Coalbed methane reserves in the Western States not specifically listed in Figure 2 (Kansas, Louisiana, Oklahoma, Louisiana, and Montana) decreased significantly from 1,709 Bcf to 927 Bcf (a 45.8% decline). The largest loss in CBM reserves came from Oklahoma which went from 1,265 Bcf to 511 Bcf, representing a 59.6% decline (754 Bcf). Reserves for the remaining states either remained constant or increased slightly.

Infill drilling of Fruitland CBM wells in the San Juan Basin (Colorado and New Mexico) has decreased markedly in 2009 due to the recession. To minimize the environmental impact of infill drilling, operators are drilling deviated wells into Fruitland coal from the existing well pads. Environmental groups continue to express concern about gas seeps along the margins of the San Juan Basin in the Fruitland outcrop belt.

The States of Colorado and New Mexico continue to dominate CBM production and reserves (Figures 1 and 2). Cumulative production for Colorado and New Mexico is 15,663 Bcf through the end of 2008 which represents over 67% of the total CBM production (Figure 1). Colorado and New Mexico CBM reserves are 12,229 Bcf or 58.8% of the current CBM reserves for the United States. Cumulative production through 2008 was Coalbed methane production in Wyoming increased significantly from 401 Bcf in 2007 to 511 Bcf in 2008 representing a 42.9% increase in production. However, reserves in Wyoming declined 97 Bcf from 1,948 Bcf to 1,851 Bcf (5.0% decline).

International activity has been on the rise, and operations in the Qinshui Basin of China are the first to prove the producibility of coalbed gas from anthracite. Exploration and development activity continues in western Canada, where the Horseshoe Canyon coals host a major coalbed methane play. Horizontal drilling is playing an increasingly important role in the development of low-permeability coal seams in western Canada. Exploration and development efforts are intensifying in the Bowen, Surat, and Sydney Basins of Australia, as well as the Karoo Basin of South Africa. Coalbed methane in eastern Australia is being produced from high-permeability coal seams that can contain

large quantities of oil-prone organic matter, and produced gas is being considered for export into Asian LNG markets. A number of LNG plants (up to 5 or 6) are being considered in Australia so many of these companies are striving to book CMB reserves to justify the expenditure for LNG plant development as quickly as possible. The most likely outcome is that only 2 or 3 LNG plants will be developed.

Major potential exists in the Gondwanan coal basins of India, and development of fields and pipeline infrastructure is underway. Significant potential also exists in the coal basins of Europe and the Russian platform, and development in these areas is focusing mainly on coal-mine methane. Russia is continuing to promote CBM exploration and development but defining a market for the gas and predicting gas prices are problematic for future development. However, the coal basins in Russia may contain the largest CBM resources in the world so once a market for this gas, internally or internationally, is identified, then CBM exploration in Russia should increase significantly. Some significant exploration programs have been initiated within the past year to explore for coalbed methane in the structurally complex European coal basins of western Europe, including Germany.