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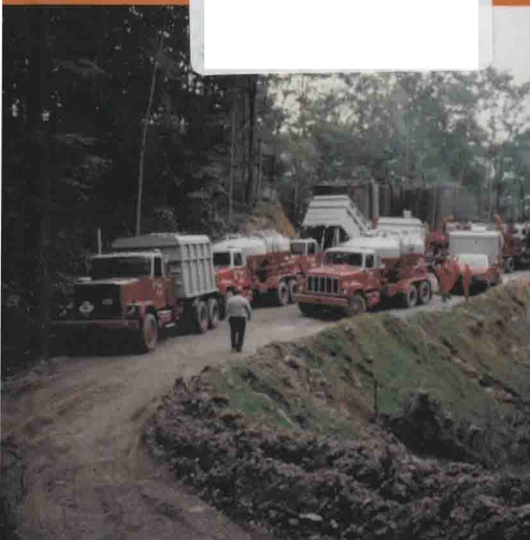

Coal Bed Methane

From Prospect to Pipeline

COAL BED METHANE

FROM PROSPECT TO PIPELINE

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COAL BED METHANE

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Preface

Coal is the most abundant and economical fossil fuel in the world today. Over the past 250 years, it has played a vital role in the growth and stability of the world economy. Total minable reserves of coal are estimated at 1 trillion tons (to a depth of 3000 ft) while the estimated reserve to a depth of 10,000 ft ranges from 17 to 30 trillion tons. Coal bed methane (CBM) and coal are syngenetic in origin. The coal seams (minable and nonminable) are a reserve for vast quantities of methane (10,000 to 30,000 TCF). Seventy countries around the world mine almost 8000 million tons of coal and produce 3 TCF of CBM per year. At this rate, coal and CBM are likely to remain a dominant source of energy in this and the next century.

CBM was a bane for mining from the very beginning. As coal is mined, methane is released in mine air. Methane becomes explosive when mixed with air in the range 4.5–15% by volume. The history of coal mining around the world is replete with mine disasters when the methane–air mixture exploded. It is estimated that about 8000 people died in the US alone. Number of fatalities is much higher for many other countries. Efforts to mitigate this disaster started in Europe via gob gas drainage with cross-measure boreholes but serious efforts to degas the coal seam prior to mining and postmining began in the US only in the 1970s. The coal industry and the erstwhile US Bureau of Mines often pooled their resources to make the mines a safer place to work and boost the productivity as well. Major achievements are as follows:

1. In-mine horizontal drilling (1974–1980). The drilling rig and the instrument system can drill up to 3000 ft long boreholes in 5–6 ft thick coal seams and degas the coal prior to mining.
2. Vertical gob wells over mined out areas (1975–1983). The European cross-measure boreholes could not cope with the highly productive US longwall faces with their fast rate of mining and consequent high volumes of methane emissions. Vertical gob wells drilled over the longwall gobs with blowers could capture 70–80% of the total emissions allowing very high rate of mining and productivities of 70–80 tons/man-day.
3. Massive hydraulic fracturing of coal seams (1984–1994). This technique allowed degasification of deeper (2000–3300 ft) coal seams and gave rise to commercial exploitation of CBM.

4. Horizontal boreholes drilled from surface (2001–2010). With the development of new instrumentations that monitored the drill bit while drilling, it became possible to drill 5000 ft long horizontal boreholes in coal seams from surface. While this technique is applicable to coal seams at all depth, it is particularly suited to very deep, thick, and gassy coal seams. Deep coal seams of the world can be successfully exploited by combining this technique with hydrofracking of horizontal legs. This is the same technique that revolutionized the gas production from Marcellus shale in the USA.

Thus it would be no exaggeration to say that CBM that was a bane to mining industry has now become a boon—a viable source of additional energy.

It is clear now that these new technologies can open up the vast coal reserve for gas production. Currently 10% of US gas production is realized from coal seams but it can easily go to 20% if the deep and thick coal seams are put on production.

The North American Coal Bed Methane Forum was created in 1985 to promote mine safety and increase energy supply by producing methane from coal seams. It is a nonprofit organization based in West Virginia, USA. It has continuously offered a seminar once or twice a year on timely issues related to CBM production and methane control in mines. The book, "Coal Bed Methane: Prospects to Pipeline" is the proceedings of the 25th Anniversary of the Forum. It covers this vast subject in 18 chapters. The book is designed to be a textbook for undergraduate and graduate level courses taught in many US universities.

The editors would like to thank all authors who wrote and presented the papers at the 25th Anniversary Forum. The publication was inordinately delayed for lack of a viable publisher. We would like to thank Elsevier and particularly Louisa Hutchins for their tremendous support in getting the document ready for publication. In spite of our efforts to avoid, there may still be some minor errors in the text. We will be indebted to careful readers if they can point them out. It would be our sincere hope and commitment that we will remove them in the second edition of this very useful book.

Hoping to keep the coal mines safe and increasing the supply of natural gas to US homes, we remain grateful for the opportunity to work together and publish this book.

Pramod Thakur
Steve Schatzel
Kashy Aminian

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CHAPTER

1

Coalbed Methane: A Miner's Curse and a Valuable Resource

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The US coal industry has been challenged over the years by the explosive coalbed methane (CBM) gas. It permeates most coalbeds, rendering mining process dangerous. Indeed, CBM was nicknamed the "miner's curse", because it escaped from mineable coal seams and exploded when mixed with air if a source of ignition was present.

The "miner's curse" is also an energy source—and possibly an environmental problem. Since the 1830s gas explosions in US coal mines have killed thousands of miners. Among the worst US mine disasters of the twentieth century was one that occurred in Northern Appalachia—362 miners perished in a gas and dust explosion at Monongah, West Virginia in 1907 (Figure 1.1). Over 600 mine explosions in US coal mines have been documented in the various coal fields (Table 1.1). Mine safety has come a long way since then. Methane in coal mines will always be a hazard, but the risk of explosion has been greatly minimized by increased safety regulations, sensitive gas detectors, improved ventilation, and methane drainage.

And therein lies an opportunity to utilize an energy source and further improve mine safety and possibly improve regional environments. Although venting gas into the atmosphere has helped to reduce underground explosions to infrequent events, it also discards potentially valuable fuel and adds "methane" (a classified greenhouse gas) to our regional atmosphere. Thus, the large volumes of CBM vented by mines represent both an economic loss and an environmental challenge.

In the 1990s, up to 300 US billion cubic feet of methane were vented from US coal mines (mostly underground operations). This was 15% of all

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FIGURE 1.1 Monongah, WV mine explosion—1907.

TABLE 1.1 Coal Mine Disasters in US Since 1839

Time Period	Coal Mine Disasters
Through 1875	19
1876–1900	101
1901–1925	305
1926–1947	147
1951–1975	35
1976–2003	15
2004–2013	2
Total	624
Undocumented	>300
Estimated total US Coal mine deaths	>8000

global methane emissions from coal mining, and less than 1% of all methane released into the atmosphere by mankind.

Methane's "greenhouse gas" potential has been stated to be many times greater than CO_2, so its release during coal mining and processing is a concern. Currently, the atmospheric methane concentration is a lesser problem than CO_2, simply because methane is much scarcer in the atmosphere, with only 1/200th the concentration of CO_2. But this may be changing: the methane percentage is slowly increasing worldwide, at a faster rate than the CO_2 percentage. The US Geological Survey has been forecasting methane to surpass CO_2 as the dominant greenhouse in the second half of the twenty-first century—if its concentration continues to grow at the present rate.