Collected Studies

**Coal Seam Natural Gas**

Also Known as “Coalbed Methane”
The Interstate Oil and Gas Compact Commission gratefully acknowledges the dedication and efforts of IOGCC Research Assistant Keith Thomas in compiling this collection of studies.

The IOGCC also would like to thank the U.S. Environmental Protection Agency for the financial support that made this publication possible.

The IOGCC also would like to thank the U.S. Department of Energy for its ongoing support.

For more information about the IOGCC or this report, visit the IOGCC Web site at www.iogcc.state.ok.us, call 405/525-3556 or send e-mail to iogcc@iogcc.state.ok.us.

Summer 2002
Collected Studies

Coal Seam Natural Gas

Also Known As “Coalbed Methane”

Interstate Oil and Gas Compact Commission
The energy value of natural gas has been known since ancient times. Capturing it for beneficial use has been the tough part. The world has lost untold quantities of natural gas. In countries other than the United States and Canada, it continues to be vented and flared in wasteful volumes. Colorless, odorless natural gas dissipates quickly into the atmosphere when freed from the rock in which it is trapped. Thirty years ago, the United States made a national policy decision to capture natural gas from what were then considered “more difficult” rocks, including coal.

Since the underground mining of coal began, humans have been aware that gas trapped in coal is freed when the coal is broken open. In traditional underground mining operations, a prime safety consideration for miners is venting gas from the mine.

Though the resource was identified, developing it as commercial natural gas was considered so difficult at the time that a federal tax credit to develop “coalbed methane” was put in place. Many believed the credit was a hollow incentive to the industry. However, this federal policy decision proved to be important for the development of this natural gas. (Identified in the tax law as “coalbed methane” the industry and government have commonly used this shorthand to identify natural gas from coal.)

Extensive research has shown that gas from coal is our nation’s most abundant new source of natural gas. It remained a novel concept to those accustomed to natural gas coming from more traditional rocks such as sandstone and limestone.

Natural gas whose source is coal now accounts for 7 per cent of total production in the United States. Twenty years ago the figure was virtually zero.

Because public policy supports development of natural gas from coal, extensive research has been conducted to learn how to harness this resource for beneficial human use. These studies have never before been published in a single volume. The most significant early work comes from the Gas Research Institute, which paved the way for current production practices. States, universities, companies and other research institutions have added to this volume of work. Even today more research is being conducted across the nation as natural gas is sought in different kinds of coal.

Because this is now an important part of the total U.S. energy mix, the industry needs to move away from using its confusing catchword “coalbed methane.” The general public understands the term “natural gas” because they use it every day. That is why we are calling this resource “natural gas” and identifying its source rock as coal seams.

Christine Hansen
Executive Director
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Introduction

One of our country’s most valuable caches of natural gas comes from a source once seen as a nuisance to the coal mining industry. Coal seam natural gas (CSNG) must now be seen as having great potential as a fossil fuel resource. There is a voluminous amount of information on this issue. Valuable studies dating back 50 years or more have been produced. The many sides of this issue have been considered for years. What is not disputed is that the United States has very large coalbeds that cover vast areas of the country. See Figure 1. The question is what to do with the natural gas present in those coalbeds.

![Figure 1](image)

Source: U.S. Geological Survey
Energy Resource Surveys Program

The coal industry has long recognized the removal of the methane-rich gas in the coalbeds as a dangerous part of the mining process. To safely mine the coal, the gas must be removed. In the past, CSNG had to be vented to allow for coal development. Such degasification wasted this valuable resource because economical methods for utilization had not been developed.

A great amount of research has been conducted on these coalbeds and the natural gas they contain. The CSNG occurs within the coal in two ways. CSNG is usually stored on the internal surfaces of the coal (sorbed gas), but can also exist in the cleats (natural fractures) as free gas in the coalbeds. To produce the more commonly found sorbed gas, it must be “desorbed” from the internal surfaces of the coal and allowed to migrate out of the matrix into natural fractures where it can be extracted.¹ See Figure 2.

The cleats found in coalbeds are usually filled with water. This water can be saline. To produce CSNG from a coalbed, the water must be removed. Removal of the water allows the gas to enter these fractures and then be extracted through a wellbore. In the early stages of CSNG production the volume of water can be great, which creates a problem for the operator, the landowner and the state. Following the completion of a CSNG well, the amount of water produced decreases with time and the volume of CSNG increases. In the later stages of production from a CSNG well, the volume of gas decreases while the amount of water produced will usually stay at the decreased level. See Figure 3. The water discharge must be done in an economical and environmentally responsible manner.

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2 Id.
Much has been written on CSNG. A wealth of information exists about the potential for exploration and production of this resource. Studies on CSNG are not confined to the coalbeds in a limited area, but rather have been conducted in many of the coal basins throughout the country. These studies have been conducted by the federal government, the geological surveys of many of the states, and by private industry. There have been in-depth studies into such issues as the environmental impact of production of natural gas from coal seams, the most economical ways to produce CSNG, and the relationship between CSNG production and coal mining interests.

In keeping with its long history of helping states to stay informed on issues pertaining to the efficient production of oil and gas, the Interstate Oil and Gas Compact Commission (IOGCC) will maintain a list of documents discussing development of CSNG. This bibliography of scientific papers, reports, articles and studies addresses pertinent issues many IOGCC member states face. The sources of these documents are the states, the United States Geological Survey, the Gas Technology Institute and other organizations. It is the desire of the IOGCC that by sharing the information available, the burden of addressing issues related to the production of natural gas from coal seams will be lessened. States have a wealth of information on this topic and must now use it to their benefit.

This compilation of CSNG information does not include all relevant documents on this issue, but rather illustrates the quality and quantity of information on the topic. This bibliography represents only a small amount of the information. These documents contain information that will help the states understand many aspects of CSNG development. The IOGCC will collect as many of the pertinent documents as possible. Papers, reports, articles and studies dealing with issues important only to those engaged in the exploration of CSNG are not included. Many of the documents can be reproduced and supplied upon request by the IOGCC or retrieved online. However, many of the documents listed in this publication can be obtained only from the organizations listed with that document.

The IOGCC gratefully acknowledges the cooperation of many of the state oil and gas regulatory agencies and the state geological surveys. With the help of its member states, the IOGCC will continue to update and expand this list.
Acronyms

The following is a list of acronyms used in this publication.

AAPG . . . . American Association of Petroleum Geologists
ACS . . . . American Chemical Society
AGS . . . . Alaska Geological Survey
AGU . . . . American Geophysical Union
BIA . . . . Bureau of Indian Affairs, U.S. Department of the Interior
BRI . . . . Basin Research Institute, Louisiana State University
CBM . . . . Coalbed Methane
CGS . . . . . Colorado Geological Survey
COGCC . . . Colorado Oil & Gas Conservation Commission
COMPAS . . Coalbed Methane Production and Stimulation Database
CSM . . . . Colorado School of Mines
CSNG . . . . Coal Seam Natural Gas
DGGS . . . . Division of Geological and Geophysical Surveys, Alaska Dept. of Natural Resources
DOE . . . . . U.S. Department of Energy
EPA . . . . . U.S. Environmental Protection Agency
FTE . . . . . Freeze-thaw/evaporation
GIS . . . . . Global Information System
GRI . . . . . Gas Research Institute
GSA . . . . . Geological Society of America
GSC . . . . . Geological Survey of Canada
GTI . . . . . Gas Technology Institute
IOGCC . . . Interstate Oil and Gas Compact Commission
KGS . . . . Kansas Geological Survey
LLL . . . . . Lawrence Livermore Laboratory
MBMG . . . Montana Bureau of Mines & Geology
MGS . . . . . Montana Geological Society
MRCP . . . Methane Recovery From Coalbeds Project, U.S. Department of Energy
NDGS . . . North Dakota Geological Survey
NETL . . . . National Energy Technology Laboratory, U.S. Department of Energy
NMGS . . . New Mexico Geological Society
NPDES . . . National Pollutant Discharge Elimination System
OGS . . . . Oklahoma Geological Survey
PGS . . . . . Pennsylvania Geological Survey
RMAG . . . Rocky Mountain Association of Geologists
SEPM . . . . Society of Economic Paleontologists and Mineralogists
SNG . . . . . Substitute Natural Gas
SPE . . . . . Society of Petroleum Engineers
STR . . . . . Salinity / Toxicity Relationship
TSOP . . . . The Society of Organic Petrology
UGMS . . . Utah Geological and Mineralogical Survey
USBM . . . United States Bureau of Mines
USGS . . . United States Geological Survey
WGA . . . . Wyoming Geological Association
WOGCC . . . Wyoming Oil & Gas Conservation Commission
WSGS . . . . Wyoming State Geological Survey
The Bibliography

The citations in this bibliography are listed alphabetically by author. Works by the same author are organized with the older of the citations listed first. The indexes at the end of the bibliography are provided to help locate works on a specific topic or on a specific area.


   **Summary:** MRCP Report.


   **Summary:** MRCP Report.


   **Summary:** MRCP Report.


   **Summary:** USGS Open File Report.

5. Affolter, R. H.; Hatch, J. R.; and Culbertson, W. C., 1979, Chemical Analyses of Coal from the Tongue River Member, Fort Union Formation, Moorhead and Southeastern Part of the North ward Extension of the Sheridan Coal Fields, Powder River and Big Horn Counties, Montana, available from the United States Geological Survey as OF 79-538.

   **Summary:** USGS Open File Report.

**Summary:** USGS Open File Report.


**Summary:** Non-USGS publication with USGS authors.


**Summary:** This report discusses the data collected on a well drilled into the Fruitland formation coal in the San Juan Basin of southeast Colorado. The data was analyzed to determine the potential of the coal seam natural gas reservoir.


**Summary:** SPE Paper

10. State of Alaska, Division of Oil and Gas, Department of Natural Resources, 1999, *Coalbed Methane Study*, available online.

**Summary:** Brief synopsis of the status and potential of the development and impact of coalbed methane in Alaska. For more information, contact Jim Clough, Alaska Division of Geological & Geophysical Surveys, 907/451-5030.


**Summary:** Paper

of Petroleum Engineers.

Summary: SPE Convention Document.


Summary: NMGS Guidebook.


Summary: OGS Report.


Summary: Conference paper, which discusses how modeling can address the interaction between regional groundwater flow, the flow system in fractured coalbeds within the Ferron Sandstone, and faults. Discusses how use of a 3-D discrete fracture network model can be used to describe a groundwater flow system in a coalbed. Presented at the 1998 annual meeting of the American Association of Petroleum Geologists.


Summary: Conference paper, which discusses how modeling can address the interaction between regional groundwater flow, the flow system in fractured coalbeds within the Ferron Sandstone, and faults. Discusses how use of a 3-D discrete fracture network model can be used to describe a groundwater flow system in a coalbed. Presented at the 1999 annual meeting of the Geological Society of America.


Summary: Article.

**Summary**: Regional groundwater model for the San Juan Basin. This model was developed as part of the comprehensive 3M Project (the three Ms stand for mapping, modeling and monitoring).


**Summary**: MRCP Report.


**Summary**: SPE Paper presented at the Rocky Mountain Regional Meeting of the Society of Petroleum Engineers.


**Summary**: USGS Open File Report.


**Summary**: This article in a Non-USGS publication by USGS authors discusses the findings of the 1995 National Assessment of Oil and Gas Resources, which was conducted by the USGS. This conference document examines physical and economic variables to explain the disparity between economic and technically recoverable coal seam natural gas.


**Summary**: Article.

**Summary:** WSGS Publication.


**Summary:** This report discusses research conducted to identify sedimentologic controls on the occurrence of coalbed methane in the Fruitland Formation in the San Juan Basin.


**Summary:** Article.


**Summary:** Symposium Document.


**Summary:** Annual report, which describes the geologic framework and hydrologic regime of coal seam natural gas produced from the Fruitland Formation of the San Juan Basin.


**Summary:** Report containing an evaluation of coalbed methane in the Fruitland Formation. Describes coal seam natural gas occurrences and resources, regional hydrodynamics, coal rank,
composition of the coal gas, and fracture patterns.


**Summary:** Symposium Document.


**Summary:** Symposium Document.


**Summary:** Report from the New Mexico Bureau of Geology and Mineral Resources.


**Summary:** Article.


**Summary:** USBM Report.


**Summary:** Article.


**Summary:** USGS Report prepared in cooperation with the U.S. Department of Energy.

**Summary:** AAPG Bulletin.


**Summary:** USGS Open File Report.


**Summary:** Conference Document.


**Summary:** Conference Document.


**Summary:** USGS Open File Report.


**Summary:** AAPG Conference Document.

Summary: GSA Short Course.


Summary: GSA Conference Document.

45. Barker, Charles E.; Biewick, Laura R. H.; Warwick, Peter D.; and San Filipo, John R., 2000, Preliminary Gulf Coast Coalbed Methane Exploration Maps; Depth to Wilcox, Apparent Wilcox Thickness and Vitrinite Reflectance, available from the United States Geological Survey as OF 00-0113.

Summary: USGS Open File Report.


Summary: Alaska DGGS Report.


Summary: AAPG Bulletin.


Summary: AAPG Conference Document.


Summary: Article.

**Summary:** This is a final report on the implementation of previously developed physical models of hydraulic fracturing on wells with coalbed methane and tight gas sands.


**Summary:** Paper.


**Summary:** Article.


**Summary:** This is a report on the Rock Creek Methane from Multiple Coal Seams Completion Project. This project focused on well drilling and completion, with emphasis on wellbore access and hydraulic stimulation.


**Summary:** Final report discusses the effectiveness of dewatering techniques for coalbed methane wells in the Warrior Coal Field. Contains field evaluations of gas lift and progressive cavity pumps.


**Summary:** This SPE paper places the environmental issues surrounding coal seam natural gas development in the San Juan Basin into historical perspective. The findings of sampling and testing programs conducted near the New Mexico community of Cedar Hill are discussed.

**Summary:** This report discusses the differences in treatment pressure behavior during the hydraulic fracturing operations on coal seams and conventional formations.


**Summary:** This report discusses the COMPAS database, which contains information on 172 hydraulic fracture treatments for 122 wells.


**Summary:** This conference paper reports on the varied pressure responses of coal seams to hydraulic fracture stimulation.


**Summary:** CSM Publication.


**Summary:** Symposium Paper.


**Summary:** Article.


Summary: Conference Paper.


Summary: Geological Society Report.


Summary: Article.


Summary: This report discusses the ability to evaluate the production and reserve potential of coal seam wells.


Summary: Details factors affecting methane development, drilling and completion methods for degasifying coalbeds. It also contains a detailed case study of a Piceance Basin mine.


Summary: USGS Open File Report.


Summary: USGS Open File Report.
69. Boyer, C. M., II; and Hirko, N. M., 1985, *Rock Creek Methane from Multiple Coal Seams Completion Project. Phase I Test Plan*, available from the Gas Technology Institute as GRI-86/0155.

**Summary:** This report discusses the Rock Creek Methane from Multiple Coal Seams Completion Project.


**Summary:** Final report on a well that was completed into the Mary Lee and Blue Creek coal seams in the Black Warrior Basin of Alabama. This well completion was used to evaluate the geologic and reservoir parameters which affect the stimulation and production of coal seam natural gas.


**Summary:** Final report of findings from a coal seam natural gas well completed into the Mary Lee and Blue Creek coal seams in the Warrior Basin of Alabama. Evaluates the geologic and reservoir parameters that affect the stimulation and production of coalbed methane. Appendixes address such issues as gas and water production, hydraulic fracturing, and a mini-frac analysis.


**Summary:** This report discusses the evaluation of the economic potential for commercial production of natural gas from the coal seams at Rock Creek in the Warrior Basin of Alabama.

73. Boyer, C. M., II; Briscoe, F. H.; Camp, B. S.; Dobscha, F. X.; and Malone, P. G., 1986, *Rock Creek Methane from Multiple Coal Seams Completion Project. Demonstrated Drilling and Completion Technology for the Multiple Coal Seams Completion Project*, available from the Gas Technology Institute as GRI-87/0084.

**Summary:** This report discusses details of drilling, casing and cementing.

Summary: This report gives the data on the methane contents of the natural gas from coal seam wells drilled at the Big Indian Creek site in the Warrior coal basin in Alabama.


Summary: This report contains the appendixes to the data in Volume I (GRI-85/0285).


Summary: This report gives an analysis of the subsurface geology of six Pennsylvanian age coal seams. This was done to estimate the coal volumes present in the Central Appalachian Basin.


Summary: GRI Report.


Summary: This report explores the potential of the natural gas from coal seams resource and the key mechanisms controlling its production.


Summary: Symposium Paper.


Summary: EPA Report.

*Deposits: Technical Evaluation and Database*, available from the Gas Technology Institute as GRI-92/0473.

**Summary:** This report on GRI-sponsored research discusses the advancements made in the low cost recovery of natural gas from coal seams.


**Summary:** This report focuses on three vehicles of GRI’s technology transfer.


**Summary:** Article.


**Summary:** USGS Open File Report.


**Summary:** USGS Paper.


**Summary:** PGS Open-File Report.

Summary: This is the final report on a literature search that resulted in a computerized retrieval system for well testing methods and data analysis procedures.


Summary: Report discusses the results discovered from data gathered from five coal seam natural gas projects located in the Piceance, San Juan and Warrior basins. The data was used to evaluate single-phase tests for determining hydrological properties.


Summary: This is a report on the evaluation of hydrologic testing of coalbeds.


Summary: This is a report on the development of hydrologic concepts and well testing techniques. Discusses a test devised to determine permeability and static reservoir pressure of a coal seam as well as the condition of the wellbore.


Summary: BLM Report.


Summary: BLM Report.


Summary: BLM Report.

**Summary:** BLM Report.


**Summary:** BLM Report.


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**Summary:** BLM Report.


**Summary:** BLM Report.

**Summary:** BLM Report.


**Summary:** BLM Report.


**Summary:** AAPG Report.


**Summary:** Article.


**Summary:** Report.


**Summary:** Symposium Paper.


**Summary:** This report discusses a study conducted to determine if mineral catalysts affect gas
formation during coal maturation.


**Summary:** Article.


**Summary:** This report discusses the geologic parameters and the methodology used in the identification, confirmation, and development of coalbed methane resources.


**Summary:** USGS Bulletin.


**Summary:** MGS Report.


**Summary:** AAPG Report.


**Summary:** RMAG Report.

Summary: Article.


Summary: OGS Open File Report.


Summary: OGS Open File Report.


Summary: OGS Open File Report.


Summary: OGS Open File Report.


Summary: OGS Circular.


Summary: RMAG Report.


Summary: USGS Open File Report.

123. Carroll, C. J., 1999, *Correlation of Producing Fruitland Formation Coals and Coalbed...*

**Summary:** Contains production database, seven cross sections, five structure and production isopach maps, production bubble map, cross sections index map and two new surface maps of the Fruitland Formation coal zones located on the Southern Ute Reservation. This 1999 report contains descriptions of suspected seep locations, fracture data, and coal correlation with the western outcrop region.


**Summary:** USGS Circular.


**Summary:** This is a final report on research conducted to identify mechanisms that influence the propagation of hydraulic fractures in coal seams and the surrounding strata, correlate the production of methane with identifiable fracture characteristics, and to specify the most effective fracture treatment designs.


**Summary:** This report discusses laboratory tests and computer simulations conducted to investigate the mechanical, physical and chemical phenomena associated with the hydraulic fracturing of coal seams.


**Summary:** Discusses the differences between the Powder River Basin and various other documented cases where subsurface fluids have been withdrawn. The authors of this report also compare coal seam natural gas production and water production from sandstones in the same area.

Summary: USBM Report.


Summary: USBM Report.


Summary: This is an annual report on data used to evaluate the geologic and production parameters for coal seam natural gas in the Brookwood and Oak Grove coal degasification fields in the Black Warrior Basin of Alabama.


Summary: AAPG Report.


Summary: This symposium paper details the coalbeds in Kentucky and the potential for natural gas from coal seams as a resource.


Summary: Report prepared for DOE.

Summary: MRCP Report.


Summary: Report prepared for DOE.


Summary: SPE Symposium Document.


Summary: Report prepared for DOE.


Summary: AAPG Report.


Summary: AAPG Report.


Summary: Symposium Paper.

141. Clark, W. F.; and Helmer, T., 1988, Completing, Equipping, and Operating Fruitland Formation

Summary: RMAG Report.


Summary: GSC Paper.


Summary: Article.


Summary: Article.


Summary: Article.


Summary: Conference Document.


Summary: USGS Circular.

**Summary:** GSA Conference Document.


**Summary:** Presents a review of the main aspects of coalbed gas geochemistry and advances in research.


**Summary:** This final report presents a listing of a technology transfer effort to implement stimulation concepts developed for the Gas Research Institute. Discusses the improvement of hydraulic fracturing operations, the development of computer-based monitoring systems and provides a detailed account of data from a large number of wells.


**Summary:** Symposium Document.


**Summary:** This SPE paper discusses the fracture permeability of the Fruitland Formation coalbed methane reservoirs in the San Juan Basin.


**Summary:** NMGS Guidebook.

**Summary:** This SPE paper provides an updated overview on coal seam natural gas potential in the Raton Basin.


**Summary:** RMAG Report.


**Summary:** Report.


**Summary:** AAPG Report.


**Summary:** RMAG Report.


**Summary:** Alaska DGGS Publication.


**Summary:** This AAPG conference document presents facts and figures on the potential for production of Alaskan coal seam natural gas.

**Summary:** CGS Report.


**Summary:** AGU Report.


**Summary:** MBMG Publication.


**Summary:** Conference paper, which reports the findings of a USGS study of the geologic and engineering controls on gas production from coalbeds. These coalbeds are found in the Ferron Sandstone member of the Mancos Shale of eastern Utah. Presented at the 1999 annual meeting of the Geological Society of America.


**Summary:** BLM Report.


**Summary:** BLM Report.


**Summary:** DOE Report.

**Summary:** This report, prepared by the COGCC staff, summarizes the findings of an investigation into changes in the levels of methane in water from water wells in La Plata County, Colorado. The report compares methane levels in ground water prior to coalbed methane development with those after the beginning of development.


**Summary:** Reports on the findings of a study on the effects of hydraulic fracturing on deep coal seams in the Piceance Basin.


**Summary:** Reports on the findings of the GRI Deep Coal Seam Project. Data given on drilling, reservoir testing, core analysis, logging and stimulation of low permeability coal reservoirs in the Piceance Basin.


**Summary:** Report on study that investigated future water production in the San Juan Basin. The study identified alternative water treatment technologies, which might be competitive with underground disposal.


**Summary:** This SPE paper discusses the use of alternate treatment technologies for coal seam natural gas produced water in the San Juan Basin to make the water suitable for surface discharge.

Summary: This SPE paper discusses water contamination caused by methane seepage from coal seam natural gas wells in the San Juan Basin.


Summary: This report presents the results of a regional geologic assessment of the Menefee formation in the San Juan basin.


Summary: Article.


Summary: USGS Open File Report.


Summary: USGS Open File Report.


Summary: Article.


Summary: This conference report gives a description and application of a new method for resource
assessment of recoverable coal seam natural gas.


**Summary:** USGS Circular.


**Summary:** Society of Organic Petrology Report.


**Summary:** USGS Open File Report.


**Summary:** USGS Open File Report.


**Summary:** IEA Coal Research Report.


**Summary:** SPE Report.

186. Dallegge, Todd A.; and Barker, Charles E., 2000, *Coal-bed Methane Gas-In-Place Resource Estimates Using Sorption Isotherms and Burial History Reconstruction; An Example from Ferron Sandstone Member of the Mancos Shale*, available from the United States Geological Survey as P 1625-B.
Summary: USGS Professional Paper.


Summary: AAPG Bulletin.


Summary: Report.


Summary: This conference paper is an assessment of how natural gas produced waters were handled in the U. S. in 1990.


Summary: Article.


Summary: Symposium Document.


Summary: RMAG Report.
193. David, C., 1999, *This Land is Your Land, This Land is My Land: But Who Owns The Coal Gas?*

**Summary:** Paper.


**Summary:** Report.


**Summary:** Report on a guidance manual for the management of water produced from wells in the Black Warrior Basin of Alabama.


**Summary:** GSC Bulletin.


**Summary:** Report.


**Summary:** GSC Bulletin.


**Summary:** Report.


Summary: WSGS Publication.


Summary: WSGS Publication.


Summary: WSGS Publication.


Summary: WSGS Publication.


Summary: WSGS Publication.


Summary: WSGS Publication.


Summary: WSGS pamphlet that details the development of coal seam natural gas in the state of Wyoming.

Summary: This GRI topical report discusses the data from a six year multi-well project that focuses on the technology required to produce gas from deeply buried coal in the Piceance Basin.


Summary: AAPG Report.


Summary: Symposium Paper.


Summary: This report discusses the gas-in-place in the Fruitland Formation coals in the San Juan Basin. Discusses the geology of the coal formation to provide a foundation for evaluating the coal seam natural gas in place.


Summary: RMAG Report.


Summary: This conference paper evaluates techniques that can be used to predict the orientation and the location of areas with a greater natural gas from coal seams reservoir permeability prior to drilling. From data collected from the Fruitland formation in the Cedar Hill Field, northern San Juan Basin, New Mexico.

213. Deeley, G. M.; and Canter, L. W., 1986, Distribution of Heavy Metals in Waste Drilling Fluids

Summary: Article.


Summary: Symposium Paper.


Summary: USBM Bulletin.


Summary: USBM Report.


Summary: Symposium Paper.


Summary: USBM Report.


Summary: USBM Circular.

**Summary:** USBM Report.


**Summary:** USBM Circular.


**Summary:** Article.


**Summary:** USBM Bulletin.


**Summary:** USBM Bulletin.


**Summary:** AAPG Report.


**Summary:** USBM Circular.

**Summary:** Article.


**Summary:** Symposium Paper.


**Summary:** Society of Sedimentary Geology Report.


**Summary:** UGMS Study.


**Summary:** Article.


**Summary:** Article.


**Summary:** DOE Paper.

**Summary:** Conference paper from the 1989 Coalbed Methane Symposium.


**Summary:** BRI Bulletin.


**Summary:** This report discusses the planning materials relevant to defining the natural gas from coal seams.


**Summary:** Sets the theoretical and mathematical basis for the conclusions reached in *Subsidence Potential Related to Water Withdrawal in the Powder River Basin*, by Case, James C.; Edgar, Thomas V.; and De Bruin, Rodney H. (Listed above).


**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** USGS Map.

Summary: USGS Map.


Summary: Conference document from the 1997 Annual Meeting of the GSA.


Summary: USGS Open File Report.


Summary: USGS Paper.


Summary: USGS Paper.


Summary: USGS Paper.

Assessment of Selected Tertiary Coal Beds and Zones in the Northern Rocky Mountains and Great Plains Region, available from the United States Geological Survey as P 1625-A.

**Summary:** USGS Paper.


**Summary:** USGS Paper.


**Summary:** USGS Paper.


**Summary:** RMAG Publication.


**Summary:** Article.


**Summary:** WGA Publication.

Summary: Report.


Summary: EPA Report.


Summary: EPA Report.


Summary: EPA Report.


Summary: EPA Report.


Summary: EPA Report.


Summary: EPA Report.

Summary: EPA Report.


Summary: EPA Report.


Summary: EPA Report.


Summary: This GRI report discusses the WELL 1D computer program that is designed to simulate the nonsteady, one dimensional, simultaneous, two-phase flow of water and methane gas through a coal seam to an unstimulated vertical well or to a hydraulically stimulated vertical well connected to a high conductivity vertical fracture.


Summary: This GRI report discusses a series of computer based models for production of methane from coal seams by vertical wells.


Summary: Pennsylvania State University Publication.

Summary: Report.


Summary: USGS Paper.


Summary: Symposium Paper.


Summary: RMAG Guidebook.


Summary: Report.


Summary: AAPG Bulletin.


Summary: USGS Conference Paper included in a USGS Circular.

Summary: Conference paper that discusses the role production of coalbed methane from wells close to and down dip from seep areas plays in the mobilization of the gas that is migrating up dip, thus increasing the rate of gas seepage from old seeps or creating new seeps.


Summary: USGS Open File Report.


Summary: This GSA conference document discusses the differing models for the Fruitland Formation coal in the San Juan Basin.


Summary: CGS Open-File Report.


Summary: USBM Report.


Summary: USBM Report.


Summary: Proposed study plan, which outlines work elements and methodology for conducting field
experiments at the Cedar Cove degasification field in Alabama. The proposed study would also include aquatic toxicity testing using a natural gas produced water, which was disposed of in the form of stream discharge.


**Summary:** Report on a study that investigated the potential causes of contamination found in the shallow groundwater of the Animas River Valley.


**Summary:** Report.


**Summary:** This GRI report discusses the costs associated with groundwater restoration.


**Summary:** U.S. Fish and Wildlife Service Report.


**Summary:** AAPG Report.


**Summary:** GSA Conference Document.

**Summary:** AAPG Report.


**Summary:** Non-USGS publication by USGS authors.


**Summary:** Discusses how coalbed gas has gone from being a mining hazard to a conventional gas resource.


**Summary:** USGS Paper.


**Summary:** USGS Open File Report.


**Summary:** AGS Conference Document.

Summary: Report of some of the findings of a BLM-USGS cooperative CBM project. This joint project sought to collect technical data on CBM resources and reservoirs in the Powder River Basin.


Summary: This GSA conference document discusses the methane gas content in Powder River basin coals.


Summary: AAPG Conference Document.


Summary: OGS Publication.


Summary: AAPG Bulletin.


Summary: AAPG Convention Document.


Summary: AAPG Bulletin.

299. FrontBurner, 1991, Reservoir Modeling / A Bright Light for Coalbed Methane Production,
Summary: This journal article discusses the COMETPC-3 Reservoir Simulator developed for the Gas Research Institute by ICF Resources.


Summary: SPE Paper.


Summary: Article.


Summary: Article.


Summary: Geological Society Report.


Summary: Article.


Summary: WGA Publication.

306. Garcia-Gonzalez, Mario; MacGowan, Donald B.; and Surdam, Ronald C., 1993, *Coal as a Source Rock of Petroleum and Gas: A Comparison Between Natural and Artificial Maturation of the

**Summary:** USGS Conference Document.


**Summary:** Report.


**Summary:** This is a GRI brochure on the COMETPC 3-D Reservoir Simulator.


**Summary:** List of publications that discuss coal seam natural gas and its technology.


**Summary:** GRI Report.


**Summary:** GRI Report.


**Summary:** GRI Report.

313. Gas Research Institute, 1994, *Coalbed Methane: GRI Changes the Way Industry Does Business*
This brochure discusses GRI's role in transforming natural gas from coal seam production in Alabama.

Summary: GRI Report.

Summary: Brochure that discusses cost effective handling and the environmentally responsible disposal of the water produced in association with the production of coal seam natural gas.

Summary: This article from GRID discusses the GRI program to evaluate the accuracy of analyzing and estimating gas-in-place.

Summary: This GRI Bulletin discusses the development of a gas-in-place analysis protocol.

Summary: This is a report on the development of a freeze-thaw/evaporation (FTE) purification process to treat produced water.

Summary: SPE Paper.

Summary: Coalbed Methane and Coal Geology, available from the Geological Institute of America.

**Summary:** Geological Society Report.


**Summary:** Article.


**Summary:** Article.


**Summary:** This is a final report on an assessment of the suitability of production methods in the recovery of natural gas from coal seams. Discusses the fact that the most limiting technology is the stimulation of water and gas flow from deeper gassy coal formations.


**Summary:** Report that discusses the technology available for recovering coal seam natural gas. This report also includes: water quality data for mine drainage in the Appalachian Basin and information on methods for the treatment of coal seam water.


**Summary:** Report.

Summary: Report on the arsenic and fluorine content of Pennsylvanian age coals from the Warrior Basin of northwestern Alabama.


Summary: AAPG / SEPM Report.


Summary: AAPG / SEPM Report.


Summary: Master’s Thesis.


Summary: USBM Circular.


Summary: Convention Presentation.


Summary: SPE Report.

This journal article discusses GRI sponsored research into the development of technology for use in the Appalachian Basin.


**Summary:** Mr. Griebling is Director of the Colorado Oil & Gas Conservation Commission. His testimony included: the history and status of CBM development in Colorado; a discussion of methane gas found in the groundwater in the Colorado portion of the San Juan Basin; an explanation of the difference between biogenic and thermogenic methane gas; and discussion of the “3M” Project.


**Summary:** Article.


**Summary:** RMAG Report.


**Summary:** This conference paper discusses research conducted on the concentration of salinity in produced water discharged to surface waters, and how these inorganic ions can be toxic to the freshwater organisms traditionally used for biomonitoring.


**Summary:** AAPG Report.

**Summary:** Conference Presentation.


**Summary:** This is the final report on the development of a three-dimensional hydraulic fracturing model for stimulating methane production from coal seams.


**Summary:** This is the final report on development of a three-dimensional model that simulates hydraulically driven fracturing as applied to the drainage of methane from coal seams.


**Summary:** Symposium Paper.


**Summary:** This GRI report discusses coal permeability and gas desorption.


**Summary:** Article.


**Summary:** Article.

**Summary:** Symposium Paper.


**Summary:** Symposium Paper.


**Summary:** Article.


**Summary:** Report.


**Summary:** Indiana Geological Survey Paper.


**Summary:** This USGS report discusses the minerals deposits of the Powder River Basin.


**Summary:** WSGS Publication.

Summary: Report.


Summary: AAPG Convention Document.


Summary: WGA Report.


Summary: CGS Report.


Summary: This GSA conference document discusses the database used in support of the United States Geological Survey led study of natural gas from coal seams resources of the Wasatch Plateau in Utah.


Summary: ACS Conference Document.

Summary: USGS Report.


Summary: Geological Society Report.


Summary: USGS Report.


Summary: USGS Report.


Summary: WSGS Report.


Summary: Article.


Summary: GTI Map.


Summary: USGS Open File Report.

**Summary:** This GRI publication provides guidelines to design well completions and hydraulic fracturing treatments in coal seams.


**Summary:** SPE Report.


**Summary:** SPE Report.


**Summary:** This guide provides information on siting, drilling, completion and production of natural gas from coal seams. Discusses key field operations and guidelines for performing those operations.


**Summary:** MGS Report.


**Summary:** Report.


**Summary:** AAPG Report.

374. Huffman, Claude, Jr.; and Swanson, Vernon E., 1994, *Geologic and Hydrologic Controls on Coalbed

Summary: Report.


Summary: USBM Circular.


Summary: This final report discusses research conducted to determine the applicability of current technology to development of coal seam natural gas reservoirs in Appalachia.


Summary: This GRI report discusses the methodologies employed to determine the relative permeability characteristics on several coal samples.


Summary: This conference paper discusses the development of a modified porous plate experiment and mathematical model used to improve the measurement and evaluation of gas and water relative permeability, capillary pressure, and pore volume in coal samples.


Summary: Report.

Summary: Report.


Summary: Convention Report.


Summary: USBM Report.


Summary: USBM Report.


Summary: USBM Report.


Summary: USBM Circular.


Summary: USBM Circular.

Summary: USBM Circular.


Summary: Article.


Summary: USBM Report.


Summary: RMAG Report.


Summary: USGS Report.


Summary: WGA Report.

**Summary:** WGA Conference Document.


**Summary:** Report.


**Summary:** WGA Conference Document.


**Summary:** Report presented at a 1993 meeting of the Wyoming Geological Association.


**Summary:** Report on natural gas from coal seams in the different basins of the Rocky Mountains. Discusses the geology of the basins and problems associated with production.


**Summary:** AAPG Bulletin.

available from the Rocky Mountain Association of Geologists in Rocky Mountain Association of Geologists Guidebook.

**Summary:** RMAG Report.


**Summary:** USGS Report / Map.


**Summary:** WGS Guidebook.


**Summary:** Alberta Research Council Report.


**Summary:** Article.


**Summary:** Article.


**Summary:** This report discusses a five-year research plan that was developed for the environmental impacts and constraints associated with gas supply technologies used to produce various types of non-conventional natural gas. Among those types studied was coalbed methane. Contains discussion of the prioritization methodology used to rank research activities, based on environmental and technical criteria.

**Summary:** This final report discusses the development of a research plan for safety issues related to gas supply technologies.


**Summary:** Report.


**Summary:** AAPG / SEPM Report.


**Summary:** Report.


**Summary:** Symposium Document.


**Summary:** Includes structural stratigraphic and hydrologic setting of Mesaverde and Fort Union coals, coal seam natural gas resources, production and possible traps.


**Summary:** Article.

**Summary:** Report.


**Summary:** Article.


**Summary:** Symposium Document.


**Summary:** Report.


**Summary:** Article.


**Summary:** This SPE paper defines the quality of water produced from coal seam natural gas wells producing from the Fruitland Formation, characterizes affected soils, evaluates the environmental effects the water has on soil, and discusses specific reclamation procedures for a portion of the San Juan Basin.

**Summary:** This report discusses the geologic assessment of Northern Appalachian Coal Basin gas-in-place estimates.


**Summary:** CGS Open-File Report.


**Summary:** Symposium Document.


**Summary:** Report.


**Summary:** This GRI-sponsored report gives a summary of the drilling and production statistics from the major coal seam gas and gas shale reservoirs in the U.S.


**Summary:** RMAG Publication.

Summary: Report.


**Summary:** Conference paper that reports on a program working to identify the mechanisms responsible for high treatment pressures as they relate to lower production of gas produced from wells treated at high pressures. These abnormally high pressures are encountered during hydraulic fracturing. Presented at the 1992 International Gas Research Conference.


**Summary:** This GRI sponsored topical report examines the mechanisms responsible for the high fracturing pressures observed in coal in order to specify stimulation procedures required to achieve fracture characteristics that optimize gas production.


**Summary:** Conference Paper.


**Summary:** This report discusses an investigation of the cavity completion mechanisms causing formation stimulation.


**Summary:** Report.


**Summary:** GRI Topical Report.

**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** USBM Report.

**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** AAPG Report.


**Summary:** AAPG Report.


**Summary:** USGS Open File Report.


**Summary:** This USGS Professional Paper presents a geologic assessment of coal deposits of the Colorado Plateau and gives new resource estimates for selected assessment units.


**Summary:** USBM Report.

**Summary:** USBM Report.


**Summary:** Report.


**Summary:** Report.


**Summary:** Symposium Paper.


**Summary:** Final report on 15 methods for analysis of single-phase well tests as they apply to low permeability coal seam natural gas reservoirs.


**Summary:** Final report on methods developed to characterize the hydrologic properties of coal seam natural gas reservoirs.


**Summary:** SPE Report.

**Summary:** Article.


**Summary:** This report discusses the geologic assessment of Black Warrior Basin, Alabama, gas-in-place estimates.


**Summary:** This report discusses the geologic assessment of the three major coal groups in the Piceance Basin and gives gas-in-place estimates.


**Summary:** AAPG Report.


**Summary:** Discussion of residual concentrations and distributions of hydrocarbon gases from methane to n-heptane. Measurements were taken from sediments recovered from seven sites.


**Summary:** Texaco Report.

**Summary:** RMAG Report.


**Summary:** AAPG Bulletin.


**Summary:** DOE Contracted Study.


**Summary:** DOE Report.


**Summary:** This GRI report discusses research into reasons why Warrior Basin wells producing natural gas from coal seams are not producing satisfactorily.


**Summary:** This topical report reviews well stimulation design considerations, diagnostic results, and production results for a number of production wells stimulated at the Rock Creek Project.


**Summary:** AAPG Report.

467. Langenberg, W.; Kalkreuth, W.; Levine, J.; Strobl, R.; Demchuk, T.; Hoffman, G.; and Jerzykiewicz,

**Summary:** Alberta Resource Council Short Course.


**Summary:** Report.


**Summary:** USGS Open File Report.


**Summary:** USGS Report.


**Summary:** USGS Open File Report.


**Summary:** Article.


**Summary:** AAPG Report.

**Summary:** GSA paper.


**Summary:** WGA Map.


**Summary:** New Mexico Bureau of Mines and Mineral Resources Bulletin.


**Summary:** Article.


**Summary:** USGS Open File Report / Map.


**Summary:** USGS Open File Report / Map.


**Summary:** USGS Map.

**Summary:** USGS Report.

482. Law, B. E., 1979, *Coal Deposits of the Emery Coal Zone, Henry Mountains Coal Field, Garfield and Wayne Counties, Utah*, available from the United States Geological Survey as MF-1082-A.

**Summary:** USGS Report / Map.

483. Law, B. E., 1979, *Surface Coal Sections in the Emery Coal Zone, Henry Mountains Coal Field, Garfield and Wayne Counties, Utah*, available from the United States Geological Survey as MF-1082-B.

**Summary:** USGS Report.


**Summary:** This AAPG paper discusses the coal-derived water and how it compares to other formation fluids.


**Summary:** AAPG Conference Document.


**Summary:** USGS Report.

Summary: AAPG Bulletin.


Summary: Paper.


Summary: USGS Report.


Summary: Conference Document.


Summary: AAPG Report.


Summary: Symposium Document.


Summary: USGS Conference Paper.


Summary: Symposium Document.

**Summary:** Report.


**Summary:** Symposium Paper.


**Summary:** This is a conference paper presented at the Coalbed Methane Symposium, 3rd, in 1991. This paper reports on an investigation into the feasibility and costs associated with treatment and disposal of waters produced with coal seam natural gas. Waters from the Black Warrior Basin in Alabama and the Lance-Fox Hills aquifer in Wyoming were used for the evaluation.


**Summary:** Report.


**Summary:** AAPG Report.


**Summary:** Article

Summary: Symposium Paper.


Summary: Alberta Research Council Report.


Summary: Symposium Paper.


Summary: Symposium Paper.


Summary: Report.


Summary: Article.


Summary: AAPG Report.

Summary: Geological Society Report.


Summary: AAPG Bulletin.


Summary: USGS Report.


Summary: Paper contains a summary of data gathered for the development of a guidance manual that presents the methodology for managing produced water in the Black Warrior Basin of Alabama. The method presented manages the water through the use of treatment ponds and National Pollutant Discharge Elimination System (NPDES) permits.


Summary: AAPG Report.


Summary: This GRI topical report discusses the findings from engineering analyses and field experiences of the Deep Coal Seam Project in the Piceance Basin of Colorado.


Summary: RMAG Report.

**Summary:** Article.

516. Logan, T. L.; Clark W. F.; and McBane Richard A., 1989, *Comparing Different Coalbed Methane Completion Techniques, Hydraulic Fracture and Openhole Cavity, at the Northeast Blanco Unit, San Juan Basin*, available from the publisher, the University of Alabama, School of Mines and Energy Development.

**Summary:** This conference paper discusses the different completion techniques used on wells in the San Juan Basin.


**Summary:** SPE Report.


**Summary:** AAPG Report.


**Summary:** This GRI topical report outlines the various techniques, costs, and potential hazards associated with openhole cavity completion of natural gas from coal seams.


**Summary:** This final report presents the 11-year history of the Deep Coal Seam and Western Cretaceous Coal Seam Projects.


**Summary:** This GRI report discusses a remedial stimulation treatment done to enhance gas
production from a previously hydraulically fractured well.


**Summary:** Conference paper. Non-USGS publication by USGS and Non-USGS authors.


**Summary:** Discussion of potential for self-ignition of coal in the immediate vicinity of coal seam natural gas wells of the Powder River Basin. This report details the conditions that favor spontaneous combustion in subbituminous coals of the Powder River Basin.


**Summary:** USGS Report.


**Summary:** USGS Report.


**Summary:** Article.


**Summary:** Article.

from the publisher, Elsevier.

Summary: Conference Document.


Summary: AAPG Report.


Summary: This is a final report on a five-year research plan that was developed to support design and permitting for disposal of solid wastes from a coal gasification facility. Discusses the regulatory and legal liabilities associated with the disposal.


Summary: Symposium Paper.


Summary: Symposium Paper.


Summary: DOE Report.


Summary: BIA Report.

Summary: AAPG Bulletin.


Summary: PGS Article.


Summary: PGS Article.


Summary: DOE Conference Paper.


Summary: RMAG Report.


Summary: Indiana Geological Survey Open-File Study.


Summary: Paper.

**Summary:** Indiana Geological Survey Open-File Study.


**Summary:** AAPG Report.


**Summary:** RMAG Report.


**Summary:** This GRI topical report discusses two openhole cavity wells evaluated to determine the reasons for the greater productivity of cavity well completions relative to cased, fractured well completions.


**Summary:** GRI Topical Report.


**Summary:** SPE Report.


**Summary:** GRI Topical Report.

**Summary:** This conference paper discusses San Juan Basin, Fruitland Formation coal seam natural gas wells completed with openhole cavities using a controlled injection-blowout technique.


**Summary:** This GRI annual report discusses the Western Cretaceous Coal Seam Project’s concentration on dynamic open hole completions in natural gas wells.


**Summary:** Article.


**Summary:** This GRI topical report summarizes coal seam natural gas reservoir and fluid properties as well as the techniques necessary to obtain quantitative estimates of the properties.


**Summary:** Article.


**Summary:** This report prepared by the Gas Research Institute is a “How-To” manual that helps producers accurately determine the gas-in-place volume of coal seam natural gas reservoirs.


**Summary:** Article.

**Summary:** This SPE paper presents the results of field trials of a new fracturing-fluid system and liquid surface-modification additive for coating proppant in the Fruitland Coal reservoir in the San Juan Basin.


**Summary:** This USGS report discusses ways to mitigate the impact of energy gasses on the environment.


**Summary:** This section of the Department of Energy’s *Annual Energy Outlook 2000* discusses unconventional gas sources such as coal seam natural gas, tight sands and gas shales.


**Summary:** Law review article.


**Summary:** TRW Report.


**Summary:** USBM Report.

Summary: USBM Report.


Summary: USBM Report.


Summary: USBM Report.


Summary: CGS Symposium Paper.


Summary: Report.


Summary: TORP Report.


Summary: AAPG Report.

**Summary:** Conference Document.


**Summary:** Final report on study of oil and gas pumping systems evaluated for coal seam natural gas dewatering operations. Ten well systems are evaluated. First of two volumes.


**Summary:** Final report on study of dewatering operations. Supplies dewatering system designs for six pump types. Includes tables and graphs that illustrate the associated costs.


**Summary:** USGS Maps / Report.


**Summary:** USGS Maps / Report.


**Summary:** USGS Maps / Report.


**Summary:** Report.


**Summary:** RMAG Report.


**Summary:** Article.


**Summary:** USGS Map / Report.


**Summary:** This guide discusses methods for quantifying the amount and type of gas present in coalbeds through the use of recovered coal samples.


**Summary:** This GRI topical report discusses an investigation which describes the release and migration of methane through coal. Emphasis is on samples taken from the Blue Creek Seam in Alabama.


**Summary:** DOE Symposium Document.


**Summary:** DOE Symposium Document.

**Summary:** SPE Conference Document.


**Summary:** Symposium Document.


**Summary:** DOE Report.


**Summary:** Article.


**Summary:** Article.


**Summary:** USGS Conference Document.

Summary: USGS Publication.


Summary: RMAG Report.


Summary: Article.


Summary: BLM Report.


Summary: USGS Report.


Summary: USGS Conference Paper.


Summary: Report.

Summary: GSA Report.


Summary: Report.


Summary: Article.


Summary: USGS Report.


Summary: Article.


Summary: AAPG Bulletin.


Summary: This AAPG bulletin discusses drilling for coal seam natural gas in the Upper Cretaceous Ferron Sandstone of central Utah.

603. Mount, David R.; and Gulley, David D., 1992, Development of a Salinity/Toxicity Relationship to Predict Acute Toxicity of Saline Waters to Fresh Water Organisms, available from the Gas Technology Institute as GRI-92/0301.

Summary: Report on work to develop a Salinity / Toxicity Relationship (STR) that can be used to
predict the toxicity of saline waters to freshwater organisms. Reports on the application of STR to field data.


**Summary:** This conference paper summarizes the findings of studies as they apply to the surface discharge of produced waters. Discusses how aquatic organisms respond to the discharge.


**Summary:** This journal article discusses a GRI study into the environmental acceptability of discharging coalbed produced waters in the Black Warrior Basin. Discusses the safety of discharging such waters.


**Summary:** This conference paper discusses the Salinity/Toxicity Relationships equations used to provide accurate predictions of the toxicity of produced waters.


**Summary:** Mountain Fuel Resources technical proposal.


**Summary:** DOE Contracted Report.


**Summary:** Bibliography containing more than 260 items in two sections: Coalbed Methane and Tight Gas Sands.

**Summary:** DOE Report.


**Summary:** RMAG Report.


**Summary:** RMAG Report.


**Summary:** NDGS Report.


**Summary:** Report.


**Summary:** Geological Society Report.


**Summary:** Article.


**Summary:** Article.

**Summary:** GSA Report.


**Summary:** EPA Report.


**Summary:** This journal article discusses the evaluation of the accuracy of measurements on coal seam reservoirs by the GRI’s Basic Research Group.


**Summary:** This GRI report discusses new log and core analysis methods used to determine the gas-in-place volume of coalbed reservoirs.


**Summary:** Article.


**Summary:** AAPG Bulletin.


**Summary:** GRI Report.

**Summary:** Article.


**Summary:** This GRI report discusses the potential for production of natural gas from Rocky Mountain region coal seams.


**Summary:** This GRI report discusses new methods used to determine the gas-in-place volume of coalbed reservoirs.


**Summary:** Symposium Paper.


**Summary:** Article.


**Summary:** WGA Publication.

Summary: RMAG Report.


Summary: Article.


Summary: Article.


Summary: This USGS Fact Sheet describes the coal seam natural gas industry in the United States and broadly discusses some of the concerns associated with its production.


Summary: RMAG Report.


Summary: This is a proposal for a study designed to provide stratigraphic and structural framework, and coal thickness models for use by industry for exploration.


Summary: AAPG Bulletin.

638. Olague, N. E.; and Smith, D. M., 1989, Diffusion of Gases in American Coals, from Fuel, v. 68,

**Summary:** RMAG Report.


**Summary:** Symposium Document.


**Summary:** This GRI report discusses the identification and development of methodologies for estimating zone thickness, coal quality, gas content, isotherm, permeability, and cleat orientation from log data.


**Summary:** USGS Conference Document.


**Summary:** Findings of a study into the biological and water quality impacts of coal seam natural gas production water disposal into surface water streams in the Cedar Cove degasification field within Alabama’s Warrior Coal Basin.


**Summary:** Examines the environmental fate and effect of a natural gas produced water effluent. This
study provides information and methodologies for defining acceptable conditions under which pro-
duced waters from coal seam natural gas wells can be discharged into surface waters.


**Summary:** Conference paper that discusses the instream effects of an NPDES-permitted discharge of produced waters on biological communities in a stream environment. Data from this study was used to develop concentration response models.


**Summary:** Final report on samples of coal seam natural gas produced water that was discharged to a receiving stream in the Warrior Coal Basin of Alabama. The study was conducted to determine the long-term environmental effects.


**Summary:** Reports on the development and testing of an instream bioassessment technique for assessing the effects of stream discharged production water. This bioassessment technique was developed in the coal seam natural gas fields of Alabama’s Warrior Basin.


**Summary:** This is a conference paper that reviews studies containing relevant information to the biological fate and effect of saline waters discharged to stream environments. Presents data relative to studies relating to producing natural gas from coal seams.


**Summary:** This conference paper asserts that recent implementation of water quality-based control of effluents with toxicity testing and possible biocriteria requirements is proof that in the future there will
be a more comprehensive regulation of the discharge of waste water. Discusses the Cedar Cove Model within the framework of existing discharge permit requirements, future regulation, and coal seam natural gas studies completed in the state of Alabama.


Summary: Presents results of water-quality, aquatic toxicity, and biomonitoring studies in the Warrior Coal Basin of Alabama. Presents the Cedar Cove Model, which is a systematic approach for monitoring the discharge of produced-water effluents to surface waters.


Summary: Conference paper discusses study that summarizes underground injection activity as an alternative to stream discharge of coal seam natural gas produced waters.


Summary: Article.


Summary: British Columbia Ministry of Energy and Mines Report.


Summary: USBM Report.


Summary: USBM Report.

**Summary:** USBM Report.


**Summary:** SPE Report.


**Summary:** SPE Report.


**Summary:** AAPG Report.


**Summary:** This SPE paper discusses applications of the concept of altered-stress fracturing as they apply to the San Juan Basin.


**Summary:** This is an annual report that discusses the geologic evaluation of coal seam natural gas production parameters for the Black Warrior Basin in Alabama.

Bulletin 145.

**Summary:** Geological Survey of Alabama Bulletin.


**Summary:** This GRI topical report discusses the geologic evaluation of coal seam natural gas production parameters for the Black Warrior Basin in Alabama.


**Summary:** AAPG Bulletin.


**Summary:** Conference paper that discusses productivity parameters in coal seam natural gas wells and the geologic controls on natural gas production from those wells.


**Summary:** Documents the rapid growth of the coal seam natural gas industry since 1984. Summarizes the current state of the industry in Alabama. This report also discusses the numerous scientific and technological advances made since 1984.


**Summary:** A review paper that discusses stratigraphic and structural controls on coal seam natural gas production in the United States with emphasis on the Black Warrior and San Juan basins.

Summary: This research paper discusses the influence of extensional and compressional folds and faults on the performance of coal seam natural gas wells.


Summary: This paper discusses fracturing, faulting, and mineralization in coal seam natural gas reservoirs.


Summary: Conference Paper.


Summary: Symposium Paper.


Summary: This paper discusses the potential for enhanced coal seam natural gas recovery through injection of carbon dioxide and the basic considerations of geology, technology, and infrastructure required to formulate an enhanced recovery strategy.


Summary: This report discusses geologic factors affecting the potential for carbon sequestration and enhanced coal seam natural gas recovery. Includes important stratigraphic, structural, geothermic,
hydrologic, and coal quality data.


**Summary:** Canadian Institute of Mining and Metallurgy Report.


**Summary:** Report on laboratory research into hydraulic fracturing procedures and products used on coal seam natural gas wells. Contains appendix with additional research papers.


**Summary:** Findings of a project that coordinates laboratory data with field operations to ensure the application of current technology in stimulating coalbed methane wells. Data used in designing fracturing and remedial treatments in the Black Warrior Basin.


**Summary:** This GRI topical report discusses research into the mechanisms of formation damage following hydraulic fracturing and its impact upon gas well productivity.


**Summary:** USBM Report.


**Summary:** SPE Symposium Document.

**Summary:** Article.


**Summary:** Article.


**Summary:** PTTC Workshop.


**Summary:** Bibliography lists reports, papers and workshop citations on the topic of coal seam natural gas. This bibliography contains only works funded by the GRI, or which extensively used GRI data.


**Summary:** Bibliography of research and development reports. Contains reports on coal seam natural gas in the Appalachian Basin.


**Summary:** Bibliography of publications on natural gas exploration in the San Juan Basin. Contains citations of works on the topic of coal seam natural gas.


**Summary:** This USGS Fact Sheet discusses the potential for natural gas production from the coal seams in the Forest City Basin.

**Summary:** Conference Document.

688. Pillard, David, *Predicting the Toxicity of Common Ions Found in Produced Waters*, available online from the Gas Technology Institute or from ENSR Consulting, Engineering, and Remediation.

**Summary:** This article discusses a software application developed to help producers determine the cause of toxicity in produced waters.


**Summary:** USBM Report.


**Summary:** IINR Document.


**Summary:** This publication discusses many aspects of development of coal seam natural gas in the Powder River Basin.


**Summary:** From Conference Proceedings.


**Summary:** SPE Report.

**Summary:** Article.


**Summary:** This conference paper discusses fracture void simulations that exhibit the spatial correlations observed in natural fractures.


**Summary:** Discusses the production potential of natural gas from coal seams. This annual report examines the work that has been done to determine how multiphase flow is controlled by the geometry of the voids in the coal cleats and the amount of saturation of each phase.


**Summary:** This final report discusses data on the gas-water relative permeability characteristics of coal cleats. Discusses data on the effective cleat porosity, aperture, and interconnectedness properties of five coal drill core samples.


**Summary:** This is an annual report that discusses data on the effective cleat porosity, aperture, and interconnectedness properties of coal core samples taken from the Fruitland Formation in the San Juan Basin of Colorado and New Mexico.


**Summary:** This report describes a method for simulating three-dimensional fracture networks used in the development of a simulator that realistically models macroscopic and meso-scale geometrical properties of coal cleats.

700. Questa Engineering Corporation, 2000, *The 3M CBM Final Report; Volume I: Analysis and Results* and *Volume II: The 3M CBM Model Users Guide*, available online from the Colorado Oil and
Gas Conservation Commission.

**Summary:** Describes the 3M Model, which was developed to conduct a large scale, two-dimensional simulation of the Colorado portion of the Fruitland Coal in the San Juan Basin. Provides a tool that can be used to evaluate the impact of various factors on gas seepage. This coal seam natural gas model can also be used to evaluate potential infill drilling, alternative production or operation scenarios, or other coal seam natural gas issues.


**Summary:** Report.


**Summary:** Article.


**Summary:** Report.


**Summary:** NETL Conference Document.


**Summary:** RMAG Conference Document.

Summary: GSA Conference Paper.


Summary: Report provides preliminary data on water samples taken from 47 coal seam natural gas wells drilled in the Powder River Basin, Wyoming. The samples were taken between June 1999 and May 2000. Includes data on major, minor and trace elements.


Summary: USGS Fact Sheet.


Summary: RMAG Report.


Summary: USGS Open-File Report.


Summary: AAPG Conference Document.


Summary: Article.

**Summary:** United Nations Conference Document.


**Summary:** AAPG Conference Document.


**Summary:** Symposium Paper.


**Summary:** Symposium Document.


**Summary:** AAPG Bulletin.


**Summary:** AAPG Conference Document.


**Summary:** USGS Circular.

**Summary:** AAPG Report. Non-USGS publication with USGS authors.


**Summary:** USGS Conference Document.


**Summary:** Symposium Document.


**Summary:** USGS Circular.


**Summary:** USGS Conference Document.


**Summary:** USGS Report.


**Summary:** USGS Report.

Summary: USGS Fact Sheet.


Summary: USGS Report.


Summary: MRCP Report.


Summary: AAPG Report.


Summary: Report.


Summary: AAPG Report.


Summary: AAPG Report.


Summary: This SPE paper discusses several aspects of the Mineral Extraction Agreement between
the current owner of a large tract of property in Colorado and New Mexico and the previous owner, who retained the mineral rights that include the Raton Basin coal seam natural gas.

735. Roberts, S. B.; Clark, A. C.; and Carey, M. A., 1988, *Analyses of Seven Core Samples from Two Tertiary Coal Beds in the Sagwon Member of the Sagavanirktok Formation, North Slope, Alaska*, available from the United States Geological Survey as OF 88-0021.

**Summary:** USGS Report.


**Summary:** WSGS Report.


**Summary:** USGS Map / Report.


**Summary:** USGS Paper.


**Summary:** USGS Paper.

of Selected Tertiary Coal Beds and Zones in the Northern Rocky Mountains and Great Plains Region, available from the United States Geological Survey as P 1625-A.

Summary: USGS Paper.


Summary: USGS Paper.


Summary: USGS Paper.


Summary: This AAPG conference document discusses the potential for natural gas production from coal seams in the Denver Basin of Colorado.


Summary: USGS Paper.


Summary: Article.

Summary: USGS Report.


Summary: Article.


Summary: Article.


Summary: Report.


Summary: Symposium Paper.


Summary: Article.


Summary: This is a final report on a survey used to explore the potential for utilization of coal seam natural gas. Discusses the premise that if certain methods of drainage and degasification used by coal
mining companies to capture methane become routine, then the investment necessary to make methane collection profitable will be justified.


**Summary:** EPA Report.


**Summary:** This AAPG conference document discusses the potential for production of natural gas from coal seams along the Gulf Coast of Texas.


**Summary:** Master’s Thesis.


**Summary:** SPE Report.


**Summary:** This GRI topical report discusses research designed to facilitate development of shallow coalbed methane reserves that were bypassed while the deeper seams were explored and developed.


**Summary:** This SPE document provides practical methods for the evaluation and development of coal seam natural gas reservoirs.

**Summary:** This conference paper discusses a three-dimensional reservoir simulation study used to history match the first 400 days of gas and water production from a multi-completion well in the Black Warrior Basin.


**Summary:** Article.


**Summary:** USGS Fact Sheet.


**Summary:** Report.


**Summary:** AAPG Report.


**Summary:** This journal article examines the major technology, research needs, and problem areas faced by the coal seam natural gas industry.

766. Schraufnagel, Richard A.; Saulsberry, J. L.; and Lambert, S. W., 1989, *Gas Production from Multiple Wells at Rock Creek*, available from the publisher, the University of Alabama, School of Mines and Energy Development.

**Summary:** This conference paper discusses the Methane from Multiple Coal Seams Project at Rock
Creek and its evaluation of the technology required for cost effective production of methane from multiple coal seams through single wellbores.


**Summary:** SPE Report.


**Summary:** AAPG Report.


**Summary:** This NETL conference document discusses the sequestration of CO₂ in coal seams as a way to mitigate rising levels of CO₂ in the atmosphere.


**Summary:** GSA Conference Document.


**Summary:** Bibliography of information on natural gas from coal seams.


**Summary:** Bibliography of information on coal seam natural gas.

**Summary**: RMAG Publication.


**Summary**: Bibliography of information on natural gas from coal seams.


**Summary**: Bibliography of information on natural gas from coal seams.


**Summary**: Article.


**Summary**: Article.


**Summary**: RMAG Publication.


**Summary**: RMAG Report.

**Summary:** AAPG / SEPM Report.


**Summary:** Article.


**Summary:** AAPG Bulletin.


**Summary:** AAPG Report.


**Summary:** AAPG Conference Document.


**Summary:** GSA Report.


**Summary:** Symposium Document.

**Summary:** AAPG Convention Document.


**Summary:** AAPG / SEPM Report.


**Summary:** Report.


**Summary:** AAPG Bulletin.


**Summary:** AAPG Bulletin


**Summary:** This SPE paper discusses pressure falloff tests performed on enhanced coal seam natural gas recovery pilot in the San Juan Basin. The tests were performed to determine effective permeability to gas, wellbore skin and the average reservoir pressure.


**Summary:** RMAG Report.

**Summary:** USBM Report.


**Summary:** SPE Report.


**Summary:** Evaluates the quality and effects of coal seam natural gas produced water discharged into the Big Sandy Creek of Alabama. Compares these waters with those from other coal seam natural gas fields in Alabama.


**Summary:** Symposium Document.


**Summary:** Symposium Document.


**Summary:** Article.

Summary: Article.


Summary: Article.


Summary: This conference paper discusses an economic analysis that was conducted for substitute natural gas (SNG) production from deep coal in the Powder River Basin of Wyoming. Results are presented in tables.


Summary: Report.


Summary: WSGS Report.


Summary: This GRI topical report discusses the COMPAS II, a microcomputer program that provides information on oil and gas wells.


Summary: Article.

Summary: Article.


Summary: Article.


Summary: SPE Report.


Summary: Report.


Summary: RMAG Report.


Summary: RMAG Report.


Summary: This report discusses the 1991 results of the Coalbed Methane Multiple Coal Seam Project.


Summary: USGS Report.

Summary: Discusses the USGS project, “Assessment of Geologic Reservoirs for Carbon Dioxide Sequestration”.


Summary: Conference paper discusses a study of hydraulic fractures in coalbeds. Project focused on 13 wells where induced fractures were intercepted by mining in the Warrior Basin.


Summary: This report presents data on the inspection of fractures from 13 wells that were intercepted by mining in the Warrior Basin in Alabama.


Summary: This report assesses the coal seam natural gas resources of the Raton Basin.


Summary: Report.


Summary: This paper discusses the analysis of production operations from the first carbon dioxide enhanced coal seam natural gas pilot. The paper asserts that the San Juan Basin test well shows that injection of carbon dioxide into deep coal seams for enhancement of coal seam natural gas recovery and the sequestration of greenhouse gas is technically and economically feasible.

**Summary:** AAPG Bulletin.


**Summary:** Symposium Paper.


**Summary:** Article.


**Summary:** KGS Open-File Report.


**Summary:** Article.


**Summary:** Article.


**Summary:** Examines drilling, completion, pipe size, spacing, and recovery of methane at the Hawk’s Nest East Mine in Colorado.

Summary: USGS Conference Document.


Summary: Society of Organic Petrology Conference Document.

830. Stricker, G. D.; and Ellis, M. S., 1999, Coal Quality and Geochemistry, Greater Green River Basin, Wyoming, 1999 Resource Assessment of Selected Tertiary Coal Beds and Zones in the Northern Rocky Mountains and Great Plains Region, from the United States Geological Survey in P 1625-A.

Summary: USGS Professional Paper.


Summary: USGS Professional Paper.


Summary: Society of Mining, Metallurgy, and Exploration Conference Document.


Summary: Conference Document.


Summary: GSA Conference Document.

**Summary:** Alberta Research Council Report.


**Summary:** Symposium Paper.


**Summary:** Article.


**Summary:** USGS Report.


**Summary:** DOE Contracted Study.


**Summary:** USGS Open File Report.


**Summary:** Article.

Methane Symposium, Tuscaloosa, Alabama, available as Paper 8713.

**Summary**: Symposium Paper.


**Summary**: University of Texas Report.


**Summary**: Conference Document.


**Summary**: Article.


**Summary**: Article.


**Summary**: Report on the development of a toxicity database from which predictive ion toxicity models could be created. These models would be used in the evaluation of options for meeting permit toxicity limits regulated by the National Pollutant Discharge Elimination System (NPDES).


**Summary**: AAPG Bulletin.

**Summary:** Article.


**Summary:** CGS Open-File Report.


**Summary:** CGS Report.


**Summary:** CGS Maps.


**Summary:** CGS Report.


**Summary:** RMAG Report.


**Summary:** New Mexico Bureau of Mines and Mineral Resources Report.

from the United States Geological Survey as OF 85-0621.

Summary: USGS Report / Map.


Summary: Report on the development of a model for evaluating coal seam natural gas potential in frontier basins, or for finding “sweet spots” in basins with established production.


Summary: This report discusses an evaluation of coal seam natural gas potential of four basins in the western United States. The evaluation was done in the context of characteristics identified in the San Juan Basin.


Summary: AAPG Conference Document.


Summary: CGS Publication.


Summary: Review of coal seam natural gas potential in the Greater Green River Basin in Wyoming and Colorado. Reports on recent production that has resulted in little gas and large volumes of water.

Summary: Texas Bureau of Economic Geology Report.


Summary: This report focuses on the refinement and validation aspects of a coal seam natural gas producibility model.


Summary: Report on the development of the third portion of a Gas Research Institute coal seam natural gas producibility model. Compares the geologic and hydrologic settings of the Piceance, San Juan and Sand Wash basins. This report also reviews the key geologic and hydrologic controls on producibility.


Summary: Bureau of Economic Geology Report.


Summary: Symposium Paper.


**Summary:** Article.


**Summary:** USGS Report.


**Summary:** USGS, Central Region Energy Resources Team Report.


**Summary:** USGS, Central Region Energy Resources Team Report / Maps.


**Summary:** Symposium Paper.


**Summary:** USGS Report.

874. Van Voast, Wayne A., 1991, *Fracture Patterns in Coal in the Western United States; Observations and Implications for Development of Coalbed Methane Resources*, available from the

**Summary:** AAPG Bulletin.


**Summary:** Report.


**Summary:** Describes existing national discharge regulations, current methods for managing coal seam natural gas produced water, current discharge permitting process, and how the increasing volume of discharged water due to increased coal seam natural gas development will affect the process.


**Summary:** Contracted Report.


**Summary:** This report discusses a study that examined the content and composition of heavy hydrocarbon constituents in coal seam reservoirs.


**Summary:** USGS Professional Paper.

881. Wanty, Richard B.; Folger, Peter F.; and Briggs, Paul H., 1993, *Ground-water Chemistry of the*

Summary: WGA Symposium Document.


Summary: USGS Fact Sheet that discusses the water co-produced with oil and gas in the oilfields of the United States.

883. Warwick, P. D.; SanFilipo, J. R.; Barker, Charles E.; and Morris, L. E., 2000, *Coal-bed Methane in the Gulf Coastal Plain; A New Frontier?*, available from the Geological Society of America in Abstracts with Programs - Geological Society of America, 31 (7).

Summary: This GSA conference document discusses the potential for production of natural gas from coal seams along the Gulf Coastal Plain.


Summary: USGS Open File Report that illustrates the location and geology of coalbeds in the Gulf Coastal Plain and their potential for coal seam natural gas production.


Summary: USGS Open File Report.


Summary: RMAG Report.

Summary: USGS Report.


Summary: Report.


Summary: DOE Contracted Study.


Summary: CGS Report.


Summary: AAPG Bulletin.

892. Wheaton, J. R.; and Lovelace, B. K., Hydrologic Issues Associated with Coal-Bed Methane Development in Montana, Reclamation Research Unit.

Summary: Report.


Summary: Symposium Document.


Summary: Bibliography that contains listings of reports on coal seam natural gas development in Alabama. Publication dates range from 1890 through 1989.

**Summary:** Article.


**Summary:** Article.


**Summary:** GSA Circular.


**Summary:** Symposium Paper.


**Summary:** Symposium Paper.


**Summary:** This CGS report provides geologic information on the coal seam natural gas resources of the Denver Basin.

Summary: Documents the distribution of mappable Cretaceous Fruitland Formation Coals of the San Juan Basin and provides a grid of correlated subsurface cross sections in La Plata County, Colorado.


Summary: Canadian Society of Petroleum Geologists Report.


Summary: Wyoming DEQ Report.


Summary: WGA Report.


Summary: WOGCC Report.


Summary: WSGS Map.


Summary: WSGS Map.


Summary: WSGS Map.

**Summary:** WSGS / DEQ Report / Map.


**Summary:** Wyoming Water Resources Center Report.


**Summary:** AAPG Report.


**Summary:** Article.


**Summary:** USBM Report.


**Summary:** USBM Report.


**Summary:** This conference paper discusses methods used to estimate reservoir characteristics and
to predict the natural gas potential of coal seam wells in the Northern and Central Appalachian basins.


**Summary:** This SPE conference document discusses GRI conducted field evaluations of coal seam natural gas technology at the Rock Creek Project site in Alabama.


**Summary:** SPE Report.


**Summary:** SPE Short Course.


**Summary:** Article.


**Summary:** Report.


**Summary:** Symposium Document.


**Summary:** Article.
The following indexes place the listings from the bibliography into easily recognizable categories. Most of the listings appear in more than one of the indexes.

I

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Contains listings that are basin or state specific, or are specific to federal lands (including Indian reservations). Citations appear alphabetically by author/editor and include the title of the work. Refer to the bibliography for more information on the publication.


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