

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Selected Bibliography of Appalachian Coalbed Methane

Paul C. Lyons¹ and Robert T. Ryder¹

Open-File Report 95-572

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

¹ U.S. Geological Survey, Reston, Virginia 22092

SELECTED BIBLIOGRAPHY OF APPALACHIAN COALBED METHANE

**Compiled by Paul C. Lyons and Robert T. Ryder,
U. S. Geological Survey,
M.S. 956 National Center, Reston, Virginia 22092**

U. S. Geological Survey Open-file Report 95-572

Introduction

This selected bibliography of Appalachian coalbed methane was developed under the Energy Program of the U. S. Geological Survey. It is intended to assist local, state, and governmental officials, private organizations, and the public-at-large in their planning for the exploration and development of Appalachian coalbed gas, an unconventional source of natural gas. The bibliography includes information on coalbed gas production, economic potential of coalbed gas, coal resources, thermal history, geologic framework, coal chemistry, coal-mine methane control and ventilation, coal experimental work, and also legal constraints affecting the development of coalbed methane. The bibliography focuses on the states of Pennsylvania, West Virginia, Kentucky, Maryland, Virginia and Ohio, but also includes information on other Appalachian states as well. In most of these states, there is very limited to moderate coalbed gas production. It is probable that national coalbed gas production will become an increasingly important energy resource well into the next century, which will reduce our dependence upon environmentally sensitive fossil fuels such as coal, conventional oil and gas sources, and on foreign petroleum.

Selected Bibliography

- Adams, M.A., 1984, Geologic overview, coal resources, and potential methane recovery from coalbeds of the central Appalachian basin, Maryland, West Virginia, Virginia, Kentucky, and Tennessee, *in* Rightmire, C.T., Eddy, G.E, and Kirr, J.N., Coalbed methane resources of the United States: American Association of Petroleum Geologists, Studies in Geology Series, no. 17, p. 45-71.
- Adams, M.A., Hewitt, J.L., and Malone, R.D., 1982, Coalbed methane potential of the Appalachians: Unconventional Gas Recovery Symposium, (Pittsburgh, Pennsylvania, May 16-18,1982), Society of Petroleum Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), Dallas, Proceedings, p. 125-134.
- Adams, M.A., Eddy, G.E., Hewitt, J.L., Kirr, J.N., and Rightmire, C.T., 1984, Geologic overview, coal resources, and potential methane recovery from coal beds of the Northern Appalachian coal basin, Pennsylvania, Ohio, Maryland, West Virginia, and Kentucky, *in* Rightmire, C.T., Eddy, G.E., and Kirr, J.N., Coalbed methane resources of the United States: American Association of Petroleum Geologists, Studies in Geology Series, no. 17, p. 15-43.
- Attanasi, E.D. and Rice, D.D., 1995, Economics and coalbed gas in the 1995 National Assessment of U.S. oil and gas resources: U.S. Geological Survey Open-file Report 95-75A, 22 p.
- Aul, G.N., Cervik, J., Finfinger, G.L., and Perry, J.H., 1988, In-mine drainage, *in* Deul, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 102-105.
- Ayers, W.W., Jr., Kaiser, W.R., Patchen, D.G., Schwietering, J.F., and Markowski, A., 1991, Geological evaluation of critical production parameters for coal bed methane resources: Quarterly Review of Methane Coal Seams Technology, v. 8, no. 4, p. 26-32.
- Bell, G.J. and Jones, A.H., 1989 Variation of mechanical strength with rank of gassy coals: 1989 Coalbed Methane Symposium (Tuscaloosa, AL, April 17-10, 1989), Paper No. 8924, p. 65-74.

- Bell, G.J., Jones, A.H., and Morales, R.H., 1988, Spalling and the development of a hydraulic fracturing strategy for coal: Gas Research Institute Report GRI-88/0349, 142 p.
- Belt, E.S., and Lyons, P.C., 1989, A thrust-ridge paleodepositional model for the Upper Freeport coal bed and associated clastic facies, Upper Potomac coal field, Appalachian basin, U.S.A., in Lyons, P. C. and Alpern, B., eds., Peat and coal: Origin, facies, and depositional models, Amsterdam, Elsevier, p. 293-328.
- Blackmer, G. C., Gold, D. P., and Furlong, K. P., 1990, Thermal and burial history of the anthracite basin, Pennsylvania, from vitrinite reflectance, rock bulk density and porosity, and fission-track analysis [abs.]: Geological Society of America Abstracts with Programs, v. 22, no. 7, p. A368-A369.
- Botoman, G., and Stith, D.A., 1978, Analyses of Ohio coals: Ohio Division of Geological Survey Circular 47, 148 p.
- Botoman, G., and Stith, D.A., 1983, Analyses of Ohio coals, 1977-1978: Ohio Division of Geological Survey Circular 50, 54 p.
- Botoman, G., and Stith, D.A., 1986, Analyses of Ohio coals, 1979-1980: Ohio Division of Geological Survey Circular 52, 26 p.
- Botoman, G., and Stith, D.A., 1988, Analyses of Ohio coals, 1982-1984: Ohio Division of Geological Survey Circular 55, 17 p.
- Boyer, C.M., and Kelafant, J.R., 1988, Geologic assessment of natural gas from coal seams in the central Appalachian basin: Chicago, Illinois, Gas Research Institute Report GRI-88/0302, 97 p.
- Bragg, L. J., 1995, Coal quality data bases status report: U. S. Geological Survey Administrative Report, 11 p.
- Bryer, C.W., Malone, R.D., and Hunt, A.E., 1982, Preliminary resource assessment of coalbed methane in the U.S.: Society of Petroleum Engineers of AIME, SPE/DOE 19799, p. 99-116.

- Bryer, C.W., Covatch, G.L., and Mroz, T.H., 1984, Production potential for coalbed methane in U.S. basins: SPE/DOE/GRI Unconventional Gas Recovery Symposium (Pittsburgh, PA, May 13, 1984), Society of Petroleum Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) Paper, p. 15-28.
- Bryer, C.W., Mroz, T.H., and Covatach, G.L., 1987, Coalbed methane production potential in U.S. basins: *Journal of Petroleum Technology*, v. 39, p. 821-834.
- Carlton, R.W., 1989, Coal-bed analyses: Ash and sulfur: *Ohio Geology Newsletter*, Spring 1989, p. 3-4.
- Cervik, J., and Sainato, A., 1988, Water infusion of coalbeds for methane control, *in* Deul, M., and Kim, A.G., *Methane control research: Summary of results, 1964-80*: U.S. Bureau of Mines Bulletin 687, p. 141-149.
- Cervik, J., Sainato, A., and Deul, M., 1977, Water infusion of coalbeds for methane and dust control: U.S. Bureau of Mines Report of Investigations 8241, 27 p.
- Cetinbass, A., Vinson, R.P., Cervik, J., and Zabetakis, M.G., 1974, Methane and dust controls for longwalls: Pocahontas No.3 coalbed, Grundy, Va.: U.S. Bureau of Mines Report of Investigations 7849, 16 p.
- Chyi, L.L., Barnett, R.G., Burford, A.E., Quick, T.J., and Gray, R.J., 1987, Coalification patterns of the Pittsburgh coal: Their origin and bearing on hydrocarbon maturation: *International Journal of Coal Geology*, v. 7, p. 69-83.
- Collins, S.L., 1992, Chemistry and reflectance of eastern Kentucky coal related to fracture-controlled diagenetic fluid migration [abs.]: *Geological Society of America, Abstracts with Programs*, v. 24, no. 7, p. A272.
- Colton, G.W., Perry, W.J., and MacKenzie, J.D., 1981, Joint patterns in coal, black shale, gray shale and mudrocks, and limestone and dolomite in the Appalachian basin: U.S. Geological Survey Open-file Report 81-837, 4 maps, scale 1:1,000,000.
- Couchet, M.L., 1978, Resources of the Pittsburgh (No. 8) coal in the Belmont field, Ohio: *Ohio Division of Geological Survey Report of Investigations No. 105*, 12 p., 4 pls.

- Couchot, M.L., Crowell, D.L., Van Horn, R. G., and Struble, R.A., 1980, Investigation of the deep coal resources of portions of Belmont, Guernsey, Monroe, Noble, and Washington Counties, Ohio: Ohio Division of Geological Survey Report of Investigations No. 116, 49 p., 3 pls.
- Counts, R.A., 1989, Legal aspects of coalbed methane: 1989 Coalbed Methane Symposium, Proceedings, (Tuscaloosa, AL) p. 29-31.
- Cross, A.T., 1952, The Geology of Pittsburgh coal--Stratigraphy, petrology, origin and composition, and geologic interpretation of mining problems: Second Conference on the Origin and Constitution of Coal (Crystals Cliffs, Nova Scotia, June, 1952), Proceedings, p. 32-99.
- Cross, A.T. and Schemel, M.P., 1956, Economic resources of the Ohio River Valley in West Virginia: West Virginia Geological Survey, Publication V-22b, Pt. 2, 129 p.
- Currens, J.C., Bragg, L.J., and Hower, J.C., 1987, Analysis of coal samples from the Hazard District, Kentucky (Breathitt, Knox, Leslie, and Perry Counties and parts of Letcher and Harlan Counties): Kentucky Geological Survey Information Circular No.19, 301 p.
- Currens, J.C., Bragg, L.J., and Hower, J.C., 1987, Analysis of coal samples from the Big Sandy District, Kentucky (Floyd, Johnson, Morton, and Pike Counties): Kentucky Geological Survey Information Circular No. 20, 421 p.
- Currens, J.C., Bragg, L.J., and Hower, J.C., 1987, Analysis of coal samples from the southwestern district, Kentucky (Clay, Jackson, Knox, Laurel, Lee, McCreary, Owsley, Whitley, and parts of Bell, Clinton, Estill, Madison, Pulaski, Rockcastle, and Wayne Counties): Kentucky Geological Survey Information Circular No. 21, 338 p.
- Damberger, H., 1974, Coalification patterns of Pennsylvanian coal basins of the eastern United states, in Dutcher, R.R., Hacquebard, P.A., Schopf, J.M., and Simon, J.A., eds., Carbonaceous materials as indicators of metamorphism: Geological Society of America Special Paper 153, p. 53-74.
- DeBrasse, T.A., and Vohwinkle, J.C., 1974, Oil and gas fields of Ohio: Ohio Division of Geological Survey, 1 sheet, scale 1:500,000.

- Decker, D., 1988, Evaluating coal-bed methane commercial viability in northern and central Appalachian basin [abs.]: American Association of Petroleum Geologists Bulletin, v. 72, p. 959.
- Deul, M., 1975, Recover coalbed gas: Hydrocarbon Processing (July, 1975), p. 86-87.
- Deul, M., 1978, The methane content of coalbeds in Region III: Symposium on Methane Gas from Coalbeds: Development, Production, and Utilization (Coraopolis, Pennsylvania, January 17-18, 1978), Proceedings, p. 5-7.
- Deul, M., and Cervik, J., 1977, Methane drainage in the Pittsburgh coalbed: 17th International Conference on Safety of Mining Works (Varna, Bulgaria, October 3-7, 1977), p. 9-15.
- Diamond, W.P., 1987, Underground observation of mined-through stimulation treatments of coalbeds: Quarterly Review of Methane from Coal Seams Technology, v. 4, no. 4, p. 19-29.
- Diamond, W.P., 1993, Methane control for underground coal mines, in Law, B.E., and Rice, D.D., eds., Hydrocarbons from Coal: American Association of Petroleum Geologists, Studies in Geology Series, no. 38, p. 237-267.
- Diamond, W.P., and Oyler, D.C., 1988, Directional drilling for degasification of coalbeds in advance of mining, in Deul, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 128-133.
- Diamond, W.P., McCulloch, C.M., and Bench, B.M., 1976, Use of surface joint and photolinear data for predicting subsurface coal cleats orientation: U.S. Bureau of Mines Report of Investigations 8120, 13 p.
- Diamond, W. P., LaScola, J. C., Hyman, D. M., 1986, Results of direct method determination of the gas content of U. S. coalbeds: U.S. Bureau of Mines Information Circular 9067, 95 p

- Diamond, W.P., Kelafant, J.R., Wicks, D.E., Malone, P., and Schräufnagel, R., 1987, Geological and economic appraisal of gas from coalbeds in the northern Appalachian coal basin [abs.]: Society for Mining, Metallurgy, and Exploration-American Institute of Mining, Metallurgical and Petroleum Engineers (SME-AIME), Eastern Regional Meeting (Pittsburgh, Pa., October 12-13, 1987), Abstracts, p. 10.
- Diamond, W.P., Elder, C.H., and Jeran, P.W., 1988, Influence of geology on methane emission from coal, in Deul, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 26-40.
- Diamond, W.P., Iannacchione, A.T., Puglio, D.G., and Steidl, P.F., 1988, Geologic studies of gassy coalbeds, in Deul, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 41-78.
- Diamond, W.P., Jeran, P.W., and Trevits, M.A., 1993, An analysis of production trends and the potential for increasing gas flow from longwall gob gas vent holes: 1993 International Coal-bed Methane Symposium Proceedings, v. II, p. 443-452.
- Dodge, C.H. and Glover, A.D., compilers, 1984, Coal resources of Greene County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 86, pt. 1, 67 p.
- Edmunds, W.E., and Koppe, E.F., 1968, Coal In Pennsylvania: Pennsylvania Geological Survey, 4th ser., Educational Series 7, 29 p.
- Edmunds, W.E., Berg, T.M., Sevon, W.D., Piotrowski, R.C., Heyman, L., and Rickard, L.V., 1979, Pennsylvania and New York, in The Mississippian and Pennsylvanian (Carboniferous) Systems in the United States: U.S. Geological Survey Professional Paper 1110B, p. B1-P33.
- Elder, C.H., and Deul, M., 1975, Hydraulic stimulation increases degasification rate of coalbeds: U.S. Bureau of Mines Report of Investigations 8047, 17 p.
- Englund, K.J., 1974, Sandstone distribution patterns in the Pocahontas Formation of southwest Virginia and southern West Virginia, in Briggs, G., ed., Carboniferous of the Southeastern United States: Geological Society of America Special Paper 148, p. 31-45.

- Englund, K.J., Gillespie, W.H., Cecil, C.B., Windolph, J.F., Jr., and Crawford, T.J., 1985, Characteristics of the Mississippian-Pennsylvanian boundary and associated coal-bearing rocks in the southern Appalachians: U. S. Geological Survey Open-file Report 85-577, 83 p.
- Farnell, S.K., 1987, Who owns the gas in coal?--A legal update: 1987 Coalbed Methane Symposium)Tuscaloosa, Alabama, November 16-19, 1987), Proceedings, p. 11-13.
- Fields, H.H., Krickovic, S., Sainato, A., and Zabetakis, M.G., 1973, Degasification of virgin Pittsburgh coalbed through a large borehole (West Virginia): U.S. Bureau of Mines Report of Investigations 7800, 30 p.
- Fields, H.H., Perry, J.H., and Deul, M., 1975, Commercial-quality gas from a multipurpose borehole located in the Pittsburgh coalbed: U.S. Bureau of Mines Report of Investigations 8025, 14 p.
- Findlay, C., Krickovic, S., and Carpetta, J.E., 1973, Methane control by isolation of a major coal panel--Pittsburgh coalbed: U.S. Bureau of Mines, Report of Investigations 7790, 11 p.
- Findlay, C., Krickovic, S., and Carpetta, J.E., 1973, Use of isolated coal panels in the Pittsburgh coalbed: Symposium on Methane Control in Eastern U.S. Coal Mines (Morgantown, West Virginia, May, 1973), U.S. Bureau of Mines Information Circular 8621, p. 39-45.
- Gillies, A., and Snygg, A., 1981, Development of technology for coalbed methane recovery program planning: Chicago, Illinois, Gas Research Institute Report GRI-81/0008.2, 72 p.
- Glover, A. D., compiler, 1990, Coal resources of Cambria and Blair Counties, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 96, pt. 1, 129 p.
- Glover, A.D., in press, Coal resources of Indiana County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report.
- Grau, R.H., III, 1987, An overview of methane liberation from U.S. coal mines in the last 15 years: Third U.S. Mine Ventilation Symposium, University Park, Pennsylvania, Proceedings, p. 251-255.

- Grau , R.H., III, and LaScola, J.C., 1984, Methane emissions from U.S. coal mines in 1980: U.S. Bureau of Mines Information Circular 8987, 13 p.
- Gwinn, V.E., 1964, Thin-skinned tectonics in the Plateau and northwestern Valley and Ridge Provinces of the central Appalachians: Geological Society of America Bulletin, v. 75, p. 863-900.
- Hansen, M.C., 1983, Ohio's coal industry: Ohio Geology Newsletter, Winter 1983, p. 1-5.
- Harper, J.A., 1989, Effects of recurrent tectonic patterns on the occurrence and development of oil and gas resources in western Pennsylvania: Northeastern Geology, v. 11, no. 4, p. 225-245.
- Harris, L.D., and Milici, R.C., 1977, Characteristics of thin-skinned style of deformation in the southern Appalachians, and potential hydrocarbon traps: U.S. Geological Survey Professional Paper 1018, 40 p.
- Henderson, J.A., Jr., 1983, Preliminary coal-resources estimate of Montgomery and Pulaski Counties, in Stanley, C.B., and Schultz, A.P., Coalbed methane resource evaluation Montgomery County, Virginia: Virginia Division of Minerals Resources Publication 46, p. 32-33.
- Henika, W.S., 1994, Internal structure of the coal bearing portion of the Pine Mountain thrust sheet [abs.]: Geological Society of America, Southeastern Section Meeting (Blacksburg, Virginia, April 7-8, 1994), Abstracts with Programs, v. 26, no., 4, p. 19.
- Hennen, R. W., 1912, Doddridge and Harrison Counties: West Virginia Geological and Economic Survey, Morgantown, Publication CGR-5a, 712 p.
- Hennen, R.V., and Reger, D.B., 1913, Marion, Monongalia and Taylor Counties: West Virginia Geological and Economic Survey, Morgantown, Publication CGR-17a, 844 p.
- Hobba, W.A., Jr., 1991, Relation of fracture systems to transmissivity of coal and overburden aquifers in Preston County, West Virginia: U.S. Geological Survey Water-Resources Investigations Report 89-4127, 24 p.

- Hobbs, G.W. and Winkler, R.O., 1990, Economics and financing of coalbed methane ventures: An analysis of the resource potential of methane from coal seams, its economic merits, financing and the investment due diligence process: Eastern Coalbed Methane Forum (Tuscaloosa, AL, January, 1990), Dames and Moore, Cincinnati, Ohio, 58 p.
- Hower, J.C., and Davis, A., 1981, Application of vitrinite reflectance anisotropy in the evaluation of coal metamorphism: Geological Society of American Bulletin, v. 92, p. 350-366.
- Hunt, A. M., 1991, Appalachian basin coal-bed methane [abs.]: American Association of Petroleum Geologists Bulletin, v. 75, p. 1384-1385.
- Hunt, A.M., and Steele, D.J., 1991, Coalbed methane development in the Appalachian Basin: Quarterly Review of Methane from Coal Seams Technology, v 8, p. 10-19.
- Hunt, A. M., and Steele, D.J., 1991, Coalbed methane technology development in the Appalachian basin: Gas Research Institute Report GRI-90/0288, 122 p.
- Hunt, A.M., and Steele, D.J., 1992, Coalbed-methane-technology in the Appalachian Basin: Dames and Moore, Cincinnati, Ohio, Report No. GRI-92-0138 to the Gas Research Institute, Chicago, Illinois, 177 p.
- Irani, M.C., and Kissell, F.N., 1988, Methane emission in underground bituminous coal mines, in Duel, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 7-17.
- Jacobsen, E.F., and Lyons, P.C., 1985, Coal geology of the Lower Youghiogeny coal field, Garrett County, Maryland: U. S. Geological Survey Coal Investigations Map C-101, scale 1:24,000, with text.
- Jeran, P.W., Lawhead, D.H., and Irani, M.C., 1977, Methane emissions from four working places in the Beckley Mine, Raleigh County, W. Va: U.S. Bureau of Mines Report of Investigations 8212, 18 p.
- Johnson, E. C., 1992, Who owns coalbed methane?: Appalachian Pipeline, v. 3, no. 2, p. 5-7.

- Kelafant, J.R., and Boyer, C.M., 1988, A geologic assessment of natural gas from coal seams in the Central Appalachian Basin: Gas Research Institute Topical Report, GRI 88/0302, 66 p.
- Kelafant, J., Wicks, D., and Kuuskraa, V., 1987, Coal-bed methane potential of northern Appalachian basin [abs.]: American Association of Petroleum Geologists Bulletin, v. 71, p. 1107.
- Kelafant, J.R., Kuuskraa, V.A., and Wicks, D.E., 1988, Coal-bed methane potential of central Appalachian basin [abs.]: American Association of Petroleum Geologists Bulletin, v. 78, p. 965-966.
- Kelafant, J.R., Kuuskraa, V.A., and Wicks, D.E., 1988, A geologic assessment of natural gas from coal seams in the northern Appalachian coal basin: Chicago, Illinois, Gas Research Institute Report 88/0039 (under Contract No. 5084-214-1066), Chicago, Illinois, Gas Research Institute, 81 p.
- Kelafant, J.R., Kuuskraa, V.A., and Wicks, D.E., 1988, Geologic assessment of natural gas from coal seams in the northern Appalachian coal basin: ICF-Lewin Energy, Fairfax, Virginia, Report PB-88-232640, 90 p.
- Kelafant, J.R., Boyer, C.M., and Zuber, M.D., 1988, Production potential and strategies for coalbed methane in the central Appalachian basin: 1988 Eastern Regional Conference (Charleston, West Virginia, November 1-4, 1988), Proceedings, p. 305-312.
- Kertis, C. A., 1984, Recognition and prediction of coalbed discontinuities, Indiana and Armstrong Counties, Pennsylvania: Columbia, Missouri, University of Missouri, M.A. thesis, 88 p.
- Kertis, C.A., Ulery, J.P., and King, R.I., 1983, Methane in Pennsylvania coal: An overview, in Pennsylvanian coal: Resources, Technology and Utilization: The Pennsylvania Academy of Science, p. 457.
- Kim, A.G., 1973, The composition of coalbed gas: U. S. Bureau of Mines Report of Investigations 7762, 9 p.
- Kim, A.G., 1974, Methane in the Pittsburgh coalbed, Washington County, Pa.: U.S. Bureau of Mines Report of Investigations 7969, 16 p.

- Kim, A.G., and Kissell, F.N., 1988, Methane formation and migration in coalbeds, in Deul, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 18-25.
- Kirr, J., 1980, The methane potential from coal seams in the Richmond basin of Virginia: Final Technical Report, Energy Systems Groups, TRW, Inc., McLean, Virginia, 92 p.
- Kissell, F.N., 1972, Methane migration characteristics of the Pocahontas No. 3 coalbed: U.S. Bureau of Mines Report of Investigations 7649, 19 p.
- Kissell, F.N., 1972, The methane migration and storage characteristics of the Pittsburgh, Pocahontas No. 3 and Oklahoma Hartshorne coalbeds: U.S. Bureau of Mines Report of Investigations 7667, 22 p.
- Kissell, F.N., 1977, Trace elements in Ohio coals: Ohio Division of Geological Survey Report of Investigations 103, 12 p.
- Knox, L.M., Cooper, J.L., Hogentobler, M.N., and Valle, M.J., 1992, Coal bed methane exploration and results, Richmond basin, Virginia [abs.]: American Association of Petroleum Geologists-SEPM-EMD-OPA -CSPG Convention, Abstracts, v. 67.
- Krickovic, S., and Kalasky, J.D., 1972, Methane emission rate study in a deep Pocahontas No. 3 coal bed mine in conjunction with drilling degasification holes in the coal bed: U. S. Bureau of Mines Report of Investigations 7703, 12 p.
- Krickovic, S., Moore, T.D., Jr., and Carpetta, J.E., 1973, Bleeder system in virgin area in a Pittsburgh coalbed mine: U.S. Bureau of Mines Report of Investigations 7805, 8 p.
- Kulander, B.R., and Dean, S.L., 1993, Coal-cleat domains and domain boundaries in the Allegheny Plateau of West Virginia: American Association of Petroleum Geologists Bulletin, v. 77, p. 1374-1388.
- Kulander, B.R., Dean, S.L., and Williams, R.E., 1980, Fracture trends in Allegheny Plateau of West Virginia: West Virginia Geological and Economic Survey, publication Map WV-11, 2 sheets, scale 1:250,000.

- Kuuskras, V.A., 1993, Eastern U.S. coalbed methane, gas shales and tight sands: Resources, geology and engineering challenges [abs.]: Geological Society of America, Abstracts with Programs, v. 25, no. 6, p. A301-A302.
- Kvasnicka, D., 1994, Geohydrologic feasibility study of the northern and central Appalachian basins areas for the potential application of a production process patented by Jack W. McIntyre: Department of Energy Report DOE/R6/99202-T9, 38 p.
- LaCaze, J.A., Jr., and Wheeler, R.L., 1980, Expression of a cross-strike structural discontinuity in Pennsylvanian rocks of the eastern Plateau Province: *Southeastern Geology*, v. 21, p. 287-297.
- Law, B.E., 1993, Relationship between coal rank and cleat spacing: Implications for the prediction of permeability in coal: International Coalbed Methane Symposium, Report CONF-930530, University of Alabama, Tuscaloosa, Alabama, p. 435-441.
- Levine, J. R., 1983, Coal rank patterns in the Pennsylvania anthracite region, in Nickelsen, L.P., and Cotter, E., eds., Silurian depositional history and Alleghanian deformation in Pennsylvania Valley and Ridge: Annual Field Conference of Pennsylvania Geologists, 48th, (Danville, PA), Guidebook, p. 67-73.
- Levine, J. R., and Davis, A., 1989, The relationship of coal optical fabrics to Alleghanian tectonic deformation in the central Appalachian fold-and-thrust belt, Pennsylvania: *Geological Society of America Bulletin*, v. 101, p. 1333-1347.
- Lewin, J. L., 1994, Coalbed methane: Recent court decisions leave ownership "in the air": *West Virginia Law Review*, v. 96, no. 3, p. 631-684.
- Lewin, J. L., and Siriwardane, H. J., 1993, New perspectives on the indeterminacy of coalbed methane ownership: Proceedings of the International Coalbed Methane Symposium (Birmingham, Alabama, May 17-21, 1993), Tuscaloosa, Alabama, University of Alabama, p. 305-316.
- Lewis, S.E., and Hower, J.C., 1990, Implications of thermal events on thrust emplacement sequence in the Appalachian fold and thrust belt: Some new vitrinite reflectance data: *Journal of Geology*, v. 98, p. 927-942.

- Lyons, P.C., Jacobsen, E.F., and Scott, B.K., 1985, Coal geology of the Castleman coal field, Garrett County, Maryland: U. S. Geological Survey Coal Investigations Map C-98, scale 1:24,000, with text.
- Magbee, B. D., and Alkire, B. D., 1954, Oil and gas in Morgan County, Ohio: Ohio Division of Geological Survey Report of Investigations 22, 69 p.
- Markowski, A. K., 1991, Preliminary feasibility study of the coal-bed methane resource in Pennsylvania [abs.]: American Association of Petroleum Geologists Bulletin, v. 75, p. 1387.
- Markowski, A. K., 1992, Preliminary feasibility study of the coal-bed methane resource in Pennsylvania, *in* Harper, J.A and Cozart, C.L., Oil and gas developments in Pennsylvania in 1990 with ten-year review and forecast: Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Topographic and Geologic Survey, Progress Report 204, p.36.
- Markowski, A.K., 1992, Geologic evaluation of critical production parameters for coal-bed methane in Pennsylvania, *in* Harper, J.A. and Cozart, C.L., Oil and gas developments in Pennsylvania in 1990 with ten-year review and forecast: Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Topographic and Geologic Survey, Progress Report 204, p. 36-37.
- Markowski, A.K., 1992, Geologic aspects of coalbed methane occurrence in Pennsylvania [abs.]: American Association of Petroleum Geologists, v. 76, no. 8, p. 1281.
- Markowski, A.K., 1993, Coalbed methane: New energy from an old scourge?: Pennsylvania Geology, v. 24, no. 2, p. 8-14.
- Markowski, A.K., 1995, Reconnaissance of gas contents and geological aspects of the coalbed methane resources in Pennsylvania [abs.]: International Unconventional Gas Symposium (Tuscaloosa, Alabama, May 16-19, 1995), Abstract No. 9514.
- Markowski, A.K., in review, Reconnaissance of the coalbed methane resources in Pennsylvania: Bureau of Topographic and Geologic Survey, Department of Environmental Resources, unpub. report, 13 p.

- Markowski, A.K., in preparation, Reconnaissance of the coalbed methane resources in Pennsylvania: unpub. report, Pennsylvania Geological Survey.
- Maslowski, A., 1990, Coalbed gas seeks growth path: *Northeast Oil World*, v. 10, no. 7, p. 17-18.
- McBane, R.A., Schwochow, S.D., and Stevens, S.H., 1991, Editors, *Quarterly Review of Methane from Coal-Seams Technology*: Gas Research Institute, Chicago, Illinois, v. 8, 61 p.
- McCulloch, C.M., and Deul, M., 1973, Geologic factors causing roof instability and methane emission problems; the Lower Kittanning coalbed, Cambria Co., Pa.: U. S. Bureau of Mines Report of Investigations 7769, 25 p.
- McCulloch, C.M., Deul, M., and Jeran, P.W., 1974, Cleat in bituminous coalbeds: U.S. Bureau of Mines Report of Investigations 7910, 25 p.
- McCulloch, C.M., Diamond, W.P., Bench, B.M., and Deul, M., 1975, Selected geologic factors affecting mining of the Pittsburgh coalbed: U.S. Bureau of Mines Report of Investigations 8093, 72 p.
- Merritts, W. M., Poundstone, W.N., and Light, B.A., 1962, Removing methane (degasification) from the Pittsburgh coalbed in northern West Virginia: U.S. Bureau of Mines Report of Investigations 5977, 45 p.
- Milici, R.C., and de Witt, W. Jr., 1988, The Appalachian basin, in Sloss, L.L., ed., *Sedimentary cover--North American craton*: Geological Society of America, *The Geology of North America*, DNAG Volume D-2, p. 427-469.
- Milici, R.C., Gathright, T.M., Gwin, M.R., and Miller, B.W., 1982, Subtle bedding plane faults--a major factor of coal mine roof falls in southwestern Virginia [abs.]: Geological Society of America, *Abstracts with Programs*, v. 14, nos. 1-2, p. 65.
- Miller, M.S., 1974, Stratigraphy and coal beds of Upper Mississippian and Lower Pennsylvanian rocks in southwest Virginia: *Virginia Division of Mineral Resources Bulletin* 84, 211 p.

- Moore, T.D., Jr., Deul, M., and Kissell, F.N., 1976, Longwall gob degasification with surface ventilation boreholes above the Lower Kittanning coal bed: U.S. Bureau of Mines Report of Investigations 8195, 13 p.
- Mutchler, N.E., and Sachse, H.R., 1981, Legal aspects of coalbed gas: *Journal of Petroleum Technology*, v. 33, p. 1861-1868.
- Nickelsen, R.O., and Hough, V.D., 1967, Regional orientation of joints in the Appalachian Plateau [abs.]: *Geological Society of America Bulletin*, v. 69, p. 1624.
- Nickelsen, R.O., and Hough, V.D., 1967, Jointing in the Appalachian Plateau of Pennsylvania: *Geological Society of America*, v. 78, p. 609-630.
- Nolde, J.E., 1994, Coal beds, coal zones, and key stratigraphic names in the Pennsylvanian of Southwestern Virginia: *Virginia Division of Minerals Resources*, Publication 136, chart with text.
- Nolde, J.E., 1995, Coalbed methane in Virginia: *Virginia Minerals*, Commonwealth of Virginia, Division of Mineral Resources, Department of Mines, Minerals and Energy, v. 41, no. 1, p. 1-7.
- Northeast Oil and Gas World, 1993, Belden & Blake buys coalbed methane project: *Northeast Oil and Gas World*, v. 13, no. 9, p. 5.
- O'Hara, K., Hower, J.C., and Rimmer, S.M., 1990, Constraints on the emplacement and uplift history of the Pine Mountain thrust sheet, eastern Kentucky: Evidence from coal rank trends: *Journal of Geology*, v. 98, no. 1, p. 43-51.
- Oldham, A.V., Repine, T. E., Blake, B.M., and Timberlake, K.J., 1993, Coal-bed methane resources and subsurface definition of the Middle Pennsylvanian Allegheny Formation in northern West Virginia [abs.]: *American Association of Petroleum Geologists Bulletin*, v. 77, p. 8.
- Oldham, A.V., Repine, T.E., Jr., Markowski, A.K., and Harper, J.A., 1993, Geological aspects of coalbed methane occurrence in the Northern Appalachian Coal Basin: GRI Contract 5091-214-2261 (April, 1992-August 1993), Chicago, Illinois, Gas Research Institute, 86 p.

- Olszewski, A.J., Zuber, M.D., Schraufnagel, R.A., and McLennan, J.D., 1993, Integration of log, core, and well test data improves coalbed methane reservoir evaluation: International Coalbed Methane Symposium (Birmingham, AL., May 17-21, 1993), p. 263-272.
- Overbey, W.K., Jr., Locke, C.D., Reeves, T.K., Johnson, H.R., and Salamy, S.P., 1993, An innovative approach to natural gas resource development including basin analysis, completion, and stimulation of coalbed methane and conventional gas resources in southern West Virginia: Report CONF-930530 International Coalbed Methane Symposium, University of Alabama, Tuscaloosa, Alabama, p. 413-419.
- Oyler, D. C., and Diamond, W. P., 1982, Drilling a horizontal coalbed methane drainage system from a directional surface borehole: U.S. Bureau of Mines Report of Investigations 8640, 50 p.
- Pashin, J.C., and Carroll, R.E., 1993, Origin of the Pottsville Formation (Lower Pennsylvanian) in the Cahaba synclinorium of Alabama: Genesis of coal-bed reservoirs in a synsedimentary foreland thrust system: 1993 International Coal-bed Methane Symposium Proceedings, v. II, p. 623-637.
- Patchen, D.G., Schwietering, J.F., Repine, T.E., and Avary, K.L., 1991, Coalbed gas potential in the Pittsburgh-Huntington synclinorium, northern West Virginia [abs.]: American Association of Petroleum Geologists Annual Convention (Dallas, Texas, April 7-10, 1991), American Association of Petroleum Geologists Bulletin, v. 75, p. 651.
- Patchen, D.G., Schwietering, J.F., Avary, K.L., and Repine, T.E., 1991, Coalbed gas production, Big Run and Pine Grove fields, Wetzel County, West Virginia: Morgantown, West Virginia Geological and Economic Survey Publication C-44, 33 p.
- Patchen, D.G., Schwietering, J.F., Repine, T.E., Avary, K.L., Grady, W., and Timberlake, K., 1991, Geologic controls on gas accumulation and production, northern West Virginia [abs.]: Geological Society of American, Abstracts with Programs, v. 23, no. 5, p. A38.
- Pennsylvanian Geological Survey, 1992, Distribution of Pennsylvania coals: Map 11, 3rd ed., scale 1:2,000,000.
- Perry, W.J., Jr., 1980, Surface joint patterns as a guide to fracture reservoirs: U.S. Geological Survey Professional Paper, 39 p.

- Perry, W.J., Jr., Smith, G., and Lee, M.W., 1977, Seismic modelling of complexly deformed fold-and-thrust-belt rocks, Central Appalachians: First Eastern Gas Shales Symposium, U.S. Energy Research and Development Administration, Preprints, p. 327.
- Petroleum Information Corporation, 1990-present, Southeastern U.S. Coalbed Methane Report(s): Petroleum Information Corporation Monthly Reports, v. 1 (1990) to v. 6 (1995), variously paged.
- Petroleum Information Corporation, 1993, BLM moves to promote regulation, development of coalbed methane in seven eastern states: Petroleum Information Corporation, Southeastern U.S. Coalbed Methane Report, v. 4, no. 6, p. 6.
- Petroleum Information Corporation, 1993, Belden & Blake closes purchase of Pennsylvania coalbed project: Petroleum Information Corporation, Appalachian Basin Report, September 2, 1993, p. 8.
- Petroleum Information Corporation, 1995, Ohio removed from list of affected coalbed methane states: Petroleum Information Corporation, Appalachian Basin Report, February 23, 1995, v. 34, no. 8, p. 11
- Popp, J.T., and McCulloch, C.M., 1976, Geological factors affecting methane in the Beckley coalbed: U.S. Bureau of Mines Report of Investigations 8137, 39 p.
- Potts, N.R., Bayliss, J.T., and Lawson, L.R., Jr., 1975, A literature survey on the removal of methane from coal: Virginia Energy Office, Richmond, Virginia, Report PB-247562, 28 p.
- Price, P.H., and Headlee, A.J.W., 1943, Natural coal gas in West Virginia: American Association of Petroleum Geologists Bulletin, v. 27, p. 529-537.
- Puglio, D.G., and Argall, G.O., Jr., Editors, 1981, Evaluating geology, mining problems and methane content of coalbeds through exploration programs in the northern Appalachian coalfield: International Coal Exploration Symposium (Calgary, Canada, August 23, 1981), San Francisco, Miller Freeman Publications, p. 267-282.
- Repine, T.E., Jr., 1990, Coalbed methane--A new West Virginia industry?: Mountain State Geology, Spring 1990 issue, p. 1, 6-7.

- Repine, T.E., Jr., Ashton, K.C., and Blake, B.M., Jr., 1990, Coal bed methane in West Virginia [abs.]: American Association of Petroleum Geologists, Eastern Section Meeting (London, Ontario, September 10-12, 1990), American Association of Petroleum Geologists Bulletin, v. 74, p. 1309.
- Repine, T.E., Jr., Blake, B.M., Jr., Ashton, K.C., Schwietering, J.R., and Grady, W.C., 1991, Coal bed methane research in West Virginia's northern coalfield [abs.]: American Association of Petroleum Geologists Bulletin, v. 75, p. 660.
- Rice, D. D., 1995, Geological framework and description of coal-bed gas plays, *in* Gautier, D.L., Dolton, G.L., Takahaski, K.I., and Varner, K.L., eds., 1995 National Assessment of United States Oil and Gas Resources-- Results, Methodology, and Supporting Data: U.S. Geological Survey Digital Data Series DDS-30, 103 p., maps.
- Rightmire, C.T., Eddy, G.E., and Kirr, J.N., Editors, 1984, Coalbed methane resources of the United States: American Association of Petroleum Geologists, American Association of Petroleum Geologists, Studies in Geology Series 17, 387 p.
- Rodgers, J., 1970, The tectonics of the Appalachians: New York, John Wiley and Sons, 271 p.
- Schatzel, S.J., Garcia, F., and McCall, F.E., 1993, Methane sources and emissions of two longwell panels of a Virginia coal mine [abs.]: American Association of Petroleum Geologists, 1993 Annual Convention, Abstracts, p. 178.
- Schettler, P.D., Parmely, C.R., and Wampler, D.L., 1987, Physicochemical properties of methane storage and transport in Devonian shale: Annual Report, June 1986-May 1987, Chicago, Illinois, Gas Research Institute, Contract No. 5085-213-1143, Juniata College, Huntingdon, PA, 161 p.
- Schraufnagel, R.A., 1990, Spalling and the development of a hydraulic fracture strategy for coal: Chicago, Illinois, Gas Research Institute Report GRI-90/0078, 142 p
- Schraufnagel, R.A., 1990, Spalling and the development of a hydraulic fracture for coal: Chicago, Illinois, Gas Research Institute Report GRI-90.0078, 96 p.

- Schwietering, J.F., Patchen, D.G., and Markowski, T.K., 1992, Geological aspects of coal-bed methane occurrence in the northern Appalachian coal basin: West Virginia Geological and Economic Survey and Pennsylvania Topographic and Geologic Survey, unpublished report, 85 p.
- Scott, A.R., 1993, Composition and origin of coalbed gases from selected basins in the United States: International Coalbed Methane Symposium, (Birmingham, Alabama, May 17-21, 1993), Proceedings, v. 1, p. 207-222.
- Shoemaker, H.B., Rennick, G.E., Wise, R.L., and Gilmore, D.W., 1979, Methane production from Snodgrass No. 2, Pricetown, West Virginia, in Wise, R.L., ed., Proceedings of the Second Annual Methane Recovery from Coal Beds Symposium: Morgantown Energy Technology Center, West Virginia, Proceedings, p. 114-130.
- Sinclair, J.F., 1995, Geologic controls in the Nora Coalbed Methane Field, southwest Virginia [abs.]: American Association of Petroleum Geologists 1995 Annual Convention (Houston, Texas, March 5-8, 1995), Abstracts, American Association of Petroleum Geologists Bulletin, v. 79, in press.
- Skema, V.W., compiler, 1987, Coal resources of Washington County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 93, pt. 1, 96 p.
- Skema, V.W., compiler, 1988, Coal resources of Westmoreland County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 94, pt. 1, 127 p.
- Slingerland, R. and Beaumont, C., 1989, Tectonics and sedimentation of the Upper Paleozoic foreland basin in the Central Appalachians, in Slingerland, R., and Furlong, K., leaders, Sedimentology and thermal-mechanical history of basins in the central Appalachian orogen: 28th International Congress, Field Trip Guidebook T152, American Geophysical Union, p. T152:4-T152:24.
- Soot, P., 1989, Horizontal well coalbed methane production relative to cleat orientation: Coalbed Methane Symposium, Tuscaloosa, Alabama, April 17-20, 1989, University of Alabama, Tuscaloosa, Alabama, Report CONF-890411, p. 117-123.

Southworth, C.S., 1986, Side-looking airborne radar image map showing cross-strike structural discontinuities and lineaments of the central Appalachians: U.S. Geological Survey Miscellaneous Field Studies Map MF-1891, 1 sheet, scale 1:500,000; 1 pamphlet, 14 p.

Stanley, C.B., and Schultz, A.P., 1983, Coal-bed methane resource evaluation, Montgomery County, Virginia: Virginia Division of Minerals Resources Publication 46, 59 p.

Steele, D.J., 1990, Coalbed methane technology development in the Appalachian basin: Quarterly Review of Methane from Coal Seams Technology, v. 7, no. 4, p. 23-?.

Stevens, D.W., 1959, A survey of the factors which affect mining of the lower Mississippian coals in Montgomery, Virginia: Blacksburg, Virginia, Virginia Polytechnic Institute and State University, M. S. thesis, 75 p.

Struble, R.A., Collins, H.R., and Kohout, D.L., 1971, Deep-core investigation of low-sulfur coal possibilities in southeastern Ohio: Ohio Division of Geological Survey Report of Investigations 81, 29 p., 4 pls.

Telle, W.R., and Thompson, D.A., 1987, Preliminary characterization of the coal-bed methane potential of the Cahaba coal field, central Alabama: 1987 Coal-bed Methane Symposium, Proceedings, p. 141-151.

Tilton, J.G., 1976, Gas from coal deposits: Report presented before the National Research Council, January 15, 1976, Washington, D.C., 30 p.

Trevits, M.A., Richards, W.L., and Von Schonfeldt, H.A., 1980, Determining the feasibility of using vertical boreholes to drain gas from the Pocahontas No. 3 coalbed, Buchanan County, VA.: SPE/Department of Energy Symposium on Unconventional Gas Recovery (Pittsburgh, May 18-20, 1980), Society of Petroleum Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), Proceedings, p. 329-334.

Trevits, M.A., Lambert, S.W., Steidl, P.F., and Elder, C.H., 1988, Methane drainage through small-diameter vertical boreholes, *in* Deul, M., and Kim, A.G., Methane control research: Summary of results, 1964-80: U.S. Bureau of Mines Bulletin 687, p. 106-127.

- Trinkle, E.J., Sitler, J.A., Sasso, J.A., Kardosh, W.F., and Ting, F.T.C., 1978, Coalification pattern of West Virginia coals [abs.]: Geological Society of America Abstracts with Programs, v. 10, no. 7, p. 506.
- Ulery, J.P., 1988, Geological factors influencing the gas content of coalbeds in southwestern Pennsylvania: U.S. Department of Interior Report of Investigations No. 9195, 32 p.
- Ulery, J.P., 1991, The composition and volume of desorbed and residual gas contained in coal beds recovered from a deep core hole in southwestern Pennsylvania [abs.]: American Association of Petroleum Geologists Bulletin, v. 75, no. 8, p. 1391.
- Ulery, J.P., and Molinda, G.M., 1984, Influence of overlying strata on methane emissions in a northern West Virginia coal mine: U. S. Bureau of Mines Report of Investigations 8879, 14 p.
- Ver Steeg, K., 1942, Jointing in the coalbeds of Ohio: Economic Geology, v. 37, p. 503-509.
- Von Schonfeldt, H., Pothini, B.R., Aul, G.N., and Henderson, R.L., 1982, Production and utilization of coal-bed methane gas in Island Creek Coal Company mines: Proceedings of the Unconventional Gas Recovery Symposium ((Pittsburgh, Pennsylvania), Society of Petroleum Engineers/Department of Energy Paper 10817, p. 235-244.
- Wanless, H.R., 1975, Appalachian region, *in* McKee, E.D., and Crosby, E.J., coordinators, Paleotectonic investigations in the Pennsylvanian System in the United States, Part 1, Introduction and regional analyses of the Pennsylvanian System: U.S. Geological Survey Professional Paper 853, p. 17-63.
- West Virginia Geological and Economic Survey and Pennsylvania Topographic and Geologic Survey, 1991, Geological aspects of coal-bed methane occurrence in the northern Appalachian basin: Gas Research Institute Contract No. 5087-214-1544, 85 p.
- Wheeler, R.L., Winslow, M., Horne, R.R., Kulander, B., Drahovzal, J.A., Gold, D.P., Gilbert, O.E., Werner, E., Sites, R., and Perry, W.J., Jr., 1979, Cross-strike structural discontinuities in thrust belts, mostly Appalachian: Southeastern Geology, v. 20, p. 193-203.

- White, I.C., 1891, Bituminous coal field of Pennsylvania, Ohio, and West Virginia: U.S. Geological Survey Bulletin 65, 212 p.
- Wilkes, G. P., 1988, Mining history of the Richmond coalfield of Virginia: Virginia Division of Mineral Resources Publication 85, 51 p.
- Wise, D.U., Belt, E.S., and Lyons, P.C., 1991, Clastic diversion by fold salients and blind thrust ridges in coal-swamp development: *Geology*, v. 19, p. 514-517.
- Zebrowitz, M.J., Kelafant, J.R., and Boyer, C.M., 1991, Reservoir characterization and production potential of the coal seams in northern and central Appalachian basins: 1991 Coalbed Methane Symposium, (Tuscaloosa, University of Alabama, May 13-16, 1991), Proceedings, p. 391-402.
- Zhang, E., and Davis, A., 1993, Coalification patterns of the Pennsylvanian coal measures in the Appalachian foreland basin, western and south-central Pennsylvania: *Geological Society of America Bulletin*, v. 105, p. 162-174.