

CURRICULUM VITAE
RONALD F. BROADHEAD
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Citizenship: U.S.

PROFESSIONAL EXPERIENCE:

Principal Senior Petroleum Geologist, New Mexico Bureau of Geology (formerly Mines and Mineral Resources	July 2003-present
Principal Senior Petroleum Geologist and Associate Director For Industry Liason, New Mexico Bureau of Mines and Mineral Resources	December 1998-June 2003
Senior Petroleum Geologist and Assistant Director New Mexico Bureau of Mines and Mineral Resources	1994-1998
Senior Petroleum Geologist, Head Library of Subsurface Data New Mexico Bureau of Mines and Mineral Resources	1992-present
Petroleum Geologist, Head Petroleum Section New Mexico Bureau of Mines and Mineral Resources	1988-1992
Faculty Adjunct, Earth and Environmental Sciences Department New Mexico Institute of Mining and Technology	1983-present
Petroleum Geologist New Mexico Bureau of Mines and Mineral Resources	1981-1988
Petroleum Geologist, Cities Service Oil Company Tulsa and Oklahoma City	1979-1981

EDUCATION:

M.S. in Geology, University of Cincinnati Thesis: Gas-bearing Ohio Shale along Lake Erie Advisor: Professor Paul Edwin Potter	1979
Duke University Marine Laboratory Pivers Island, North Carolina	1977 (summer)
B.S. in Geology, New Mexico Institute of Mining and Technology (with Highest Honors)	1977

HONORS AND AWARDS:

2016	Career Achievement Award from the New Mexico Oil & Gas Association
2015	Distinguished Service Award from American Association of Petroleum Geologists
2014	Charles H. Taylor Fellow , American Association of Petroleum Geologists
2009	Distinguished Service Award from West Texas Geological Society

Awards and Honors (continued)

- 2008 **Honorary Membership** from Roswell Geological Society
2004 **Long Service Award** from the House of Delegates of the American Association of Petroleum Geologists
2002 **Monroe G. Cheney Science Award** from Southwest Section American Association of Petroleum Geologists
2002 **A.I Levorsen Award** for best paper presented at Southwest Section American Association of Petroleum Geologists annual convention, Ruidoso New Mexico
1977 **Union Oil Company Summer Fellowship in Marine Geology**
1977 **Estwing Award** for Outstanding Geoscience Graduate, New Mexico Institute of Mining and Technology

PROFESSIONAL AFFILIATIONS:

American Association of Petroleum Geologists (member since 1978; Editor Search and Discovery, 2012-present; House of Delegates, 1986-2004; Rocky Mountain Membership Committee, 1987-1993; Technical Program Chair for Rocky Mountain Section meeting, 2000)
SEPM, the Society for Sedimentary Geology (member since 1979)
New Mexico Geological Society (President, 1993; Vice President, 1992; Treasurer, 1991; Secretary, 1990)
Roswell Geological Society (member)
West Texas Geological Society (member)
Four Corners Geological Society (member)
Albuquerque Geological Society (member)
Sigma Xi (President, New Mexico Tech Chapter, 1989-1990)
Potential Gas Committee of the Potential Gas Agency (member)

CIVIC AFFILIATIONS:

Friends of the Socorro Public Library (Vice President, 2005).

SYNERGISTIC ACTIVITIES (selected)

Editor of Search and Discovery, the online exploration and production journal of the American Association of Petroleum Geologists, 2011 – present.

Co-advisor, New Mexico Tech AAPG Imperial Barrel Award Team, 2016 & 2017.

Instructor, Earth Science 460 (Subsurface and Petroleum Geology), 1982-2013.

Advisor New Mexico Tech Student Chapter of AAPG, 1997-2001 (NMT Student Chapter won Best Student Chapter Award in 1999).

Technical program chair, Rocky Mountain Section AAPG annual meeting, 2000.

President New Mexico Geological Society, 1993.

Member of Rocky Mountain Membership Committee of AAPG, 1987-1993.

Member House of Delegates of AAPG, 1986-2004.

President, New Mexico Tech Chapter of Sigma Xi, 1989-1990.

MAJOR PROJECTS AT NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES:

- **Petroleum, helium and CO₂ potential of New Mexico.** Project performed in conjunction with the Petroleum Recovery Research Center and funded by the New Mexico State Land Office.
- **Evaluation of the oil & gas resources of the Secretary of Interior's Potash Area, Eddy County, New Mexico.** This ongoing project, performed in conjunction with the Petroleum Recovery Resource Center, the NMT Petroleum Engineering Dept., and the NMT Management Dept. is funded by a consortium of oil companies with the goal of providing a current and independent estimate of the oil and gas resources within the Secretary's Potash Area.
- **Induced seismicity resulting from injection of produced oilfield water in New Mexico.** This work grew out of a public workshop conducted at New Mexico Tech during August 2014. Cooperating scientists are Mark Person and Sue Bilek of the NMT Earth and Environmental Sciences Dept.
- **Petroleum geology and plays on the Mancos Shale in the San Juan Basin.** This work grew out of work performed for the NMT-sponsored San Juan Basin Energy Conference, March 2013.
- **Natural gas potential of north-central New Mexico** (funded by New Mexico State Land Office). Principal Investigator. Mapped and analyzed distribution of CO₂-rich gases throughout New Mexico.
- **Carbon dioxide in New Mexico: geologic distribution of natural occurrences:** (funded by New Mexico State Land Office). Principal Investigator. Mapped distribution of hydrocarbon production and shows, subsurface structure and stratigraphy, and assessed petroleum source rocks in the Las Vegas, Raton and San Luis Basins and assessed potential for undiscovered natural gas resources.
- **Mississippian of southeastern New Mexico** (multiple projects funded by New Mexico State Land Office). Principal Investigator. Mapped and analyzed the structure and stratigraphy of Mississippian strata in southeastern New Mexico. Grouped currently productive reservoirs into 4 stratigraphically and structurally defined plays and described those plays.
- **Helium resources of New Mexico** (funded by New Mexico State Land Office and New Mexico Commissioner of Public Lands). Principal Investigator. Mapped and analyzed distribution of helium-rich gases in New Mexico and developed models for helium exploration.
- **Development of a Fuzzy Expert System for the Reduction of Risk in Petroleum Exploration** (in conjunction with the New Mexico Petroleum Recovery Research Center and the Computer Science Department of New Mexico Institute of Mining and Technology). **Co-Principal Investigator.** \$2.9 million contract awarded end of 1998 by U.S. Department of Energy, commenced work 1999.
- **Petroleum Geology of Frontier Basins in New Mexico.** Evaluated the petroleum potential of frontier basins in New Mexico. This work has involved extensive subsurface mapping of nonproductive to marginally productive frontier basins in the state. Mapping involved a combination of well data, biostratigraphic data, gravity and magnetic field data, and 2-dimensional seismic lines. Structure and stratigraphic data were integrated with lithofacies studies, petrographic studies, and hydrocarbon source-rock analyses to form an integrated picture of the petroleum geology and petroleum systems in these basins. Work has involved extensive collaboration and interaction with the petroleum industry in New Mexico. Evaluated basins include the Tucumcari Basin of east-central New Mexico, the Estancia Basin of central New Mexico, the Carrizozo Basin of central New Mexico, the Tularosa Basin – Orogrande Basin area of south-central New Mexico, and Pennsylvanian age elevator basins in central and northeast New Mexico (elevator basins are deep narrow grabens characterized by deposition of both source facies and reservoir rocks and are self-contained petroleum systems). 1986-present.
- **Mineral and Energy Resource Assessment of the McGregor Range, Otero County, New Mexico.** \$300K project funded by the U.S. Army Corps of Engineers through TRC-Mariah Associates, Inc. Served as **Principal Investigator** coordinating research and budgets of other workers and performed the oil and gas assessment work. The McGregor Range encompasses approximately 1,000 mi² in Otero County, south-central New Mexico. It is used by the U.S. Army as a practice and target range for conducting military exercises, especially bombardment with projectiles and air-to-ground weapons, as well as for the testing of experimental weaponry. The project involved assessing recoverable mineral and energy resources on the McGregor bombing and artillery range. The project was required by federal law in order to comply with federal regulations regarding continued withdrawal and military use of the McGregor Range by the U.S. Army. This project involved extensive field and laboratory work on the restricted access lands of the McGregor Range and involved coordination of the work of more

than 20 scientists and technicians from the New Mexico Bureau of Mines and Mineral Resources, the Earth Data Analysis Center of the University of New Mexico, the New Mexico State University, and the University of Texas at El Paso. The project also involved liaison with U.S. Army security forces for purposes of gaining access to this militarily restricted area. The final product was a comprehensive report of more than 500 pages that is presently held confidential by the U.S. Army. 1997.

- **Evaluation of Mineral Resources at the Waste Isolation Pilot Plant (WIPP) Site.** Funded by Westinghouse Electric Corporation. Served as lead scientist in evaluation of oil and gas resources of 16 square mile WIPP Land Withdrawal Area and adjacent lands. Integrated comprehensive subsurface geological study and petroleum engineering study which evaluated oil and natural gas resources producible through primary and secondary (waterflood) recovery. 1994-1995.
- **Atlas of Major Rocky Mountain Gas Reservoirs.** \$1.5 million project funded principally by Gas Research Institute and U.S. Department of Energy. **Project CoDirector. Project Director** for last year of project. Roles as Project CoDirector and Director involved supervising and coordinating efforts and budgets of 36 professional personnel at New Mexico Bureau of Mines and Mineral Resources, Colorado Geological Survey, Utah Geological Survey, Geological Survey of Wyoming, Intera Information Technologies, Inc., Methane Resources Group, Ltd., and Barlow and Haun Associates, as well as writing 12 sections of atlas. 1991-1993.
- **New Mexico Library of Subsurface Data.** **Supervisor** from 1988 to present. Duties include supervising two full-time staff members and three student assistants organizing New Mexico Library of Subsurface Data, and routinely answering service requests for information from industry, the general public, and government agencies. Most requests concern the oil and gas industry in the state, but many requests are also received regarding groundwater resources and data useful to the minerals industries. Initiated program to computerize drilling records, well logs, and other information on the 90,000 oil and natural gas wells that have been drilled in New Mexico. The New Mexico Library of Subsurface Data is affiliated with the U.S. Department of Energy Regional Petroleum Technology Transfer Center located at New Mexico Tech since 1994. Subsurface library staff recently completed digital maps of oil and gas fields in New Mexico which are available to the public over the internet and are linked to the state's computerized database of oil and gas production. Currently raising private-sector funds to permit construction of additional core archival facilities.
- **New Mexico Petroleum Source Rock Project.** Cooperative project funded by New Mexico Bureau of Mines and Mineral Resources, New Mexico Oil Conservation Division, New Mexico Energy Research and Development Institute, and private industry (more than 20 contributing companies). **Project Manager.** Source-rock analyses of more than 100 key oil and gas exploration wells and outcrop sections in New Mexico. 1987-present (ongoing). A computer database of data generated by this project has been completed and reproduced on CD-ROM as a New Mexico Bureau of Mines and Mineral Resources product.
- **Geology of gas-producing Abo red beds, southeastern New Mexico.** This project involved a subsurface and surface analysis of the nonmarine red beds of the Abo Formation (Permian) in southeastern New Mexico. Gas was discovered in the Abo in the late 1970's and a drilling boom began to exploit this gas in the early-mid 1980's. This project was undertaken in concurrence with the drilling boom in an effort to more fully understand the geologic controls on gas distribution. Resulted in several publications as well as a two-day field trip jointly sponsored by the New Mexico Bureau of Mines and Mineral Resources and the Roswell Geological Society (a largely industry-supported group).
- **Mineral Resource Potential of Cibola, McKinley, Rio Arriba, San Juan, Sandoval, and Valencia Counties, New Mexico.** Cooperative project with U.S. Bureau of Land Management and several New Mexico Bureau of Mines and Mineral Resources staff. Evaluated petroleum, carbon-dioxide, and helium potential of these counties. 1984-1986.

EDUCATIONAL ACTIVITIES AT NEW MEXICO TECH

- **Geology/Geophysics 571 – AAPG IBA Competition.** I co-taught this course involved lectures and extensive advising for the NMT AAPG Imperial Barrel Award Team. Spring 2016, 2017.
- **Earth Science 460 (formerly Geology 460 and 464), Subsurface and Petroleum Geology.** Lecture and laboratory course. Taught this course 24 times from 1982 until 1983 (annually from 1997 through

2013. Course is required for petroleum engineering majors and passed ABET review. This course was essentially taught largely on my own time and was essentially uncompensated. A total of 328 students passed my course through the years.

- **Geology 581, Directed study in petroleum source rocks.** Taught on demand, 2000-2001.
- **Advise and direct M.S. research projects.** Recent matriculated graduate research advisees are Heidi Justman, Jason Lennane, and Jake Sharp. Have also served on numerous M.S thesis committees at New Mexico Tech including Jenna Donatelli, Ken Lemley, Curtis McKallip, Weiqiang Wu, Greg Little and Maqsood Ali of the Earth and Environmental Sciences Department and Kelsey Seals, Shigao Ren, Ketil Hareland, Steven Sanchez, Xi Xiaokui and Ryan Robinson of the Petroleum Engineering Department.

NEW MEXICO TECH INSTITUTIONAL SERVICE

- NMT Search Committee for Vice President for Academic Affairs, 2016
- NMT Presidential Search Committee, 2015-2016
- NMT Search Committee for Vice President for Academic Affairs, 2013
- Search Committee for Director of New Mexico Bureau of Geology and Mineral Resources, 2012
- New Mexico Bureau of Geology and Mineral Resources Petroleum Geologist Search Committee (Chair), 2001
- New Mexico Bureau of Geology and Mineral Resources Petroleum Geologist Search Committee (Chair), 1999
- New Mexico Bureau of Geology and Mineral Resources Petroleum Geologist Search Committee, 1995
- NMT Institute Space Committee, 1990-1991.
- New Mexico Bureau of Geology and Mineral Resources Petroleum Geologist Search Committee, 1989
- NM Bureau of Geology tenure committees (1989-2004; 1995-1999; 1999-2003; 2001-2003)

EXTERNALLY FUNDED PROJECTS

Project name	Funding organization	Cooperative Investigators/Scientists	Role	Start year	End year
New analysis of oil & gas potential of Secretary of Interior's Potash Area	Industry consortium (Bopco, OXY USA, Chevron, Devon, XTO)	R. Balch, M. Cather (PRRC), T. Engler (NMT Petroleum Engineering Dept.), Y. Yuan, NMT Management Dept.)	geologist	2015	2016
National Geothermal Data System - New Mexico Contribution	U.S. Department of Energy	S. Kelley (NMBGMR) D. Ulmer-Scholle (NMT)	geologist	2010	2013
New Mexico saline aquifer database	U.S. Geological Survey	D. Ulmer-Scholle (NMT)	PI	2010	2011
National Geologic & Geophysical Preservation Program	U.S. Geological Survey	A. Trivitt-Kracke, A. Lopez (NMBGMR)	PI	2010	2011

Project name	Funding organization	Cooperative Investigators/Scientists	Role	Start year	End year
National Geologic & Geophysical Preservation Program	U.S. Geological Survey	A. Trivitt-Kracke, A. Lopez (NMBGMR)	PI	2009	2010
National Geologic & Geophysical Preservation Program	U.S. Geological Survey	A. Trivitt-Kracke, A. Lopez (NMBGMR)	PI	2008	2009
Carbon dioxide accumulations in New Mexico	New Mexico State Land Office		PI	2008	2009
Natural gas potential of north-central New Mexico	New Mexico State Land Office		PI	2007	2008
National Geologic & Geophysical Preservation Program	U.S. Geological Survey	A. Trivitt-Kracke, A. Lopez (NMBGMR)	PI	2007	2008
Barnett Shale in southeastern New Mexico	New Mexico State Land Office		PI	2006	2007
Mississippian strata of southeastern New Mexico	New Mexico State Land Office		PI	2005	2006
Geologic trends oil oil & gas production in potash area	U.S. Bureau of Land Management	Patrick Walsh (NMBGMR)	PI	2005	2006
Helium in New Mexico	New Mexico State Land Office		PI	2004	2005
Permian Basin structure maps	New Mexico State Land Office		PI	2003	2004
Oil, gas & mineral resources of Laguna Bonitas area	New Mexico Energy, Minerals and Natural Resources Dept.	Ginger McLemore (NMBGMR)	geologist	2003	2003

Project name	Funding organization	Cooperative Investigators/Scientists	Role	Start year	End year
Play analysis of major oil reservoirs in Permian Basin	U.S. Department of Energy	Shirley Dutton and 4 other geologists and engineers at Bureau of Economic Geology (at Univ. of Texas); Bill Raatz (NMBGMR)	PI (NM part only)	2002	2004
Oil, natural gas & helium potential of Chupadera Mesa area	New Mexico State Land Office		PI	2002	2003
Roadmap for unconventional natural gas technology	Gas Technology Institute	Tom Engler (NMT Petroleum Engineering Dept) Martha Cather (PRRC) Bill Raatz (NMBGMR)	geologist	2002	2002
Petroleum potential of Sin Nombre area	New Mexico State Land Office		PI	2001	2002
Tucumcari Basin source rocks and structure	New Mexico State Land Office		PI	2000	2001
Exploration risk reduction with fuzzy expert tool	U.S. Department of Energy	Bill Weiss & Bob Balch (PRRC)	co-PI	1999	2005
Mineral and energy assessment of McGregor Range	U.S. Army Corp of Engineers through TRC-Mariah, Inc.	G. Austin, V. McLemore, J. Barker (NMBGMR; J. Witcher of New Mexico State University)	PI	1994	1995
Atlas of Major Rocky Mountain Gas Reservoirs	Gas Research Institute	N. Whitehead, J. Robertson, F. Luo of New Mexico Bureau of Geology; S. Speer of Roswell NM; 31 geologists and engineers from Geol Survey of Wyoming, Colorado Geol Survey, Utah Geol Survey, Barlow & Haun, Inc., Methane Resources Group, Ltd., Intera Inc.	PI	1991	1993

CITIES SERVICE COMPANY, 1979-1981

I spent my first 3 months in the Basin Studies Group, and applied research unit in Tulsa. In this group I was part of a team that was developing a computer-based exploration tool based on principal components analysis of geologic data. From there, I attended the 6 month Exploration Training Program in Tulsa. After that I was transferred to the Oklahoma City Office where I developed drilling prospects, evaluated acreage positions, and did wellsite duty which encompassed recommendations on testing and completing wells vs. plug and abandonment, etc. Primary areas of responsibility for prospect evaluation and acreage evaluation included the Arkoma Basin of Oklahoma and Arkansas, the Ouachita thrust belt, the central Oklahoma uplift area, extreme southwestern Oklahoma and the Texas panhandle. Wellsite duties included wells drilled in the Arkoma Basin, the Oklahoma panhandle and western Kansas.

LEGISLATIVE PRESENTATIONS (New Mexico)

Broadhead, R.F., 2013, Geology of oil & gas in Mancos Shale, San Juan Basin: Presented to New Mexico House of Representatives Water & Natural Resources Interim Committee, Farmington NM, August 29, 2013.

Broadhead, R.F., 2013, Overview of hydraulic fracturing in New Mexico: Presented to joint meeting of New Mexico House of Representatives Energy & Natural Resources Committee and Agriculture & Water Resources Committee, Santa Fe NM, February 11, 2013.

Broadhead, R.F., 2012, New Mexico Oil and Gas Production, presented to New Mexico House of Representatives Energy and Natural Resources Committee, Santa FE NM, February 3, 2012.

INVITED PRESENTATIONS:

Helium: Geology of accumulations and relationship to other natural gases in the reservoir. Presented to AAPG Geoscience Technology Workshop, Houston TX, October 2016.

Carbon dioxide and helium gases in New Mexico: Distribution and relation to other gases in the reservoir, presented to Geological Society of America Annual Meeting, Denver CO, September 2016.

Exploring the potential linkages between oil-field brine reinjection, crystalline basement permeability, and triggered seismicity for the Dagger Draw oil field, southeastern New Mexico, USA using hydrologic modeling: Geological Society of America, Annual meeting abstracts, Denver CO, September 2016. **Mark Person was the speaker.**

Petroleum geology of Mora County. Presented to Mora County Commission, February 23, 2016.

The Upper Mancos Shale in the San Juan Basin: Three plays, conventional and unconventional. Presented at monthly dinner meeting of Roswell Geological Society, November 10, 2015.

Overview of selected shale plays in New Mexico. Presented at City Different Petroleum Club, Santa Fe NM, July 30, 2015.

What are hydraulic fracturing and directional drilling? Presentation made in conjunction with presentation of F. David Martin, New Mexico Secretary of Energy, Minerals and Natural Resources at Annual meeting of New Mexico Rural Water Association, April 13, 2015.

Broadhead, R.F., 2014, Induced seismicity in New Mexico, presented to NM Tech Workshop on Induced Seismicity, August 21, 2014, Socorro NM.

- Broadhead, R.F., 2014, Overview of selected shale plays in New Mexico, presented at Rocky Mountain Association of Geologists Luncheon meeting, August 6, 2014.
- Broadhead, R.F., 2014, Mississippian of southeast New Mexico Part I: Carbonate stratigraphy, reservoir characteristics and plays, presented as Rocky Mountain Association of Geologists pre-luncheon talk, August 6, 2014.
- Broadhead, R.F., Mississippian of southeast New Mexico Part II: The Barnett Shale, presented as Rocky Mountain Association of Geologists pre-luncheon talk, August 6, 2014.
- Broadhead, R.F., 2014, Mississippian of southeast New Mexico Part III: The lower Morrow or “false” Barnett shale, presented as Rocky Mountain Association of Geologists pre-luncheon talk, August 6, 2014.
- Broadhead, R.F., 2014, Hydraulic fracturing in NM presented to NM Tech Workshop on Hydraulic Fracturing, March 27, 2014, Socorro NM.
- Broadhead, R., 2012, Helium in New Mexico: Geologic distribution and exploration possibilities. Presented to Permian Basin Section SEPM luncheon meeting, October 24, 2012.
- Broadhead, R.F., 2012, Mississippian carbonates of southeastern New Mexico: stratigraphy and reservoir characteristics, presented to:
- Albuquerque Geological Society luncheon meeting, March 7, 2012.
- Roswell Geological Society dinner meeting, September 13, 2011.
- Broadhead, R.F., 2012, Shale gas possibilities in New Mexico, presented to Shale Gas Conference sponsored by New Mexico Tech Center for Energy Policy, Hobbs, NM, January 12-13, 2012.
- Broadhead, R.F., 2011, Helium in New Mexico: Geologic distribution and exploration possibilities: presented to New Mexico State University Geosciences Department Fall Colloquium, September 21, 2011.
- Broadhead, R., 2010, Petroleum geologic framework of the Tukumcari Basin, east-central New Mexico, with a synopsis of recent exploratory activity: Society of Independent Professional Earth Scientists, 47th annual meeting, Colorado Springs CO, June 2010.
- Broadhead, R.F., 2009, Petroleum geology framework of the Tukumcari Basin, presented to West Texas Geological Society luncheon program, August 11, 2009.
- Broadhead, R.F., 2009, Geologic history of naturally occurring CO₂ deposits in New Mexico, presented to Research Experience in Carbon Sequestration (RECS) symposium, Albuquerque, New Mexico, July 20, 2009.
- Broadhead, R.F., 2009, Petroleum geology of the Tukumcari Basin, presented to Albuquerque Geological Society, January 7, 2009.
- Broadhead, R.F., 2008, The natural gas potential of the Raton and Las Vegas Basins, north-central New Mexico, presented to Roswell Geological Society, November 11, 2008.
- Broadhead, R.F., 2008, Core workshop and field trip – examples and analogues for the Tukumcari Basin, given for Shell Oil Company Western U.S. Tight Sands Exploration Team, October 20-22, 2008, Socorro NM.
- Broadhead, R.F., 2008, The geology and uses of helium, presented at Rio Rancho Public Library, October 18, 2008.

Broadhead, R.F., 2008, Remaining oil and gas resources of New Mexico, presented to:

Four Corners Geological Society, September 19, 2008.

Roswell Geological Society, January 15, 2008.

An introduction to petroleum geology, with applications to New Mexico. Presented to Socorro Rotary Club, February 21, 2007.

Helium in New Mexico: Geologic distribution and exploration possibilities. Presented at Albuquerque Geological Society luncheon, February 7, 2007.

Underdeveloped oil fields in Upper Pennsylvanian and Lower Permian carbonate reservoirs of southeastern New Mexico: Initial development missed major reserves. Presented to American Association of Petroleum Geologists, 2006 Annual Convention, Houston TX, April 12, 2006.

Oil, natural gas and helium potential of Chupadera Mesa area. Presented to Roswell Geological Society, September 12, 2006.

Helium in New Mexico: geologic distribution and exploration possibilities, presented to:

Tulsa Geological Society, October 10, 2006.

Roswell Geological Society, Roswell NM, November 8, 2005.

Exploration possibilities for helium in New Mexico with emphasis on Socorro County. Presented to Socorro Rotary Club, December 7, 2005

Evaluation of potential for oil & gas inside Secretary's potash area. Presented to U.S. Bureau of Land Management Resource Advisory Committee, Socorro NM, September 22, 2005.

Remaining oil and natural gas resources of New Mexico, presented to:

Albuquerque Geological Society, Albuquerque NM, June 1, 2005

City Different Petroleum Club, Santa Fe NM, February 23, 2005.

Petroleum source rocks and structure of the Tucumcari Basin, east-central New Mexico. Presented to Tulsa Geological Society, Tulsa OK, May 24, 2005.

Oil, natural gas, and helium potential of Chupadera Mesa, central New Mexico. Presented to Midland, TX Chapter of the Society of Professional Earth Scientists, Midland TX, May 18, 2005.

Underdeveloped oil fields in Upper Pennsylvanian and Lower Wolfcampian carbonates of southeast New Mexico, presented to:

Mid-Continent Section Meeting of American Association of Petroleum Geologists, Wichita, Kansas, August 29, 1999.

Southwest Section Meeting of American Association of Petroleum Geologists, Abilene, Texas, March 2, 1999.

Albuquerque Geological Society, September 1997.

Petroleum source rocks in late Paleozoic elevator basins: the Tucumcari, Estancia, Vaughn, and Carrizozo Basins, presented to:

Four Corners Geological Society, Farmington, New Mexico, January 22, 1999.

Roswell Geological Society, Roswell, New Mexico, January 12, 1999.

Permian Basin Section SEPM, Midland, Texas, December 1998.

Petroleum geology of Tucumcari Basin, east-central New Mexico presented to Albuquerque Geological Society, November 1998.

Petroleum geology of Estancia Basin presented to Santa Fe Geological Society, February 1998.

Underdeveloped oil fields in the Upper Pennsylvanian and Lower Wolfcampian of southeast New Mexico presented to Albuquerque Geological Society, September 1997.

Petroleum Geology of Estancia Basin, New Mexico presented to Roswell Geological Society, March 1996.

Geology of Bravo dome carbon dioxide gas field: presented to:

American Association of Petroleum Geologists, Annual Meeting, April 1991

Roswell Geological Society, Roswell, NM, October 1991

West Texas Geological Society, Midland, TX, July 1992.

Petroleum geology of Pennsylvanian and Lower Permian strata, Tucumcari Basin: presented to: Rocky Mountain Association of Geologists, Denver, CO, September 1987

West Texas Geological Society, Midland, TX, March 1989

Roswell Geological Society, Roswell, NM, April 1989

Albuquerque Geological Society, Albuquerque, NM, June 1989.

Abo sands in subsurface, southeast New Mexico: presented to:

Permian Basin Section SEPM, Midland, TX, March 1985

Albuquerque Geological Society, Albuquerque, NM, June 1985.

SELECTED PUBLICATIONS:

Zhang, Y., Edel, S., Pepin, J., Person, M., **Broadhead, R.**, Stone, W., Bilek, S., Mozley, P., and Evans, J., in press, Exploring the potential linkages between oil-field brine reinjection, crystalline basement permeability, and triggered seismicity for the Dagger Draw oil field, southeastern New Mexico, USA using hydrologic modeling: Geofluids journal.

SELECTED PUBLICATIONS (continued):

- Edel, S., Bilek, S, and **Broadhead, R.** 2016, Earthquake Relocation in SE New Mexico, USA: Possible Induced Seismicity in the Area of the Waste Isolation Pilot Plant (WIPP) Site, Bulletin of the Seismological Society of America (submitted).
- Broadhead, R.F., 2015, The Upper Mancos Shale in the San Juan Basin: Three plays, conventional and unconventional: American Association of Petroleum Geologists, Search and Discovery, Document No. 10791, 39 p.
- Broadhead, R.F., 2015, Petroleum geology of the Las Vegas Basin: an overview, *in* Lindline, J., Petronis, M., and Zebrowski, J., eds., Geology of the Las Vegas region: New Mexico Geological Society, Guidebook 66, p. 253-260.
- Broadhead, R.F., 2012, Hydrocarbon-water and CO₂-water systems in the pre-Cretaceous section in the New Mexico part of the Raton Basin: *The Mountain Geologist*, v. 49, no. 2, p. 55-74.
- Broadhead, R.F., 2010, The Woodford Shale in southeastern New Mexico: distribution and source rock characteristics: *New Mexico Geology*, v 32 no 3, p. 79-90.
- Broadhead, R.F., 2009, Mississippian strata of southeastern New Mexico: distribution, structure, and hydrocarbon plays: *New Mexico Geology*, v 31 no 3, p. 65-76.
- Broadhead, R.F., Mansell, M., and Jones, G., 2009, Carbon dioxide in New Mexico: Geologic distribution of natural occurrences: New Mexico Bureau of Geology and Mineral Resources, Open file report 514, 131 p., 20 plates, 1 database, CD-ROM.
- Broadhead, R., 2009, Oil and natural gas potential of the Albuquerque Basin, *in* Price, L.G., Bland, D., Johnson, P.S., and Connell, S.D., eds., Water, natural resources, and the urban landscape, The Albuquerque region: New Mexico Bureau of Geology and Mineral Resources, Decision Makers Field Conference 2009, p. 80-86.
- Broadhead, R.F., 2008, The natural gas potential of the Raton and Las Vegas Basins, Colfax and Mora Counties, north-central New Mexico, *in* Bowden, C.E., Raines, M.A., and Hinterlong, G.D., *The Permian Basin: Geological models to the world: West Texas Geological Society, Publication 08-120 (CD-ROM)*, paper is 45 pages.
- Broadhead, R.F., 2008, The natural gas potential of north-central New Mexico: Colfax, Mora and Taos Counties: New Mexico Bureau of Geology and Mineral Resources, Open file report 510, CD-ROM.
- Broadhead, R.F., 2008, Interpretive stratigraphic contouring, *in* Leetaru, H., (ed.), AAPG Teaching sets in petroleum geology: American Association of Petroleum Geologists: AAPG Datapages, CD-ROM.
- Broadhead, R.F., and Gillard, L., 2007, The Barnett Shale in southeastern New Mexico: Distribution, thickness, and source rock characterization: New Mexico Bureau of Geology and Mineral Resources, Open file report 502, CD-ROM.
- Broadhead, R.F., 2006, Mississippian strata of southeastern New Mexico: Distribution, structure and hydrocarbon plays, *in* Raines, M.A., ed., Resource plays in the Permian Basin: Resources to reserves: West Texas Geological Society, Publication 06-117, p. 12-28.
- Broadhead, R.F., 2006, Mississippian strata in southeastern New Mexico, including the Barnett Shale: Thickness, structure and hydrocarbon plays: New Mexico Bureau of Geology and Mineral Resources, Open file report 497, CD-ROM.
- Broadhead, R.F., 2005, Helium in New Mexico – geologic distribution, resource demand, and exploration possibilities: *New Mexico Geology*, v. 27, no. 4, p. 93-101.
- Broadhead, R.F., 2005, Helium in New Mexico: Geologic distribution and exploration possibilities, *in* Lufholm, P.H., and Cox, D., eds., Unconventional reservoirs technology and strategies – alternate perspectives for the Permian Basin: West Texas Geological Society, Publication 05-115, p. 85-98.
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