

Oil and gas activities in New Mexico in 1998

by Ronald F. Broadhead, New Mexico Bureau of Mines and Mineral Resources, NMIMT, Socorro, NM 87801

Introduction

Drilling for oil and natural gas in New Mexico increased slightly in 1998. A total of 1,604 wells were completed in 1998, an increase of 2.7% from the 1,562 wells completed in 1997. In the Permian Basin, southeast New Mexico, 959 wells were

completed in 1998, down from 1,086 wells completed in 1997. In the San Juan Basin, northwest New Mexico, 642 wells were completed in 1998, up from the 474 wells completed during 1997.

During 1998, there was significant exploratory activity in the producing Permian and San Juan Basins. There was

also significant exploratory activity in presently nonproductive frontier areas such as the Albuquerque-Belen Basin, the Tucumcari Basin, the Pedregosa Basin, the Tularosa Basin, and in the Carrizozo Basin of eastern Socorro and western Lincoln Counties. Rank wildcat wells were drilled in the San Juan Basin and Tularosa Basin-Otero platform area. Other exploratory activities such as seismic data acquisition and leasing continued into 1998 and 1999 in these areas. Exploration and drilling continued in the emergent CO₂ exploration play of Catron County, New Mexico, and adjacent areas of Arizona.

The locations of significant exploratory wells completed in 1998 are shown in Fig. 1. Table 1 summarizes the significant exploratory discoveries, and Table 2 summarizes significant, but unsuccessful, exploratory wells. Table 3 lists significant exploratory wells that were being drilled at the end of 1998 or were scheduled to be drilled in 1999. Each well is designated by a number in parentheses that refers to its location in Fig. 1 and its description in Tables 1, 2, or 3.

Permian Basin, southeast New Mexico

Drilling activity decreased in 1998 in the three geologic subdivisions of the Permian Basin: the Delaware Basin, the Central Basin platform, and the Northwest shelf; 959 wells were completed in this area in

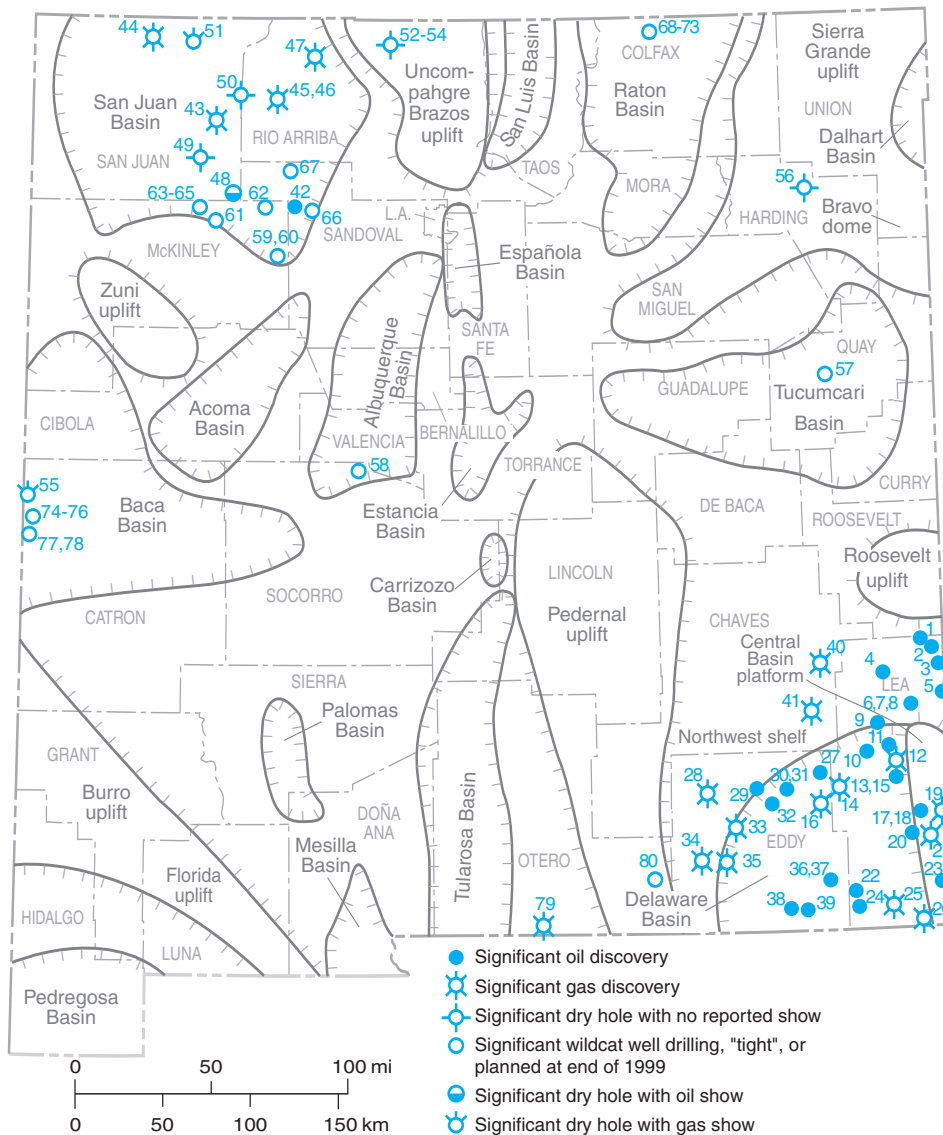


FIGURE 1—Significant oil and gas discoveries, dry holes, and frontier wildcat wells drilled in New Mexico in 1998. Major geologic features are from Broadhead and King (1988), Cather and Johnson (1984), Kelley (1978), Kottowski and Stewart (1970), Meyer (1966), Molenaar (1977), Thompson and Jacka (1981), and Woodward et al. (1978).

Also in this issue

Upcoming meetings	p. 93
Bureau has new director	p. 94
Los Medaños Member	
of the Rustler Formation	p. 97
NMGS 2000 Spring Meeting	p. 103
Juan Tabó area, Albuquerque	p. 104
NMGS 2000 Fall Field Trip	p. 111
Service/News	p. 112
Index to Volume 21	p. 114
NMG subscription information	p. 115

Coming soon

Late Jurassic ammonites
Pancho Villa State Park

1998, a decrease of 12% from the 1,086 wells completed during 1997; 672 of these wells were completed as oil producers, 187 were completed as gas producers, and 100 were dry and abandoned, resulting in a success rate of 90%. In addition, 50 other wells were drilled in southeast New Mexico in 1998; these other wells include injection wells for waterfloods, salt-water disposal wells, and wells that were junked and abandoned before reaching their primary objective. Drilling activity was concentrated in Permian reservoirs on the Northwest shelf and Central Basin platform and in the Delaware Basin.

Drilling activity softened markedly in the last half of 1998 because of low oil prices. Many operators sold their oil for less than \$10 per barrel during the last half of the year. These prices made financing of new oil wells extremely difficult for most operators. When feasible, operators switched activities to gas exploration and development.

Upper Guadalupian reservoirs

Shallow (2,000–4,000 ft) oil and associated gas reservoirs of the Yates and Queen Formations (Permian: upper Guadalupian) were major targets of development drilling in 1998. Approximately 60 wells were completed in these zones. Drilling was primarily for development in mature fields on the Central Basin platform in Lea County. Activity was widespread, with wells drilled in 17 pools. Significant numbers of development wells were completed in Yates and Queen reservoirs in the Jalmat and Eumont pools of Lea County. One significant wildcat discovery was made in Guadalupian reservoirs. Gas was discovered in the Seven Rivers Formation in the Conoco No. 127 Warren Unit (19) in Lea County.

San Andres and Grayburg reservoirs

Oil and associated gas reservoirs in the shallow (2,000–5,000 ft) San Andres and Grayburg Formations (Permian: lower Guadalupian) were primary targets of development drilling in 1998. Approximately 190 wells were completed in these zones. Drilling was primarily for development of mature fields on the southern part of the Northwest shelf in northern Eddy and Lea Counties. Activity was widespread with wells drilled in 28 pools. Major development took place in the Red Lake pool of northern Eddy County where 41 producing wells were drilled. Significant development drilling also took place in the Artesia pool of Eddy County where 37 wells were completed successfully and in the Grayburg–Jackson pool of Eddy County where 26 wells were completed successfully. Significant development also took place in the Maljamar and Eunice–Monument pools of Lea County;

seven waterflood injection wells were drilled in the Eunice–Monument pool. Although exploration along the mature San Andres and Grayburg trends was limited, two significant discoveries were made. The Santa Fe Energy No. 1 Humble Hume 5 State (10) discovered oil in the San Andres Formation in central Lea County, and the Texaco No. 16 Henderson (21) discovered gas in the San Andres in southeast Lea County.

Delaware Mountain Group sandstones

Basinal sandstone reservoirs of the Delaware Mountain Group (Permian: Guadalupian) continued to be one of the more active plays in southeast New Mexico, but low oil prices resulted in decreased drilling activity compared to previous years. During 1998, 105 wells were drilled in search of oil in these reservoirs in the Delaware Basin. Depth to production typically ranges from 5,000 to 8,000 ft, but can be as shallow as 2,000 ft in the northern part of the Delaware Basin. Exploration was less active than in previous years, with only six exploratory wells drilled, three of which were discoveries. Development was mostly by infill drilling and conservative stepouts from known production; the development success rate of Delaware reservoirs was 95% in 1998. Development wells were drilled in 34 oil pools. The Red Tank West and Livingston Ridge South pools were the most intensely developed Delaware reservoirs in 1998. As in the past few years, most of the drilling was for oil in the Brushy Canyon Formation, the lowermost of the three sandstone-bearing formations that constitute the Delaware.

Three significant discoveries of oil in the Delaware were made during 1998. Oil was discovered in Delaware sandstones in the Texaco No. 1 Cotton Draw 9L Federal (24), in the Pogo No. 1 FNR 26 Federal (36), and in the Santa Fe Energy No. 1 Chaparral 10 well (38).

Bone Spring basinal sediments

Basinal allochthonous carbonates and sandstones of the moderately deep (6,000–10,000 ft) Bone Spring Formation (Permian: Leonardian) were sparsely drilled in 1998. Approximately 20 wells were drilled for oil and gas in these reservoirs within the Delaware Basin. The Bone Spring play has been relatively inactive for the past few years as shallower targets in the Delaware Mountain Group were given preference for exploration and development drilling. Development wells were drilled in 14 oil pools in eastern Eddy and western Lea Counties. Exploration for hydrocarbons in Bone Spring reservoirs surged in 1994, and this exploratory activity has continued through 1998. Two discoveries were made

in Bone Spring reservoirs in 1998. Oil was discovered in the Enron No. 1 Duggan 12 Federal well (31) in the northern part of the Bone Spring play where production is obtained mostly from basinal allochthonous carbonates. Oil was also discovered along the southern margin of the Bone Spring play in the Sonat Exploration No. 1 Lotos 10 Federal (37) where production is obtained mostly from allochthonous basinal sandstones.

Yeso shelf sediments

Shallow shelf carbonate reservoirs of the Yeso Formation (Permian: Leonardian) were primary targets in 1998 with 188 development wells drilled in 40 pools. Most activity was on the Central Basin platform in southern Lea County, but there was also some minor development of oil pools astride the shelf edge in southern Eddy County. Production is obtained from all four carbonate members of the Yeso (descending): Paddock, Blinebry, Tubb, and Drinkard members. In many of

New Mexico GEOLOGY

• Science and Service

ISSN 0196-948X

Volume 21, No. 4, November
1999

Editors: Jane C. Love, Nancy S. Gilson
Cartographers: Kathryn E. Glesener,
Sandra H. Azevedo

EDITORIAL BOARD

Steve M. Cather, NMBMMR, Chairman
Thomas Giordano, NMSU
Laurel B. Goodwin, NMIMT

Published quarterly by
New Mexico Bureau of Mines and
Mineral Resources
a division of New Mexico Institute of
Mining and Technology

BOARD OF REGENTS

Ex-Officio
Gary Johnson, Governor of New Mexico
Michael S. Davis, Superintendent of Public Instruction
Appointed
Robert E. Taylor, Pres., 1997–2003, Silver City
Randall E. Horn, Sec/Treas., 1997–2003, Albuquerque
Ann Murphy Daily, 1999–2004, Santa Fe
Sidney M. Gutierrez, 1997–2001, Albuquerque
Kathryn E. Wavrik, Student Mem., 1999–2000, Socorro

New Mexico Institute of Mining and Technology
President Daniel H. López

New Mexico Bureau of Mines and Mineral Resources
Director and State Geologist Peter A. Scholle

Subscriptions: Issued quarterly, February, May, August,
November; subscription price \$10.00/calendar year.

Editorial Matter: Articles submitted for publication
should be in the editor's hands a minimum of five (5)
months before date of publication (February, May,
August, or November) and should be no longer than
20 typewritten, double-spaced pages. All scientific
papers will be reviewed by at least two people in the
appropriate field of study. Address inquiries to Jane C.
Love, Editor of *New Mexico Geology*, New Mexico
Bureau of Mines and Mineral Resources, Socorro, New
Mexico 87801-4796.

Published as public domain, therefore reproducible without
permission. Source credit requested.

the pools, production from two or all three of these zones is commingled. In some pools, Yeso production is commingled with oil production from underlying Abo (Permian: Wolfcampian) carbonates. Pools with the most drilling activity in 1998 were the Eunice North and Blinebry pools of southeast Lea County, which produce from the Blinebry, Tubb, and Drinkard members, and the Empire East and Loco Hills pools of Eddy County, which produce primarily from the Paddock. Oil was discovered in the Yeso in the Marbob Energy No. 1 Cedar Lake Federal well (27) and in the Arco Permian No. 1 Red Lake 3 Federal well (29). Both of these discoveries are located along the western part of the Yeso trend where Yeso production is sparse.

Abo sandstone and carbonate reservoirs

Development of sandstone reservoirs in the Pecos Slope and Pecos Slope West gas pools was subdued in 1998 with only four development wells completed in these "tight" gas reservoirs. There was somewhat more aggressive development of oil-bearing Abo carbonate reservoirs on the Northwest shelf and on the Central Basin platform with 67 wells drilled in 22 reservoirs. Activity was concentrated in the Monument, Monument North, Wantz, and Vacuum pools of central Lea County where 42 development wells were successfully completed. Exploration for hydrocarbons in Abo reservoirs surged in 1998. One significant discovery was made in Abo shelf-margin carbonate reservoirs along the southern part of the Northwest shelf (15). Two significant discoveries (4, 40) were made on the Northwest shelf where Abo production is widely scattered from this relatively sparsely drilled area. Three discoveries (17, 18, 20) were made on the Central Basin platform in east-central Lea County where the Abo play is mature.

Wolfcamp carbonates

Moderately deep (9,000–11,000 ft) carbonate reservoirs in the Wolfcamp Group (Permian: Wolfcampian) were developed at a limited rate in 1998. Fourteen development oil wells and 14 development gas wells were completed successfully in 19 pools in northern and central Eddy County and in southern and central Lea County. Exploration for Wolfcamp hydrocarbons resulted in three significant exploratory discoveries during 1998. In Eddy County, oil was discovered in the Wolfcamp in the Burlington Resources No. 1 Corral Draw 9 Federal (39). In Lea County, oil was discovered in the Wolfcamp in the Cobra Oil and Gas No. 1 State 19 (22) and in the Burlington Resources No. 2 Pitchfork 4 Federal (25).

Upper Pennsylvanian carbonates

Moderately deep (7,000–10,000 ft) Cisco and Canyon (Upper Pennsylvanian) carbonate reservoirs continued to be developed in 1998 but at a slower rate than in previous years. Fifty-four development wells were successfully completed in 19 reservoirs. Activity was concentrated in the Dagger Draw North and Travis pools where 20 development wells were successfully completed. There were five significant exploratory oil discoveries in Upper Pennsylvanian carbonates during 1998 (6, 7, 8, 13, 32) and one significant gas discovery (34).

Strawn reservoirs

Development of moderately deep (10,000–12,000 ft) Strawn (Middle Pennsylvanian) reservoirs continued at a slow but steady pace in 1998. Development of existing reservoirs was moderately slow, with 26 development wells successfully completed in 12 pools. Exploration for oil and gas in Strawn carbonate reservoirs was also subdued. Nevertheless, one discovery was made. Gas was discovered in the Strawn in the Yates No. 1 Spring ART Federal (33) in central Eddy County.

Atoka and Morrow "deep gas" reservoirs

The deep (10,000–14,000 ft) gas reservoirs in the Atoka and Morrow Groups (Lower Pennsylvanian) saw increased development in 1998. Nine development gas wells and two development oil wells were successfully completed in 12 Atoka reservoirs, and 82 development gas wells were successfully completed in 45 Morrow gas reservoirs. Drilling activity was widespread and evenly distributed among these gas pools. Exploratory drilling also increased over previous years, and several discoveries were made. Exploration for gas in Morrow reservoirs resulted in three discoveries (16, 35, 41), and exploration for gas in the shallower Atoka reservoirs resulted in four discoveries (11, 12, 14, 28). Although the Atoka produces gas throughout most of southeast New Mexico, an oil play of modest size has emerged from the Atoka during the past few years in northern Lea County; one significant oil discovery (9) was made in the Atoka in this play during 1998.

Devonian, Silurian, and Ordovician reservoirs

Exploration for oil in seismically defined structural traps in the lower Paleozoic section was strong on the Central Basin platform and on the Northwest shelf. Many traps in the lower Paleozoic are formed by relatively small anticlinal and fault-bounded anticlinal closures. Four exploratory oil discoveries were made in

Devonian reservoirs in northern Lea County (1, 2, 3, 5), and one gas discovery was made in southern Lea County (26). In addition, oil was discovered in Fusselman dolostones (Silurian) in the Texaco No. 6 United Royalty A (23) in southern Lea County. Exploration for structural traps in the Devonian, Silurian, and Ordovician sections is expected to remain strong through 1999. Better definition of the relatively small structures that form traps in the lower Paleozoic has been made possible by 3-D seismic techniques, although this relatively new technology has not yet been fully utilized to define such factors as seal integrity or migration pathways. These factors are apparently important when considering entrapment of hydrocarbons in the lower Paleozoic section on the Northwest shelf.

Tularosa Basin area, south-central New Mexico

In the Otero platform area, east of the Tularosa Basin of south-central New Mexico, the Harvey E. Yates No. 1Y Bennett Ranch well (79) was drilled to a reported total depth of 7,100 ft in 1987. Although most information concerning the well is confidential, the well is a gas discovery that flowed 4,400 MCFD (thousand ft³ gas per day) from an interval within the Mississippian section. Subsequent to the drilling of the Bennett Ranch well, more than 51,000 acres of state trust land were leased in south-central Otero County during the June lease sale. Burlington Resources acquired more than 31,000 acres of these leases. Other successful bidders included Michael Shearn, Doug Schutz, Daniel Gonzales, Ted Ferguson, Harvey E. Yates Co., Yates Petroleum Corp., Hat Ranch, David Petroleum, the Blanco Co., and Perry & Perry, Inc. Although commercial production has not been established from the Tularosa Basin area, exploratory wells drilled in the area have encountered promising shows of oil and gas. King and Harder (1985) discussed the petroleum geology of this region.

East of the Tularosa Basin area in south-east Otero County, a lease play emerged during 1997 in an area approximately 20 mi east of the Bennett Ranch well. The Presco No. 1 Indian Creek Federal (80) is scheduled to be drilled to a total depth of 4,000 ft to test the Abo Formation (Permian) as part of this play.

San Juan Basin, northwest New Mexico

Drilling activity increased during 1998 in the San Juan Basin. There were 642 completions during the year, an increase of 35% from the 474 completions in 1997. The success rate was 98%, with 623 wells completed as gas producers, seven wells com-

TABLE 1—Significant wildcat discoveries in New Mexico in 1998; the term formation is used in an informal sense. **BOPD**, bbls oil per day; **BCPD**, bbls condensate per day; **MCFD**, thousand ft³ gas per day; **BWPD**, bbls water per day; **IP**, initial potential; **IPP**, initial potential pumping; **IPF**, initial potential flowing; **owwo**, old well worked over; **owdev**, old well reentered and deviated.

No. on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Completion date (mo/yr)	Total depth (ft)	Formation at total depth	Producing formation	Producing interval (ft)	Initial potential	Oil gravity (degrees API)
1	1-9S-36E, Lea	Layton Enterprises No. 2 El Zorro G Federal	Jan. 98	12,369	Devonian	Devonian	12,345–12,369	IPP 186 BOPD	45
2	31-9S-37E, Lea	Marbob Energy No. 1 Lewis	May 98	12,505	Devonian	Devonian	12,460–12,505	IPF 225 BOPD	
3	25-10S-37E, Lea	UMC Petroleum No. 1 Hood State	Mar. 98	12,180	Devonian	Devonian	11,986–12,024	IPP 360 BOPD + 327 BWPD	
4	6-11S-35E, Lea	Manzano Oil No. 1 Snake Eyes State (owwo)	Apr. 98	13,447	Devonian	Abo (Permian)	9,086–9,114	IPF 75 BOPD + 60 MCFD	44
5	27-12S-38E, Lea	Charles B. Gillespie No. 1 Hodge	Jan. 98	12,138	Devonian	Devonian	12,133–12,138	IPF 140 BOPD	43
6	5-13S-36E, Lea	Saba Energy No. 1 Guye Fern	Dec. 98	11,220	Upper Pennsylvanian	Upper Pennsylvanian	10,932–11,128	IP 1 BOPD + 95 BWPD	
7	7-13S-36E, Lea	Saba Energy No. 1 Saba State (owwo)	Feb. 98	14,031	Upper Pennsylvanian	Upper Pennsylvanian	10,652–10,670	IPF 320 BOPD + 350 MCFD	45
8	8-13S-36E, Lea	Saba Energy No. 1 Morris	Oct. 98	11,240	Upper Pennsylvanian	Upper Pennsylvanian	10,695–10,710	IPP 201 BOPD + 314 MCFD + 57 BWPD	
9	27-14S-34E, Lea	Aspen Exploration No. 1 Aspen 27 State (owdev)	May 98	12,730	Atoka (Pennsylvanian)	Atoka (Pennsylvanian)	12,422–12,427	IPF 30 BOPD + 392 MCFD + 22 BWPD	44
10	5-16S-34E, Lea	Santa Fe Energy No. 1 Humble Hume 5 State (owwo)	Mar. 98	13,010	Mississippian	San Andres (Permian)	4,984–5,040	IPP 5 BOPD	34
11	10-16S-35E, Lea	Yates Petroleum No. 1 Big Flat ASN State	Sep. 98	12,500	Mississippian	Atoka (Pennsylvanian)	11,892–11,903	IPF 66 BOPD + 3,373 MCFD + 4 BWPD	
12	23-16S-35E, Lea	TMBR/Sharp Drilling No. 2 Eidson 23	Sep. 98	12,010	Mississippian	Atoka (Pennsylvanian)	11,717–11,824	IPF 1,676 MCFD + 75 BCPD + 9 BWPD	53
13	22-17S-35E, Lea	Primero Operating No. 1 State 22 (owwo)	Jan. 98	12,596	Morrow (Pennsylvanian)	Upper Pennsylvanian	10,492–10,509	IPF 59 BOPD + 57 MCFD	
14	28-18S-32E, Lea	Mewbourne Oil No. 1 Querecho 28 Federal	Aug. 98	13,050	Morrow (Pennsylvanian)	Atoka (Pennsylvanian)	12,292–12,306	IPF 1,999 MCFD + 746 BCPD	54
15	7-18S-35E, Lea	Texaco No. 11 State AN	Jan. 98	11,681	Atoka (Pennsylvanian)	Abo (Permian)	8,284–8,806	IPP 150 BOPD + 128 MCFD	
16	19-19S-31E, Eddy	Santa Fe Energy No. 1 Hackberry 19 Federal	Aug. 98	12,400	Morrow (Pennsylvanian)	Morrow (Pennsylvanian)	11,983–11,995	IPF 5 BOPD + 242 MCFD + 73 BWPD	54
17	3-20S-37E, Lea	METEX Oil & Gas No. 1 Cooper	Feb. 98	7,100	Abo (Permian)	Drinkard (Permian); Abo (Permian)	6,735–6,838; 6,995–6,999	IPF 145 BOPD + 3,657 MCFD IPF 2,138 MCFD + 15 BOPD	
18	13-20S-38E, Lea	Collins & Ware No. 1 Pearl (owwo)	May 98	7,851	Abo (Permian)	Abo (Permian)	6,018–7,480	IPP 3 BOPD + 21 BWPD	36
19	28-20S-38E, Lea	Conoco No. 127 Warren Unit (owwo)	Apr. 98	8,784	Abo (Permian)	Seven Rivers (Permian)	3,027–3,066	IPF 1,090 MCFD	
20	19-21S-37E, Lea	Titan Resources No. 4 State DC	Nov. 98	7,200	Abo (Permian)	Abo (Permian)	6,958–7,138	IPP 21 BOPD + 47 MCFD + 32 BWPD	37
21	30-21S-37E, Lea	Texaco No. 16 Henderson	Jan. 98	6,900	Drinkard (Permian)	San Andres (Permian)	4,035–4,103	IPP 85 MCFD + 314 BWPD	
22	19-24S-33E, Lea	Cobra Oil & Gas No. 1 State 19 (owwo)	Jun. 98	15,966	Morrow (Pennsylvanian)	Wolfcamp (Permian)	13,656–13,980	IPF 29 BOPD + 689 MCFD	59
23	19-24S-38E, Lea	Texaco No. 6 United Royalty A	Apr. 98	11,294	Ellenburger (Ordovician)	Fusselman (Silurian)	9,062–9,110	IPP 358 BOPD + 2 MCFD + 451 BWPD	
24	9-25S-32E, Lea	Texaco No. 1 Cotton Draw 9L Federal	Jan. 98	13,578	Wolfcamp (Permian)	Delaware (Permian)	4,684–4,848	IPP 10 BOPD + 10 MCFD + 13 BWPD	39

TABLE 1—continued

No. on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Completion date (mo/yr)	Total depth (ft)	Formation at total depth	Producing formation	Producing interval (ft)	Initial potential	Oil gravity (degrees API)
25	4-25S-34E, Lea	Burlington Resources No. 2 Pitchfork 4 Federal (owdev)	May 98	13,955	Atoka (Pennsylvanian)	Wolfcamp (Permian)	13,546–13,880	IPF 1,398 MCFD + 150 BCPD + 12 BWPD	53
26	17-26S-36E, Lea	Vista Resources No. 1 South Lea Federal (owwo)	Nov. 98	21,240	Precambrian	Devonian	17,755–17,898	IPF 1,565 MCFD	
27	18-17S-31E, Eddy	Marbob Energy No. 1 Cedar Lake Federal	Jul. 98	11,651	Morrow (Pennsylvanian)	Yeso (Permian)	4,697–4,988	IPP 20 BOPD + 1,038 BWPD	
28	16-18S-24E, Eddy	Penwell Energy No. 1 Southern Cross 16 State	Apr. 98	8,580	Morrow (Pennsylvanian)	Atoka (Pennsylvanian)	7,721–7,728	IPF 494 MCFD	
29	3-18S-27E, Eddy	Arco Permian No. 1 Red Lake 3 Federal	Jan. 98	3,645	Yeso (Permian)	Yeso (Permian)	3,044–3,592	IPF 19 BOPD + 18 MCFD + 233 BWPD	42
30	10-18S-29E, Eddy	Yates Petroleum No. 1 Loco ASI Federal	Sep. 98	11,520	Mississippian	Mississippian	11,397–11,409	IPF 16 BOPD + 881 MCFD	
31	12-18S-29E, Eddy	Enron No. 1 Duggan 12 Federal	Apr. 98	11,743	Mississippian	Bone Spring (Permian)	6,809–6,925	IPF 53 BOPD + 138 MCFD + 155 BWPD	42
32	20-19S-28E, Eddy	Marathon No. 1 Lightfoot 20 State	Jul. 98	10,000	Strawn (Pennsylvanian)	Upper Pennsylvanian	9,624–9,724	IPF 25 BOPD + 11 BWPD	
33	23-20S-26E, Eddy	Yates Petroleum No. 1 Spring ART Federal	Oct. 98	10,500	Morrow (Pennsylvanian)	Strawn (Pennsylvanian)	9,280–9,287	IPF 139 MCFD	
34	22-22S-22E, Eddy	Penwell Energy No. 2 Wagon Wheel Federal Unit	Jul. 98	8,180	Strawn (Pennsylvanian)	Canyon (Pennsylvanian)	7,538–7,604	IP 688 MCFD	
35	18-22S-24E, Eddy	Yates Petroleum No. 5 Hickory ALV Federal	Jan. 98	10,520	Morrow (Pennsylvanian)	Morrow (Pennsylvanian)	9,955–10,290	IPF 2,916 MCFD + 7 BCPD + 18 BWPD	
36	26-23S-30E, Eddy	Pogo Producing No. 1 FNR 26 Federal	Dec. 98	10,000	Bone Spring (Permian)	Delaware (Permian)	7,598–7,612	IPP 166 BOPD + 170 MCFD + 260 BWPD	
37	10-24S-31E, Eddy	Sonat Exploration No. 1 Lotos 10 Federal (owwo)	Nov. 98	15,350	Morrow (Pennsylvanian)	Bone Spring (Permian)	11,530–11,548	IPP 47 BOPD + 83 MCFD + 75 BWPD	
38	10-25S-28E, Eddy	Santa Fe Energy No. 1 Chaparral 10	Oct. 98	13,275	Morrow (Pennsylvanian)	Delaware (Permian)	4,776–4,794	IP 62 BOPD + 50 MCFD + 47 BWPD	38
39	9-25S-29E, Eddy	Burlington Resources No. 1 Corral Draw 9 Federal	Oct. 98	12,236	Wolfcamp (Permian)	Wolfcamp (Permian)	11,325–12,194	IPF 47 BOPD + 387 MCFD + 29 BWPD	58
40	34-10S-30E, Chaves	Primero Operating No. 1 Apache Springs Federal	Jun. 98	10,580	Devonian	Abo (Permian)	7,590–7,610	IPF 315 MCFD	
41	22-13S-30E, Chaves	Boyd & McWilliams No. 1 Federal 22 (owdev)	Feb. 98	10,731	Devonian	Morrow (Pennsylvanian)	9,702–9,710	IPF 7 BOPD + 370 MCFD	
42	27-20N-4W, Sandoval	Limark No. 1 Federal 27	Mar. 98	6,100	Entrada (Jurassic)	Entrada (Jurassic)	5,864–5,866	IPP 36 BOPD + 224 BWPD	35
43	10-26N-9W, San Juan	Dugan Production No. 5 Huerfanito	Aug. 98	6,803	Dakota (Cretaceous)	Chacra (Cretaceous)	2,904–3,135	gas	
44	4-31N-12W, San Juan	Burlington Resources No. 12M Newberry	Oct. 98	7,290	Dakota (Cretaceous)	Mancos (Cretaceous)	5,728–5,812	IP 166 MCFD	
45	19-27N-5W, Rio Arriba	Burlington Resources No. 138E San Juan 27-5 Unit	Apr. 98	7,767	Dakota (Cretaceous)	Gallup (Cretaceous)	6,750–7,151	IPF 323 MCFD (commingled w/ Dakota)	
46	20-28N-5W, Rio Arriba	Burlington Resources No. 54E San Juan 28-5 Unit	May 98	7,961	Dakota (Cretaceous)	Gallup (Cretaceous)	6,912–7,333	IPF 492 MCFD (commingled w/ Dakota)	
47	30-30N-3W, Rio Arriba	Mallon Oil No. 10 Jicarilla 464-30	Jul. 98	4,121	Pictured Cliffs (Cretaceous)	San Jose (Tertiary); Nacimiento (Tertiary)	1,683–1,699 2,540–2,636	IPF 1,416 MCFD	

TABLE 2—Significant wildcat dry holes in New Mexico in 1998. D&A, dry and abandoned; TA, temporarily abandoned; J&A, junked and abandoned; perf, perforated; frac, fractured.

No. on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Completion date (mo/yr)	Total depth (ft)	Formation at total depth	Status	Comments
48	20-21N-8W, San Juan	Merrion Oil & Gas No. 5 Santa Fe 20	Sep. 98	5,720	Entrada	D&A	Perf & frac Gallup 3,463–3,744 ft, swabbed oil-cut fluid. Perf Mesaverde 1,288–1,294 ft, 1,572–1,582 ft, 1,852–1,912 ft, no results reported.
49	2-23N-10W, San Juan	Dugan Production No. 5 Wit's End	Jan. 98	1,210	Pictured Cliffs (Cretaceous)	D&A	Perf Pictured Cliffs 1,091–1,097 ft.
50	1-27N-8W, San Juan	Conoco No. 1 Stove Canyon	Jan. 98	13,962	Precambrian	D&A	Drilled to test Pennsylvanian section.
51	8-31N-10W, San Juan	Burlington Resources No. 2 Marcotte	Apr. 98	14,032	Precambrian	TA	Perf Leadville (Mississippian), results "tight"; perf Pennsylvanian (flowed 750 MCFD).
52	24-31N-2E, Rio Arriba	Tom Puff No. 1 Garcia	Jul. 98	460	Dakota (Cretaceous)	J&A	Drilled to test Dakota (Cretaceous).
53	24-31N-2E, Rio Arriba	Tom Puff No. 4 Garcia	Oct. 98	1,010	Dakota (Cretaceous)	D&A	Drilled to test Dakota (Cretaceous).
54	24-31N-2E, Rio Arriba	Thomas Oil & Gas No. 1R Garcia	Dec. 98	506	Dakota (Cretaceous)	D&A	Drilled to test Dakota (Cretaceous).
55	13-2N-21W, Catron	Ridgeway Arizona Oil No. 2–13 State	Mar. 98	2,717	Precambrian	D&A	CO ₂ exploratory test; results confidential.
56	35-21N-29E, Harding	Amoco No. 1 Bueyeros Com.	Jan. 98	5,379	Precambrian	D&A	Deeper zone CO ₂ exploratory test in Bravo Dome field.

pleted as oil producers, and 12 wells plugged and abandoned. An additional two wells were drilled for disposal of produced waters, and four wells were junked and abandoned before their primary objectives could be reached. Drilling concentrated on development of gas reservoirs in the Fruitland coals (Cretaceous), Pictured Cliffs and other Mesaverde sandstones (Cretaceous), and Dakota sandstones (Cretaceous). Exploration for gas in Pennsylvanian carbonates continued with the drilling of two deep wildcat wells.

Tertiary sandstones

Sandstone reservoirs in the San Jose, Nacimiento, and Ojo Alamo Formations (Tertiary) in north-central Rio Arriba County have become the objects of a new gas play within the last 2 yrs. The initial discovery wells were drilled in late 1997, and development continued through 1998 and into 1999. Initially, only sandstones in the Ojo Alamo were pursued, but the play subsequently enlarged to include the San Jose and Nacimiento Formations. In 1998, 31 successful development gas wells were completed in this play. One discovery well was also drilled (47). Depth to productive San Jose sandstones is approximately 1,700 ft in this area, whereas depth to productive Nacimiento sandstones is approximately 2,200 ft, and depth to productive Ojo Alamo sandstones is approximately 3,200 ft. This emerging play has been discussed recently in the Oil and Gas Journal (1998).

Fruitland coalbed-methane reservoirs

Gas reservoirs of the Fruitland Formation (Upper Cretaceous) continued to be aggressively developed in 1998 although at a slower rate than in previous years. Approximately 70 wells were completed in the Fruitland. Most of these wells were drilled in coalbed-methane reservoirs of the giant Basin pool in eastern San Juan County and western Rio Arriba County.

Pictured Cliffs Sandstone

Gas reservoirs in the Pictured Cliffs Sandstone (Upper Cretaceous) were major targets for development drilling in 1998. Approximately 100 wells were completed in these reservoirs. Development drilling was concentrated in the Ballard, Fulcher Kutz, and Kutz West pools of northeast San Juan County and in the Blanco South pool of northwest Rio Arriba County. Exploration for gas in Pictured Cliffs sandstones was subdued in 1998 with most exploratory drilling concentrated on developing and extending previously discovered gas.

Mesaverde sandstones

Development of gas reservoirs in Mesaverde sandstones (Upper Cretaceous) increased markedly during 1998. Approximately 230 development gas wells were completed in Mesaverde sandstones. Almost all of these wells were drilled to increase well density. In most of the wells drilled during 1998, production from the

Mesaverde sandstones is commingled with production from the Pictured Cliffs Sandstone. In 1998, most Mesaverde wells were drilled in the Blanco pool of northeast San Juan and northwest Rio Arriba Counties.

Gallup Sandstone

Oil reservoirs in the Gallup Sandstone (Upper Cretaceous) saw mild development activity during 1998. Eight development wells were completed successfully in seven reservoirs. Two significant exploratory discoveries were made. Gas was discovered in the Gallup in the Burlington Resources No. 138E San Juan 27–5 Unit (45) and in the Burlington Resources No. 54E San Juan 28–5 Unit (46).

Dakota Sandstone

Oil and gas reservoirs in sandstones of the Dakota Sandstone (Upper Cretaceous) were developed aggressively in 1998. One oil well and 164 gas wells were completed in Dakota reservoirs. Drilling was concentrated in the giant Basin pool of northeast San Juan and west Rio Arriba Counties. In many wells, production from the Dakota is commingled with production from Mesaverde and Gallup sandstones (Upper Cretaceous). On the east flank of the basin, three shallow exploratory wells were drilled to test the Dakota and were abandoned without establishing production.

Entrada Sandstone

TABLE 3—Significant wildcat wells being drilled, not completed, “tight,” or scheduled to be drilled at the end of 1998.

No. on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Comments
57	31-10N-30E, Quay	Sonoma Energy No. 1 Briscoe (owwo)	Reentry of Sunray Mid-Continent No. 1 Briscoe, drilled in 1958 to total depth of 9,071 ft. Will test oil shows in Pennsylvanian section below 7,000 ft.
58	28-4N-1E, Socorro	Twining Drilling No. 2 NFT	Scheduled to be drilled to total depth of 8,500 ft in Albuquerque Basin to test Santa Fe Group (Tertiary).
59	10-17N-5W, McKinley	Petrosun No. 1 Red Dog Federal	Scheduled to be drilled to 4,600 ft to test Entrada (Jurassic).
60	33-18N-5W, McKinley	Tiger Exploration No. 1 Cholla Federal	Scheduled to be drilled to 4,800 ft to test Entrada (Jurassic).
61	6-19N-9W, McKinley	Limark Corp. No. 1 Navajo 6	Scheduled to be drilled to 5,200 ft to test Entrada (Jurassic).
62	13-20N-6W, McKinley	Merrion Oil & Gas No. 2 Chaco Wash	Scheduled to be drilled to 6,050 ft to test Entrada (Jurassic).
63	7-20N-10W, McKinley	Synergy Operating No. 1 Fajada Wash 7	Scheduled to be drilled to 5,200 ft to test Entrada (Jurassic).
64	7-20N-10W, McKinley	Synergy Operating No. 2 Fajada Wash 7	Scheduled to be drilled to 5,200 ft to test Entrada (Jurassic).
65	2-20N-11W, McKinley	Synergy Operating No. 1 Fajada State 2	Scheduled to be drilled to 5,100 ft to test Entrada (Jurassic).
66	26-20N-3W, Sandoval	High Plains Petroleum No. 1 Fork Rock	Drilled to total depth of 2,804 ft to test Mesaverde (Cretaceous).
67	8-22N-4W, Sandoval	Mallon Oil No. 3 Jicarilla	Scheduled to be drilled to 6,500 ft to Morrison Formation (Jurassic).
68	1-31N-19E, Colfax	Pennzoil No. 11B VPR-Canadian River	Scheduled to be drilled to total depth of 2,300 ft in Vermejo Formation (Cretaceous). Coalbed-methane test.
69	6-31N-20E, Colfax	Pennzoil No. 62C VPR-Canadian River	Scheduled to be drilled to total depth of 2,300 ft in Vermejo Formation (Cretaceous). Coalbed-methane test.
70	36-32N-19E, Colfax	Pennzoil No. 361J VPR-Canadian River	Scheduled to be drilled to total depth of 2,300 ft in Vermejo Formation (Cretaceous). Coalbed-methane test.
71	36-32N-19E, Colfax	Pennzoil No. 362H VPR-Canadian River	Scheduled to be drilled to total depth of 2,300 ft in Vermejo Formation (Cretaceous). Coalbed-methane test.
72	31-32N-20E, Colfax	Pennzoil No. 311K VPR-Canadian River	Scheduled to be drilled to total depth of 2,300 ft in Vermejo Formation (Cretaceous). Coalbed-methane test.
73	31-32N-30E, Colfax	Pennzoil No. 312E VPR-Canadian River	Scheduled to be drilled to total depth of 2,300 ft in Vermejo Formation (Cretaceous). Coalbed-methane test.
74	16-1N-20W, Catron	Ridgeway Arizona Oil No. 1 North State 16	Drilled to 2,959 ft. CO ₂ exploratory well.
75	4-1N-21W, Catron	Ridgeway Arizona Oil No. 1 State 1-4	Drilled to 2,540 ft. CO ₂ exploratory well.
76	36-1N-21W, Catron	Ridgeway Arizona Oil No. 2 State North 36	Drilled to 3,968 ft. CO ₂ exploratory well. Horizontal well.
77	16-1S-21W, Catron	Ridgeway Arizona Oil No. 1 State 1-16	Drilled to 2,861 ft. CO ₂ exploratory well.
78	36-1S-21W, Catron	Ridgeway Arizona Oil No. 1 South State 36	Drilled to 3,173 ft. CO ₂ exploratory well.
79	14-26S-12E, Otero	Harvey E. Yates No. 1Y Bennett Ranch	Drilled to total depth of 7,100 ft. Gas discovery flowed 4,400 MCFD from interval within the Mississippian section.
80	14-23S-20E, Otero	Presco No. 1 Indian Creek Federal	Scheduled to be drilled to 4,000 ft to test Abo Formation (Permian).

Exploration for oil reservoirs in the Entrada Sandstone (Jurassic) in northwest New Mexico continued during 1998. Oil was discovered in the Entrada in the Limark No. 1 Federal 27 well (42). The Merrion Oil and Gas No. 5 Santa Fe 20 well (48) was drilled to a total depth of

5,720 ft to test the Entrada but was abandoned without establishing production. In the southern part of the San Juan Basin, eight wells (59–65, 67) are scheduled to be drilled to test the Entrada in 1999.

Pennsylvanian carbonates

Exploration for hydrocarbons in Pennsylvanian carbonate reservoirs was resurgent during 1997, and exploratory activity continued into 1998 and 1999. Although modest production of oil and gas is obtained from Pennsylvanian reservoirs on the western flank of the San Juan Basin,

the Pennsylvanian section has been tested by relatively few wells throughout most of the basin and remains a promising exploratory target. Five extension and development gas wells were successfully completed in the Barker Dome field of northwest San Juan County. Burlington Resources and Conoco have cooperative ongoing exploratory programs targeted at Pennsylvanian reservoirs in the deeper, poorly tested parts of the basin. The Burlington Resources No. 2 Marcotte well (51) was drilled in the north-central part of the basin to a depth of 14,032 ft to test Pennsylvanian and Mississippian reservoirs. An interval of unreported depth in the Pennsylvanian section was perforated and flowed gas at a rate of 750 MCFD. Carbon dioxide gas was reportedly recovered during a production test of the Leadville Limestone (Mississippian), although the exact composition of the gas remains confidential. A second exploratory well (50) was spudded by Conoco late in 1997 and completed in 1998 in the central part of the basin. Burlington and Conoco have indicated that they will continue with their exploration program.

Albuquerque Basin

Exploratory efforts continued in the Albuquerque-Belen Basin of central New Mexico. Twining Drilling announced that it will drill its second exploratory well in 3 yrs within the basin. The Twining No. 2 NFT well (58) is scheduled to be drilled to a total depth 8,500 ft in the southernmost part of the basin to test the Santa Fe Group (Tertiary).

Exploratory interest in the Albuquerque Basin has been intermittent. The Burlington No. 1Y Westland Development well is the latest in a series of wells drilled by Burlington, Davis Oil Company, Vastar Resources, and Twining Oil Company over the last 3 yrs. In the early 1980s, Shell and UTEX Oil Company drilled eight wildcat wells in the basin in search of hydrocarbons in the Cretaceous section. During the late 1990s, exploration in the basin was resurgent, and Davis Oil Company drilled two deep wells to test the Cretaceous section, and Twining drilled one deep well to test the Tertiary section in the southern part of the basin. Although production was not established by those wells, significant shows of gas were encountered, and analyses of drilling indicate that the necessary parameters for commercial production are present within the basin. Black (1982, 1989) and Molenaar (1988) summarized the petroleum geology and the history of oil and gas exploration in the Albuquerque Basin.

Northeast New Mexico

Exploratory activity in northeast New Mexico increased during 1998. Devel-

opment of CO₂ resources and exploration for new CO₂ resources in the Bravo Dome area continued. Exploratory activity continued in the Tucumcari Basin as plans were made to reenter and test an abandoned exploratory well. Although no new wells were drilled, additional state lands were leased in the Tucumcari Basin. In early 1999, plans were announced to embark on a large project to explore for and develop coalbed-methane resources in the Raton Basin.

The Bravo Dome carbon dioxide field of Union and Harding Counties saw continued activity in 1998. Thirteen wells were drilled to develop additional carbon dioxide resources in the Tubb sandstone (Permian) within the Bravo Dome field in Union County. The Amoco No. 1 Bueyeros Com. well (56) was drilled in Harding County in search of additional carbon dioxide resources. That well was drilled to a total depth of 5,379 ft. Top of Precambrian was encountered at 2,834 ft, and Precambrian granitic rocks and gabbroic sills were drilled from 2,834 ft to total depth.

In the Tucumcari Basin, Sonoma Energy announced plans to reenter the Sunray Mid-Continent No. 1 Briscoe well (57), which had been drilled in 1958 to a total depth of 9,071 ft. The well will test Pennsylvanian sandstones below 7,000 ft that exhibited oil shows on the mudlog of the original Sunray well. Those shows were not tested by Sunray. During the April 1998 state lease sale, Jim Wilson successfully bid on 1,320 acres of state trust land in Quay County and acquired an additional 640 acres during the July lease sale. Another 640 acres of state trust land in Quay County were leased by Yates Petroleum Corp. during the May lease sale. During the October lease sale, Col. R. B. Rodke successfully bid on 512 acres of state trust land, also located in Quay County. Although commercial production of hydrocarbons has not been obtained from the Tucumcari Basin, marginally commercial discoveries of both oil and gas were made in the early 1980s (Broadhead and King, 1988). Primary objectives in the basin are Pennsylvanian sandstones and limestones and Lower Permian dolostones.

During late 1998, Pennzoil announced plans to drill six coalbed-methane exploratory wells in the Raton Basin (68–73). In early 1999, Pennzoil and Sonat Energy announced plans to jointly explore for and develop coalbed-methane resources in Cretaceous strata of the Raton Basin (Oil and Gas Journal, 1999). Objectives may be coals in both the Raton Formation and the Vermejo Formation at depths between 1,000 and 2,500 ft. There will be at least 35 wells drilled in 1999, and an estimated 600 wells will be drilled in subsequent years. In 1989, Pennzoil had drilled approximately 30 wells as part of a pilot project to evaluate coalbed-methane

resources in the basin. Although the existence of substantial resources was indicated by that project, lack of adequate pipeline facilities and low gas prices prevented development of the resources at that time.

Southwest New Mexico

No petroleum exploration wells were drilled in southwest New Mexico during 1998; however, exploratory work continued in the Carrizozo Basin of eastern Socorro and northwest Lincoln Counties as a follow up to the two wells drilled by Manzano Oil during 1996. One of those wells encountered an excellent gas show in the Atoka (Lower Pennsylvanian) section, and plans were made to reenter that well in 1999.

Ridgeway Arizona Oil Company continued to explore for CO₂ in western Catron County. Six wells (55, 74–78) were drilled or completed during 1998. These wells were drilled to delineate the eastern boundary of a CO₂ field that was discovered in the Holbrook Basin of eastern Arizona during 1994 (Heylman, 1997; Petzet, 1997). The CO₂ is trapped in sandstone reservoirs in the Yeso and Abo Formations (Permian). Although reserves will not be fully defined until all of the wells have been drilled and evaluated, preliminary calculations indicate several trillion ft³ CO₂ may be present (Riggs, 1997). Although no pipeline presently exists to transport the CO₂ to market, construction of a 600-mi pipeline to southern California is being considered (Petzet, 1997); CO₂ transported to California would be used in enhanced oil recovery. Other options may include building a pipeline to transport the CO₂ to the Permian Basin where it could be used in enhanced oil recovery.

ACKNOWLEDGMENTS—Roy Johnson of the New Mexico Oil Conservation Division reviewed the manuscript. Kathy Glesener and Sandy Azevedo drafted the illustration.

References

- Black, B. A., 1982, Oil and gas exploration in the Albuquerque Basin; in Wells, S. G., Grambling, J. A., and Callender, J. F. (eds.), Albuquerque country II: New Mexico Geological Society, Guidebook 33, pp. 313–324.
- Black, B. A., 1989, Recent oil and gas exploration in the northern part of the Albuquerque Basin; in Lorenz, J. C., and Lucas, S. G. (eds.), Energy frontiers in the Rockies: Albuquerque Geological Society, p. 13.
- Broadhead, R. F., and King, W. E., 1988, Petroleum geology of Pennsylvanian and Lower Permian strata, Tucumcari Basin, east-central New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 119, 75 pp.
- Cather, S. M., and Johnson, B. D., 1984, Eocene tectonics and depositional setting of west-central New Mexico and eastern Arizona: New Mexico Bureau of Mines and Mineral Resources, Circular 192, 33 pp.

Heylman, E. B., 1997, Arizona's Holbrook salt basin holds oil, gas opportunities: *Oil and Gas Journal*, v. 95, no. 18, pp. 127-132.

Kelley, V. C., 1978, *Geology of the Española Basin, New Mexico*: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 48, scale 1:125,000.

King, W. E., and Harder, V. M., 1985, Oil and gas potential of the Tularosa Basin-Otero platform-Salt Basin graben area, New Mexico and Texas: New Mexico Bureau of Mines and Mineral Resources, Circular 198, 36 pp.

Kottlowski, F. E., and Stewart, W. J., 1970, The Wolfcampian Joyita uplift in central New Mexico: New Mexico Bureau of Mines and Mineral Resources, Memoir 23, pt. I, pp. 1-31.

Meyer, R. F., 1966, *Geology of Pennsylvanian and Wolfcampian rocks in southeast New Mexico*: New Mexico Bureau of Mines and Mineral Resources, Memoir 17, 123 pp.

Molenaar, C. M., 1977, Stratigraphy and depositional history of Upper Cretaceous rocks of the San Juan Basin area, with a note on economic resources; *in* Fassett, J. E., and James, H. L. (eds.), *San Juan Basin III: New Mexico Geological Society, Guidebook 28*, pp. 159-166.

Molenaar, C. M., 1988, Petroleum geology and hydrocarbon plays of the Albuquerque Basin-San Luis rift basin, New Mexico and Colorado: U.S. Geological Survey, Open-file Report 87-450-S, 26 pp.

Oil and Gas Journal, 1996, Worldwide EOR survey: *Oil and Gas Journal*, v. 94, no. 16, pp. 45-61.

Oil and Gas Journal, 1998, Multiwell Ojo Alamo development advancing in San Juan Basin: *Oil and Gas Journal*, v. 96, no. 17, p. 77.

Oil and Gas Journal, 1999, New Mexico Raton Basin coalbed methane development resumes: *Oil and Gas Journal*, v. 97, no. 17, p. 50.

Petzet, G. A., 1997, Arizona's Holbrook CO₂ area may hold oil, gas reserves: *Oil and Gas Journal*, v. 95, no. 42, pp. 84-85.

Riggs, D., 1997, Development of an Arizona CO₂ field: oral presentation given to CO₂ oil recovery forum, Petroleum Recovery Research Center, New Mexico Institute of Mining and Technology, Oct. 29, 1997.

Thompson, S., III, and Jacka, A. D., 1981, Pennsylvanian stratigraphy, petrography, and petroleum geology of the Big Hatchet Peak section, Hidalgo County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 176, 125 pp.

Woodward, L. A., Callender, J. F., Seager, W. R., Chapin, C. E., Gries, J. C., Shaffer, W. L., and Zilinski, R. E., 1978, Tectonic map of the Rio Grande rift region in New Mexico, Chihuahua, and Texas; *in* Hawley, J. W. (compiler), *Guidebook to Rio Grande rift in New Mexico and Colorado*: New Mexico Bureau of Mines and Mineral Resources, Circular 163, Sheet 2.

Upcoming geologic meetings

Conference title	Dates	Location	Contact for more information
Los Alamos Geological Society Earth Treasures Show	Dec. 4-5, 1999	Los Alamos Inn Los Alamos, NM	Paul Bradley 1666 34th St. Los Alamos, NM 87545
American Water Resources Association (AWRA) 1999 Water Resources Conference	Dec. 5-9	Seattle, WA	AWRA 950 Herndon Pkwy., Ste. 300 Herndon, VA 20170-5531 USA Fax: (703) 904-1228 awrahq@aol.com Web Site: www.awra.org
American Geophysical Union Fall Meeting	Dec. 13-17	San Francisco, CA	AGU Meetings Dept. 2000 Florida Avenue, NW Washington, DC 20009 Phone: (800) 966-2481 Fax: (202) 328-0566 meetinginfo@agu.org
Second Wallace E. Pratt Memorial Conference Pratt II Conference "Petroleum Provinces of the 21st Century"	Jan. 12-15, 2000	San Diego, CA	Fred Dix, Coordinator AAPG Convention Dept. P. O. Box 979 Tulsa, OK 74101-0979 Fax: (800) 281-2283
Ocean Sciences Meeting	Jan. 24-28	San Antonio, TX	AGU Meetings Dept. 2000 Florida Avenue, NW Washington, DC 20009 Phone: (800) 966-2481 Fax: (202) 328-0566 meetinginfo@agu.org
Tucson Gem and Mineral Show	Feb. 10-13	Convention Center Tucson, AZ	Tucson Gem & Mineral Society Phone: (520) 322-5773
Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP 2000)	Feb. 20-24	Arlington, VA	L. Cramer, ExpoMasters 7632 E. Costilla Avenue Englewood, CO 80112 Phone: (303) 771-2000 Fax: (303) 843-6232 lcramer@compuserve.com Web Site: www.sageep.com
Albuquerque Gem & Mineral Club Treasures of the Earth	Mar. 24-26	UNM Continuing Education Center Albuquerque, NM	Linda Kirkpatrick Phone: (505) 892-4929
Remote Sensing and Hydrology	Apr. 2-7	Santa Fe, NM	L. O'Hare, USDA-ARS Hydrology Lab Rm. 104, Bldg. 007, BARC-W, Beltsville, MD 20705 Phone: +1-301-504-7490 lohare@hydrolab.arsusda.gov
New Mexico Geological Society Spring Meeting (see this issue p. 103 for details)	Apr. 7	Macey Center NMIMT Socorro, NM	Nelia Dunbar NMBMMR NMT, 801 Leroy Pl. Socorro, NM 87801 Phone: (505) 835-5783 nelia@nmt.edu
Seismological Society of America 95th Annual Meeting	Apr. 9-12	San Diego, CA	B. Smith Institute of Geophysics and Planetary Physics U.C., La Jolla, CA 92093-0225 Phone: (858) 534-6145 Fax: (858) 534-2902 ssay2k@ucsd.edu
AAPG Annual Meeting and Exhibition	Apr. 16-19	New Orleans, LA	AAPG Convention Dept., convenc@aapg.org
Geology and Ore Deposits 2000: The Great Basin and Beyond	May 15-18	Reno-Sparks, NV	Geological Society of Nevada P.O. Box 12021 Reno, NV 89510 Phone: (775) 323-3500 gsnsymp@nbgm.unr.edu Web Site: www.gsnv.org