

Oil and gas activities in New Mexico in 1999

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 decreased slightly in 1999. A total of 1,539 wells were completed in 1999, a decrease of 4.1% from the 1,604 wells completed in 1998. In the Permian Basin, southeast New Mexico, 768 wells were completed in 1999, down from 959 wells completed in 1998. In the San Juan Basin, northwest New Mexico, 743 wells were completed in 1999, up from the 642 wells completed during 1998.

During 1999, 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 Tucumcari Basin, northeasternmost New Mexico, the Pedregosa Basin, the Tularosa Basin–Otero platform–Salt Basin graben area, and in the Carrizozo Basin of eastern Socorro and western Lincoln Counties. A rank wildcat well was drilled in the San Juan Basin. Other exploratory activities such as seismic data acquisition and leasing continued into 1999 and 2000 in these areas. Resource evaluation 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 1999 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 1999 or were scheduled to be drilled in 2000. 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 1999 in the three geologic subdivisions of the Permian Basin: the Delaware Basin, the Central Basin platform, and the Northwest shelf; 768 wells were completed in this area in 1999, a decrease of 20% from the 959 wells completed during 1998; 448 of these wells were completed as oil producers, 192 were completed as gas producers, and 60 were dry and abandoned, resulting in a success rate of 90%. In addition, 17 other wells were drilled in southeast New Mexico in 1999; 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.

Activity increased in the last half of 1999 because of an increase in oil prices from approximately \$10 per barrel at the beginning of the year to more than \$20 per barrel at the end of the year. Many operators sold their oil for less than \$10 per barrel during 1998 and the beginning of 1999. These prices made financing of new oil wells extremely difficult for most operators. When feasible, many operators switched activities to gas exploration and development. However, with sustained increases in prices at the end of the year and with oil prices increasing to more than \$25 per barrel in early 2000 and gas prices increasing to more than \$3 per thousand ft³ (MCF), many operators have been developing plans for more aggressive 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 significant of development drilling in 1999. Approximately 65 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 13 pools. Significant numbers of

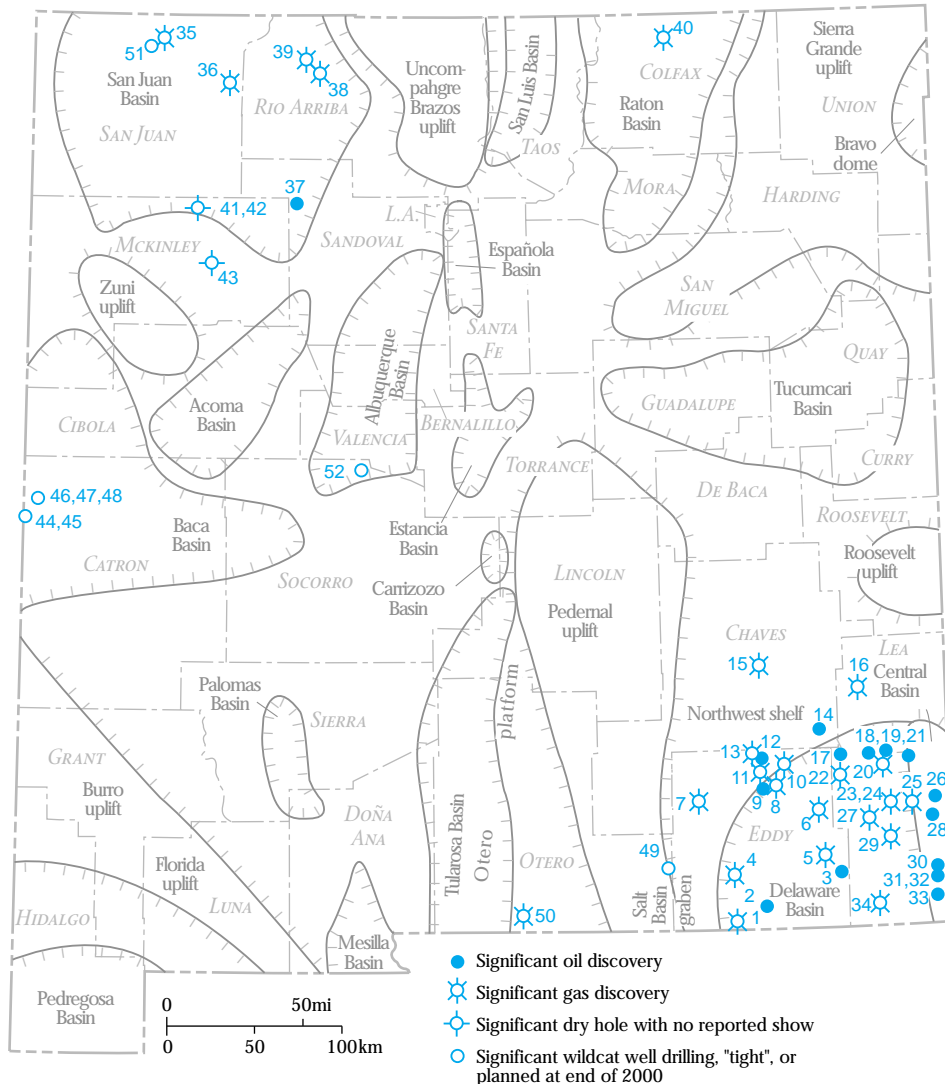


FIGURE 1—Significant oil and gas discoveries, dry holes, and frontier wildcat wells drilled in New Mexico in 1999. Major geologic features are from Broadhead and King (1988), Cather and Johnson (1984), Kelley (1978), Kottlowski and Stewart (1970), Meyer (1966), Molenaar (1977), Thompson and Jacka (1981), and Woodward et al. (1978).

TABLE 1—Significant wildcat discoveries in New Mexico in 1999; the term formation is used in an informal sense. **BOPD**, bbls oil per day; **BCPD**, bbls condensate per day; **MCFGD**, thousand ft³ gas per day; **BWPD**, bbls water per day; **owwo**, old well worked over.

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	23-26S-24E Eddy	Marbob Energy No. 1 Primero Federal	2/99	8,055	Morrow (Pennsylvanian)	Morrow (Pennsylvanian)	7,769–7,779	2,793 MCFGD	
2	26-25S-26E Eddy	Chevron No. 1 Cable Ranch 26	1/99	5,613	Bone Spring (Permian)	Delaware (Permian)	2,928–2,944	12 BOPD	
3	14-23S-31E Eddy	Devon Energy No. 1 Todd 14K Federal	10/99	16,550	Devonian	Bone Spring (Permian) Wolfcamp (Permian)	10,800–11,597 11,734–11,782	12 BOPD + 12 MCFGD + 8 BWPD	
4	34-23S-24E Eddy	Yates Petroleum No. 1 Bat ARO Federal (owwo)	1/99	8,900	Atoka (Pennsylvanian)	Upper Pennsylvanian	8,036–8,120	104 MCFGD	
5	13-22S-30E Eddy	Mitchell Energy No. 1 Apache 13 Federal (owwo)	5/99	14,278	Morrow (Pennsylvanian)	Wolfcamp (Permian)	11,908–11,924	1,001 MCFGD + 27 BCPD	58
6	18-19S-31E Eddy	Santa Fe Energy No. 1 Hackberry 18 Federal (owwo)	4/99	12,350	Morrow (Pennsylvanian)	Atoka (Pennsylvanian)	11,354–11,370	1,192 MCFGD	
7	12-19S-23E Eddy	Yates Petroleum No. 1 Altwein B Federal Com (owwo)	5/99	8,565	Mississippian	Atoka (Pennsylvanian)	7,944–7,973	382 MCFGD	
8	10-18S-28E Eddy	Louis Dreyfus Natural Gas No. 1 Fireweed 10 Federal	8/99	11,062	Mississippian	Cisco (Upper Pennsylvanian)	8,720–8,866	489 MCFGD	
9	26-18S-27E Eddy	Yates Petroleum No. 1 Pierre AGF State (owwo)	7/99	10,350	Mississippian	Wolfcamp (Permian)	7,291–7,357	43 BOPD + 804 MCFGD + 12 BWPD	
10	8-17S-29E Eddy	Enron No. 1 Conoco 8 State	11/99	10,920	Mississippian	Upper Pennsylvanian	9,569–9,580	1,819 MCFGD	
11	36-17S-27E Eddy	Mewbourne Oil No. 1 Chalk Bluff 36 State (owwo)	10/99	10,060	Mississippian	Atoka (Pennsylvanian)	9,466–9,484	317 MCFGD + 2 BCPD + 2 BWPD	
12	25-17S-27E Eddy	Mack Energy No. 1 Spruce Federal (owwo)	8/99	9,985	Morrow (Pennsylvanian)	Wolfcamp (Permian)	6,906–6,931	129 BOPD + 240 MCFGD	50
13	1-16S-27E Eddy	Ocean Energy No. 1 Diamond Mound Federal (owwo)	10/99	8,985	Mississippian	Strawn (Pennsylvanian)	8,165–8,180	60 MCFGD	
14	16-14S-30E Chaves	Manzano No. 1 SV Vest State (owwo)	5/99	10,757	Devonian	Wolfcamp (Permian)	7,888–7,894	6 BOPD + 8 BWPD	40
15	35-10S-26E Chaves	Yates Petroleum No. 1 Samedan ATH State (owwo)	9/99	6,692	Montoya (Ordovician)	Wolfcamp (Permian)	5,248–5,690	57 MCFGD	
16	23-12S-33E Lea	Toco LLC No. 1 Tower Lea	2/99	10,160	Devonian	Abo (Permian)	8,400–8,519	4,000 MCFGD + 28 BOPD + 8 BWPD	
17	10-16S-32E Lea	Nearburg Production No. 1 Rancho Verde 10 State	4/99	10,368	Wolfcamp (Permian)	Wolfcamp (Permian)	9,806–9,848	672 BOPD + 602 MCFGD	43
18	6-16S-34E Lea	Kaiser Francis Oil No. 1 TCH Ranch 6 (owwo)	3/99	12,600	Atoka (Pennsylvanian)	Canyon (Pennsylvanian)	11,482–11,514	51 BOPD + 70 MCFGD + 33 BWPD	44
19	2-16S-35E Lea	Yates Petroleum No. 1 Field APK State Com	2/99	12,830	Mississippian	Morrow (Pennsylvanian)	12,301–12,448	72 BOPD + 1061 MCFGD + 3 BWPD	
20	16-16S-35E Lea	TMBR/Sharp Drlg No. 1 New Mexico EQ State (owwo)	3/99	12,600	Morrow (Pennsylvanian)	Strawn (Pennsylvanian)	11,729–11,757	250 MCFGD + 400 BWPD	
21	33-16S-36E Lea	Arrington Oil & Gas No. 1 Brassie	7/99	9,347	Abo (Permian)	Abo (Permian)	8,891–8,924	8 BOPD + 118 BWPD	
22	22-17S-32E Lea	Mack Energy No. 1 MC Federal	10/99	14,912	Ordovician	McKee (Ordovician)	14,805–14,821	1,422 MCFGD + 8 BCPD	62
23	27-19S-35E Lea	Louis Dreyfus Natural Gas No. 1 Toro 27 State Com	9/99	13,192		Morrow (Pennsylvanian)	12,888–12,897	2,102 MCFGD + 127 BOPD	44
24	33-19S-35E Lea	Louis Dreyfus Natural Gas No. 1 Toro 33 State	2/99	13,322	Morrow (Pennsylvanian)	Morrow (Pennsylvanian)	12,864–12,878	936 MCFGD + 264 BCPD	
25	13-19S-36E Lea	Chevron No. 17 Monument 13 State (owwo)	7/99	7,502	Abo (Permian)	Drinkard (Permian)	6,696–6,770	2,200 MCFGD + 3 BOPD	
26	19-19S-38E Lea	Beach Exploration No. 1 Laughlin	12/99	4,550	San Andres (Permian)	San Andres (Permian)	4,284–4,359	11 BOPD + 58 MCFGD + 63 BWPD	31
27	19-20S-34E Lea	Louis Dreyfus Natural Gas No. 1 Greenstone Federal Com	12/99	13,900	Atoka (Pennsylvanian)	Atoka (Pennsylvanian)	12,662–12,668	776 MCFGD	
28	4-20S-38E Lea	Capataz Operating No. 1 Keach	7/99	7,921	Devonian	San Andres (Permian)	4,224–4,262	5 BOPD + 65 BWPD	

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)
29	30-21S-35E Lea	VF Petroleum No. 1 Merchants A (owwo)	2/99	13,100	Morrow (Pennsylvanian)	Bone Spring (Permian)	8,422–8,443	44 MCFGD + 6 BWPD	
30	22-22S-37E Lea	Homestake Oil & gas No. 2 Sarah Johnston	7/99	7,475	Montoya (Ordovician)	Drinkard (Permian)	6350–6493	126 BOPD + 435 MCFGD + 25 BWPD	39
31	4-23S-37E Lea	Texaco No. 1 Sims RRA (owwo)	6/99	10,254	Ellenburger (Ordovician)	Wolfcamp (Permian)	7,246–7,312	2 BOPD + 126 MCFGD	
32	34-23S-37E Lea	Plains Petroleum No. 24 E C Hill B Federal (owwo)	12/99	9,555	Ordovician	Simpson (Ordovician)	9,235–9,383	59 BOPD + 173 MCFGD + 61 BWPD	40
33	15-24S-37E Lea	Altura No. 24 South Mattix Federal Unit (owwo)	6/99	10,012	Bliss (Ordovician)	Silurian	7,118–7,160	39 BOPD + 89 MCFGD + 6 BWPD 42	
34	17-25S-34E Lea	EOG Resources No. 3 Javelina 17 Federal	12/99	14,080	Wolfcamp (Permian)	Wolfcamp (Permian)	13,704–13,832	897 MCFGD + 78 BOPD	49
35	15-30N-11W San Juan	Burlington Resources No. 13 Morris A (owwo)	9/99	5,060	Point Lookout (Cretaceous)	Chacra (Cretaceous)	3,095–3,448	807 MCFGD (commingled with Mesaverde)	
36	6-27N-8W San Juan	Cross Timbers Operating No. 5E Schwerdtfeger A (owwo)	5/99	7,192	Dakota (Cretaceous)	Gallup (Cretaceous)	6,111–6,554	71 MCFGD + 80 BWPD (commingled with Dakota)	
37	23-20N-4W Sandoval	Penwell Energy No. 1 Penistaja Federal 23	7/99	6,350	Jurassic	Entrada (Jurassic)	5,998–6,004	112 BOPD + 174 BWPD	36
38	11-28N-2W Rio Arriba	Mallon Oil No. 1 Jicarilla 28-02-11	2/99	4,050	Lewis (Cretaceous)	Nacimiento (Tertiary) Ojo Alamo (Tertiary)	2,788–3,166 3,258–3,474	63 MCFGD	
39	20-29N-2W Rio Arriba	Mallon Oil No. 1 Jicarilla 29-02-20	3/99	3,870	Lewis (Cretaceous)	San Jose (Tertiary)	1,219–1,564	63 MCFGD (commingled with Pictured Cliffs)	
40	6-31N-20E Colfax	Sonat Raton No. 2 VPR Canadian River 3120	9/99	2,370	Pierre (Cretaceous)	Vermejo (Cretaceous)	1,978–2,208	Coalbed methane discovery	

development wells completed in Yates and Queen reservoirs in the Jalmat and Langlie–Mattix pools of Lea County. Seven development wells were successfully completed in the Russell Yates pool along the southern margin of the Northwest shelf in Eddy 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 major targets of development drilling in 1999. Approximately 90 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 different pools. Major development took place in the Red Lake pool of northern Eddy County where 10 producing wells were drilled. Significant development drilling also took place in the Artesia pool of Eddy County where 15 wells were completed successfully and in the Grayburg–Jackson pool of Eddy County where 10 wells were completed successfully. Significant development also took place in the Vacuum and Eunice–Monument pools of Lea County. Although exploration along the mature San Andres and Grayburg trends was limited, two significant discoveries were made. The Beach Exploration No. 1 Laughlin (26) discovered oil in the San Andres Formation in

east-central Lea County. The Capataz Operating No. 1 Keach (28) also discovered oil in the San Andres in east-central 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 during the past couple of years resulted in decreased drilling activity compared to previous years. During 1999, 50 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

TABLE 2—Significant wildcat dry holes in New Mexico in 1999. D&A, dry and abandoned; rec, recovered.

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
41	7-20N-10W McKinley	Synergy Operating No. 1 Fajada Wash 7	6/99	4,876	Chinle (Triassic)	D&A	DST 4,869–4,704 ft (Entrada), rec 2,350 ft water + 2,000 ft drilling mud
42	2-20N-11W McKinley	Synergy Operating No. 1 Fajada State 2	6/99	5,030	Chinle (Triassic)	D&A	Drilled to test Entrada Sandstone (Jurassic)
43	18-16N-9W McKinley	Nerdlihc No. 2 Bullseye	9/99	2,400	Morrison (Jurassic)	D&A	Perf 1,806–2,168 ft (Dakota) swabbed water

TABLE 3—Significant wildcat wells being drilled, not completed, “tight,” or scheduled to be drilled at the end of 1999.

No. on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Comments
44	16-1S-21W Catron	Ridgeway Arizona No. 1 State 1-16	Drilled to total depth of 2,861 ft in Abo Fm. (Permian) and temporarily abandoned. CO ₂ evaluation well.
45	36-1S-21W Catron	Ridgeway Arizona No. 1 South State 36	Drilled to total depth of 3,173 ft in Precambrian rocks and temporarily abandoned. CO ₂ evaluation well.
46	16-1N-20W Catron	Ridgeway Arizona No. 1 North State 16	Drilled to total depth of 2,959 ft in Precambrian rocks. CO ₂ evaluation well.
47	36-1N-21W Catron	Ridgeway Arizona No. 1 North State 36	Schedule to drill to total depth of 3,050 ft in Pennsylvanian strata. CO ₂ evaluation well.
48	36-1N-21W Catron	Ridgeway Arizona No. 2 North State 36	Drilled to total depth of 3,968 ft in Abo Fm. (Permian). CO ₂ evaluation well.
49	14-23S-20E Otero	Presco Incorporated No. 1 Indian Creek Federal	Drilled to an estimated total depth of 4,000 ft to test Abo (Permian).
50	14-26S-12E Otero	Harvey E. Yates No. 1Y Bennett Ranch	Gas discovery drilled during 1997 flowed 4,400 MMCFGD from interval within the Mississippian section.
51	22-30N-11W San Juan	Burlington Resources No. 2 Vasaly Com	Drilled to an estimated depth of 13,000 ft to test Pennsylvanian. Rig released in early 2000.
52	28-4N-1 Socorro	Twining Drilling No. 2 NFT	Scheduled to drill to 12,500 ft.

part of the Delaware Basin. Exploration was less active than in previous years, with only one exploratory well completed as a discovery. Development was mostly by infill drilling and conservative stepouts from known production. Development wells were drilled in 19 oil pools. The Red Tank West pool was the most intensely developed Delaware reservoir in 1999. 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.

One significant discovery of oil in the Delaware was made during 1999. Oil was discovered in Delaware sandstones in the Chevron No. 1 Cable Ranch 26 well (2).

Yeso shelf sediments

Shallow shelf carbonate oil reservoirs of the Yeso Formation (Permian: Leonardian) were primary targets in 1999 with 182 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 margin 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 the pools, production from two or more 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 1999 were the Eunice North and Blinebry pools of southeastern Lea County, which produce from the Blinebry, Tubb, and Drinkard Members, and the Empire East and Loco Hills pools along the margin of the Northwest shelf in Eddy County, which

produce primarily from the Paddock. One significant exploratory discovery was made in 1999. Gas was discovered in the Drinkard in the Chevron No. 17 Monument 13 State well (25) in east-central Lea County. This discovery is located along the western part of the Lea County Drinkard trend where Drinkard 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 1999 with only seven 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 32 wells drilled in 13 reservoirs. Activity was concentrated in the Wantz, Monument Southeast, and Goodwin pools of central Lea County where 17 development wells were successfully completed. Exploration for hydrocarbons in Abo reservoirs was modest in 1999. One significant discovery was made in Abo shelf-margin carbonate reservoirs along the southern part of the Northwest shelf (21). One significant gas discovery (16) was made on the Northwest shelf where Abo production is widely scattered from this relatively sparsely drilled area.

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 1999. 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 13 oil pools in eastern Eddy and western Lea Counties. Two discoveries were made in Bone Spring reservoirs in 1999. Oil and gas were discovered in the Devon Energy No. 1 Todd 14K Federal well (3) in the central part of the Bone Spring play where production is obtained mostly from basinal sandstones. The Devon well discovered oil and gas in both the Bone Spring and in the Wolfcamp. Gas was also discovered along the eastern margin of the Bone Spring play in the VF Petroleum No. 1 Merchants A well (29).

Wolfcamp carbonates

Moderately deep (9,000–11,000 ft) carbonate reservoirs in the Wolfcamp Group (Permian: Wolfcampian) were developed at a limited rate in 1999. Eleven development oil wells and 17 development gas wells were completed successfully in 20 pools in northern and central Eddy County and in southern and central Lea County. Two development gas wells were completed in the Foor Ranch field along the northern part of the Wolfcamp play in central Chaves County. Exploration for Wolfcamp hydrocarbons surged during 1999 and resulted in eight exploratory discoveries. In Chaves County, gas was discovered in the Wolfcamp in the Yates Petroleum No. 1 Samedan ATH State (15), and oil was found in the Manzano No. 1 SV Vest State well (14). In Eddy County, gas was discovered in the Wolfcamp in the Mitchell Energy No. 1 Apache 13 Federal (5). Oil was discovered in the Wolfcamp of Eddy County in the Yates Petroleum No. 1 Pierre AGF State (9) and in the Mack Energy No. 1 Spruce Federal well (12). In Lea County,

oil was discovered in the Wolfcamp in the Nearburg Production No. 1 Rancho Verde 10 State well (17) and in the Texaco No. 1 Sims RRA well (31). Gas was discovered in the EOG Resources No. 3 Javelina 17 Federal well (34). Oil and gas were discovered in both the Wolfcamp and in the Bone Spring in the Devon Energy No. 1 Todd 14K Federal well (3).

Upper Pennsylvanian carbonates

Moderately deep (7,000–10,000 ft) Cisco and Canyon (Upper Pennsylvanian) carbonate reservoirs continued to be developed in 1999 but at a slower rate than in previous years. Thirty-nine development wells were successfully completed in 12 reservoirs. Activity was concentrated in the Indian Basin pool where 19 development wells were successfully completed. There were four significant exploratory discoveries in Upper Pennsylvanian carbonates during 1999 (4, 8, 10, 18).

Strawn reservoirs

Development of moderately deep (10,000–12,000 ft) Strawn (Middle Pennsylvanian) reservoirs continued at a slow but steady pace in 1999. Development of existing reservoirs was moderately slow, with 18 development wells successfully completed in 16 pools. Exploration for oil and gas in Strawn carbonate reservoirs was also subdued. Nevertheless, two discoveries were made. Gas was discovered in the Strawn in the Ocean Energy No. 1 Diamond Mound Federal (13) in northeast Eddy County and in the TMBR/Sharp Drlg No. 1 New Mexico EQ State well (20) in central Lea 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 1999. Sixteen development gas wells and one development oil well were successfully completed in 15 Atoka reservoirs, and 68 development gas wells were successfully completed in 33 Morrow gas reservoirs. Drilling activity was widespread and evenly distributed among these gas pools. The greatest activity in Eddy County was in the Crow Flats pool (nine successful completions), the Turkey Track North pool (seven successful completions), and the Logan Draw pool (seven successful completions). Exploratory drilling was also strong, and several discoveries were made. Exploration for gas in Morrow reservoirs resulted in four discoveries (1, 19, 23, 24), and exploration for gas in the shallower Atoka reservoirs resulted in four discoveries (6, 7, 11, 27).

Devonian, Silurian, and Ordovician reservoirs

Exploration for oil in seismically defined structural traps in the lower Paleozoic section was strong on the Central Basin plat-

form and on the Northwest shelf. Many traps in the lower Paleozoic are formed by relatively small anticlinal and fault-bounded anticlinal closures. Nine successful development wells were completed in nine separate pools in Lea County during 1999. Three exploratory oil discoveries were made in lower Paleozoic reservoirs in northern Lea County (22, 32, 33). Exploration for structural traps in the Devonian, Silurian, and Ordovician sections is expected to remain strong through 2000. 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–Otero platform–Salt Basin graben 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 (50) 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 MCFGD (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 1998, and additional acreage was acquired to the south in Texas during 1998 and 1999. 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 (49) was drilled to an estimated total depth of 4,000 ft during early 2000 to test carbonates of the Abo Formation (Permian) as part of this play. Information on the well had not been released at the time this report was written. Sun Valley Energy shot a 3-D seismic survey in this area as part of this play.

San Juan Basin, northwest New Mexico

Drilling activity increased during 1999 in the San Juan Basin. There were 743 completions during the year, an increase of 16% from the 642 completions in 1998. The

success rate was 99%, with 733 wells completed as gas producers, three wells completed as oil producers, and five wells plugged and abandoned. An additional well was drilled for disposal of produced waters, and one well was junked and abandoned before its primary objective 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 deep gas in Pennsylvanian carbonates continued.

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 3 yrs. The initial discovery wells were drilled in late 1997, and development has continued into 2000. Initially, only sandstones in the Ojo Alamo were pursued, but the play subsequently enlarged to include the San Jose and Nacimiento Formations. In 1999, 20 successful development gas wells were completed in this play. Two discovery wells were also drilled (38, 39). 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 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 1999 although at a slower rate than in previous years. Approximately 114 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 with activity concentrated in San Juan County during the past year.

Pictured Cliffs Sandstone

Gas reservoirs in the Pictured Cliffs Sandstone (Upper Cretaceous) were major targets for development drilling in 1999. Approximately 100 wells were completed in these reservoirs. Development drilling was concentrated in the Ballard, Fulcher Kutz, Kutz West, Aztec, and Twin Mounds pools of northeast San Juan County. Exploration for gas in Pictured Cliffs sandstones was subdued in 1999 with most drilling concentrated on developing and extending previously discovered gas.

Mesaverde sandstones

Development of gas reservoirs in

Mesaverde sandstones (Upper Cretaceous) increased markedly during 1999. Approximately 260 development gas wells were completed in Mesaverde sandstones. Almost all of these wells were drilled to increase well density. In many wells drilled during 1999, production from the Mesaverde sandstones is commingled with production from the Pictured Cliffs Sandstone. In 1999, most Mesaverde wells were drilled in the Blanco pool of northeast San Juan and northwest Rio Arriba Counties.

Gallup Sandstone

Reservoirs in the Gallup Sandstone (Upper Cretaceous) saw mild development activity during 1999. Four development wells were completed successfully in three reservoirs. One significant exploratory discovery was made. Gas was discovered in the Cross Timbers Operating No. 5E Schwerdtfeger A (36) northeast and basinward of the main Gallup productive trend.

Dakota sandstones

Oil and gas reservoirs in sandstones of the Dakota Group (Upper Cretaceous) were developed aggressively in 1999. Approximately 225 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).

Entrada Sandstone

Exploration for oil reservoirs in the Entrada Sandstone (Jurassic) in northwest New Mexico continued during 1999. Oil was discovered in the Entrada in the Penwell Energy No. 1 Penistaja Federal 23 (37). The Synergy Operating No. 1 Fajada Wash 7 (41) and No. 1 Fajada State 2 (42) were drilled to test the Entrada approximately 15 mi southwest of the productive trend but were abandoned without establishing production.

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. One development gas well was successfully completed in the Ute Dome field of northwest San Juan County. Burlington Resources and Conoco have had cooperative ongoing exploratory programs targeted at Pennsylvanian reservoirs in the deeper, poorly tested parts of the basin. The third well in their joint program,

Burlington Resources No. 2 Vasaly Com (51), was drilled in the north-central part of the basin to an estimated depth of 13,000 ft to test Pennsylvanian and Mississippian reservoirs. Information on the well has not yet been released.

Albuquerque Basin

Exploratory efforts continued in the Albuquerque Basin of central New Mexico. Twining Drilling still has plans to drill its second exploratory well within the basin. The Twining No. 2 NFT well (52) is scheduled to be drilled to a total depth of 12,500 ft in the southernmost part of the basin.

Exploratory interest in the Albuquerque Basin has been intermittent. The Twining well will be the latest in a series of wells drilled by Burlington, Davis Oil Company, Vastar Resources, and Twining Oil Company over the last 4 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. Although production was not established by those wells, significant shows of gas were encountered, and analyses of drilling indicated that the necessary parameters for commercial production are present within the basin. During the late 1990s, exploration in the basin was resurgent, and Davis Oil Company drilled two deep wells to test the Tertiary section in the southern part of the basin. Black (1982, 1989) and Molenaar (1988) summarized the petroleum geology and the history of oil and gas exploration within the Albuquerque Basin.

Northeast New Mexico

Exploratory activity in northeast New Mexico increased during 1999. Exploratory activity continued in the Tucumcari Basin. Although no new wells were drilled, additional state lands were leased. El Paso Energy assumed coalbed-methane operations from Sonat Raton in the Raton Basin and continued with a large project to explore for and develop coalbed-methane resources. There was no development of CO₂ resources or exploration for new CO₂ resources in the Bravo Dome area for the first time in many years.

Exploratory interest continued in the Tucumcari Basin during 1999. During the December state lease sale, Gene D. Wilson and Associates successfully bid on 4,609 acres of state trust land in northwestern 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. Primary objectives in the basin are Pennsylvanian sandstones and limestones and Lower Permian dolostones (Broadhead and King, 1988; Broadhead and Chapin, 1999).

During late 1998, Pennzoil announced plans to drill additional coalbed-methane exploratory wells in the Raton Basin. 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). Sonat has since been acquired by El Paso Energy. El Paso Energy has continued with plans to develop this new resource. Objectives may be coals in both the Raton Formation and the Vermejo Formation at depths between 1,000 and 2,500 ft. Twenty-three wells were successfully 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. A pipeline is being constructed northward into Colorado where it will link with major pipeline systems in that state. Additional plans include the construction of a pipeline that will head eastward to Clayton, New Mexico, and Dumas, Texas.

Elsewhere in northeastern New Mexico W. G. Vanbeber successfully bid on 1,252 acres of state trust land in northeasternmost Union County during the July 1999 state lease sale. Yates Petroleum Corp. leased 80 acres of state trust land during the same sale. Although objectives are not known in this play, Lower Pennsylvanian sandstones and Ordovician carbonates have potential in the area.

Southwest New Mexico

No petroleum exploration wells were drilled in southwest New Mexico during 1999. Exploratory work continued in the Carrizozo Basin of eastern Socorro and northwestern 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.

Ridgeway Arizona Oil Company continued to evaluate CO₂ resources in western Catron County. Several wells have been drilled in westernmost Catron County and in Apache County, Arizona, in the past few years for this purpose (Heylmun, 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.

Elsewhere in southwest New Mexico, there was significant leasing activity in the Pedregosa Basin of Hidalgo County. During the May 1999 state lease sale, David Gonzales successfully bid on 31,340 acres of state trust land in the Playas Valley in the eastern part of the bootheel of Hidalgo County. Doug Schutz leased 4,078 acres during the same sale, and F. L. Shogrin successfully bid on 919 acres. Although oil and gas production has not been established in southwestern New Mexico or adjacent areas of the Pedregosa Basin in Arizona and Mexico, considerable potential exists. Lower Cretaceous sandstones and carbonates, Pennsylvanian and Permian shelf to shelf-margin carbonates, and Ordovician dolostones are favorable targets (Thompson, 1981; Thompson and Jacka, 1981).

Acknowledgments. Roy Johnson of the New Mexico Oil Conservation Division reviewed the manuscript. Kathy Glesener 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 Chapin, C. E., 1999, Petroleum systems in late Paleozoic elevator basins, southern Ancestral Rocky Mountains (abs.): American Association of Petroleum Geologists, Official program 1999 annual convention, p. A16.
- Broadhead, R. F., and King, W. E., 1988, Petroleum geology of Pennsylvanian and Lower Permian strata, Tatum 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, 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, 1981, Petroleum source rocks in exploration wells drilled to Paleozoic or Mesozoic units, Hidalgo and Grant Counties, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Open-file report 153, 126 pp.
- 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.