Oil and gas discovery wells drilled in New Mexico in 1991

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by *Ronald F. Broadhead*, New Mexico Bureau of Mines and Mineral Resources

Introduction

More wells were drilled for oil and gas in New Mexico in 1991 than in 1990. Data obtained from the New Mexico Oil Conservation Division indicate 1,624 wells were completed in 1991, up 5% from the 1,549 wells completed in 1990 but down 43% from the record 2,867 wells completed in 1981. In the Permian Basin, southeast New Mexico, 889 wells were completed in 1991, up from 803 completions in 1990; 585 wells were completed as oil producers and 184 wells were completed as gas producers while 120 wells were plugged and abandoned, resulting in a success rate of 87%. In the San Juan Basin, northwest New Mexico, 735 wells were completed in 1991, down from 746 completions in 1990; 57 wells were completed as oil producers and 655 wells were completed as gas producers while 23 wells were plugged and abandoned, resulting in a success rate of 97%. In addition, two wells were completed in the west Bravo dome carbon dioxide gas unit of southern Harding County. Three exploration and development wells were completed in Colfax County.

Total footage of hole drilled in 1991 was 6.522 million ft, up 3% from 6.313 million ft drilled in 1990. The average footage drilled per well in 1991 was 4,016 ft, 59 ft less than the average well drilled in 1990.

The downturn in drilling over the past 10 years has been accompanied by seriously decreased exploratory efforts. Several major oil companies announced reduction or elimination of onshore exploration efforts in the United States. Exploratory activity has rebounded somewhat in the last three years, however. The resurgence in exploration has generally been led by independent operators and smaller oil companies. During 1991, there was significant frontier exploratory activity in Raton and Tucumcari

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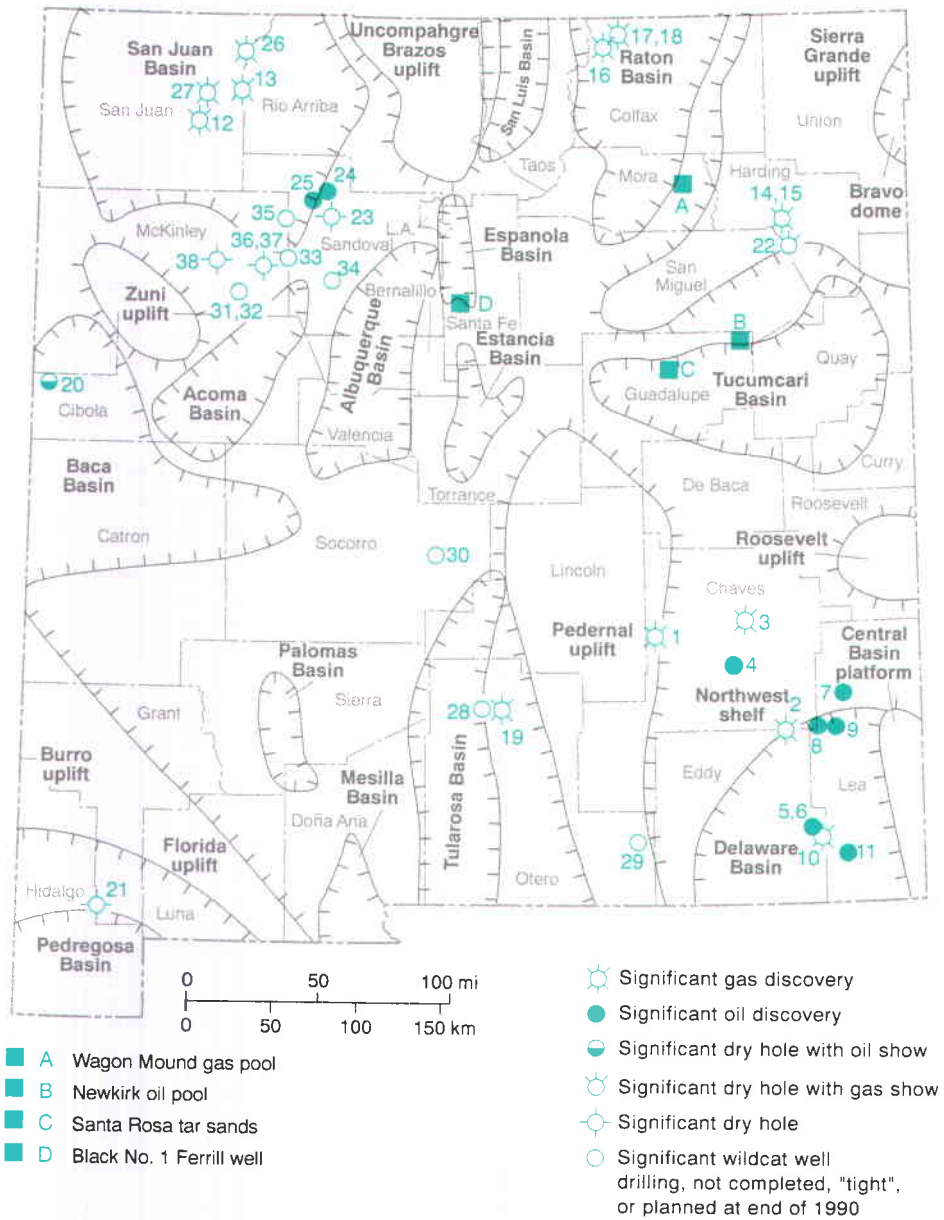

FIGURE 1—Significant oil and gas discoveries, frontier wildcat wells, and horizontal wells drilled in New Mexico during 1991. Major geologic features are from Broadhead and King (1988), Cather and Johnson (1984), Kelley (1978), Kottlowski and Stewart (1970), Meyer (1966), Molenaar (1977), Thompson and Jacka (1981), and Woodward et al. (1978).

Also in this issue

NMGS 1992 abstracts	p. 76
Middle Jurassic Summerville Formation	p. 79
NMG subscription information	p. 92
NMGS 1993 call for papers	p. 93
Summary of New Mexico state taxes on natural resource production	p. 93
Service/News	p. 94
Upcoming geologic meetings	p. 94
Index to Volume 14	p. 95
Staff notes	p. 96

Basins, the southeasternmost San Juan Basin (Cabezon area), the Gallup–Zuni sag, the Sacramento Mountains, the northern rim of the Pedregosa Basin, and in Socorro County (Fig. 1).

For purposes of this report, a *significant wildcat discovery* is defined as a well in which commercial amounts of oil or gas were discovered in a stratigraphic unit more than 5 miles from the limits of previously discovered pools with commercial production from that stratigraphic unit. A *significant wildcat dry hole* is defined as a dry hole that was drilled in a not-yet-productive basin or a part of a basin and in which petroleum reservoirs were evaluated. The locations of significant wildcat wells that were completed in 1991 are shown in Fig. 1. Table 1 summarizes the significant wildcat discoveries and Table 2 summarizes the significant wildcat dry holes. Table 3 summarizes wells in which horizontal drilling took place in New Mexico during 1991. Table 4 lists other significant wildcat wells that were being drilled, were not completed, or were held "tight" at the end of 1991.

Each well is designated by a number in parentheses that refers to its location in Fig. 1 and its description in Tables 1, 2, 3, or 4.

Southeast New Mexico

Drilling activity increased in 1991 in the three geologic subdivisions of the Permian Basin: the Delaware Basin, the Central Basin platform, and the Northwest shelf. Eleven significant wildcat discoveries were made in the Permian Basin during 1991 (Fig. 1, nos. 1–11; Table 1, nos. 1–11). McKamey et al. (1988) presented stratigraphic charts of oil- and gas-producing rock units in southeastern New Mexico, as well as geologic summaries of oil and gas pools.

Four significant wildcat discoveries were made in the Delaware Basin during 1991. Three discoveries were in basinal sandstones of the Delaware Mountain Group. Oil was discovered in the Delaware Cherry Canyon sandstones in the Yates Petroleum No. 3 Lost Tank AIS State (5) and the Yates Petroleum No. 1 Unocal AHU Federal (6). Oil was found in Delaware Brushy Canyon sandstones in the Ray Westall No. 1 Federal 30 (11). In a fourth well, the Mercury Exploration No. 1 Connally Federal (10), gas was discovered in the Cisco–Canyon (Pennsylvanian) section.

Both oil and gas reservoirs were targets of exploratory drilling in the Delaware Basin during 1991, although exploration for oil predominated. The main targets for oil exploration were deep-basin sandstones of the lower parts of the Delaware Mountain Group (Permian): the Brushy Canyon Formation and the Cherry Canyon Formation. Eleven Delaware Mountain discoveries were made in Eddy County and six in Lea County, and three were significant as defined in this report; some discoveries were extensions of existing pools while others discovered new pools within five miles of existing pools. The 17 Delaware Mountain discoveries were more than the total number of discoveries in all other stratigraphic units in the Delaware Basin. Other targets for oil exploration were Pennsylvanian and Wolfcampian (Lower Permian) carbonates. Exploratory drilling for natural gas was concentrated mostly in Morrowan and Atokan sandstones (Pennsylvanian).

Development drilling in the Delaware Basin was predominantly for oil during 1991. As with exploratory drilling, the primary targets were shallow (4,000–6,000 ft) Delaware Mountain sandstones; more than 120 development oil wells were successfully completed in the Delaware sandstones during 1991. Activity was widespread with significant numbers of wells drilled in the East Catclaw Draw, Livingston Ridge, Lost Tank, and East Loving pools of Eddy County and the Hat Mesa and Quail Ridge pools of Lea County. Other major targets of development drilling for oil were the moderately deep (6,000–10,000 ft) basinal Bone Spring (Permian) carbonates, the deep (10,000–11,000 ft) Wolfcampian carbonates, and moderately deep (7,000–10,000 ft) middle and upper Pennsylvanian (Strawn, Cisco–Canyon) carbonates. Cisco and Canyon reservoirs were intensively developed in the North Dagger Draw and South Dagger Draw pools of northwest Eddy County. Morrowan and Atokan clastics (Lower Pennsylvanian) were the main targets for gas development drilling during 1991, but development of gas reservoirs was slow.

No significant wildcat discoveries were made on the Central Basin platform during 1991. There was, however, limited exploration for oil in Blinebry, San Andres, and Seven Rivers (Permian) carbonates. Development drilling was mostly for oil in the shallow (2,000–5,000 ft) San Andres, Grayburg, Queen, and Yates Formations (Permian) and in the moderately deep (5,000–7,000 ft) Drinkard and Blinebry zones of the Yeso Formation (Permian). Notable gas development was in isolated gas zones in the Yates Formation at the Jalmat pool and in the Queen Formation at the Eumont pool.

Seven significant wildcat discoveries were made on the Northwest shelf during 1991 despite relatively light drilling activity. On the southern part of the shelf, gas was found in the Abo (Permian) in the McClellan Oil No. 2 McClellan A Federal (2). Oil was discovered in the Canyon (Pennsylvanian) section in the Yates Petroleum No. 1 Fort AIO (7) and in the Yates Petroleum No. 1 Scratchy Ranch State Unit (8). Oil was found in San Andres carbonates in the Charles B. Gillespie, Jr. No. 1 State Q (9). Toward the northwest, hydrocarbons were discovered in Ordovician reservoirs in the BHP Petroleum No. 1 Puffer State (3) and in the BHP Petroleum No. 1 Conoco 8 Federal (4). Gas was discovered in Abo red beds (Permian) southwest of the West Pecos Slope pool in the Yates Petroleum No. 1 Blackwater Unit (1). Exploration for gas on the Northwest shelf was limited during 1991; main targets were Abo sandstones.

Development drilling on the Northwest shelf was slow in 1991. Nevertheless, there was significant development of oil reservoirs in the shallow (2,000–6,000 ft) Paddock, Glorieta, San Andres, Grayburg, and Queen reservoirs (Permian) of southern Chaves County and northern Eddy and northern Lea Counties. Development of Paddock and San Andres reservoirs was especially strong in the Lovington and West Lovington pools.

The Roosevelt uplift and adjacent areas were drilled sparsely during 1991. No significant wildcat discoveries were made and exploration was minimal. Exploration was concentrated on finding traps in Siluro–Devonian, Pennsylvanian, and Wolfcampian (Lower Permian) reservoirs.

Significant exploration took place in Otero County. A significant gas discovery was made in the Lower Pennsylvanian

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TABLE 1—Significant wildcat discoveries in New Mexico in 1991; the term formation is used in an informal sense. **BOPD,** bbls oil per day; **MCFPD,** thousand ft^3 gas per day; **BCPD,** bbls condensate per day; **BWPD,** bbls water per day; **IP,** initial potential; **IPF,** initial potential flowing; **IPP,** initial potential pumping; **owwo,** old well worked over; **owdd,** old well drilled deeper.

Number 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	19-9S-22E, Chaves	Yates Petroleum No. 1 Blackwater Unit	3/91	3,650	Precambrian	Abo (Permian)	3,331–3,441	IPF 771 MCFPD	
2	27-15S-30E, Chaves	McClellan Oil No. 2 McClellan A Federal (owwo)	2/91	11,100	Morrow (Pennsylvanian)	Abo (Permian)	8,161–8,167	IPF 25 MCFPD	
3	24-8S-27E, Chaves	BHP Petroleum (Americas) No. 1 Puffer State	2/91	6,810	Granite Wash	Montoya (Ordovician)	6,371–6,452	IP 7910 MCFPD	
4	8-11S-27E, Chaves	BHP Petroleum (Americas) No. 1 Conoco 8 Federal (owwo)	4/91	6,625	Ellenburger (Ordovician)	Ellenburger (Ordovician)	6,464–6,482	IPP 26 BOPD + 40 MCFPD +9 BWPD	
5	36-21S-31E, Eddy	Yates Petroleum No. 3 Lost Tank AIS State	3/91	8,620	Bone Spring (Permian)	Cherry Canyon (Permian)	6,783–7,084	IPP 173 BOPD + 75 MCFPD + 108 BWPD	37.5
6	1-22S-31E, Eddy	Yates Petroleum No. 1 Unocal AHU Federal	5/91	8,500	Bone Spring (Permian)	Cherry Canyon (Permian)	7,069–7,149	IPP 206 BOPD + 125 MCFPD +129 BWPD	38.0
7	20-13S-34E, Lea	Yates Petroleum No. 1 Fort AIO	7/91	10,981	Canyon (Pennsylvanian)	Canyon (Pennsylvanian)	10,828–10,847	IPP 30 BOPD + 5 BWPD	37.2
8	14-15S-32E, Lea	Yates Petroleum No. 1 Scratchy Ranch State Unit (owdd)	12/91	13,320		Canyon (Pennsylvanian)	10,536–10,594	IPP 22 BOPD + 53 MCFPD +63 BWPD	
9	4-15S-33E, Lea	Charles B. Gillespie, Jr. No. 1 State Q (owwo)	6/91	10,360	Pennsylvanian	San Andres (Permian)	4,940–4,965	IPP 30 BOPD + 130 BWPD	21
10	15-22S-32E Lea	Mercury Exploration No. 1 Connally Federal (owwo)	3/91	15,120	Morrow (Pennsylvanian)	Cisco–Canyon (Pennsylvanian)	13,290–13,360	IPF 166 MCFPD + 0.053 BCPD	52
11	30-23S-34E, Lea	Ray Westall No. 1 Federal 30	4/91	8,500	Brushy Canyon (Permian)	Brushy Canyon (Permian)	8,353–8,380	IPP 20 BOPD + 50 MCFPD + 20 BWPD	
12	14-25N-11W, San Juan	Texaco Inc. No. 2 Navajo Allottee T (owwo)	5/91	6,034	Dakota (Cretaceous)	Farmington (Cretaceous)	740–788	IPP 45 MCFPD	
13	15-27N-8W, San Juan	Maralex Resources No. 10 Oxnard W N Federal	7/91	2,220	Pictured Cliffs (Cretaceous)	Kirtland (Cretaceous)	1,492–1,502	IPF 76 MCFGPD + 2 BWPD	
14	18-19N-29E, Harding	OXY U.S.A. No. 18 West Bravo Dome GU	1/91	2,928	Precambrian	Tubb (Permian)	2,756–2,796	IP 1,800 MCFGPD (CO_2)	
15	32-19N-30E, Harding	OXY U.S.A. No. 20 West Bravo Dome GU	1/91	2,165	Precambrian	Tubb (Permian)	1,924–1,954	IP 2,300 MCFGPD (CO_2)	
16	16-30N-17E, Colfax	Pennzoil No. 161 Castle Rock 3017	4/91	2,876	Vermejo (Cretaceous)	Vermejo (Cretaceous)	2,538–2,767	IPP 1,500 BWPD	
17	32-31N-18E, Colfax	Pennzoil No. 322 Castle Rock 3118	4/91	2,165	Vermejo (Cretaceous)	Vermejo (Cretaceous)	1,672–1,957	IPP 170 MCFGPD + 228 BWPD	
18	32-31N-18E, Colfax	Pennzoil No. 323 Castle Rock 3118	4/91	2,180	Vermejo (Cretaceous)	Vermejo (Cretaceous)	1,712–1,963	IPP 290 MCFGPD + 411 BWPD	
19	7-14S-11E Otero	Cibola Energy No. 1 Ysletano Canyon Federal	10/91	5,028		Morrow (Pennsylvanian)	4,024–4,040	IP 300 MCFGPD	

TABLE 2—Significant wildcat dry holes in New Mexico in 1991; the term formation is used in an informal sense. **D&A,** dry and abandoned; **BLW,** bbls load water; **perf,** perforated; **acid,** acidized; **frac,** artificially fractured.

Number on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Completion date (mo/yr)	Total depth (ft)	Formation at depth	Status	Comments
20	34-8N-20W, Cibola	Burr O & G No. 1-34 Zuni Tribal	7/91	874	Yeso (Permian)	D&A	Perf and acid 628–640 (Yeso), swabbed water with slight oil show. Live oil shows in dolostone at 620–645 ft.
21	16-27S-16W, Grant	Arthur B. Ramsey No. 1 Ramsey State 16	5/91	1,672	Cretaceous	D&A	
22	2-17N-29E, Harding	OXY U.S.A. No. 21 West Bravo Dome GU	1/91	3,097	Tubb (Permian)	D&A	Perf, acid, and frac 2,819–2,866 ft (Tubb), flowed 125 BLW + weak gas.
36	5-15N-6W, McKinley	Merrion O & G No. 1 Grey Mesa	8/91	3,219	Entrada (Jurassic)	D&A	Entrada test
37	33-16N-6W, McKinley	Merrion O & G No. 1 Kahuna Grande	10/91	3,281	Entrada (Jurassic)	D&A	Entrada test
38	21-16N-9W, McKinley	Merrion O & G No. 1 Boomer Sooner	11/91	3,257	Entrada (Jurassic)	D&A	Entrada test

TABLE 3—Wells drilled in New Mexico in 1991 with a significant horizontal deviation. (The amount of horizontal drilling is indicated by the difference between the total depth and the true vertical depth.) The term formation is used in an informal sense. **D&A,** dry and abandoned; **perf,** perforated; **IPP,** initial potential pumping; **IPF,** initial potential flowing; **BOPD,** bbls oil per day; **BWPD,** bbls water per day; **MCFPD,** thousand ft^3 gas per day.

Number on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Completion date (mo/yr)	Total depth (ft)	True vertical depth (ft)	Pool	Objective formation	Status	Comments
23	22-19N-2W, Sandoval	Meridian Oil No. 1 Piedra Lumbre	12/91	6,500		wildcat	Mancos (Cretaceous)	D&A	
24	7-20N-2W, Sandoval	Veteran Exploration No. 7-3 Johnson	9/91	6,208	4,508	Rio Puerco (Mancos)	Mancos (Cretaceous)	oil	Perf 4,068–6,155 ft (Mancos); IPP 564 BOPD + 1 BWPD.
25	11-20N-3W, Sandoval	Veteran Exploration No. 1 Renegade	1/91	6,309	4,646	Rio Puerco (Mancos)	Mancos (Cretaceous)	oil	Producing from 3,250–4,645 ft open hole; IPP 11 BOPD + 23 MCFGPD + 2 BWPD.
26	34-30N-8W, San Juan	Meridian Oil No. 5 Howell L	10/91	6,069	3,653	Navajo City (Chacra)	Chacra (Cretaceous)	gas	Perf 4,031–6,022 ft (Chacra); IPF 781 MCFPD.
27	31-27N-10W, San Juan	Meridian Oil No. 300 Huerfano Unit	10/91	8,065	5,550	Angels Peak (Gallup)	Gallup (Cretaceous)	gas	Perf 5,495–7,965 ft (Gallup); IPF 15,240 MCFPD.

TABLE 4—Significant wildcat wells that were being drilled, not completed, "tight," or planned in New Mexico at the end of 1991.

Number on Fig. 1	Location (section-township-range, county)	Operator, well number, and lease	Comments
28	20-14S-11E, Otero	Cibola Energy No. 1 Virden	Spud 6/20/90. Drilled to total depth of 4,991 ft. "Tight" hole.
29	35-22S-20E, Otero	Frank Groce No. 1 Otero 35 Federal	Scheduled to drill to 8,000 ft to test Pennsylvanian.
30	11-4S-6E, Socorro	Mountain States Pet. No. 1 Hattie Lacy	Spud 9/11/91. Scheduled to drill to 3,200 ft. "Tight" hole.
31	14-14N-8W, McKinley	Merrion O & G No. 1 San Mateo	Scheduled to drill to total depth of 2,400 ft to test Entrada (Jurassic).
32	25-14N-8W, McKinley	Merrion O & G No. 1 San Lucas	Scheduled to drill to total depth of 1,100 ft to test Hospah (Cretaceous).
33	12-16N-5W, McKinley	Merrion O & G No. 1 Cañada Calladita	Scheduled to drill to total depth of 3,720 ft to test Entrada (Jurassic).
34	15-15N-2W, Sandoval	Merrion O & G No. 1 Cañada Bonita	Scheduled to drill to total depth of 3,000 ft to test Entrada (Jurassic).
35	27-19N-5W, McKinley	High Plains Petroleum No. 1 Mammoth Fed.	Scheduled to drill to 2,050 ft to Point Lookout (Cretaceous).

section in the Cibola Energy No. 1 Ysletano Canyon Federal (19). This well had been spudded in the Sacramento Mountains during 1987 but was not completed until 1991. If a market can be found for the gas and if pipeline connections can be made, it would be the first commercial well drilled in Otero County. A second well (28) was drilled in the general area and remains "tight." In eastern Otero County, plans were made during late 1991 to drill the Frank Groce No. 1 Otero 35 Federal (29) in order to test the Pennsylvanian section.

Northwest New Mexico

In 1991, 735 wells were completed in northwest New Mexico, down 1% from the 746 completions in 1990. Virtually all drilling was in the San Juan Basin, dominated by development of coal-bed methane in the Fruitland Formation (Cretaceous).

Exploratory drilling resulted in two significant discoveries in 1991. Gas was found

in the Farmington Sandstone (Cretaceous) in the Texaco No. 2 Navajo Allottee T (12). Gas was also found in the Kirtland Shale (Cretaceous) in the Maralex Resources No. 10 Oxnard W N Federal (13). By the end of 1991, Merrion Oil and Gas had staked locations for four wildcat wells (31–34) in the southeasternmost San Juan Basin, south of established production; the principal exploratory objective is the Entrada Sandstone (Jurassic). These wells will be drilled by Merrion as part of a program to evaluate more than 600,000 acres of leases held by Santa Fe Energy in San Juan, McKinley, Sandoval, and Cibola Counties (Oil and Gas Journal, 1990a). Three wildcat Entrada tests drilled in the area by Merrion in 1991 (36–38) were abandoned without establishing production. High Plains Petroleum scheduled a Cretaceous wildcat (35) in the same general area as the Merrion wells.

Other exploratory efforts concentrated on defining new oil reserves in 1991. Nine wells have extended known limits of production from the Gallup sandstone (Cretaceous) in San Juan County. Exploration for gas was minimal.

Most development drilling in the San Juan Basin during 1991 was for shallow (approximately 2,000 ft) coal-bed methane in the Fruitland Formation (Cretaceous). Approximately 550 wells were completed as gas producers in the Fruitland during 1991. Kelso et al. (1988) estimated that the total gas contained within Fruitland coal beds in the San Juan Basin is 50 trillion ft^3 (TCF); most of that gas is within the New Mexico part of the basin, but the most prolific coal beds appear to be concentrated mainly in the Colorado part of the basin. Similarly, Ayers and Ambrose (1990) estimated a total volume of Fruitland gas between 43 and 49 TCF. It is not known what percentage of the gas is recoverable under current economic conditions with currently employed technology, but this reservoir represents a major addition to the state's gas supplies. In March 1991, gas produced from the Fruitland was 38% of the gas produced from the San Juan Basin and 22% of total gas produced from New Mexico (Whitehead, 1991). Whitehead (1991) summarized coal-bed methane in the Fruitland.

Development drilling for gas in reservoirs other than the Fruitland was sluggish in 1991 and was confined almost entirely to San Juan and Rio Arriba Counties. Gas wells were completed in Dakota, Gallup, Tocito, Mesaverde, and Pictured Cliffs sandstones (Cretaceous).

Development drilling for oil was subordinate to development drilling for gas in 1991. Only 57 oil wells were completed in the San Juan Basin during 1991, a 24% decrease from the 75 wells completed during 1990. Gallup sandstone reservoirs in San Juan and Rio Arriba Counties were the major development targets with drilling activity concentrated in the Bisti and South Bisti pools. Oil reservoirs in the Dakota Sandstone of Rio Arriba County were also developed.

Five wells were drilled in the San Juan Basin during 1991 with a significant horizontal deviation (Table 3). Three wells (23–25) were drilled to test the Mancos Shale (Cretaceous) in the southeast San Juan Basin. Two of those wells (24, 25) were successfully completed in the Rio Puerco Mancos oil pool. Two other wells with horizontal deviation (26, 27) were drilled in the central part of the basin. The Meridian Oil No. 5 Howell L (26) established gas production in the Chacra interval (Cretaceous) and the Meridian Oil No. 300 Huerfano Unit (27) established gas production in Gallup sands (Cretaceous).

Elsewhere in northwest New Mexico, one exploratory well, which had been spudded in 1990, was completed in the Gallup–Zuni sag. The Gallup–Zuni sag is a synclinal feature on the west side of the Zuni uplift; it connects the San Juan Basin with the Baca Basin. The Burr Oil and Gas No. 1–34 Zuni Tribal (20) was drilled on a southwest-plunging anticlinal nose located one mile northeast of the Atarque monocline. Total depth was reached at 874 ft and shows of live oil were reported in dolostone at 620–645 ft in the Yeso Formation (Permian). The well was abandoned without establishing production. It was the third dry hole drilled in the past three years on the Zuni Reservation to test large, previously undrilled surface structures.

Northeast New Mexico

There was relatively little petroleum exploration in northeast New Mexico during 1991. After additional drilling, Pennzoil abandoned its coal-bed methane play in the Raton Basin. Drilling of carbon dioxide reservoirs took place in the west Bravo dome area. Exploratory leasing continued in the Tucumcari Basin.

Petroleum has not been produced commercially in northeast New Mexico except from relatively small and isolated operations. In the 1970s, marginally commercial amounts of gas were produced from the Morrison Formation (Jurassic) and Dakota Sandstone (Cretaceous) at the currently inactive Wagon Mound pool in Mora County (Fig. 1, letter A). Since the 1980s, the Newkirk pool (Fig. 1, letter B) has produced 595 bbls heavy oil from sandstones in the Santa Rosa Formation (Triassic) with the aid of a pilot steamflood operation. In the 1930s, approximately 153,000 tons of tar sands were quarried from the Santa Rosa Formation near the town of Santa Rosa in Guadalupe County (Gorman and Robeck, 1946; Fig. 1, letter C); the tar sands were used for road-surfacing material in New Mexico and neighboring states. In southern Santa Fe County, the Black Oil No. 1 Ferrill (Fig. 1, letter D) has produced 719 bbls oil from the Niobrara Shale and lower Mancos Shale (Cretaceous) since the well was drilled in 1985.

In the Raton Basin, Pennzoil completed three significant wells (16–18) that tested and evaluated coal-bed methane resources in the Vermejo Formation (Cretaceous). Pennzoil has drilled approximately 30 exploratory and developmental wells in the New Mexico part of the basin since 1989. These wells were drilled as part of a pilot program to evaluate coal-bed methane potential in the basin. Despite success in establishing commercial gas reserves, the coal-bed methane wells will be temporarily abandoned because of low gas prices. Drilling will be resumed when natural gas prices increase and further development is warranted economically. More than 300 additional wells may be drilled eventually, and existing wells will be re-entered.

Evaluation of carbon dioxide resources in the west Bravo dome unit of Harding County continued. In early 1991, two wells drilled by OXY U.S.A. (14, 15) established production from the Tubb sandstone (Permian), the principal reservoir in the Bravo dome field. A third well (22) was abandoned after failing to establish commercial levels of production. Further development of carbon dioxide resources may ensue. Most of the carbon dioxide produced at Bravo dome is transported through pipelines to the Permian Basin where it is used in enhanced oil recovery.

No wells were drilled or spudded in the Tucumcari Basin during 1991. However, large-scale leasing continued during the year. During the April 1991 state lease sale, Labrador Oil Co. successfully bid on 33,352 acres of State Trust Land in central Guadalupe County. During the September 1991 sale, Tenison Oil Co. successfully bid on 1,040 acres of State Trust Land in northern Quay County. And in the October sale, Labrador Oil Co. successfully bid on an additional 16,222 acres of State Trust Land in central and northeast Guadalupe County. Federal and private lands were also leased in the basin. Drilling should follow the extensive leasing that occurred in 1991 and 1990 (Broadhead, 1991). Pennsylvanian and Permian strata are primary targets in the Tucumcari Basin (Broadhead and King, 1988).

Southwest New Mexico

Two petroleum exploration wells (21, 30) were drilled in southwest New Mexico during 1991, one in Hidalgo County and one in Socorro County. Elsewhere, a large lease play emerged in Catron County.

Along the northern margin of the Pedregosa Basin of Grant County, the Arthur B. Ramsey No. 1 Ramsey State 16 (21) was ☞

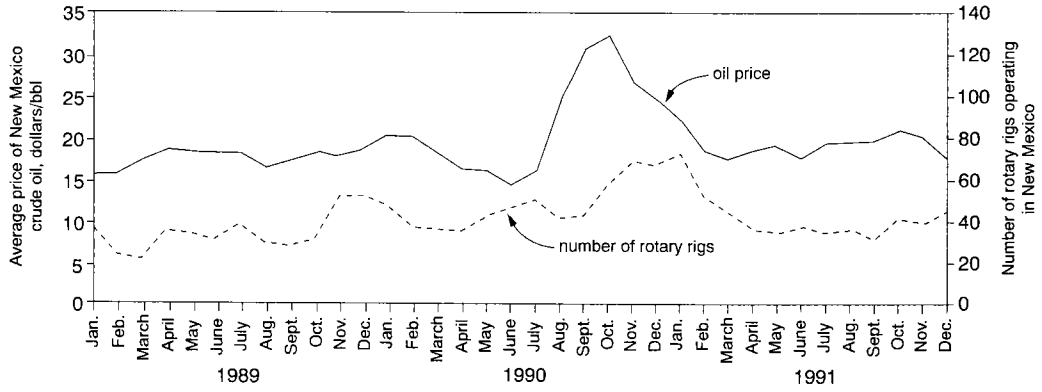

FIGURE 2—Average monthly crude oil price and number of active rotary drilling rigs in New Mexico during 1989, 1990, and 1991. Data from New Mexico Taxation and Revenue Dept. and Oil and Gas Journal (1989, 1990b, 1991).

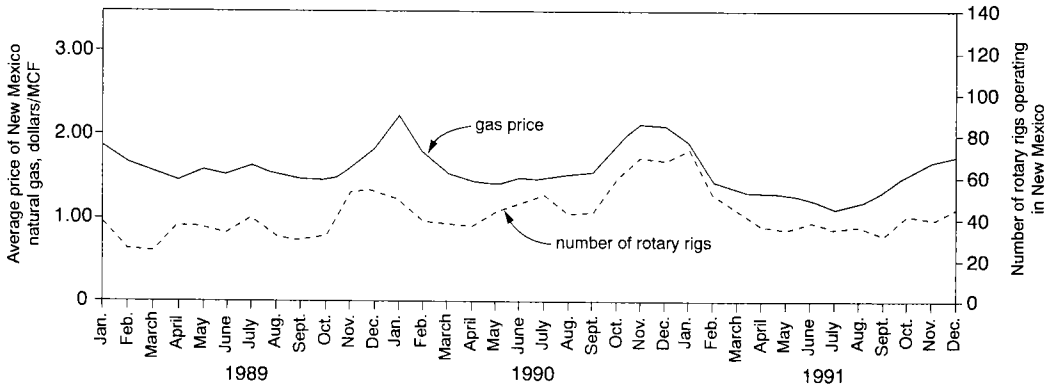

FIGURE 3—Average monthly natural gas price and number of active rotary drilling rigs in New Mexico during 1989, 1990, and 1991. Data from New Mexico Taxation and Revenue Dept. and Oil and Gas Journal (1989, 1990b, 1991).

drilled in the northern part of the Little Hatchet Mountains. The well was spudded in the Ringbone Formation (Cretaceous) and was drilled to a total depth of 1,672 ft in Cretaceous rocks before being abandoned without reported shows. Although production has not been established from the Pedregosa Basin, the Paleozoic and Lower Cretaceous sections are promising targets (Thompson, 1981).

In eastern Socorro County, the Mountain States Petroleum No. 1 Hattie Lacy (30) was drilled on a large north-plunging anticline that forms the eastern boundary of the Jornada del Muerto. The well was spudded in the Yeso Formation (Permian) and reached an unreported total depth during September 1991. The well is presently considered "tight."

No drilling occurred elsewhere in New Mexico during 1991. However, in the Baca Basin of west-central Catron County, Dugan Production Co. successfully bid on 3,843 acres of State Trust Land during the October 1991 state lease sale. Wengerd (1959), Foster (1964), Woodward and Grant (1986), and Broadhead and Black (1989) have discussed the petroleum potential of this area.

Production and economics

In 1990, New Mexico was the seventh largest producer of crude oil and the fourth largest producer of natural gas in the United States (Energy Information Administration, 1991). Production of crude oil and lease condensate in New Mexico in 1991 was approximately 70.4 million bbls, an increase of 3.4% from the 68.1 million bbls produced during 1990 (New Mexico Oil Conservation Division data). Production of natural gas in 1991 was approximately 1,019 billion ft^3 (BCF), an increase of 5.6% from the 965 BCF produced in 1990. In 1991, 93% of the state's oil and 46% of the state's gas were produced from the Permian Basin and adjoining areas of southeast New Mexico; 7% of the state's oil and 54% of the state's gas were produced from the San Juan Basin of northwest New Mexico.

As of December 31, 1990, New Mexico had proved crude oil reserves of 687 million bbls (Energy Information Administration, 1991); the Permian Basin contains 92% of the state's proved oil reserves and the San Juan Basin contains 8% of the state's proved oil reserves. Additionally, New Mexico had reserves of 75 million bbls of lease condensate (Energy Information Administration, 1991); 71% of the state's condensate reserves are in the San Juan Basin and 29% of the state's condensate reserves are in the Permian Basin. Furthermore, there are an additional 256 million bbls of crude oil reserves in existing reservoirs that may be economically recoverable through implementation of existing enhanced-recovery technology (Energy Information Administration, 1991); 99% of those reserves are in the Permian Basin. As of December 31, 1990, New Mexico had proved natural gas reserves of 18.5 TCF (Energy Information Administration, 1991); the San Juan Basin contains 81% of the state's gas reserves and the Permian Basin contains 19% of the state's gas reserves.

The estimated value of oil produced in New Mexico during 1991 was approximately $1.4 billion (New Mexico Oil Conservation Division data). The estimated value of produced gas was also approximately $1.4 billion. The state derives a large amount of revenue from taxes and royalties levied on oil and gas production (Table 5). In 1990, New Mexico received $299 million from oil and gas taxes and from oil and gas royalties on State Trust Lands. In addition, New Mexico received $103 million as its share of revenues from leases on federal lands within the state; this value includes bonuses, royalties, and rentals derived from leases and production of oil, gas, and coal.

The increase in oil production during 1991 resulted mostly from an increase in oil prices. The average sales price of New Mexico crude oil increased suddenly to

TABLE 5—State oil and gas revenues collected in 1991. Data from New Mexico Taxation and Revenue Dept., Oil and Gas Accounting Division.

Tax or royalty	Amount collected in 1991
Severance tax	$ 91,889,512
School tax	$ 76,851,038
Ad valorem tax	$ 24,673,351
Conservation tax	$ 4,390,108
Royalty on state trust land	$101,176,752
TOTAL	$298,980,761

more than $30.00/bbl during the onset of the Persian Gulf War at the end of 1990 (Fig. 2). After successful military action by the allied coalition, prices subsequently decreased and stabilized at approximately $20.00/bbl and were sustained at values somewhat greater than before the war. The spike in oil prices at the end of 1990 resulted in increased drilling activity (Fig. 2) which led to increased oil production from new wells. More important, however, was that the higher prices provided incentive to increase or re-establish production from existing wells, particularly those with marginal production. This is a strong indication that production in New Mexico will increase as a result of favorable economic changes. A sustained increase in oil prices will result in an increase in exploration for new reserves, which should help increase production or at least stem the rate of decline. Gradual decreases in future reserves and production will probably be arrested only if the number of operating rigs is increased substantially or if a major discovery is made.

The increase in gas production in 1991 was caused primarily by an increased demand for gas, although productive capacity rose as a result of extensive development of coal-bed methane reservoirs in the San Juan Basin. Primary markets for New Mexico gas are in California. New Mexico gas faces stiff competition in California from fuel oil, Wyoming gas, and imported subsidized Canadian gas. Competition from fuel oil will decrease if the price of crude oil stays relatively high; also, natural gas may replace fuel oil in many markets because it is a more environmentally desirable fuel.

The price of New Mexico gas averaged $1.42/MCF during 1991 (Fig. 3). This is the lowest price since 1979 ($1.39/MCF) and is substantially lower than the maximum annual price of $2.77/MCF reached in 1984. The low prices of natural gas are spread throughout the nation and are not confined to New Mexico (Oil and Gas Journal, 1992). The low prices have been caused by growing domestic gas supplies, new imports of Canadian gas, and a stagnant U.S. economy that has resulted in sluggish demand. Prices are not expected to increase in the near future. One of the consequences of low prices is that drilling for natural gas will continue at a diminished rate; exploration for and development of gas resources will be minimal.

The construction of several new pipelines (Broadhead, 1991; Whitehead, 1991) will provide New Mexico producers greater flexibility when attempting to market their gas and will open markets in the midwest. However, the new pipelines will have no effect on the nationwide gas surplus and prices will remain relatively low. One bright spot has emerged for New Mexico producers, however. If the North American Free Trade Agreement is signed, it is probable that markets for New Mexico gas will develop in northern Mexico.

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