# Oil and gas discovery wells drilled in New Mexico in 1988

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# Oil and gas discovery wells drilled in New Mexico in 1988

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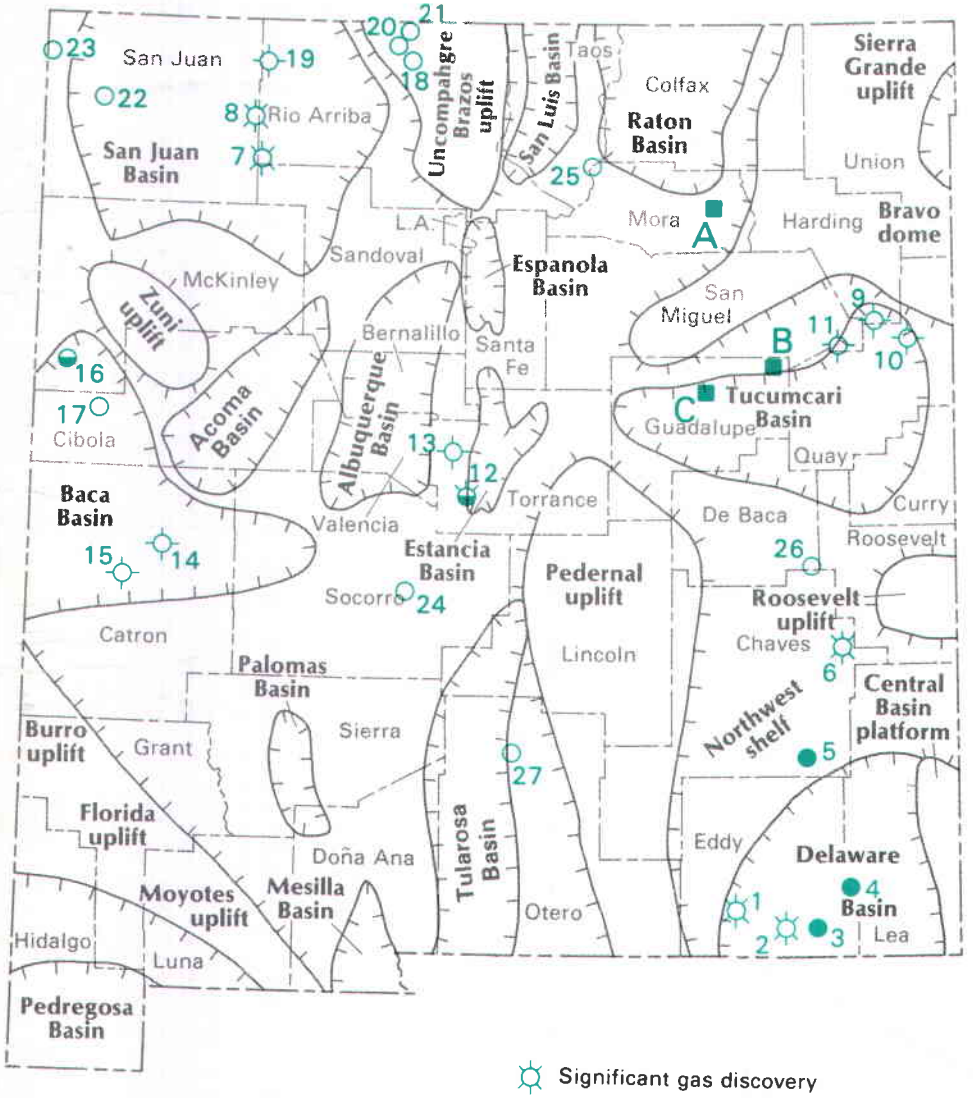


FIGURE 1—Significant oil and gas discoveries and wildcat wells drilled in New Mexico in 1988. Major geologic features are taken from Broadhead and King (1988), Cather and Johnson (1984), Kelley (1978), Kottlowski and Stewart (1970), Meyer (1966), Molenaar (1977), Thompson and Jacka (1981), and Woodward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

## Introduction

More wells were drilled for oil and gas in New Mexico in 1988 than in 1987. Data obtained from the New Mexico Oil Conservation Division indicate 1,043 wells were completed in 1988, up 11% from the 938 wells completed in 1987 but down 64% from the record 2,867 wells completed in 1981. In the Permian Basin, southeast New Mexico, 738 wells were completed in 1988, down from 740 completions in 1987; 435 wells were completed as oil producers, 139 wells were completed as gas producers, and 164 wells were plugged and abandoned, resulting in a success rate of 78%. In the San Juan Basin, northwest New Mexico, 305 wells were completed in 1988, up from 198 completions in 1987; 74 wells were oil producers, 176 wells were gas producers, and 55 wells were plugged and abandoned, resulting in a success rate of 82%. In addition, two wells were completed in the Bravo dome carbon dioxide gas field of southern Union and eastern Harding Counties.

Total footage of hole drilled in 1988 was 5,344,414 ft, up from 4,767,394 ft in 1987. The average depth of wells drilled in 1988 was 5,124 ft, 41 ft more than the average depth drilled in 1987.

## Also in this issue



## Coming soon

Review of Mesozoic nomenclature
Eagle Nest–Granite Hill area rocks
Fenton Hill granodiorite

The downturn in drilling over the past seven 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. Despite this, however, significant exploratory drilling continued in the Baca, Estancia, and Tucumcari Basins and in the Gallup–Zuni sag west of the Zuni uplift (Fig. 1). Locations were staked at the end of 1988 for frontier wildcat wells to be drilled in eastern Socorro County, north-central Otero County, Taos County, western Cibola County, and northeast Rio Arriba County.

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 1988 are shown in Figure 1. Table 1 summarizes the significant wildcat discoveries and Table 2 summarizes the significant wildcat dry holes. Table 3 lists other significant wildcat wells that were being drilled, were not completed, or were held "tight" at the end of 1988.

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

## Southeast New Mexico

Drilling activity remained slow in 1988 in the three geologic subdivisions of the Permian Basin: the Delaware Basin, the Central Basin platform, and the Northwest shelf. Drilling activity was also light on the Roosevelt uplift. Despite the slow drilling activity, however, the Permian Basin yielded several significant oil and gas discoveries in 1988 (Fig. 1; Table 1). McKamey (1988) presented stratigraphic charts of oil- and gas-producing rock units in southeastern New Mexico, as well as geologic summaries of recently discovered oil and gas pools.

The Delaware Basin, the deep marine part of the Permian Basin, yielded four significant discoveries in 1988. Gas was found in Cisco strata (Pennsylvanian) in the BTA Oil Producers No. 1 8710 JV–P Tank B (1). Gas was found in Wolfcamp strata (Permian) in the Enron Oil & Gas No. 1 Harkey State 35 (2). The Wolfcamp also yielded a significant oil discovery in the Enron Oil & Gas No. 1 Queen Lake Federal 20 (3). Oil was discovered in basinal Brushy Canyon sandstones of the Delaware Mountain Group (Permian) in the Pogo Producing No. 1 Neff Federal 13 (4). Because of the relatively slack gas market, exploration in the Delaware Basin was concentrated primarily on finding new oil reserves; less effort was concentrated on finding new gas reserves. Major targets for oil exploration were basinal sandstones of the Bone Spring Formation and Delaware Mountain Group (Permian) and Wolfcamp carbonate reservoirs (Permian). Exploration for gas was concentrated mostly in Cisco, Canyon, Strawn, Atokan, and Morrowan reservoirs (Pennsylvanian). There was limited exploration for oil in the deep (10,000–13,000 ft) Silurian and Devonian carbonate reservoirs.

Development drilling in the Delaware Basin was mostly for oil in 1988. Major targets for development drilling were oil reservoirs in the shallow (4,000–6,000 ft) Delaware Mountain Group (Permian) and moderately deep (6,000–10,000 ft) Bone Spring Formation (Permian). Development drilling for gas was mostly in deep (10,000–14,000 ft) Atokan and Morrowan (Lower Pennsylvanian) clastic units.

No significant wildcat discoveries were made on the Central Basin platform in 1988. Exploration was concentrated on deep (10,000–12,000 ft) Silurian and Devonian targets under the platform and along the western border areas of the platform. Several exploratory wells were drilled for this purpose and several old abandoned wells were re-entered with attempts to recomplete for Silurian and Devonian discoveries. Development drilling was mostly for oil in the shallow (2,000–5,000 ft) Queen and Grayburg sandstones (Permian) and San Andres

TABLE 1—Significant wildcat discoveries in New Mexico in 1988; the term formation is used in an informal sense. **BOPD,** bbls oil per day; **BWPD,** bbls water per day; **MCFGPD,** thousand $ft^3$ gas per day; **IP,** initial potential; **IPF,** initial potential, flowing; **IPP,** initial potential, pumping; **IPCAOF,** initial potential, calculated absolute open flow; **NR,** not released; **owwo,** old well worked over.

| 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 | 34–23S–24E, Eddy | BTA Oil Producers No. 1 8710 JV–P Tank B | 6/88 | 9,975 | Barnett (Mississippian) | Cisco (Pennsylvanian) | 8,036–8,120 | IPF 724 MCFGPD | |
| 2 | 35–24S–27E, Eddy | Enron Oil & Gas No. 1 Harkey State 35 | 2/88 | 12,920 | Morrow (Pennsylvanian) | Wolfcamp (Permian) | 10,364–10,380 | IP 416 MCFGPD | |
| 3 | 20–24S–29E, Eddy | Enron Oil & Gas No. 1 Queen Lake Federal 20 | 3/88 | 12,390 | Atoka (Pennsylvanian) | Wolfcamp (Permian) | 9,884–10,034 | IPF 47 BOPD + 67 MCFGPD + 171 BWPD | 46.6 |
| 4 | 13–22S–31E, Eddy | Pogo Producing No. 1 Neff Federal 13 | 9/88 | 14,975 | Morrow (Pennsylvanian) | Delaware (Permian) | 7,119–7,158 | IPF 232 BOPD + 160 MCFGPD + 131 BWPD | 36.5 |
| 5 | 9–14S–29E, Chaves | Santa Fe Exploration No. 1 Holmstrom Federal | 9/88 | 9,758 | Devonian | Devonian | 9,728–9,758 | IPF 403 BOPD + 14 MCFGPD | 46 |
| 6 | 29–7S–31E, Chaves | Robert N. Enfield No. 1 McCombs E | 4/88 | 9,182 | Precambrian | Devonian | 8,477–8,551 | IPCAOF 1,802 MCFGPD | |
| 7 | **30–24N–7W, Rio Arriba** | Dugan Production Corp. No. 1 Ollie | 2/88 | 2,200 | Pictured Cliffs (Cretaceous) | Fruitland Pictured Cliffs (Cretaceous) | 2,084–2,091; 2,091–2,096 | IPP 35 MCFGPD + 25 BWPD | |
| 8 | 1–26N–8W, San Juan | Meridian Oil Inc. No. 1 Luthy (owwo) | 9/88 | 2,207 | Pictured Cliffs (Cretaceous) | Fruitland (Cretaceous) | 1,964–2,105 | NR. Gas well. | |


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carbonates (Permian). Sirgo–Collier, Inc. continued extensive development of a waterflood unit in the Dollarhide Queen oil pool of southeast Lea County. Chevron continued its infill drilling program of the Eunice–Monument Grayburg–San Andres oil pool of east-central Lea County. Other targets of development drilling on the Central Basin platform were oil reservoirs in the Blinebry, Tubb, and Drinkard zones of the Yeso Formation (Permian).

Two significant wildcat discoveries were made on the Northwest shelf in 1988. Oil was found in Devonian reservoirs in the Santa Fe Exploration No. 1 Holmstrom Federal (5). Gas was found in Devonian reservoirs in the Robert N. Enfield No. 1 McCombs E (6) in east-central Chaves County.

In contrast with other parts of the Permian Basin, development drilling of oil and gas pools on the Northwest shelf continued at a relatively brisk pace during 1988. Major targets were oil reservoirs in the shallow (2,000–6,000 ft) Grayburg and San Andres Formations (Permian). Conoco and Phillips continued extensive infill drilling programs in the Maljamar Grayburg–San Andres oil pool of northwest Lea County. Conoco began its second carbon dioxide flood in the Maljamar pool early in 1989. Phillips continued its extensive infill drilling program in the Vacuum Grayburg–San Andres oil pool of northwestern Lea County. There was limited development of deeper oil reservoirs: Wolfcamp (Permian) carbonates, Pennsylvanian carbonates, and Ordovician carbonates.

The only gas pools extensively developed on the Northwest shelf in 1988 were the Pecos Slope Abo and West Pecos Slope Abo gas pools of northwest and north-central Chaves County. More than 50 infill wells and extension wells were drilled in those pools, which produce from "tight" fine-grained red beds of the Abo Formation at depths of 3,500–5,000 ft. Production from most of the 600 wells in the Abo gas pools was shut in during early June when it was discovered that trace amounts of arsenic were present in the Abo gas. Wells which connected to Enron Corporation's Transwestern pipeline were shut in; most Abo gas is transported to customers in California through this pipeline. Arsenic concentrations were estimated to be 500 micrograms/$m^3$ for gas delivered to the Transwestern pipeline and 0.05 ppb for gas delivered to the El Paso Natural Gas pipeline that serves the area (Slaton, 1988). Nine gas-treatment units were installed in the Pecos Slope Abo pools. Those treatment units remove the arsenic from the gas before it enters the main pipeline (Slaton, 1989). Abo gas production resumed in December, 1988.

The Roosevelt uplift and adjacent areas were drilled sparsely in 1988. No significant wildcat discoveries were made. Development drilling was concentrated on oil reservoirs in the southern part of Roosevelt County; primary targets were in the Todd San Andres oil pool and the North Bluitt Silurian–Devonian oil pool. Development of Ordovician and Pennsylvanian reservoirs in the Tule gas field of northwest Roosevelt County continued.

TABLE 2—Significant wildcat dry holes drilled in New Mexico in 1988; the term formation is used in the informal sense. **D&A,** dry and abandoned; **perf,** perforated; **acid,** acidized; **owdd,** old well drilled deeper; **OTD,** old total depth; **TD,** total depth.

| Number on Fig. 1 | Location (section–township–range, county) | Operator, well number, and lease | Completion date (month/year) | Total depth (ft) | Formation at total depth | Status | Comments |
|---|---|---|---|---|---|---|---|
| 9 | 16–14N–32E, Harding | Michael K. Galvis No. 1 State HGH | 7/88 | 1,098 | San Andres (Permian) | D&A | Lost circulation in San Andres Formation (Permian). |
| 10 | 16–13N–34E, Quay | Esperanza Energy No. 1 Logan State | 6/88 | 3,600 | Precambrian | D&A | Perf & acid 3,220–3,330 ft & 3,190–3,200 ft (granite) with no show. Perf & acid 3,112–3,120 ft (Abo) with no show. Perf 2,598–2,622 ft (Tubb) with no show. |
| 11 | 31–13N–30E, San Miguel | Tom L. Ingram No. 1 Gihon (owdd) | 9/88 | 4,744 | Precambrian | D&A | Tested several zones; no details available. Old well completed in 1986. OTD 2,579 ft in Yeso (Permian). |
| 12 | 6–3N–7E, Torrance | Bruce Wilson No. 1X Judd | 3/88 | 2,840 | Permian | D&A | Perf & acid 1,628–1,634 ft, 1,876–1,882 ft, 2,246–2,252, 2,440–2,444 ft (Permian). Oil & gas show reported. |
| 13 | 12–6N–6E, Torrance | John Aday No. 2 D'Spain | 6/88 | 1,900 | Pennsylvanian | D&A | Spudded in 1983. TD reached in 1984. Abandoned in 1988. |
| 14 | 27–1S–13W, Catron | Shell Western Exploration & Production No. 1 SWEPI et al. Aspen Federal | 4/88 | 9,000 | Precambrian | D&A | "Tight" hole. No reported |
| 15 | 21–3S–15W, Catron | Shell Western Exploration & Production No. 1 SWEPI et al. Mangas Mountains Federal | 12/87 | 7,808 | Precambrian | D&A | "Tight" hole. No reported shows. TD reached on 11/10/87. |
| 16 | 28–11N–19W, McKinley | Burr Oil & Gas No. 1 Zuni | 12/88 | 1,885 | Yeso (Permian) | D&A | Lost circulation at 1,110 ft (San Andres). Encountered wet oil in San Andres (Permian), salt water in Glorieta (Permian), and salt water and oil in Yeso (Permian). Unable to drill deeper or run drill-stem test because hole caved in. Drilled on Piñon Springs anticline. |

## Northwest New Mexico

In 1988, 305 wells were completed in northwest New Mexico, up from 198 completions in 1987 but down from 405 completions in 1986 and 863 completions in 1985. The diminished rate of drilling since 1986 has been caused by depressed gas prices and a depressed market for gas, which is the primary petroleum product of the San Juan Basin. Depressed oil prices have also taken a toll on drilling activity in the San Juan Basin.

Exploratory drilling resulted in two significant discoveries in 1988. Gas was discovered in Fruitland coal beds and the Pictured Cliffs Sandstone (Cretaceous) in the Dugan Production Corp. No. 1 Ollie (7). Gas was discovered in Fruitland coal beds during a workover of the Meridian Oil Inc. No. 1 Luthy (8), an abandoned Pictured Cliffs gas well. Exploration was concentrated in the north-central part of the basin in eastern San Juan and western Rio Arriba counties. The principal exploration target in the San Juan Basin in 1988 was coal-bed methane in the Fruitland Formation (Cretaceous). Most exploratory well completions were made by re-entering older wells that had previously produced from Cretaceous reservoirs present at greater depths than the Fruitland.

Most development drilling in the San Juan Basin was for coal-bed methane in the Fruitland. 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. More than 120 development wells and pool extension wells were completed in the Fruitland in 1988. Fruitland gas reservoirs have been ignored for many years because of low production volumes; exploration and development have been concentrated in deeper, more prolific reservoirs in the Upper Cretaceous. However, lower costs involved with drilling the shallower Fruitland reservoirs (approximately 2,000 ft deep) compensate partially for the low volumes of gas production. More importantly, producers are eligible for a federal gas-production tax credit for wells drilled be-

TABLE 3—Significant wildcat wells that were being drilled, not completed, "tight", or planned in New Mexico at the end of 1988. **owwo,** old well worked over.

| Number on Fig. 1 | Location (section–township–range, county) | Operator, well number, and lease | Comments |
|---|---|---|---|
| 17 | 27–8N–18W, Cibola | Merrion Oil & Gas No. 1 Galestina Canyon | Drilled to total depth of 2,770 ft. Perforated Permian. "Tight" hole. |
| 18 | 2–30N–3E, Rio Arriba | Heyse Oil No. 1 Rio Chama | Scheduled to drill to 2,000 ft to Precambrian. Drilled to total depth of 254 ft then shut down due to mechanical problems. |
| 19 | 10–30N–7W, Rio Arriba | Blackwood & Nichols Co. No. 501 Northeast Blanco Unit | Drilled to 8,956 ft to test Entrada (Jurassic). Tested Entrada, Bluff, and Morrison with no reported shows. Converted to water injection well. |
| 20 | 19–31N–3E, Rio Arriba | Spur Oil No. 1 South | Location staked. Scheduled to drill to 1,100 ft to test Entrada (Jurassic). |
| 21 | 29–32N–3E, Rio Arriba | Spur Oil No. 1 Quinlan Ranch 29 | Drilled to total depth of 3,865 ft in Entrada (Jurassic). Perf Greenhorn (Cretaceous) from 2,340 to 2,370 ft. |
| 22 | 17–27N–17W, San Juan | Chuska Energy No. 1 Table Mesa Navajo Tribal | Location staked. Scheduled to drill to 8,300 ft to test McCracken Sandstone (Devonian). |
| 23 | 13–30N–21W, San Juan | Chuska Energy No. 2 Beclabito (owwo) | Location staked. Scheduled to test McCracken Sandstone (Devonian) at 5,000 ft. |
| 24 | 1–4S–3E, Socorro | James K. Anderson No. 1 Wishbone Federal | Scheduled to drill to 4,000 ft to test Permian and Pennsylvanian sections. |
| 25 | 35–24N–14E, Taos | Conoco, Inc. No. 1 Taos Trough Unit | Scheduled to drill to 6,000 ft to test Pennsylvanian section. Location staked in 1986. Operator changed from Leonard Minerals. |
| 26 | 15–2S–28E, De Baca | Esperanza Energy No. 1 McClain Ranch | Scheduled to drill to 3,000 ft to test Glorieta Sandstone (Permian). |
| 27 | 7–14S–11E, Otero | Cibola Energy No. 1 Ysletano Canyon Federal | Scheduled to drill to 3,800 ft in Devonian strata. Location staked in 1986. |

fore January 1, 1991; that tax credit applies to gas produced from those wells prior to the year 2000. As a result of the tax credit, a drilling boom started as operators rushed to develop their reserves before the deadline. Meridian Oil Company and Amoco Production Company are the major operators in the coal-bed methane play; Nassau Resources, Southland Royalty, Northwest Pipeline, Blackwood & Nichols, and Union Texas Petroleum also have significant holdings and have drilled wells within the New Mexico part of the San Juan Basin (Neil H. Whitehead III, personal communication 1989). Other significant targets of development drilling for natural gas in 1988 were the Pictured Cliffs Sandstone (Cretaceous), sandstones in the Mesaverde Group (Cretaceous), and the Dakota Sandstone (Cretaceous).

Although development drilling for oil was subordinate to development drilling for gas in 1988, significant efforts were still made. Major targets of development drilling for oil were the Gallup and Dakota Sandstones (Cretaceous) and the lower part of the Mancos Shale (Cretaceous). Effort was concentrated in the Bisti Gallup, South Bisti Gallup, Lybrook Gallup, and West Lindrith Gallup–Dakota oil pools.

Production in the San Juan Basin is almost entirely from Cretaceous reservoirs. Relatively minor amounts of production are obtained from stratigraphic traps in the Entrada Sandstone (Jurassic) in the southeastern part of the basin and from Pennsylvanian, Mississippian, and Devonian reservoirs in structural traps along the western flank of the basin. Significant exploration focused on Jurassic and Paleozoic targets in 1988, but the Jurassic and Paleozoic remain essentially frontiers for petroleum exploration.

In the central part of the basin, the Blackwood & Nichols No. 501 Northeast Blanco Unit (19) was drilled to a total depth of 8,956 ft; Entrada, Bluff, and Morrison sandstones (Jurassic) were tested without reported shows. In the easternmost part of the basin, which is also known as the Chama Basin, the Spur Oil No. 1 Quinlan Ranch 29 (21) drilled to a total depth of 3,865 ft in the Entrada Sandstone; the Greenhorn Limestone (Cretaceous) was tested without reported show. The Heyse Oil No. 1 Rio Chama (18) was scheduled to reach a total depth of 2,000 ft in Precambrian, but drilling was terminated at a depth of 254 ft because of mechanical problems with the rig; it remains unknown if the operator plans to resolve those problems and continue drilling. Farther north, location was staked for the Spur Oil No. 1 South (20) which reportedly will be drilled to a total depth of 1,100 ft to test the Entrada.

Along the western flank of the San Juan Basin, Chuska Energy entered into an exploration agreement with the Navajo Nation on their reservation. As a result of that agreement, locations for two wells (22, 23) were staked. Those wells are scheduled to drill to the McCracken Sandstone (Devonian), which unconformably overlies Precambrian basement. Presumably, carbonate reservoirs of Pennsylvanian and Mississippian age are also exploratory targets in those wells.

Elsewhere in northwest New Mexico, two exploratory wells were drilled 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 and the Baca Basin. The Merrion Oil & Gas No. 1 Galestina Canyon (17) was drilled on a prominent anticline to a total depth of 2,770 ft. Production casing was set and perforated. The well was "tight" in early 1989, but apparently commercial production was not established. Farther to the north, the Burr Oil & Gas No. 1 Zuni (16) was spudded on the Piñon Springs anticline and subsequently drilled to a total depth of 1,885 ft in the Yeso Formation (Permian); oil shows were reportedly encountered in the San Andres Formation (Permian) and in the Yeso. The well was abandoned because the hole caved in. The Piñon Springs anticline remains poorly tested.

The Burr well was drilled as part of an exploration agreement made by the Zuni Pueblo with Burr and High Plains Petroleum Corp. The agreement covers an exploration area of more than 20,000 acres. Under the terms of the agreement, two additional wells will be drilled in southwestern McKinley County during 1989. One well will test the Wompia Springs anticline and the other well will test the Galestina monocline.

### Northeast New Mexico

Petroleum exploration continued in the frontier areas of northeast New Mexico in 1988. Three wildcat wells were drilled in the Tucumcari Basin and two wildcat wells were plugged in the Estancia Basin. Development of the Bravo dome carbon dioxide gas field continued. Petroleum has not been produced commercially in northeast New Mexico except during a brief period in the 1970's when marginally commercial amounts of gas were produced from the Morrison Formation (Jurassic) and Dakota Sandstone (Cretaceous) at the currently inactive Wagon Mound field in Mora County (Fig. 1, letter A). In the 1980's, the Newkirk pool (Fig. 1, letter B) has produced 508 bbls heavy oil from the Santa Rosa Formation (Triassic) with the aid of a pilot steamflood project. McKallip (1987) reported on the geology of the steamflood project in the Newkirk pool. In the 1930's, approximately 153,000 tons of tar sands were mined from the Santa Rosa Formation near the town of Santa Rosa in Guadalupe County (Gorman and Robeck, 1946; Fig. 1, letter C).

In the Estancia Basin of Torrance County, the Bruce Wilson No. 1X Judd (12), which had been drilled in 1987, was plugged in 1988. The No. 1X Judd had been drilled to a total depth of 2,840 ft in the Abo red beds (Permian). Oil and gas shows were reported, presumably in the Yeso or Abo Formations (Permian). The John Aday No. 2 D'Spain (13) was finally plugged; the well was spudded in 1983 and had been drilled to a total depth of 1,900 ft by April, 1984. No shows were reported.

Exploratory activity continued in the Tucumcari Basin in 1988. Drilling was concentrated along the northern margin of the basin. The Michael K. Galvis No. 1 State HGH (9)

was drilled to a total depth of 1,098 ft in granite wash (Pennsylvanian) and subsequently abandoned. No shows were reported in this well; circulation was lost in the San Andres Formation (Permian). The Esperanza Energy No. 1 Logan State (10) was drilled to a total depth of 3,600 ft in Precambrian basement. The Precambrian, a sandstone in the Abo Formation (Permian), and the Tubb sandstone (Permian) were tested through casing perforations, but no shows were reported. The Tom L. Ingram No. 1 Gihon (11; Fig. 2) was re-entered and deepened in 1988. The well had originally been drilled to a total depth of 2,579 ft in 1986 and was a San Andres (Permian) test. It was reentered in 1988 and drilled to a new total depth of 4,744 ft in Precambrian basement. Apparently, several zones were tested before the well was abandoned, but details of completion and testing operations are not available. Broadhead and King (1988) reported on the petroleum geology of the Tucumcari Basin.

Exploratory activity was quiet elsewhere in northeast New Mexico. No wells were drilled in either the Raton or San Luis Basins. However, the clastic Cretaceous section of the Raton Basin has considerable petroleum potential and wells drilled into the Cretaceous in past years have encountered significant and promising shows of gas. Speer (1976) and Woodward (1987) discussed the petroleum geology of the Raton Basin.

A location remained staked for the Conoco No. 1 Taos Trough Unit (25) in the Sangre de Cristo Mountains. The location was originally staked in 1986 by Leonard Minerals; the operator was subsequently changed to Conoco. The well will spud in the Pennsylvanian section and is scheduled to be drilled to a total depth of 6,000 ft. The No. 1 Taos Trough Unit will be the first petroleum exploration well drilled in Taos County.

Development of the Bravo dome carbon dioxide gas field of southern Union and southeastern Harding Counties continued at a slow pace. In 1988, two wells were drilled. The main reservoir at Bravo dome is the Tubb sandstone (Permian), which lies at depths of approximately 2,000 ft. Minor production is obtained from Santa Rosa sandstones (Triassic). Most carbon dioxide produced from the Bravo dome field is used for enhanced oil recovery in the west Texas part of the Permian Basin. Eventually, as production wanes from oil fields under waterflood in the New Mexico part of the Permian Basin, carbon dioxide will be used increasingly for enhanced oil recovery in the New Mexico part of the Permian Basin. The demand for carbon dioxide in both New Mexico and Texas will increase. Exploration for additional carbon dioxide reserves in northeast New Mexico will be needed.

### Southwest New Mexico

Two significant wildcat wells were abandoned in the Baca Basin of southwestern New Mexico during 1988. The Shell Western Exploration and Production No. 1 SWEPI et al. Mangas Mountains Federal (15) was drilled to a total depth of 7,808 ft during 1987 and was subsequently abandoned without reported shows. The Shell No. 1 SWEPI et al. Aspen Federal (14) was drilled to a total depth of 9,000 ft and abandoned in 1988. Both wells are "tight." They were drilled in a federal exploration unit known as the "Magic Area." This exploration unit was formed by a consortium of Shell, Standard Oil (Sohio, now BP Exploration), and Elf Aquitaine in 1986 and covers approximately 3.5 million acres in northern Catron and western Socorro Counties. A third well, the Shell No. 1 Mangas Mountains Federal, located in Sec. 21, T3S, R15W, Catron County, was drilled and abandoned in 1987. Extensive reflection seismic surveys have been run by the consortium in the Magic Area. The Shell exploration and drilling program constitutes the first comprehensive effort to evaluate and test the petroleum potential of central Catron County. Primary targets in Catron County are Upper Cretaceous sandstones, the San Andres Formation, Glorieta Sandstone, sandstones and carbonates in the Yeso Formation (Permian), and Pennsylvanian sandstones and limestones.

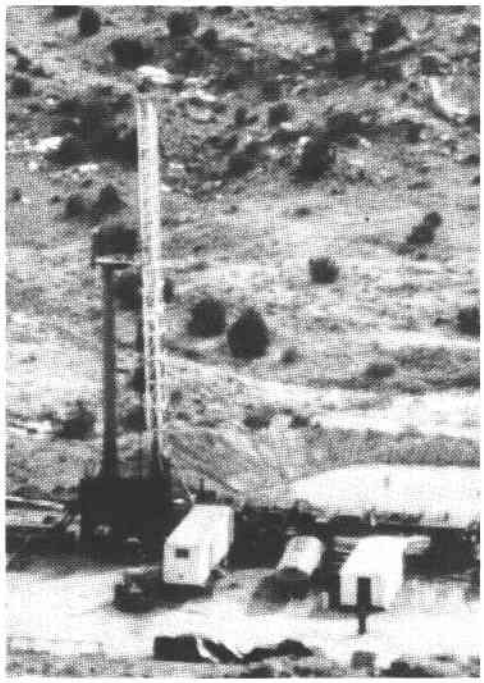

FIGURE 2—Tom L. Ingram No. 1 Gihon (Fig. 1, no. 11; Table 1, no. 11) drilling on the northern margin of the Tucumcari Basin, January 1988.

In eastern Socorro County at the northern end of the Jornada del Muerto, plans were made to spud the James K. Anderson No. 1 Wishbone Federal (24). That well will be drilled on the Prairie Springs anticline and is scheduled to drill to Precambrian basement at a depth of 4,000 ft. Primary targets are Pennsylvanian sandstones and limestones.

No exploration wells were drilled elsewhere in southwest New Mexico in 1988. However, the Paleozoic and Lower Cretaceous sections of the Pedregosa Basin are promising targets (Thompson, 1980, 1981).

### Oil and gas production

In 1987, 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, 1988). Production of crude oil and lease condensate in New Mexico in 1988 was approximately 71.2 million bbls, a decrease of 1.5% from the 72.3 million bbls produced in 1987 (New Mexico Oil Conservation Division data). Production of natural gas in 1988 was approximately 781 billion $ft^3$ (BCF), a decrease of 4.0% from the 813 BCF produced in 1987. In 1987, 89% of the state's oil and 52% of the state's gas were produced from the Permian Basin; 11% of the state's oil and 48% of the state's gas were produced from the San Juan Basin. As of December 31, 1987, New Mexico had proved crude oil reserves of 654 million bbls oil, an increase of 10 million bbls from December 31, 1986 (Energy Information Administration, 1988); the Permian Basin contains 93% of the state's proved oil reserves and the San Juan Basin contains 7% of the state's proved oil reserves. Additionally, New Mexico had reserves of 63 million bbls of lease condensate as of December 31, 1987 (Energy Information Administration, 1988); 75% of the state's condensate reserves are in the San Juan Basin and 25% of the state's condensate reserves are in the Permian Basin. As of December 31, 1987, New Mexico had proved natural gas reserves of 12.6 trillion $ft^3$ (TCF), an increase of 0.1 TCF from December 31, 1986 (Energy Information Administration, 1988); the San Juan Basin contains 75% of the state's gas reserves and the Permian Basin contains 25% of the state's gas reserves. Those reserve estimates apparently do not include coal-bed methane in the Cretaceous of the San Juan Basin. Kelso et al. (1988) stated that coals in the Fruitland Formation (Cretaceous) contain an estimated 50 TCF gas in place in the San Juan Basin; approximately 70% of that gas is located within the New Mexico part of the basin. It is not known what percentage of the coal-bed methane is recoverable.

The decrease in oil production in 1988 can be attributed to a decline in the price of crude oil since January 1986 (Fig. 3). The posted price of west Texas intermediate crude oil with a gravity of 40° API (the "benchmark" crude oil of the United States) fell 55% from $27.25/bbl in January 1986 to $12.25/bbl in July 1986. The price subsequently rose to $20.00/bbl in August 1987 and then fell to $13.75/bbl in November 1988. Since the end of 1988, posted prices for west Texas intermediate crude have risen to $17.75/bbl in March 1989 (Oil and Gas Journal, 1989a), when this article was written.

The sharp fall in oil prices at the beginning of 1986 was due to a sudden rise in oil production by several major producing countries (notably Great Britain and Latin American and Middle Eastern countries) in an effort to increase income from oil revenues. The rise in oil production created an oversupply of oil and caused prices to plummet. A gradual reduction of world petroleum

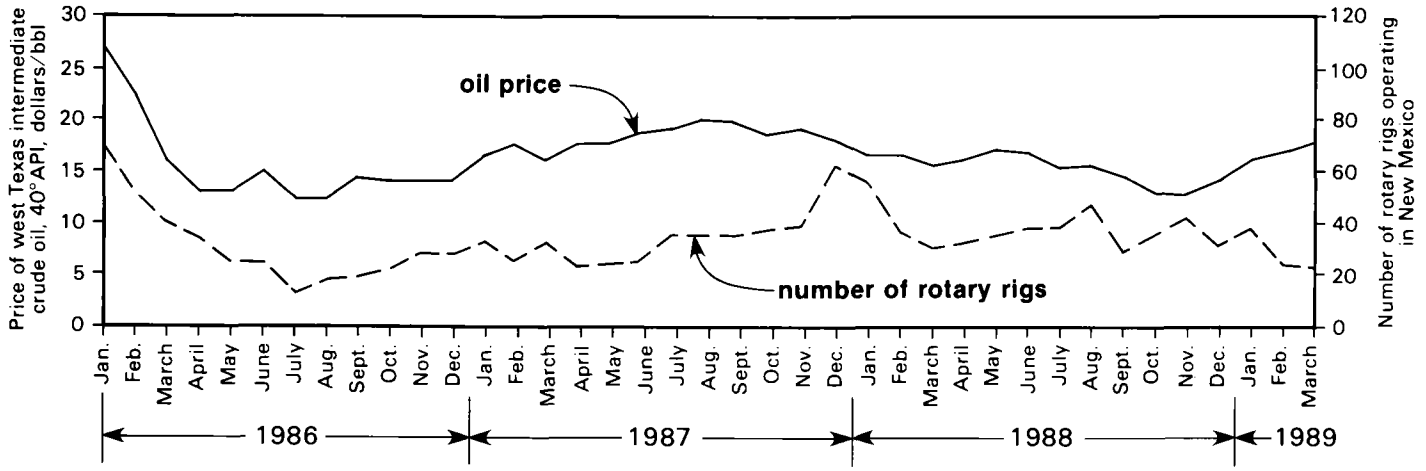


FIGURE 3—Monthly crude oil prices and number of active rotary rigs in New Mexico during 1986, 1987, 1988, and early 1989. Data from Oil and Gas Journal (1986a, b; 1987a, b; 1988a, b; 1989a, b).

stocks, rising worldwide demand, and partially successful attempts by OPEC nations to reinstate production ceilings caused a subsequent gradual, albeit unsteady, price increase.

Because of the decrease in oil prices, many marginal and stripper wells were shut in or plugged. Their production may never be regained unless oil prices increase sufficiently to justify the expense of re-opening such wells. Stripper wells are defined as wells that produce less than 10 bbls per day. Approximately 20% of oil production in New Mexico is from stripper wells.

Declining oil prices have also resulted in a decrease in drilling and exploration activity, which is reflected in the rig count for the state (Fig. 3). Oil reserves found and developed during the "boom" drilling years of 1980–1982 reached peak development in 1983 and 1984. The drilling slump of 1983–1985 and the more serious decrease in drilling during 1986, 1987, and 1988 led to fewer exploration and development wells being drilled than in the boom years. As a consequence of decreased drilling fewer discoveries were made and existing reserves were not developed as quickly as in the past. The inevitable result was decreased production.

The Department of Energy (Energy Information Administration, 1988) indicated that proved reserves in New Mexico increased by 10 million bbls from 1986 to 1987, but only 1 million bbls were added by new field discoveries, and only 1 million bbls were added by discoveries of new reservoirs in old fields; 12 million bbls were added by extensions of existing fields. This 14 million bbls of additions were not sufficient to replace the 69 million bbls of crude oil which were produced during 1987. The calculated 10 million bbls increase of reserves was caused by revision of reserve calculations in known fields. These revisions resulted partially from infill drilling programs. The increase did not result from discovery of new hydrocarbons. However, oil discoveries made during the last five to six years provide major new exploration targets and have added new oil reserves and production that have supplanted declining production and reserves of older pools. These discoveries were made in the Strawn, Cisco, and Wolfcamp carbonates of the Northwest shelf and Delaware Basin, the Bone Spring Formation and Delaware Mountain Group of the Delaware Basin, and the Dakota and Gallup Sandstones of the San Juan Basin.

Continued oil discoveries in the San Juan and Permian Basins, as well as positive signs and hydrocarbon shows encountered by wildcat wells drilled in the frontier areas, will encourage exploratory drilling and development. However, the number of active rotary rigs in New Mexico is tied to the price of oil (Fig. 3). Gradual declines in future reserves and production will probably be halted only if oil prices rise enough to increase substantially the number of active rigs. Oil prices must not only rise, but also stabilize if an increase of the rig count is to occur. Indeed, a decline in volatility of oil prices may affect exploration and drilling as much as, or more than, an increase in prices alone. Until the rig count increases, exploratory discoveries will not keep pace with production and reserves will decline, unless a major discovery is made by one of the few rigs currently drilling. However, exploration for, and development of, major oil accumulations are profitable even at a low price of $10/bbl.

The decrease in gas production in 1988 was caused by a decreased demand for gas, rather than a decreased capability to produce gas. Primary markets for New Mexico gas are in California, and those markets continue to use and convert to alternate energy sources including fuel oil, hydroelectric power, and imported subsidized Canadian gas. Competition from fuel oil will decrease if the price of crude oil stays relatively high. The recently signed U.S.–Canadian Free Trade Agreement may cause increased competition from Canadian gas.

Most of the gas produced in 1987 and 1988 was not replaced by new discoveries of gas in conventional reservoirs. The calculated increase in gas reserves during 1987 (Energy Information Administration, 1988) was caused mostly by revision of calculations of reserves in known fields, rather than by discovery of gas in new fields or by extension of existing fields. Only 1 BCF were discovered in new fields during 1987; 13 BCF were added by discovery of new reservoirs in old fields; 144 BCF were added by extension of existing fields. These additions were not sufficient to replace the 813 BCF which were produced during 1987. However, the major reserves of coal-bed methane that were added during 1987 and 1988 do not appear in the reserve estimates of the Department of Energy. If a market for that coal gas can be found, then the long-term outlook for gas production in New Mexico is good.

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# Summary of New Mexico state taxes on natural resource production as of July 1, 1989

compiled by *James M. Barker*, New Mexico Bureau of Mines and Mineral Resources

| Commodity | Tax | Rate and base |
|---|---|---|
| Potash | Resource<br>Processor; Service*<br>Severance | 0.50% of taxable value<br>0.125% of taxable value<br>2.5% of taxable value |
| Molybdenum | Resource<br>Processor; Service*<br>Severance | 0.333% of taxable value<br>0.75% of taxable value<br>0.125% of taxable value |
| Other taxable resources (except potash and molybdenum) | Resource; Processor; Service* | 0.75% of taxable value |
| Copper | Severance<br>Service; Processor* | 0.50% of taxable value<br>0.75% of taxable value |
| Gold, silver | Severance | 0.20% of taxable value |
| Lead, zinc, molybdenum, manganese, thorium, rare-earth, and other metals | Severance | 0.125% of taxable value |
| Clay, gravel, gypsum, sand, pumice, and other nonmetals | Severance | 0.125% of taxable value |
| Coal: surface<br>underground | Severance<br>Severance | $1.17 per short ton until July 1, 1993<br>$1.13 per short ton until July 1, 1993 |
| Uranium | Resource<br>Severance | 0.75% of taxable value<br>3.5% of 50% of sales price |
| Oil, carbon dioxide | Severance | 3.75% of taxable value |
| Natural gas | Severance | $0.163 per 1,000 cu ft *or* 3.75% of taxable value, whichever is higher; except new wells (after May 1, 1987) at 3.75% only |
| Oil, gas, and carbon dioxide | School<br>Ad valorem | 3.15% of taxable value<br>Many rates (counties certify annually on September 1 to Taxation and Revenue Department) |
| Oil, gas, geothermal energy, carbon dioxide, coal, and uranium | Conservation<br>School | 0.18% of taxable value<br>3.15% of taxable value |
| Gas and hydrocarbons incidental to processing | Natural gas processor | 0.45% of taxable value |

*Subject to only one of these taxes at a time. Data source: Taxation and Revenue Department, P.O. Box 2308, Santa Fe, New Mexico 87504–2308 (505/827–2700). For information about severance and resource taxes contact Cindy Lovato (505/827–0812); for oil and gas taxes contact Michael Holden (505/827–0805).