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PETROLEUM EXPLORATION WELLS DRILLED IN WEST-CENTRAL NEW MEXICO

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Abstract—Ninety-five petroleum exploration wells have been drilled in west-central New Mexico. Wells have been drilled in the Acoma and Baca basins and in the Gallup sag, as well as on the Lucero uplift. The first well was drilled in 1919. Drilling continues, and exploration has been active in the 1980's. Although commercial amounts of oil and gas have not yet been discovered, promising shows of oil and gas have been encountered. Both source rocks and reservoirs appear to be present in this geologically complex area.

In the Acoma basin, reservoirs are present in Upper Cretaceous sandstones, in Permian limestones, dolostones and sandstones and in Pennsylvanian sandstones and limestones. Pennsylvanian shales, limestones and dolostones of the San Andres Formation (Permian) may be source rocks.

On the Lucero uplift, dolostones of the San Andres Formation (Permian) and Pennsylvanian sandstones and limestones are reservoir objectives. Possible source rocks are San Andres carbonates and Pennsylvanian shales. Oil and gas may also have been generated to the west in the Acoma basin and subsequently migrated updip into reservoirs on the Lucero uplift, or petroleum may have been generated to the east in the Albuquerque basin and subsequently migrated vertically through basin-bounding faults into the Lucero uplift.

In the Baca basin, reservoirs are present in Upper Cretaceous sandstones, Permian carbonates and sandstones, and Pennsylvanian sandstones. Possible source rocks are Upper Cretaceous marine shales and Permian carbonates. Upper Cretaceous coal beds may be reservoirs and source rocks for gas in west-central Cibola County.

In the Gallup sag, main reservoir objectives are limestones in the San Andres Formation (Permian), the Glorieta Sandstone (Permian) and sandstones and carbonates in the Yeso Formation (Permian). Source-rocks are poorly documented but may also be present in Yeso dolostones.

INTRODUCTION

West-central New Mexico is an exploratory frontier for oil and gas. Ninety-five petroleum exploration wells have been drilled in this large area (Figs. 1, 2; Table 1). Wells have been drilled in the Tertiary Baca basin (including Shell Oil Company's Magic area), Acoma basin, Lucero uplift and Gallup sag. No wells have been drilled on the Zuni uplift, on the Mogollon plateau or in the Magdalena and Bear Mountains. The first well drilled in west-central New Mexico was the Carter Oil Company No. 2 Santa Fe (Fig. 2, no. 81; Table 1, no 81); it was drilled in 1919 on the Piñon Springs anticline in the Gallup sag. It is

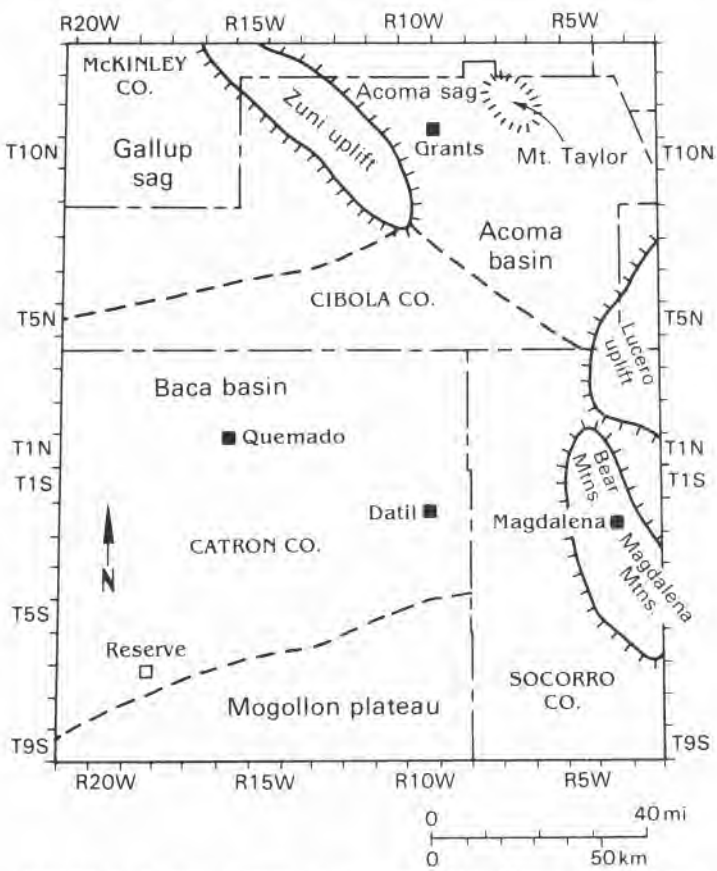

FIGURE 1. Tectonic elements of west-central New Mexico. Modified from Cather and Johnson (1984) and Clemons et al. (1981).

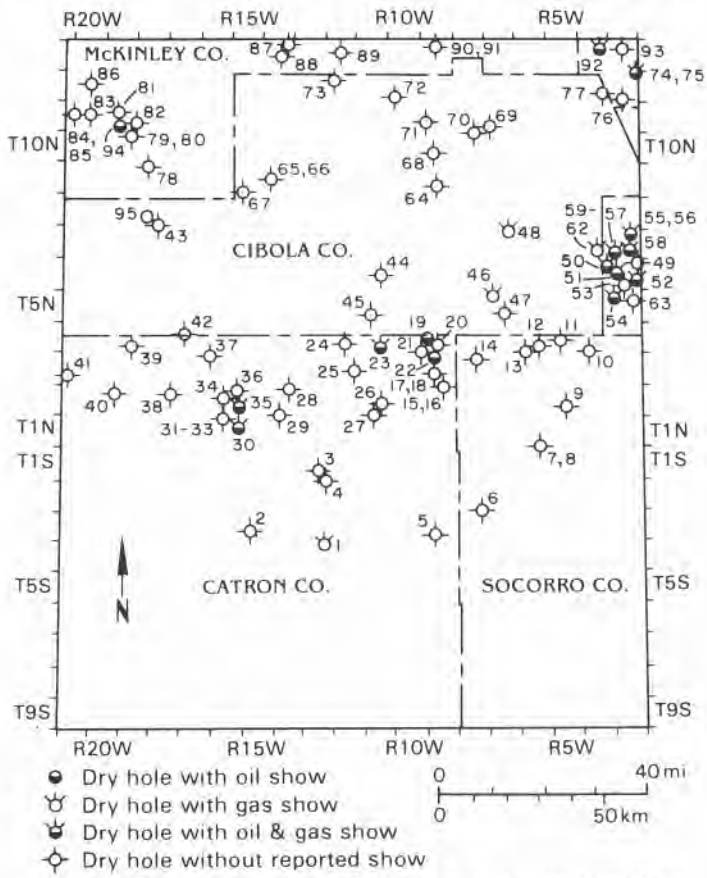

FIGURE 2. Petroleum exploration wells drilled in west-central New Mexico. See Table 1 for well data.

TABLE 1. Petroleum exploration wells drilled in west-central New Mexico. *DST*, drill-stem test; *rec.*, recovered; *perf.*, perforations. Data from New Mexico Bureau of Mines and Mineral Resources except where otherwise noted.

Number on Fig. 1	Location (section-township-range county)	Operator well number, and lease	Completion date (month/year)	Status	Total depth ft (m)	Rock unit at surface	Rock unit at total depth	Reported shows of oil and gas; additional comments
1	2-4S-13W, Catron	Shell Western Exploration & Production No. 1 SWEPI et al. State	9/87	D&A	7,000 (2,134)	volcanics (Tertiary)	Precambrian	DST 4834-5110 ft (Yeso), rec. nonflammable gas and 2755 ft mud. DST 5270-5397 ft (Yeso), rec. nonflammable gas and 33 bbl mud-cut water. Perf. 4834-4870 ft (Yeso). Perf. 4022-4034 ft, 4073-4130 ft, 4180-4200 ft (San Andres).
2	21-3S-15W, Catron	Shell Western Exploration & Production No. 1 SWEPI et al. Mangus Mountains Federal	12/87	D&A	7,808 (2,380)	basalt (Quaternary-Tertiary)	Precambrian	"Tight" hole
3	27-1S-13W, Catron	Shell Western Exploration & Production No. 1 SWEPI et al. Aspen Federal	4/88	D&A	9,000 (2,743)	volcanics (Tertiary)	Precambrian	"Tight" hole
4	35-1S-13W, Catron	Tenneco Oil No. 1 Federal	7/67	D&A	7,900 (2,408)	volcanics (Tertiary)	Precambrian	DST 5698-5750 ft (San Andres), rec. 1177 ft mud-cut water. DST 5790-5850 ft (Glorieta), rec. 2980 ft mud-cut water.
5	29-3S-9W, Catron	Sun Oil Co. No. 1 Plains of San Augustine unit	6/66	D&A	12,284 (3,744)	alluvium (Quaternary)	Precambrian	DST 9945-10304 ft (Yeso), rec. 1395 ft mud + 1860 ft watery mud + 5510 ft water.
6	35-2S-8W, Socorro	Southland Royalties No. 1 Augustine	1958	D&A	1,795 (547)	gravel (Quaternary)	volcanics (Tertiary)	Stratigraphic test
7	35-1N-6W, Socorro	Whigham, Inc. No. 1 Santa Fe Pacific Davis Pueblo	5/79	D&A	1,163 (354)	Mesaverde (Cretaceous)	Dakota (Cretaceous)	
8	35-1N-6W, Socorro	Transocean Oil Co. No. 1 Henderson Santa Fe Pacific Railroad	3/77	D&A	9,379 (2,859)	Mesaverde (Cretaceous)	Precambrian	
9	15-2N-5W, Socorro	J. C. Green et al. No. 1	1932?	D&A	425 (130)	Cretaceous		
10	32-4N-3W, Socorro	White & Mangels No. 1 State	7/47	D&A	201 (61)	Permian	Precambrian	
11	17-4N-5W, Socorro	Spanel & Heinze No. 1-9608 Santa Fe Pacific Railroad	8/59	D&A	5,000 (1,524)	Chinle (Triassic)	Precambrian	Heavy flow of fresh water from 700-1100 ft (Glorieta and San Andres). DST 4237-4297 ft (Pennsylvanian), rec. salt water.
12	27-4N-6W, Socorro	Transocean Oil Co. No. 1 Major Santa Fe Pacific Railroad	7/77	D&A	4,690 (1,430)	Triassic	Precambrian	DST 3975-4020 ft (Pennsylvanian), rec. 3810 ft muddy water.
13	32-4N-6W, Socorro	Ohio Oil Co. No. 1 McDonald State	11/26	D&A	1,997 (609)	Chinle (Triassic)	igneous dike (Tertiary)	Artesian water at 470 and 630 ft. Artesian water at 1185 ft (Glorieta). Drilled on Payne anticline[1].
14	2-3N-8W, Socorro	L. H. Mitchel & Sons No. 1 Red Lake	1925	D&A	4,012 (1,223)	Triassic	Precambrian	Water at 920-929 ft (Triassic). Heavy flow of water in limestone at 3630 ft (Pennsylvanian). Water at 3650 ft and 3825 ft (Pennsylvanian).
15	34-3N-9W, Catron	E. J. Gorman No. 1 Gorman	1924	D&A	168 (51)	Crevasse Canyon (Cretaceous)		Drilled on Cibola anticline[1].
16	34-3N-9W, Catron	E. J. Gorman No. 2 Gorman	11/33	D&A	501 (153)	Crevasse Canyon (Cretaceous)		Drilled on Cibola anticline to test Gallup Sandstone (Cretaceous)[1].
17	21-3N-9W, Catron	Transocean Oil Co. No. 1 Turner Santa Fe Pacific Railroad	5/77	D&A	5,220 (1,591)	Cretaceous	Precambrian	DST 2387-2422 ft (San Andres), rec. 1812 ft mud cut water. DST 2490-2500 ft (San Andres), rec. 1077 ft water.
18	21-3N-9W, Catron	Black Oil Co. No. 6 Santa Fe Pacific Railroad	6/87	D&A	680 (207)	Mancos (Cretaceous)	Mancos (Cretaceous)	Hit water zone while air drilling at 650 ft.
19	19-4N-9W, Catron	Spanel & Heinze No. 1-9609 Santa Fe Pacific Railroad	11/59	D&A	1,700 (518)	Crevasse Canyon (Cretaceous)[1]	Chinle (Triassic)[1]	Oil shows at 1127-1160 ft in Dakota Sandstone (Cretaceous). Drilled on Cow Springs anticline to test Cretaceous section[1].
20	19-4N-9W, Catron	Morris B. Jones No. 1 Santa Fe Pacific (also known as Cambridge & Nail No. 1 Santa Fe Pacific)	9/81	D&A	5,106 (1,556)	Crevasse Canyon (Cretaceous)[1]		DST 4664-4693 ft (Pennsylvanian), rec. 3562 ft muddy water.

TABLE 1 (continued)

Number on Fig. 1	Location (section-township-range county)	Operator well number, and lease	Completion date (month/year)	Status	Total depth ft (m)	Rock unit at surface	Rock unit at total depth	Reported shows of oil and gas; additional comments
21	30-4N-9W, Catron	Red Feather Oil Co. No. 1 Cow Springs	1925	D&A	510 (155)	Crevasse Canyon (Cretaceous)	Mancos (Cretaceous)	Drilled on Cow Springs anticline to test Cretaceous section[1].
22	30-4N-9W, Catron	Red Feather Oil Co. No. 2 Cow Springs	5/26	D&A	1,330 (405)	Crevasse Canyon (Cretaceous)	Morrison (Jurassic)	Oil shows from 965-1000 ft in Dakota Sandstone (Cretaceous). Drilled on Cow Springs anticline to test Cretaceous section[1].
23	27-4N-11W, Catron	Spanel & Heinze No. 1-9617 Santa Fe Pacific Railroad	9/59	D&A	5,394 (1,644)	Cretaceous	Precambrian	Oil and gas show reported in San Andres (Permian). Drilled on Hickman anticline[1].
24	?-4N-12W, Catron	King et al. No. 1	1924	D&A	637 (194)			
25	14-3N-12W, Catron	Samedan Oil No. 1 Laguna Federal	11/84	D&A	5,915 (1,803)	Cretaceous	Precambrian	DST 4246-4360 ft (Yeso), rec. 370 ft mud + 277 ft mud-cut water + 2776 ft water.
26	14-2N-11W, Catron	Reeves Bros. No. 1 Reeves	8/79	D&A	650 (198)	Baca (Tertiary)	Permian	
27	26-2N-11W, Catron	Reeves No. 2 Reeves	8/79	D&A	770 (235)	Baca (Tertiary)	Permian	
28	2-2N-14W, Catron	Transocean Oil Co. No. 1 State 2094	7/77	D&A	6,030 (1,838)	volcanics (Tertiary)	Precambrian	DST 4010-4095 ft (San Andres), rec. 90 ft mud + 772 ft mud-cut water.
29	33-2N-14W, Catron	Transocean Oil Co. No. 1 State 2095	3/78	D&A	5,542 (1,689)	sand & gravel (Quaternary)	Precambrian	
30	3-1N-16W, Catron	R. C. Bailey No. 1 H. Baca	1933	D&A	480 (146)	Cenozoic	Cretaceous?[1]	Oil show from 450 to 480 ft.
31	3-1N-16W, Catron	R. C. Bailey No. 2 H. Baca	1936	D&A	505 (154)	Cenozoic	Cretaceous?[1]	Converted to water well.
32	3-1N-16W, Catron	R. C. Bailey & Monsen No. 1 Anastasio Baca	1928	D&A	500 (152)	Cenozoic	Cretaceous?[1]	
33	35-2N-16W, Catron	A. R. Fenner No. 1 R. C. Bailey	1929	D&A	408 (124)	Baca (Tertiary)		Completed as water well.
34	35-2N-16W, Catron	A. R. Fenner No. 2 R. C. Bailey	1930	D&A	670 (204)	Baca (Tertiary)	Cretaceous[1]	Oil and gas show at 483 ft.
35	26-2N-16W, Catron	Transocean Oil Co. No. 1 Federal 23688	2/78	D&A	5,810 (1,771)	volcanics	Precambrian	
36	11-2N-16W, Catron	Claude Huckleberry No. 1 Federal	12/56	D&A	5,642 (1,720)	Baca (Tertiary)	Precambrian	DST 1025-1126 ft (Gallup) rec. 626 ft mud-cut fresh water. DST 5309-5642 ft (Abo and Precambrian), rec. 4000 ft salt sulfur water.
37	6-3N-16W, Catron	Cleary Petroleum, Inc. No. 1 Wheeler	11/63	D&A	2,605 (794)	Mesaverde (Cretaceous)	Permian	Drilled to test San Andres Formation (Permian)[1].
38	12-2N-18W, Catron	Transocean Oil Co. No. 1 State 2111	6/77	D&A	4,275 (1,303)	Mesaverde (Cretaceous)	Precambrian	DST 1590-1633 ft (San Andres), rec. 1400 ft water. DST 2582-2902 ft (Yeso), rec. 850 ft mud + 870 ft salt water. DST 2570-2580 ft (Yeso), rec. 1149 ft mud-cut water + 829 ft salt water.
39	27-4N-19W, Catron	Skelly Oil Co. No. 1 Claude A. Teel	2/52	D&A	1,140 (374)	Dakota (Cretaceous)	San Andres (Permian)	Hole abandoned because of lost circulation in large crevice or cave in San Andres Formation (Permian). Stratigraphic test.
40	7-2N-19W, Catron	Skelly Oil Co. No. 1 M. N. Teel	3/52	D&A	2,365 (721)	Mesaverde (Cretaceous)	Yeso (Permian)	Stratigraphic test.
41	27-3N-21W, Catron	Skelly Oil Co. No. 1 Goesling	1/52	D&A	2,597 (792)	Chinle (Triassic)	Precambrian	Stratigraphic test.
42	8-4N-17W, Catron	Tiger Oil No. 1 State B	5/78	D&A	4,491 (1,369)	Mesaverde (Cretaceous)		
43	34-8N-18W, Cibola	Cecil Gustin No. 1 Crockett	12/82	J&A	2,562 (781)	Mancos (Cretaceous)		Junked and abandoned. Drilling collars and fishing tools lost in hole.
44	14-6N-11W, Cibola	Southland Royalty No. 1 Federal Lucero 14	5/60	D&A	4,638 (1,414)	Cretaceous	Precambrian	Water at 2555 ft (San Andres).
45	29-5N-11W, Cibola	Western Drilling Company	1956	D&A	980 (299)	alluvium (Quaternary)		Uranium test hole.

TABLE 1 (continued)

Number on Fig. 1	Location (section-township-range county)	Operator well number, and lease	Completion date (month/year)	Status	Total depth ft (m)	Rock unit at surface	Rock unit at total depth	Reported shows of oil and gas; additional comments
46	5-5N-7W, Cibola	Spanel & Heinze No. 1-9612 Santa Fe Pacific Railroad	8/59	D&A	4,992 (1,522)	Cretaceous	Precambrian	Lost circulation from 1600 to 2100 ft (Chinle-San Andres). Fresh water in Glorieta Sandstone. DST 4430-4533 ft (Pennsylvanian), rec. very slight gas-cut mud + slight water-cut mud. DST 4537- 4637 ft (Pennsylvanian) had slight gas show.
47	27-5N-7W, Cibola	Cities Service No. 1 Santa Fe A	2/83	D&A	5,344 (1,629)	Mancos (Cretaceous)	Precambrian	Perf. 3506-3529 ft (Yeso) perf. 3440-3444 ft (Yeso) perf. 2212-2222 ft (Yeso)
48	2-7N-7W, Cibola	Sun Oil Co. No. 1 Pueblo of Acoma	3/60	D&A	4,794 (1,461)	Jurassic	Precambrian	DST 2470-2527 ft (upper Yeso), rec. 2040 ft muddy fresh water. DST 4486-4526 (Pennsylvanian), rec 430 ft heavy gas-cut mud + 240 ft brackish water; gas was 95% CO_2 + 0.13% He.
49	1-6N-3W, Valencia	Reese & Jones No. 1 NZ	4/80	D&A	3,215 (980)	basalt (Quaternary)	Precambrian	Perf. 1841-1862 ft (Pennsylvanian); perf. 1385-1400 ft (Pennsylvanian).
50	7-6N-3W, Valencia	Refiners Petroleum No. 1 White Ridge	10/71	D&A	4,298 (1,310)	San Andres (Permian)	Precambrian	Oil & gas shows at 3120-3150, 3520-3542, 3805-3825, 3865-3886, and 3865-3886, and 4210-4250 ft (Pennsylvanian)[3]. DST 3974-4131 ft (Pennsylvanian), rec. 300 ft mud + 360 ft water-cut mud + 2320 ft salt water. DST 4200-4272 ft (Pennsylvanian), rec. 20 ft mud.
51	8-6N-3W, Valencia	Reese & Jones No. 1 Tecolote	5/74	D&A	3,512 (1,070)	Yeso (Permian)	Precambrian	Oil & gas shows at 1900-1920, 2460-2475, 2575-2670, 2720-2775, 3025-3091, and 3092-3497 ft (Pennsylvanian)[3]. DST 2468 -2528 ft (Pennsylvanian), rec. 300 ft mud; DST 2540-2614 ft (Pennsylvanian), rec. 15 ft mud + 2217 gas-cut muddy water; DST 3310-3350 ft (Pennsylvanian), rec. 2191 ft heavy gas-cut mud and water.
52	13-6N-3W, Valencia	Reese & Jones No. 1 Lawton	4/75	D&A	2,410 (735)	basalt (Quaternary)	Precambrian	Oil & gas shows at 500-560, 610-690, 760-900, 960-1010, 1054-1100, 1110-1170, 1410-1580, 1630-1740, 2100-2130, and 2165-2200 ft (Pennsylvanian)[3].
53	22-6N-3W, Valencia	Reese & Jones No. 3 NZ	4/80	D&A	2,725 (831)	Abo (Permian)	Precambrian	DST 2095-2125 ft (Pennsylvanian), rec. 110 ft mud; perf. 2514-2528 ft (Pennsylvanian), acidized perf. 2474-2493 ft (Pennsylvanian), acidized; perf. 2270-2296 ft (Pennsylvanian), acidized; perf. 1312-1328 ft (Pennsylvanian), acidized.
54	32-6N-3W, Valencia	Refiners Petroleum No. 1 Romero	5/71	D&A	3,028 (923)	Abo (Permian)	Precambrian	Oil & gas show at 2030-2050 ft.[3] DST 2440-2550 ft (Pennsylvanian), rec. 91 ft slight oil & gas-cu mud + 124 ft watery oil & gas-cut mud + 1230 ft slight oil & gas-cut salt water; DST 2620-2747 ft (Pennsylvanian), rec. 315 ft mud + 1115 ft slight gas & oil-cut mud + 690 ft gas-cut water. Perf. 2492-2504 ft, 2640-2650 ft, 2710-2720 ft (Pennsylvanian), acidized.
55	12-7N-3W, Valencia	Hoosier Oil No. 1 Valley	1926?	D&A	700? (213)	San Andres (Permian)		Oil show at 500 ft (Yeso?).
56	14-7N-3W, Valencia	Richard King, Jr. No. 1 Wilson Heirs Unit	10/58	D&A	3,993 (1,217)	San Andres (Permian)	Precambrian	Oil & gas shows at 2085, 2095, 2105, 2945-2958, 3030-3050, 3130-3150, 3660-3670, 3690-3700, 3740-3752, 3798-3845, 3856-3874, and 3882-3900 ft.[3]

TABLE 1 (continued)

Number on Fig. 1	Location (section-township-range county)	Operator well number, and lease	Completion date (month/year)	Status	Total depth ft (m)	Rock unit at surface	Rock unit at total depth	Reported shows of oil and gas; additional comments
57	34-7N-3W, Valencia	Reese & Jones No. 1 Carrizo	7/74	D&A	3,588 (1,094)	Yeso (Permian)	Precambrian	Oil & gas shows at 2440-2610, 2810-2925, 3000-3140, 3260-3305, and 3400-3570 ft (Pennsylvanian)[3]. DST 2468-2575 ft (Pennsylvanian), rec. 60 ft oil & gas-cut mud; DST 3319-3395 ft (Pennsylvanian), rec. 2400 ft water; DST 3465-3530 ft (Pennsylvanian), rec. 65 ft mud. Perf. 2702-2712 ft, 2515-2531 ft, 2482-2500 ft, 2426-2438 ft (Pennsylvanian), swabbed water with traces of oil & gas.
58	36-7N-3W, Valencia	Reese & Jones No. 1 Lucero	6/74	D&A	2,962 (903)	Abo (Permian)	Precambrian	Oil & gas shows at 780-950, 1130-1230, 1400-1520, 1670-1890, 1910-1930, and 2652-2845 ft (Pennsylvanian)[3]. DST 1670-1843 ft (Pennsylvanian), rec. 3 ft slight gas-cut mud; DST 2480-2513 (Pennsylvanian), rec. 2000 ft mud.
59	26-7N-4W, Cibola	Gore & Lipson No. 1 Federal B	10/58	D&A	3,674 (1,120)	Triassic	Pennsylvanian?	
60	27-7N-4W, Cibola	Acme Oil Co. No. 1 NM & Arizona Land Co.	3/31	D&A	4,966 (1,514)	Triassic	Precambrian	Oil and gas show from 1651-1694 ft (Yeso); slight gas show from 2339-2345 ft (Abo); slight oil show from 2584-2588 (Pennsylvanian); slight gas show from 3550-3610 ft (Pennsylvanian); gas show at 3645 ft (Pennsylvanian); gas show from 3660-3570 ft (Pennsylvanian); gas show at 3813-3823 ft (Pennsylvanian); gas show at 4530-4535 ft (Pennsylvanian). Drilled on South Suwanee anticline[2].
61	27-7N-4W, Cibola	Williams & Gore No. 1 NM Land and Cattle Co.	2/57	D&A	3,715 (1,132)	Triassic	Pennsylvanian?	Drilled on South Suwanee anticline.
62	27-7N-4W, Cibola	Honolulu-New Mexico No. 2A NM & Arizona Land & Cattle Co.	8/59	D&A	3,604 (1,098)	Triassic	Pennsylvanian?	Drilled on South Suwanee anticline.
63	35-6N-3W, Cibola	NM & Arizona Land Company No. 5 Penteco Trinity	6/87	D&A	1,650 (503)	Pennsylvanian	Precambrian	Perf. & frac 1425-1438 ft; perf. & acidized 1458 1474 ft, 1484-1490 ft, 1524-1528 ft; no shows.
64	28-9N-9W, Cibola	Joe Salazar No. 1 Acoma	9/84	D&A	2,520 (768)	Cretaceous	San Andres (Permian)	Completed as water well.
65	17-9N-14W, Cibola	Harold J. Secheler No. 1 Bond	2/62	J&A	2,606 (794)	Cretaceous	Pennsylvanian?	
66	17-9N-14W, Cibola	S&S Oil Producers No. 1A Bond	4/67	D&A	2,480 (756)	Zuni (Jurassic)		
67	32-9N-15W, Cibola	Eidal Manufacturing No. 32 State	5/71	D&A	3,110 (948)	Mancos (Cretaceous)	Permian	DST 2858-2940 ft (San Andres), rec. 2000 ft muddy water.
68	21-10N-9W, Cibola	Larrazolo & Cornell No. 1 Gottlieb	11/54	D&A	4,913 (1,497)	basalt (Quaternary)	Precambrian	
69	30-11N-7W, Cibola	Worldwide Exploration Consultants No. 1 Federal 30	8/78	D&A	2,865 (873)	volcanics (Tertiary)		
70	36-11N-8W, Cibola	Topaz Southwest No. 1 State (owdd)	5/85	D&A	2,953 (900)	Mesaverde (Cretaceous)	Entrada (Jurassic)	Perf. 1390-1400 ft (Greenhorn), swabbed water. Perf. 1574-1584 (Dakota), swabbed water. Perf. 2200-2210 ft (Morrison), swabbed water. Perf. 2570-2580 ft (Morrison), swabbed water.
71	30-11N-9W, Cibola	Gravity Petroleum Co. No. 1 Clara Reed	7/34	D&A	110 (34)	Triassic		
72	30-12N-10W, Cibola	Pres Sel Development Co. No. 1 Morris	7/35	D&A	372 (113)	alluvium (Quaternary)		
73	6-12N-12W, Cibola	W. A. Hurley No. 1 State	10/48	D&A	175 (53)	San Andres (Permian)		

TABLE 1 (continued)

Number on Fig. 1	Location (section-township-range county)	Operator well number, and lease	Completion date (month/year)	Status	Total depth ft (m)	Rock unit at surface	Rock unit at total depth	Reported shows of oil and gas; additional comments
74	1-12N-3W, Cibola	Siemens & Boyd No. 1 Dave Armijo	5/41	D&A	800 (244)	Cretaceous		Water at 50 ft, 390 ft, & 485 ft. Slight gas show at 500 ft. Slight oil show at 685 ft.
75	1-12N-3W, Sandoval	F. B. Umbarger No. 1 Armijo	12/45	D&A	1,000 (305)	Mancos (Cretaceous)	Morrison (Jurassic)	
76	21-12N-3W, Sandoval	Michael P. Grace No. 1 Sandy	3/73	D&A	1,500 (457)	Cretaceous		Completed as water well.
77	23-12N-4W, Cibola	Austra-Tex Oil No. 1 Exxon Mineral Fee	9/87	D&A	5,723 (1,744)	Mancos (Cretaceous)	Precambrian	
78	5-9N-18W, McKinley	Cities Service No. 1 Zuni A	11/63	D&A	2,591 (790)	Triassic	Precambrian	
79	2-10N-19W, McKinley	Robert O. Lister No. 1 Zuni	9/69	D&A	1,290? (393)	Triassic		Stratigraphic test
80	2-10N-19W, McKinley	Robert O. Lister No. 1X Zuni	10/67	D&A	1,636 (499)	Triassic		Perf. & squeezed 1502-1597 ft (Fort Apache); perf. & squeezed 1033-1090 ft (San Andres); perf. 980-986 ft.
81	17-11N-19W, McKinley	Carter Oil Co. No. 2 Santa Fe	1919	D&A	1,980 (604)	Chinle[2] (Triassic)	Yeso[2] (Permian)	Drilled on Pinon Springs anticline.
82	35-11N-19W, McKinley	William G. Coffey No. 1 Coffey Federal	12/69	D&A	2,235 (681)	Chinle (Triassic)	Precambrian	Perf. & acidized 1074-1140 ft (San Andres); perf. & acidized 1174-1272 ft, 1525-1636 ft (Glorieta).
83	16-11N-20W, McKinley	High Plains Petroleum No. 1 Johnson State	7/81	D&A	1,680 (512)	alluvium (Tertiary)	San Andres (Permian)	DST 1590-1680 ft (San Andres), rec. 30 ft mud.
84	18-11N-20W, McKinley	High Plains Petroleum No. 1Y Yates State	1/83	D&A	3,547 (1,081)	Entrada (Jurassic)	Precambrian	DST 1872-1922 ft (Glorieta); DST 1940-2030 ft (Glorieta). Completed as water well.
85	18-11N-20W, McKinley	Reese & Jones No. 1 Yates State	2/81	D&A	2,340 (713)	Entrada (Jurassic)		
86	16-12N-20W, McKinley	Sierra Oil & Gas No. 1 Seco Yates State 16	10/81	D&A	3,557 (1,084)	Jurassic	Precambrian	Perf. 1511-1514 ft, 1580-1585 ft, 1621-1626 ft, 1958-2015 ft (Triassic); acidized. Perf. 2064-2071 ft (San Andres), acidized Perf. 2110-2126 ft, 2209-2227 ft, 2248-2253 ft, 2351-2366 ft (Glorieta), acidized. Perf. 2504-2508 ft, 2838-2843 ft, 2857-2862 ft (Yeso), acidized. Perf. 3490-3496 ft (Abo), acidized.
87	2-13N-14W, McKinley	S. Dysart et al. No. 1	7/26	D&A	356 (109)	Triassic		
88	14-13N-14W, McKinley	Miley and Bailey No. 1 State	10/25	D&A	600 (183)	Triassic		
89	9-13N-12W, McKinley	McKinley Oil and Gas Co. No. 1	1924	D&A	1,540 (469)	Triassic		
90	4-13N-9W, McKinley	Schleuter No. 1 Schleuter	1925?	D&A	500 (152)	Mancos (Cretaceous)		
91	2-13N-9W, McKinley	Thoreau & Seven Lakes Oil Co. No. 3 Branson	1921	D&A	404 (123)	Mancos (Cretaceous)		
92	2-13N-4W, Sandoval	Continental Oil Co. No. 1 L-Bar Cattle Company	12/35	D&A	6,220 (1,896)	Mancos (Cretaceous)	Precambrian	Gas & rainbow oil show at 2900 ft (Glorieta?). Oil & gas show at 3280 ft (Yeso).
93	10-13N-3W, Sandoval	Texaco No. 1 Howard Major	6/64	D&A	6,387 (1,947)	Mancos (Cretaceous)	Precambrian	
94	28-11N-19W, McKinley	Burr Oil & Gas No. 1 Zuni	12/88	D&A	1,885 (575)	Triassic	Yeso (Permian)	Encountered wet oil in San Andres (Permian), salt water in Glorieta (Permian), and salt water and oil in Yeso (Permian) Unable to drill deeper because of hole cave in. Drilled on Pinon Springs anticline.
95	27-8N-18W, Cibola	Merrion Oil & Gas No. 1 Galestina Canyon	1988		2,770 (844)	Mancos (Cretaceous)	Yeso? (Permian)	Well "tight" at time this report was written. Spudded in 6/88.

[1] Foster (1964)
[2] Bates (1942)
[3] Reese (1975)

interesting and not insignificant to note that, as of the writing of this report, the last well drilled in west-central New Mexico, the Burt Oil & Gas No. 1 Zuni (Fig. 2, no. 94; Table 1, no. 94), was also drilled on the Piñon Springs anticline. As of January 1989, production had not been established within the area covered by this report.

Prior to 1950, few exploratory wells were drilled in west-central New Mexico (Table 2). These wells were generally shallow and targeted Cretaceous reservoirs. After 1950, drilling activity increased, and most wells targeted deeper Permian and Pennsylvanian reservoirs. Many of these later wells were drilled to total depth in Precambrian basement. The 1970's and the 1980's were the decades of greatest drilling activity (Table 2). Some of the most significant wells located in west-central New Mexico have been drilled since 1985 (Table 1).

ACOMA BASIN AND ACOMA SAG

The Acoma basin occupies the northeastern part of the area covered by this report (Fig. 1). The basin is a northeast-trending synclinal depression bordered on the northwest by the Zuni uplift and on the southeast by the Lucero uplift. The northern boundary of the Acoma basin with the San Juan Basin is transitional and joins the San Juan Basin through the Acoma sag. The southwestern boundary of the Acoma basin merges with the Baca basin and is also transitional. Upper Cretaceous strata are preserved and exposed in the axial portion of the basin, but have been eroded from the flanks where Jurassic, Triassic, Permian and Pennsylvanian strata crop out.

Nineteen exploratory wells have been drilled in the Acoma basin and Acoma sag (Fig. 2; Table 1). Major reservoir objectives are Mesaverde sandstones (Upper Cretaceous), the Gallup and Dakota sandstones (Upper Cretaceous), limestones and dolostones in the San Andres Formation (Permian), the Glorieta Sandstone (Permian) and sandstones and limestones in the Madera and Sandia formations (Pennsylvanian). The Entrada Sandstone (Jurassic) is a reservoir target in the northernmost part of the basin. A pre-Pennsylvanian Paleozoic section is not present (Kottlowski, 1963). Cretaceous reservoirs crop out or are buried to only shallow depths throughout much of the basin and may be flushed with fresh water in many areas. Shows of oil and gas have been reported from the Upper Cretaceous, the Glorieta, the Yeso and the Pennsylvanian. Wengerd (1959) presented an appraisal of the petroleum potential of the Acoma basin. He concluded that porous reservoirs are present in the Pennsylvanian, Permian and Cretaceous sections and that porosity pinchouts may be present within the Pennsylvanian, Permian and Cretaceous sections. Wengerd also concluded that structural traps may have initially developed during the Pennsylvanian and continued to develop through the Permian, Triassic and to the end of the Cretaceous.

The Sun Oil Company No. 1 Pueblo of Acoma well (Fig. 2, no. 48; Table 1, no. 48) is one of the more significant exploratory wells drilled within the Acoma basin. The well was drilled to a total depth of 4794 ft (1461 m) in Precambrian. The Pennsylvanian consists of dense shelf limestones and coarse-grained conglomeratic sandstones, and it rests unconformably on Precambrian basement; it is present from depths of 3890 ft (1186 m) to 4637 ft (1413 m). Gas recovered from a drill-stem test in the Pennsylvanian consisted of 95% carbon dioxide and 0.13% helium.

Three significant wells have been drilled in the northeastern part of the Acoma basin. In the Continental No. 1 L-Bar Cattle Company (Fig. 2, no. 92; Table 1, no. 92), the Pennsylvanian is present from 5050 ft (1539 m) to 6134 ft (1870 m); Precambrian schist is present below 6134 ft. The Pennsylvanian consists of interbedded limestones and gray to black shales. Oil and gas shows were encountered in the Glorieta Sandstone and in Yeso sandstones. The Texaco No. 1 Howard Major (Fig. 2, no. 93; Table 2, no. 93), and the Austra-Tex No. 1 Exxon Mineral Fee (Fig. 2, no. 93; Table 1, no. 93) drilled similar sections of Pennsylvanian.

Possible source rocks in the Acoma basin and Acoma sag are Pennsylvanian shales and limestones and dolostones in the San Andres Formation. In the Sun No. 1 Acoma Pueblo well, Pennsylvanian shales have been thermally matured to the oil-producing stage (TAI = 2.6) and contain sufficient amounts of oil-prone amorphous and herbaceous kerogen to be considered source rocks (Bayliss and Schwarzer, 1987a). San Andres dolostones are only marginally mature (TAI = 2.2), but contain significant amounts of oil-prone amorphous and herbaceous kerogen, and may contain amounts of organic matter sufficient for petroleum generation. In the Continental No. 1 L-Bar well (Jacobson et al., 1985), the upper part of the Pennsylvanian has also been matured to the oil-producing stage (TAI = 2.9–3.1), and the basal part of the Pennsylvanian has been matured to the wet-gas generation zone (TAI = 3.2–3.6). However, amounts of organic matter in samples tested to date appear to be insufficient for petroleum generation (TOC = 0.14–0.31), and kerogens are mostly inertinitic and gas-prone woody types. Cretaceous marine shales are source rocks in the San Juan Basin, but their source quality and maturity are not as well documented in the Acoma basin. Fetid lacustrine limestones of the Todilto Limestone (Jurassic) are present in the northern part of the basin where they may be source rocks, but this has not been documented; Todilto limestones are source rocks to the north in the San Juan Basin (Vincelette and Chittum, 1981).

LUCERO UPLIFT

The Lucero uplift occupies the east-central part of the area covered by this report (Fig. 1). The uplift is bounded by a major fault system on its east side; that fault system separates the Lucero uplift from the Albuquerque basin. Within the uplift, strata dip gently westward into the Acoma basin. Pennsylvanian and Permian strata crop out on top of the uplift where the Mesozoic has been removed by erosion.

Sixteen exploratory wells have been drilled on the Lucero uplift (Fig. 2; Table 1). Most of these wells were drilled on relatively small anticlines that are morphologically superimposed on the Lucero uplift. Major reservoir objectives are porous dolostones in the San Andres Formation (Permian), massive limestones in the Gray Mesa Member of the Madera Formation (Pennsylvanian) and sandstones of the Sandia Formation (Pennsylvanian). Porosities in the Gray Mesa are low, approximately 2%; porosities in the Sandia are higher, 10–20% (Reese, 1975). Numerous, well-documented shows of oil and gas have been reported from the Gray Mesa limestones and Sandia sandstones (Table 1; Reese, 1975).

Possible source rocks on the Lucero uplift are organic-rich dolostones and limestones in the San Andres Formation (Permian) and dark-gray to black Pennsylvanian shales. Although source-rock analyses are not available for these rocks, they are lithologically and depositionally similar to equivalent strata in the Acoma basin (Sun Oil Company No. 1 Acoma Pueblo well; Fig. 2, no. 48; Table 1, no. 48). Burial and thermal histories have probably been similar in the Acoma basin and on the Lucero uplift. Petroleum may also have migrated updip from source rocks in the Acoma basin, or from the east out of source rocks in the Rio Grande rift.

The timing of the maturation of the Pennsylvanian source rocks, and of the migration of the resulting hydrocarbons, is critical to an understanding of the overall hydrocarbon-producing potential for the Penn-

TABLE 2. Historical compilation of number of wells drilled and depth of wells drilled in west-central New Mexico. Compiled from data on file at the New Mexico Bureau of Mines and Mineral Resources.

Time Period	No. of wells drilled	Total depth drilled ft (m)	Average well depth ft (m)
1910–1919	1	1,980 (604)	1,980 (604)
1920–1929	14	13,662 (4,164)	976 (297)
1930–1939	9	14,249 (4,343)	1,583 (462)
1940–1949	4	2,176 (663)	544 (166)
1950–1959	15	51,402 (15,667)	3,427 (1,047)
1960–1969	12	51,448 (15,681)	4,287 (1,307)
1970–1979	20	75,293 (22,949)	3,765 (1,148)
1980–1988	20	77,872 (23,735)	3,894 (1,187)

sylvanian sequence in the Lucero uplift area. Regional stratigraphic sections in this area which cross the northern Albuquerque basin, the Lucero uplift and the Baca basin dramatically demonstrate the westward truncation of older and older rock types by the advancing Cretaceous seas (unpublished report of Black Oil, Inc.). This is documented by the base of the Dakota Sandstone (Cretaceous), which unconformably rests on older rocks as one proceeds from north to south in this area. Encroachment of the Cretaceous seas from the northeast toward the southwest is well documented by outcrop and well control and demonstrates the existence of the large Burro uplift in southwestern New Mexico during Late Cretaceous time (Kottlowski, 1963).

The Lopatin diagram (Fig. 3) indicates that maturation in the Pennsylvanian in the Lucero area reached the oil generation window during the Early Cretaceous. Paleostructure cross sections made to honor the Lopatin diagram use the top of the Cretaceous as a flat datum (unpublished report of Black Oil, Inc.). Those reconstructions indicate that the updip direction at the time of maturation was to the west, not the east as it presently is. Likewise, there was an apparent westerly component of regional truncation as the Cretaceous seas represented now by the Dakota Sandstone transgressed up and onto the Zuni uplift from east to west. It is apparent that any hydrocarbons generated in Pennsylvanian strata during the Late Cretaceous and early Tertiary would have migrated in an updip direction, preferentially south and west toward the Zuni and Burro uplifts, and possibly vertically into post-Pennsylvanian reservoirs if sufficient density of non-sealing faults was present. With this in mind, it is interesting to examine the present structural configuration and notice that what was at one time in a downdip position in the Lucero uplift area is presently in an updip position. Only those Pennsylvanian strata that are on the western flank of the Acoma sag are still in an updip position, their original attitude at the time of primary oil migration.

The implications of this are considerable. First of all, any hydrocarbons which migrated past what would eventually become the Acoma sag and lodged in reservoirs and stratigraphic traps on the western flank of this present-day structural feature should still be entrapped and present. They would probably not have been remigrated by subsequent Laramide uplift and structural dislocation like accumulations east of the sag. To date, there have been no definitive tests of this area of potentially large stratigraphic hydrocarbon traps. Only the Southland Royalty No. 1 Federal Lucero (Fig. 2, no. 44; Table 1, no. 44) may have penetrated Pennsylvanian sediments on the western flank of the Acoma sag, but this is uncertain.

Of the hydrocarbons originally traveling from east to west during primary migration, some may have accumulated in stratigraphic traps east of the present-day Acoma sag. This oil or gas would have had a tendency to be dislodged and subsequently remigrated eastward in response to subsequent structural events, the Laramide orogeny and later Tertiary uplift of the Lucero area. The remigrated oil would have been either re-trapped or spilled to the outcrop on the Lucero uplift. Thus, any exploration that takes place from the Lucero uplift west to the axis of the Acoma sag must be done with the full knowledge that oil accumulations may have been re-migrated, displaced and re-trapped. In this scenario, early folding or faulting during the Laramide, which preceded formation of the Tertiary Lucero uplift, would become very important. Folds and fault traps on the west side of such faults would be primary areas for exploration.

The large number of oil and gas shows reported in wells on the Lucero uplift and in wells on the eastern flank of the Acoma sag are, therefore, seen primarily as shows from oil generated in Pennsylvanian source rocks. They were generated during the Late Cretaceous and early Tertiary and first migrated generally west and southwest. They were subsequently sloshed back and forth, and eventually re-migrated back to the east with the advent of Laramide unrest and formation of the late Tertiary uplift of the Lucero area.

A great deal of this re-migrated Pennsylvanian oil was probably lost to the outcrop as erosion east of and on the Lucero uplift took place

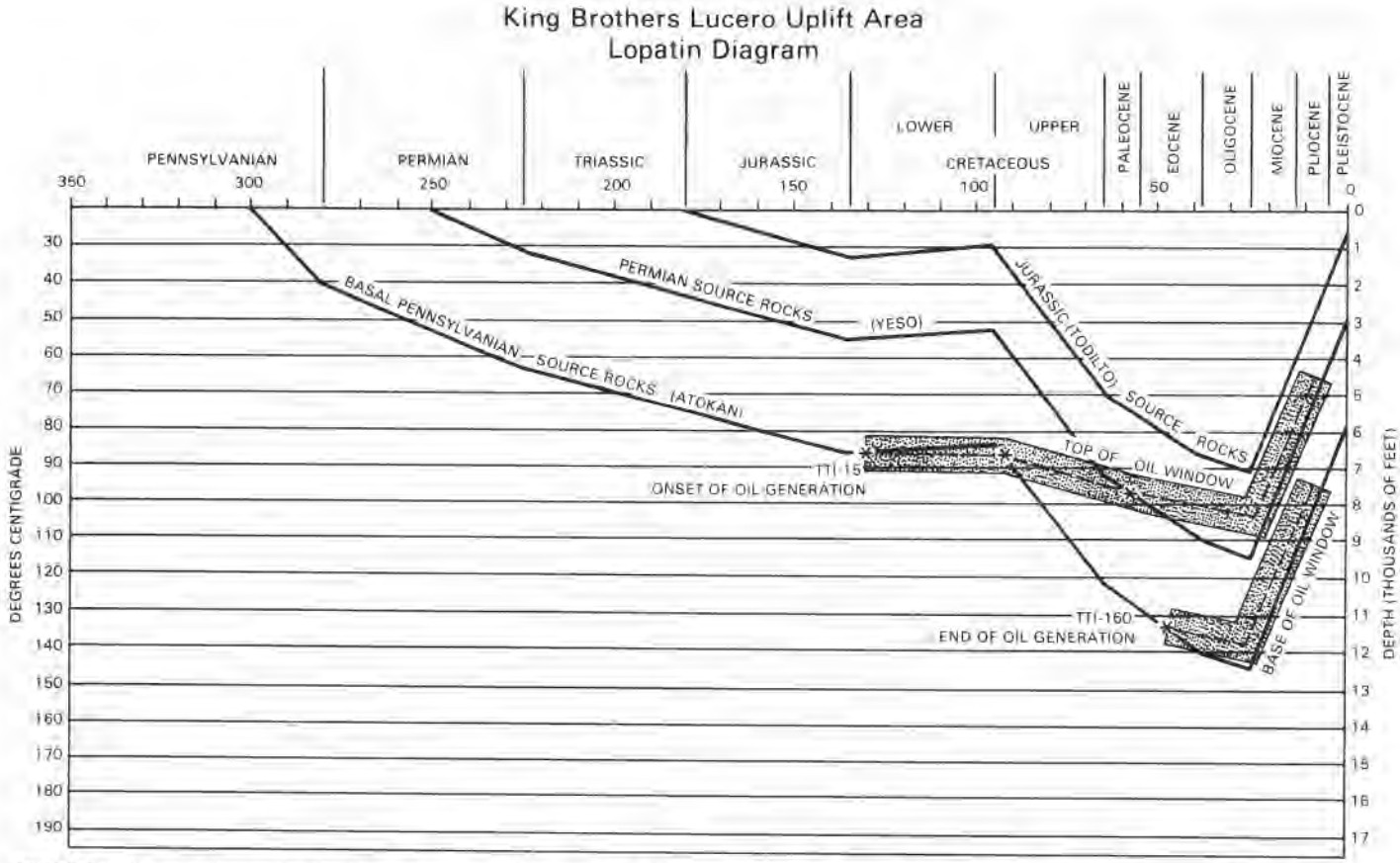

FIGURE 3. Lopatin diagram for the Lucero uplift area (from unpublished report of Black Oil, Inc.). See Waples (1980) for a discussion of Lopatin diagrams.

prior to Albuquerque-basin rifting. API gravity of additional oil close to the outcrop was probably lowered by biodegradation and/or water-washing. This was done by fresh waters which have entered the potential reservoirs on the outcrop and hydrodynamically flushed downdip to the west.

Because of the location of the numerous hydrocarbon shows in wells on the western flank of the Lucero uplift, we can also draw conclusions on the source of the oil using a second line of reasoning. It is apparent that oil and gas causing these shows could not have migrated from Cretaceous source rocks deep within the Albuquerque basin, and then up and westward, across the boundary faults, and into high structures on the Lucero uplift—then back downdip hundreds of feet and several miles to the west onto the west flank of the uplift. It is the very presence of oil shows in wells drilled on the Lucero uplift which argues convincingly that most of these oil shows originated from indigenous Pennsylvanian source rocks. These oils were generated during the Late Cretaceous and early Tertiary, and they migrated within the Pennsylvanian package. This does not, of course, preclude the possibility that some oil and gas generated in the Cretaceous or Jurassic has been entrapped along the crest of the Lucero uplift and in the large complexly folded and faulted areas along the western margin of the Albuquerque basin. These hydrocarbons could have been generated in the Todilto Limestone (Jurassic) and Cretaceous source rocks and migrated up normal faults where they could subsequently be entrapped. However, this type of oil migration and entrapment is unlikely on the western flank of the Lucero uplift.

Maturation and migration of the Cretaceous and Todilto source-rock package within the Rio Grande rift would have taken place in the middle to late Tertiary (unpublished report of Black Oil, Inc.). Those source rocks would have probably entered the oil window and generated their maximum amount of hydrocarbons with the onset of rifting in the Rio Grande rift. Deep and fast burial of these sediments took place as they subsided into the rift. The timing of generation and migration of any hydrocarbons trapped in crestal areas near the rift is thus possibly different from the timing of maturation and migration of hydrocarbons trapped farther west.

Near the rift edges, oil and gas may first have been generated in Pennsylvanian source rocks during the Late Cretaceous and early Tertiary. This oil and gas migrated to the south and west within the upper Paleozoic section and accumulated. These hydrocarbons were remigrated when subsequent Laramide and late Tertiary tectonic movements disturbed the accumulations. Later, generation and migration of hydrocarbons in the overlying Todilto and Cretaceous source rocks could have taken place during the middle to late Tertiary. It is obvious that several different generation-migration events could have taken place near the crestal areas of the Lucero uplift.

Thus, there were several generation and migration events that were each distinct in timing. The source rocks in the rift (the Todilto and Cretaceous) could well have charged the Paleozoic reservoir rocks on the Lucero uplift. Paleozoic reservoirs along the rift margin thus have a double chance at being charged, first by Pennsylvanian source rocks and later by vertical migration through faults. This would have taken place after middle to late Tertiary generation and migration in the downdropped Cretaceous and Todilto sediments immediately to the east. Indeed, if the normal faults adjacent to the eastern side of the Lucero uplift could leak ascending hydrocarbons, then the first reservoirs encountered by those hydrocarbons on the western side of the faults would have been the Pennsylvanian sands and carbonates where are presently found most of the oil and gas shows. It would not be unexpected to find a mixed genesis of oils in the reservoirs with different physical and chemical properties from oils that have only a Pennsylvanian source; the Pennsylvanian oils would be expected to be found farther to the west.

BACA BASIN

The Baca basin occupies the southwestern part of the area covered by this report. The Baca basin is a structural depression that was formed by late Laramide (Eocene) compressional tectonism (Cather and Johnson, 1984). It is overprinted on Paleozoic and Mesozoic tectonic features. Wells drilled in the basin have drilled through and tested Pennsylvanian, Permian and Cretaceous reservoirs. Wengerd (1959), Foster (1964) and Woodward and Grant (1986) presented analyses of the reservoir rocks and petroleum potential of the Baca basin.

Forty-five exploratory wells have been drilled in the Baca basin (Fig. 2; Table 1). Exploration in the basin has been sporadic for the last 60 years. Most wells drilled prior to 1960 were located on anticlines and only tested the Cretaceous section (Wengerd, 1959; Foster, 1964). Since 1960, the Pennsylvanian and Permian have been the objects of most exploration. Exploration was greatly intensified in 1985 when two million acres of federal land were leased by several firms including Shell, Elf Aquitaine, Standard Oil (Sohio), Amoco, Hunt Oil Co., High Plains Petroleum Corp., Leed Petroleum Corp., Zimmerman Resources, Love Oil Co., New Mexico and Arizona Land and Cattle Co., Gary Engery Corporation and Merrion Oil & Gas Corporation. An extensive series of reflection seismic lines were run. A consortium of Shell, Elf Aquitaine and Standard Oil drilled three wildcat wells (Fig. 2, nos. 1–3; Table 1, nos. 1–3) in a Federal exploration unit called the "Magic Area." Shell was operator for the wells. All three wells were spudded in Cenozoic outflow volcanics. Underneath the volcanics, they drilled through Cretaceous, Triassic, Permian and possibly Pennsylvanian clastic strata. The wells reached total depth in Precambrian basement. In the Shell No. 1 SWEPI et al. State, the Yeso and San Andres formations (Permian) are known to have been tested; nonflammable gas was recovered from the Yeso.

Reservoir objectives in the Baca basin are: Gallup, Tres Hermanos and Dakota sandstones (Upper Cretaceous); limestones and dolostones in the San Andres Formation (Permian); Glorieta Sandstone (Permian); sandstones, limestones and dolostones in the Yeso Formation (Permian); and Pennsylvanian sandstones. A pre-Pennsylvanian Paleozoic section is not present (Kottlowski, 1963). The Pennsylvanian section, which contains from 0 to more than 700 ft of marine strata in the Acoma basin, appears to be thin (less than 400 ft thick: Kottlowski, 1960) or non-existent throughout much of the Baca basin; where present, it consists of red shales, arkosic sandstones and minor thin limestones (Kottlowski, 1960, pp. 25–29) and is mostly nonmarine. The Cretaceous section crops out or is buried to only shallow depths throughout northern Catron County; traps in the Cretaceous may have been flushed by fresh water throughout a large part of this area. Shows of oil and gas have been reported from wells drilled throughout the Baca basin in the Dakota Sandstone (Cretaceous), San Andres Formation (Permian), Glorieta Sandstone (Permian), Yeso Formation (Permian) and the Pennsylvanian section (Table 1; Fig. 2).

Possible source rocks in the Baca basin are: marine Mancos Shale and nonmarine, gas-prone fluvial sediments (Upper Cretaceous); San Andres and Yeso limestones and dolostones. The nonmarine Pennsylvanian red beds appear to have a poor source potential. In the Sun Oil Company No. 1 San Augustine well (Fig. 2, no. 5; Table 1, no. 5), Upper Cretaceous shales, San Andres limestones and Yeso dolostones contain sufficient organic carbon to be sources and have been matured to the stage of oil generation (TAI = 2.6–3.1; Bayliss and Schwarzer, 1987b); in addition, oil-prone kerogens are present in significant amounts. In the Tenneco Oil Company No. 1 Federal (Fig. 2, no. 4; Table 1, no. 4), gray Mancos shales contain sufficient organic carbon to be source rocks, but thermal maturity is somewhat low and marginal (TAI = 2.2–2.3; Bayliss and Schwarzer, 1987c); significant amounts of oil-prone kerogens are present in these shales. In the same well, San Andres and Yeso limestones contain sufficient amounts of oil-prone kerogens to be source rocks and are moderately mature (TAI = 2.3–2.4; Bayliss and Schwarzer, 1987c). To the north in the Cambridge and Nail No. 1 Santa Fe Pacific (Fig. 2, no. 20; Table 1, no. 20; Bayliss and Schwarzer, 1987d) and the Transocean No. 1 Turner (Fig. 2, no. 17; Table 1, no. 17; Bayliss and Schwarzer, 1987e), the Cretaceous is immature (TAI = 2.0–2.1). However, limestones in the San Andres are moderately mature (TAI = 2.3) and contain sufficient amounts of oil-prone kerogens to be considered source rocks. Dolostones in the Yeso Formation also contain sufficient oil-prone kerogens to be considered source rocks but have been matured to the stage of thermal gas generation (TAI = 3.8–3.9). Pennsylvanian shales and limestones in these wells are moderately

mature (TAI = 2.2–2.4) but are too lean (TOC <0.5%) to be considered as source rocks. In the western part of the Baca basin in the Transocean No. 1 State 2111 (Fig. 2, no. 38; Table 1, no. 38), San Andres and Yeso strata are thermally immature (TAI = 2.0–2.1; Bayliss and Schwarzer, 1987f); source-rock analyses for deeper strata are not available in the western part of the basin.

Butler (1988) discussed the potential for coal-bed methane in the Cretaceous of west-central Cibola County. The play discussed by Butler straddles the area between the Baca basin and the Gallup sag (Fig. 1) and covers an area of 500–550 mi^2. Cenozoic basalt flows crop out throughout the area. The basalts unconformably overlie an Upper Cretaceous section that is 1000–2000 ft thick; 3500–4000 ft of Jurassic, Triassic and Permian strata underlie the Cretaceous. Butler believes that the Permian rests unconformably on Precambrian basement. The Upper Cretaceous section is mostly nonmarine; coal beds and carbonaceous coaly clastics with an aggregate thickness of as much as 75 ft are present in the Dakota Sandstone, Gallup Sandstone and Crevasse Canyon Formation. Methane may have been thermally generated in the coals. Although the coal gas may have migrated into sandstone reservoirs within the Upper Cretaceous, primary reservoir targets are the coal beds. Depth to reservoirs may range from 200 to 2000 ft.

GALLUP SAG

The Gallup sag, also known as the Zuni basin, is a north-trending synclinal depression located west of the Zuni uplift. It is bordered on the west by the Defiance uplift of northeastern Arizona. Boundaries with the San Juan Basin on the north and the Baca basin on the south are transitional.

Fifteen petroleum exploration wells have been drilled within the Gallup sag (Fig. 2; Table 1). Major reservoir objectives are limestones in the San Andres Formation (Permian), the Glorieta Sandstone (Permian) and sandstones and carbonates in the Yeso Formation (Permian). Nonmarine red beds of the Abo Formation (Permian) rest unconformably on Precambrian basement. A pre-Permian section does not appear to be present within the Gallup sag. Oil shows have been reported from the San Andres and Yeso in one well, the Burr Oil & Gas No. 1 Zuni (Table 1, no. 94, Fig. 2, no. 94). Upper Cretaceous sandstones are present at shallow depths and only in the eastern part of the Gallup sag.

Few source-rock analyses are available for the Gallup sag. In the Cities Service No. 1 Zuni well (Fig. 2, no. 78; Table 1, no. 78; Bayliss and Schwarzer, 1988), Yeso dolostones are moderately mature (TAI = 2.3), have sufficient amounts of kerogen to be considered source rocks (TOC = 0.27–0.54%), and the kerogen is dominantly oil-prone amorphous and herbaceous types. Cretaceous shales that may be source rocks have been eroded from the western part of the Gallup sag and are present only at shallow depths in the eastern part of the sag; source potential of these rocks has not been documented.

SUMMARY

Ninety-five petroleum exploration wells were drilled in west-central New Mexico from 1919 to 1988. Although neither oil nor natural gas has been discovered in commercial amounts, significant shows of oil and natural gas have been encountered in several wells. Source rocks and reservoirs appear to be present in the Acoma basin, Baca basin, Gallup sag and on the Lucero uplift. Exploration and the drilling of exploratory wells has continued to the present. The decades of the 1970's and 1980's have seen the greatest amount of drilling in this exploratory frontier.

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