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OIL AND GAS EXPLORATION IN THE ALBUQUERQUE BASIN

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PRE-1953 EXPLORATION

Oil and gas exploration in the vicinity of the Albuquerque basin apparently began as early as 1912. The oldest well for which records are available, and probably the first wildcat in the area, was the Tejon Oil and Development Co. No. 1 which was spudded in July 1912. Although technically just out of the recognized northern limits of the Albuquerque basin, this well was significant for its early exploration attempts in the Rio Grande rift.

In the seventy years from 1912 to 1982, at least 46 known oil and gas tests were drilled in the Albuquerque basin (fig. 1). Figure 2 is a histogram showing the exploration activity in the basin by year. The pre-1953 period of exploration was dominated by wells from several hundred to several thousand feet deep, which generally were spudded in the Quaternary and T.D.'d in Tertiary sands and gravels. However, several wells along the east side of the basin did encounter early Mesozoic or Paleozoic rocks beneath Tertiary cover along uplifted horst blocks, associated with the Hubbell Springs horst (see Kelley, 1977 and this guidebook). Until 1953, however, no well had definitely penetrated the Cretaceous section.

Numerous unconfirmed oil and gas shows were reported from an unusually high number (19) of these pre-1953 tests, and several reports of surface oil seepage were described in the basin. A private report for the Tome Land Grant by Fayett A. Jones (1934), who was later to become the head of the New Mexico Bureau of Mines in Socorro, stated, "The most notable indication of oil and gas . . . was from a live seep on the west side of the river. . . A pipe was driven into the ground a few feet deep and about a half an ounce of the crude placed in a bottle. Field tests showed the oil to be a high gravity product similar in respects to the high gravity oil from the Dakota Sandstone of the Rattlesnake structure in northwest New Mexico." Reports such as these, along with reports of both oil and gas from the early wildcat tests (see Table 1), spurred early exploration efforts.

Very few surface clues of structural closures or stratigraphic potential at depth are evident in the Tertiary and Quaternary sands and gravels which cover 90 percent of the basin. In addition, no tests prior to Shell's SFP No. 1 (drilled in 1972) were guided by seismic or other modern geophysical tools, with the possible exception of the Humble SFP No. 1 (drilled in 1953 and probably located on a gravity or magnetic anomaly).

No attempt is made in this article to discuss pre-1953 exploration in detail. Table 1 outlines briefly the chronology of early exploration.

POST1953 EXPLORATION

The period of exploration in Cretaceous rocks was initiated by the Humble SFP No. 1, which in early 1953 drilled 3,899 m (12,791 ft) of Cretaceous strata before being T.D.'d at 3,869 m (12,691 ft). The well did not reach the Dakota Sandstone. The Humble well was significant because it was the first definite penetration of the Cretaceous section. This well proved that a relatively thick Cretaceous section was present, at least in this portion of the valley, below the Tertiary basin fill. It also showed that Cretaceous rocks in this area had been buried well below the maturation level necessary to generate significant amounts of hydrocarbons from any available source rocks.

Petrophysical analysis showed abundant anthraxalite, probably produced by overcooking of entrapped hydrocarbons and organic material. Several gas shows were noted in the well, and D. S.T. 's in the Cretaceous recorded heavy gas-cut mud with slight shows of oil.

Although the Humble well proved that a Cretaceous section with some evidence of hydrocarbons was present, no follow up was made by Humble. With the exception of one test in Tertiary rocks in 1956, no further exploration was attempted in the basin until Shell's program which was initiated in the early 1970's.

There were probably several reasons for the lack of exploration activity in this period. The Humble well not only proved that Cretaceous rocks were present, but it also showed the Cretaceous section to be very deep, with available reservoirs badly cemented and with a high geothermal gradient present. Additionally, the Cretaceous section was poorly understood in 1953, even in the San Juan Basin. There were little or no published geologic and geophysical data in the Albuquerque area on Cretaceous rocks in the Albuquerque basin.

But, perhaps the most important reason for the lack of further exploration was the expanding number of discoveries of oil and gas in the San Juan Basin in the early 1950's. Exploration was cheaper and easier there and risk factors were lower. Exploration in the Albuquerque basin was much deeper, riskier, and harder to obtain geological and geophysical data, and therefore, economically much less attractive than other nearby areas.

By the late 1960's, the San Juan Basin and most other established petroleum provinces in the United States were in or approaching a mature development stage. In early 1968 geologists in Shell's Farmington Exploration Division in Farmington, New Mexico, began to recognize the importance of the Albuquerque basin as a potential future oil and gas province. Recognition of the basin's potential was based on a number of factors.

Detailed surface mapping and measurement of Cretaceous outcrop sections south and east of the San Juan Basin and surrounding the Albuquerque basin had led to a better understanding of the Cretaceous section in this area. This work helped establish the facies relationships expected to be present in the Albuquerque basin area.

Technological advances in the concepts of source rock and maturity in the late 1960's, and the application of these concepts in the San Juan Basin by Shell and others, was extended into the Albuquerque basin. The old Humble SFP No. 1 well had not only confirmed the presence of Cretaceous rocks in that part of the basin, but it had also confirmed the presence of potential source rocks. Data from this well indicated a more than adequate maturity history was associated with oil and gas shows in the well.

It became apparent that if a significant Cretaceous section was still preserved under the sands and gravels of the Albuquerque basin, it not only contained favorable reservoir facies but also probably had a rich source-rock section, an adequate maturity history, and probably structural- and stratigraphic-trap potential.

Based on meager original data, it appeared that most of the necessary ingredients for a new oil or gas field, or possibly for a whole new oil and gas province, might be hidden beneath the sands and gravels of the Rio Grande rift. Because of the high potential, levels of organic maturity and the geometry of the basin, it was conceivable that the Albuquerque basin alone could have generated as much or more oil and gas than was found in the San Juan Basin. It could have done so

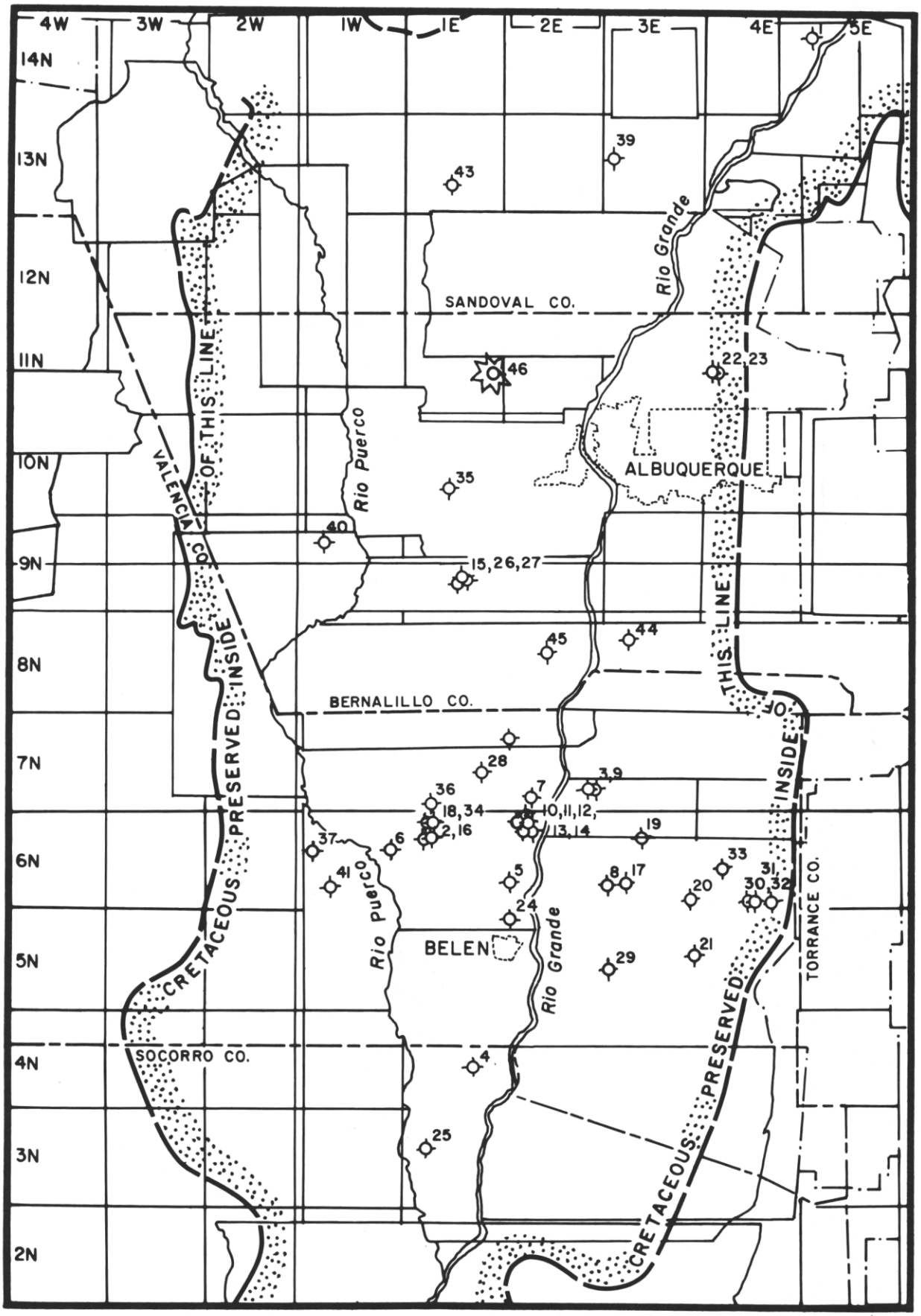


Figure 1. Outline map of the Albuquerque basin showing wildcat oil and gas tests. Well numbers refer to those in Table 1.

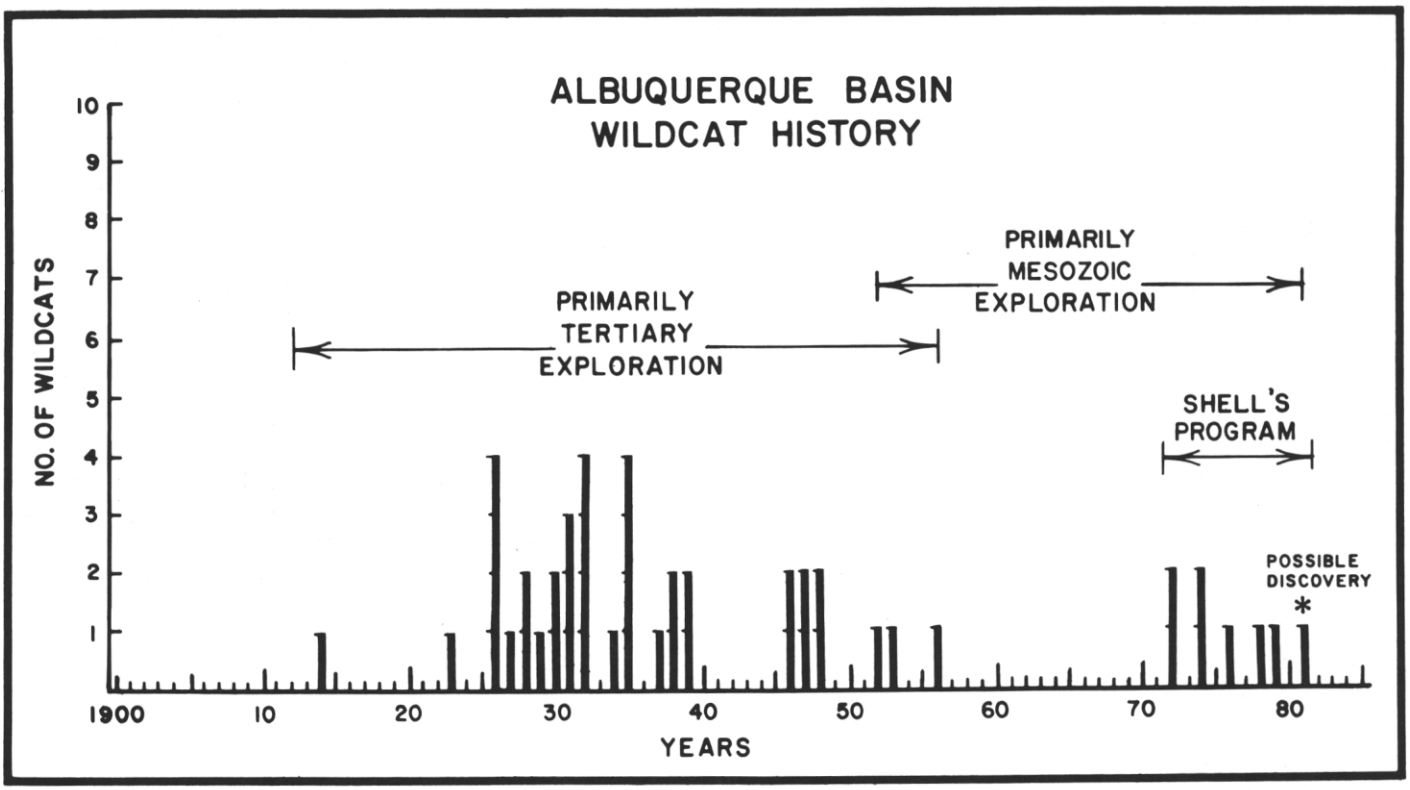


Figure 2. Histogram showing wildcat activity in the Albuquerque basin from 1900-82.

in one-third the area, and it was felt the potential of the basin might be great.

The advances in exploration technology and the changing economic climate in the late 1960's decreased the risk factors, making exploration expenses appear to be justified. After documentation of the basic data, the Shell area geologist presented this conclusion to the Farmington division manager, who agreed with the concept. He had the foresight to include all of the Albuquerque basin in the potential play area, and Shell's Albuquerque basin play was underway.

By 1970 Shell was actively acquiring an acreage position on the play and concurrently started seismic-exploration work in the basin.

The play originally encompassed 404,700 ha (hectares) (a million acres) and, at the time, was the largest single play ever made in New Mexico.

In the first phase of exploration between June, 1972, and June, 1976, Shell drilled five exploration wells. The first test, the Shell SFP No. 1, was drilled to basement on a large southerly plunging nose in the northern end of the basin in sec. 18, T13N, R3E (Black and Hiss, 1974). Although no northern closure is apparent on this structural feature, significant shows were encountered in the Cretaceous section. C, through C, gases were observed in the Dakota sandstones in this well (Black and Hiss, 1974).

The second test was drilled in late 1972 in sec. 8, T9N, R1W. This well, the Shell Wilson Trust, Laguna No. 1 also encountered shows but was drilled on the extreme western flank of the basin. Seismic closure, while possibly present at the Pennsylvanian, was probably late formed. Access to mature source rocks was evidently not present. No mappable closure at the surface was present in Cretaceous rocks.

Shell's third well, the Shell SFP No. 2, was drilled in September, 1974. This well was drilled 3.2 km (2 mi) south of Humble's old well in sec. 29, T6N, R1W and encountered high bottom-hole temperatures with levels of organic maturity probably in excess of 18 at T.D. Probable seismic misinterpretation and complex faulting makes the presence of closure at this location questionable. Anthraxalite in the pore spaces of the Humble well suggests hydrocarbons probably were present in the past, but liquid hydrocarbons, if ever present, were probably destroyed by the extreme temperatures. Shows of gas in both wells were reported to be common.

The fourth well was drilled in 1974, away from the north and west flank of the basin and away from the structural problems of the first three wells. This fourth well was probably designed to move further east into the basin onto a horst. At this location, maturity could be expected in the Cretaceous rocks, but over-cooking might be avoided. The Shell Isleta Central No. 1 was drilled in sec. 7, T7N, R2E and was the most significant well in Shell's program up to that time.

After drilling 3,691 m (12,110 ft) of Tertiary sediments, the well penetrated the top of the Cretaceous Menefee section. Gas kicks were reported on the logging equipment, and oil and gas shows were reported to have been logged throughout the remaining portion of the Cretaceous section. Unfortunately, the well cut a very large fault or system of faults near the base of the Cretaceous nonmarine section. Not only was the primary objective (Dakota Sandstone) tectonically cut out, but so were the Gallup and all of the underlying Jurassic Entrada Sandstone.

The well was not useful for evaluating primary objectives or for showing the best potential reservoirs. Nonetheless, the partial Cretaceous section evidently confirmed the existence of tight gas-bearing sands. Pipe was run, and on subsequent production tests the well reportedly produced significant, although noncommercial, amounts of gas.

If the reported gas sands in this well actually were present, they demonstrate a trap at this location and prove the existence of gas in the Cretaceous in this general area. They also prove that adequate source rocks and maturity are present in this area.

The problem in the Shell Isleta Central well appears to have been

Table 1. Wildcat oil and gas tests in the Albuquerque basin. Well numbers refer to those in Figure 1.

Well Number and Name	Location	Year Completed	Total Depth (ft)	Remarks
1. Tejon Oil & Dev. No. 1	7-14N-6E	1914	1850	rptd show oil at 1000 ft
2. Cal-New Mexico Dechares No. 1	8-6N-1E	12-21-25	2900	rptd show oil and gas
3. Stone No. 1	25-7N-2E	6-15-26	1405	
4. Belen Oil-Seipple No. 1	23-4N-1E	7-1-26	3545	rptd show of oil
5. Gilmore & Sheldon Tome Grant #1	30-6N-2E	12-2-26	1180	
6. Hub Oil-HNTH #1	13-6N-1W	12-31-26	3425	
7. Stone Horland No. 1	32-7N-2E	11-4-27	2144	rptd show of oil
8. Gilmore & Sheldon Tome #1	30-6N-3E	4-9-28	1100	
9. Stone #2	25-7N-2E	11-12-28	1976	rptd oil show
10. Harlan et al. Harlan #1	5-6N-2E	8-1-30	4223	rptd cored show of oil
11. Harlan #2	5-6N-2E	11-15-30	4021	
12. Harlan #3	5-6N-2E	4-5-31	6474	rptd several gas shows
13. Harlan #4	5-6N-2E	6-28-31	3820	rptd shows of oil and gas
14. Harlan #5	5-6N-2E	8-23-31	4007	rptd several gas shows
15. Norins Pajarito Grant #1	22-9N-1E	8-19-31	5104	rptd numerous oil and gas shows
16. West. Natural Resources No. 1	8-6N-1E	7-16-32/8-32	1725	
17. Mills Tome #1	29-6N-3E	419-15-32/8-33	507	
18. Big Three Dalies Townsite No. 1	5-6N-1E	9-29-37	6113	rptd numerous oil shows
19. Mills Tome #2	9-6N-3E	11-18-32	446	
20. Ringle Dev. Co. Fee #1	36-6N-3E	11-17-34/35	1115	
21. Ringle Dev. Co. Fuqua No. 1	13-5N-3E	2-35/3-35	100	
22. Norins N. Alb. Acres No. 1	19-11N-4E	5-35	573	
23. Norins N. Alb. Acres No. 2	19-11N-4E	8-16-35	5024	rptd CO_2 show
24. Ringle Dev. Co. Ringle No. 1	6-5N-2E	9-35/11-14-35	750	
25. Central N. Mex. Brown #1	17-3N-1E	7-37	2840	rptd numerous oil and gas shows
26. Norins No. 2	22-9N-1E	3-21-28	2780	
27. Norins Pajarito No. 3	22-9N-1E	9-27-38	2780	
28. Joiner Sanclemente No. 1	23-7N-1E	1-5-39	5606	rptd show of gas core
29. Grober Fuqua No. 1	19-5N-3E	10-18-40	3978	rptd lots gas at T.D.
30. Ringle Tome #1	34-6N-4E	6-29-47	823	rptd 25 to 50 mcfgpd from Penn.
31. Ringle Tome #2	35-6N-4E	3-1-47	890	rptd oil show
32. Ringle Tome #3	34-6N-4E	4-1-47	597	
33. Castleberry Tome No. 1	20-6N-4E	6-1-47	500	
34. Von G. No. 1	5-6N-1E	8-1-48/49	6096	rptd numerous oil and gas shows
35. Carpenter Alrisco No. 1	28-10N-1E	8-16-48	6652	
36. Long Dalies No. 1	32-7N-1E	4-11-52	6091	rptd DST slt show oil and gas
37. Humble Oil SFP #1	18-6N-1W	1-29-53	1269	rptd DST gas cut mud
38. Casey 1-A	?	1-9-56	?	?
39. Shell SFP No. 1	18-13N-3E	6-19-72	11,045	rptd oil and gas shows in K
40. Shell Laguna-Wilson Trust #1	8-9N-1W	9-21-72	11,115	rptd gas shows
41. Shell SFP #2	29-6N-1W	3-29-74	14,305	rptd gas shows
42. Shell Isleta #1	7-7N-2E	10-25-74	16,346	rptd recov. gas and oil on DST in K
43. Shell SFP #3	28-13N-1E	4-19-76	10,276	rptd minor gas
44. TransOcean Isleta No. 1	8-8N-3E	10-4-78	10,378	logged number. gas shows
45. Shell Isleta #2	16-8N-2E	11-23-79	21,266	did not reach Cretaceous rocks
46. Shell West Mesa Fed. No. 1	24-11N-1E	12-30-80	19,375	completion presently being attempted; gas being flared

Location = section, township, and range
rptd = reported
K = Cretaceous
DST = drill stem test
slt = salt water present
mcfgpd = million cubic feet of gas per day

the apparent lack of adequate reservoir quality in the small amount of the nonmarine Cretaceous section cut by the well. The primary objective reservoirs were missing, due to fault cutout of at least the lower 579 m (1,900 ft) of the Cretaceous section and the underlying Entrada Sandstone. The failure to attempt a massive fracture completion of the reported gas-bearing Mesaverde section may have been an error, as thousands of wells so treated in the San Juan Basin have demonstrated.

Another possible oversight was the reported failure to attempt to production-test several tens of feet of basal Tertiary oil and gas shows. D.S.T.'s on these zones were reportedly unsuccessful due to packer failures earlier in the drilling. At the time of Shell's attempted completion of wells in the Cretaceous section, these shows were behind pipe and probably should have been tested. The well was plugged and abandoned on July 21, 1975 after tests by Shell and the U.S. Geological Survey on potential water-bearing zones in the Tertiary strata.

The next test was the Shell SFP No. 3, drilled at what was probably a compromise loction in sec. 28, T13N, RIE, in April, 1976. The well encountered only minor shows. It was apparently drilled on a faulted anticlinal nose on the west flank of the basin and again probably lacked maturity at the Cretaceous level. There was no apparent route for hydrocarbon accessibility out of the deeper, mature areas of the basin. This location appears to have been picked in part because of a need for Shell to fulfill an exploration expenditure requirement to Santa Fe Pacific railroad company.

Based on the performance of Shell's Isleta Central No. I well, TransOcean Oil Company farmed in on the shallower of two Shell seismic prospects. The reasons for Shell's decision to farm out portions of its acreage can only be speculated upon. After five apparent dry holes were drilled with more than $20 million invested in the play, and with additional rentals coming due, it is probable that a management decision was made to "share the risk" with another party.

TransOcean commenced drilling the Isleta No. 1 on October 4, 1978. This well topped the Cretaceous at 2,414 m (7,920 ft) and encountered significant increased gas shows in this unit. Like the Shell Isleta well, however, the TransOcean well encountered a large fault at 2,679 m (8,790 ft), with the lower 488 m (1,600 ft) of the Cretaceous section and all of the Triassic and Jurassic section faulted out. The well continued into the Paleozoic and was T.D. 'd at 3,163 m (10,378 ft) in the Precambrian rocks on November 10, 1978. The well was plugged and abandoned seven days later. With the drilling of this well through 2,743 m (9,000 ft), TransOcean earned half interest in a 16,188-ha (40,000-acre) block.

Shell's next wildcat was an attempt to move out into the deep, mature portions of the basin where a full and non-structurally complex section of Cretaceous rocks could be drilled. This well was probably an attempt to test the stratigraphic potential of the Cretaceous section in an environment similar to that of the San Juan Basin. This had been the original concept of the play, but structural considerations may have gotten in the way on the first six tests.

On November 23, 1979, Shell spudded the Isleta No. 2 in sec. 16 of T8N, R2E. The well probably was expected to top the Cretaceous near 4,877 m (16,000 ft), but the well was still in basal Tertiary at T.D. of 6,482 m (21,266 ft). Rig capacity probably had been reached without attaining the Cretaceous. With at least 6,482 m (21,266 ft) of Tertiary, the total sedimentary section in this part of the basin is probably in excess of 8,687 m (28,500 ft), making an overall stratigraphic displacement of over 10,211 m (33,500 ft) across the east-bounding faults of the basin in this area. The well was plugged in May of 1980.

Shell's last (and current) attempt was spudded on December 30, 1980. The Shell West Mesa Federal No. 1 in sec. 24 of TI IN, R1E was T.D.'d at 5,906 m (19,375 ft). The well was reported plugged back to 5,244 m (17,206 ft) and after extensive D.S.T.'s and logging production casing was reportedly run to T.D. The well currently is being production tested. Shell has recently initiated an intensive leasing program, including small lot leasing in the area near Albuquerque. Rumors abound that this last well is a significant discovery.

Figure 3 shows the Cretaceous penetrations in the basin, including all the Shell wells and the TransOcean farm-in well in T8N, R3E.

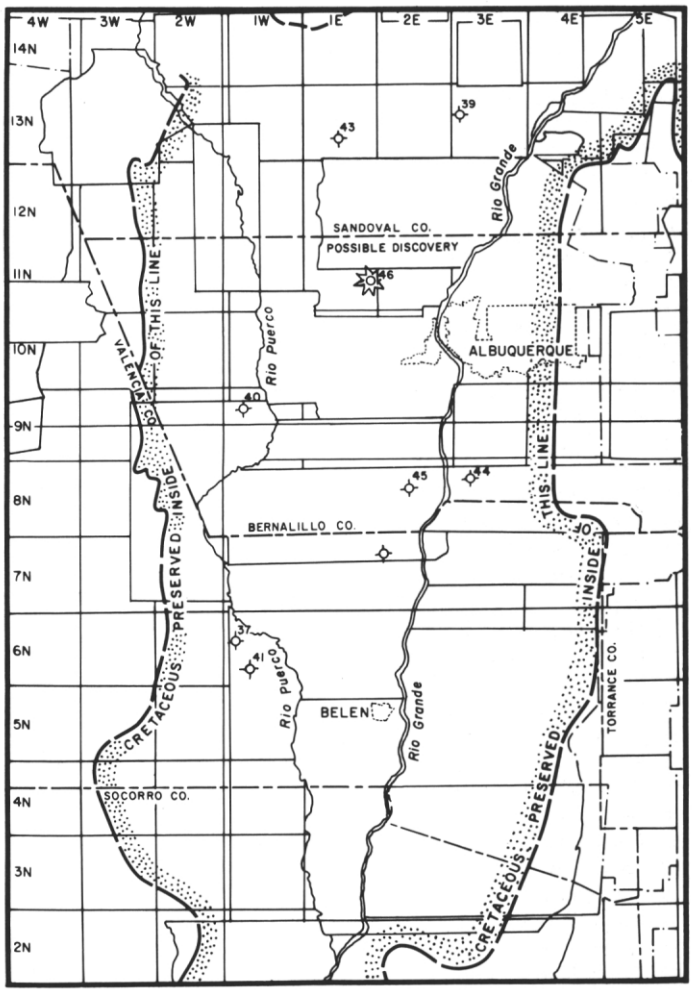


Figure 3. Outline map of the Albuquerque basin showing wildcat oil and gas tests which have penetrated Cretaceous rocks. Well numbers refer to those in Table 1.

RESUME OF CRITICAL PARAMETERS FOR EXPLORATION IN THE ALBUQUERQUE BASIN

The Albuquerque basin in north-central New Mexico is a complex graben structure, approximately 145 km (90 mi) long and 64 km (40 mi) wide, which formed in response to middle-late Tertiary extensional tectonics. High-angle normal faults bound both the east and west sides of the basin, and the maximum vertical stratigraphic displacement between the deepest portion of the basin and the highest bounding rim is estimated to be 8 to 10 km (5 to 6 mi). As much as 10,210 m (33,500 ft) of sediments ranging in age from Mississippian to late Quaternary may be present within the basin.

Figures 4, 5, and 6 reconstruct the Late Cretaceous to Pliocene history of New Mexico and show the location and general Cretaceous stratigraphy in the Albuquerque basin area. For a recent description of the general geology of the basin, see Kelley and others (1976) and Kelley (1977).

Source Rocks

Potential source rocks in the basin include black, organic-rich shales in the Pennsylvanian section; black, fetid, laminated, nonmarine limestones in the Jurassic Todilto Formation; and lipid-rich black shales of the thick marine Cretaceous section. Dark gray shales have been reported in the Tertiary, but their source-rock potential has not been determined.

The potential richness and extent of the Pennsylvanian black shales are questionable, but the source potential of Jurassic and Cretaceous strata has been established both by well control in the basin itself and by outcrop control along the basin margins.

The fetid limestones of the Todilto Formation are the source rocks for the new Entrada discoveries of high pour-point oils in the San Juan Basin (Vincelette and Chittum, 1981). These same organic-rich limestones are present over portions of the Albuquerque basin and undoubtedly have produced oil and gas where thermally matured. Confirmation of this source potential has been demonstrated by pyrolysis fluorescence of outcrop samples from both the east and west margins of the basin.

The Cretaceous stratigraphy in the basin has been determined by well and outcrop control (Black, 1979b). Based on these data, the known source-rock potential in the San Juan Basin can be projected into the Albuquerque basin and is present wherever Cretaceous rocks are present. This potential has been recently confirmed by G.S.C. (gas chromatography) analysis of the Cretaceous marine shales on the basin rims

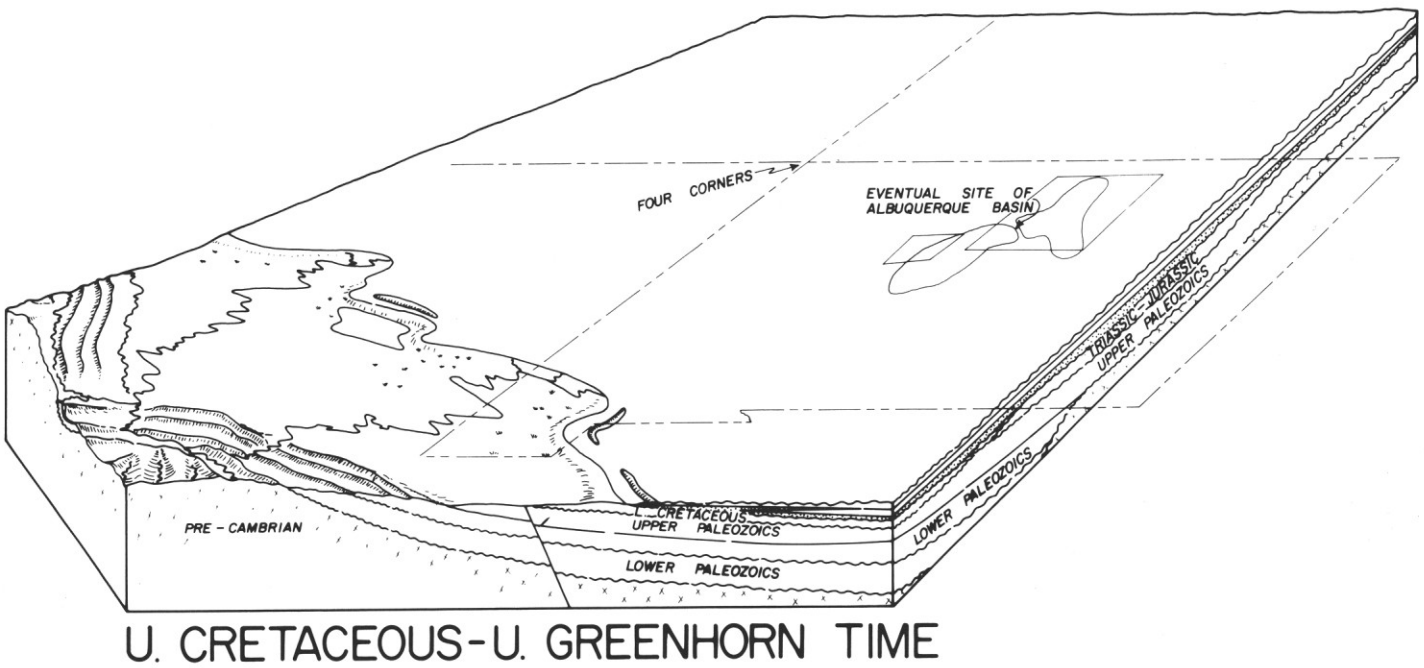


Figure 4. Cut-away block diagram of the Four Corners area during Late Cretaceous, Greenhorn Marine Transgression. Future Albuquerque basin area is shown in approximate position only.

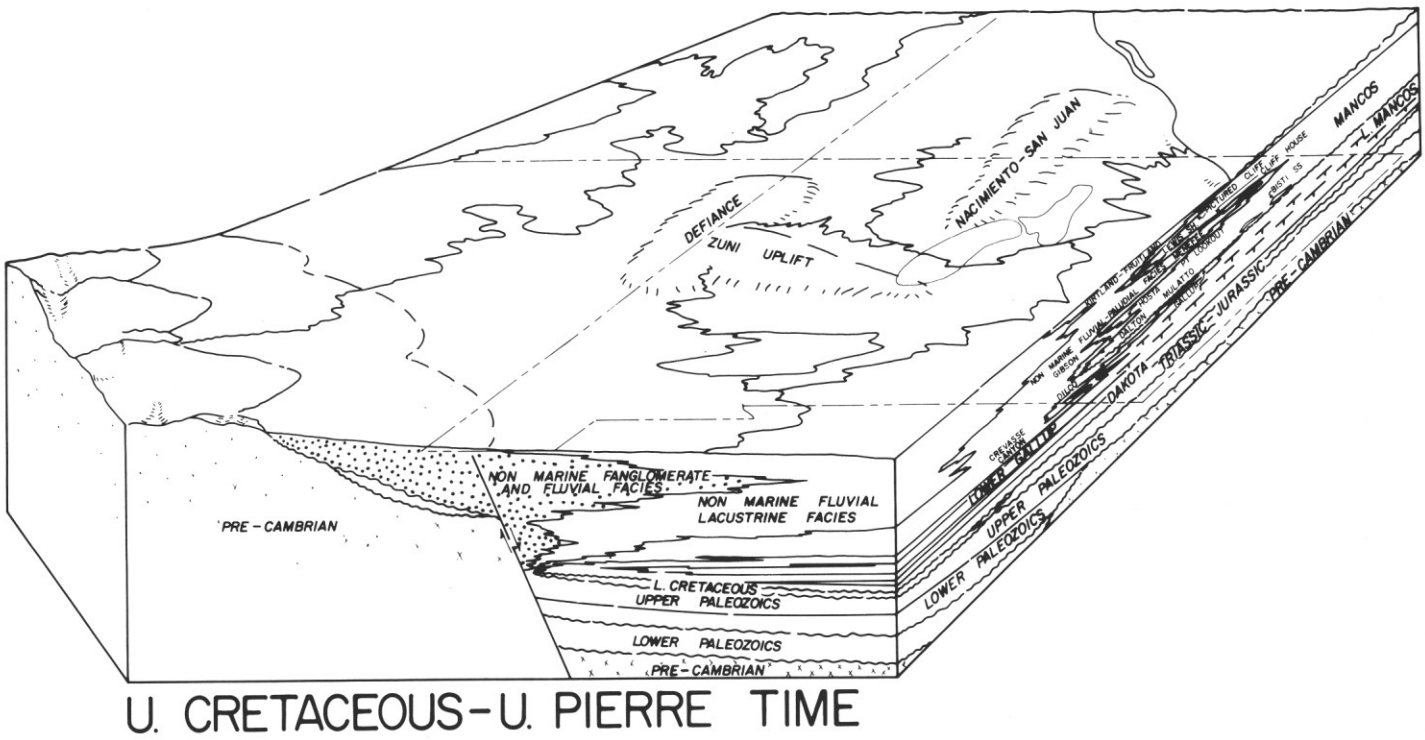


Figure 5. Cut-away block diagram showing primary Cretaceous transgressive and regressive facies across New Mexico in Late (Upper) Cretaceous (Pierre) time.

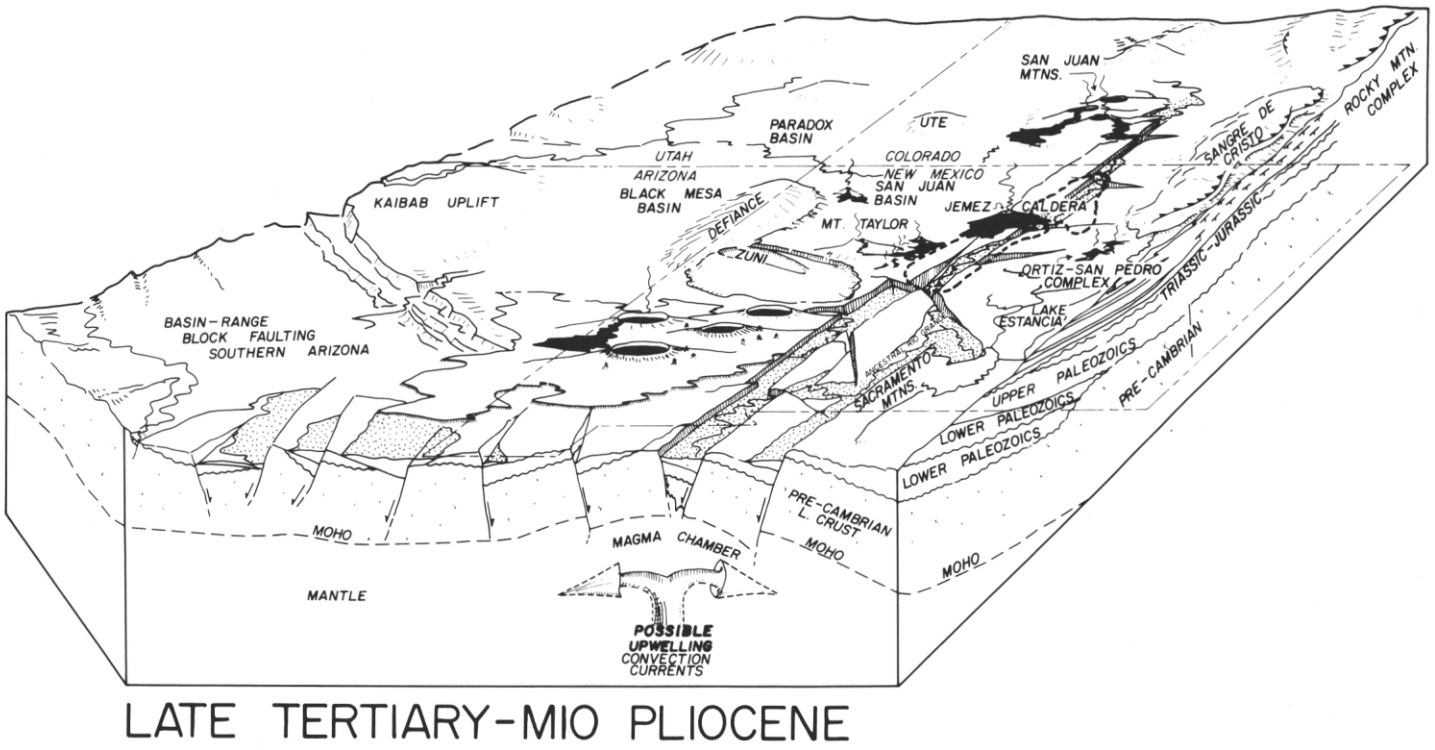


Figure 6. Highly generalized cut-away block diagram of New Mexico showing various Miocene to Pliocene features associated with rifting.

as well as the older Humble SFP No. I drilled in 1952. Thin-section analysis and G.S.C. analysis have confirmed the presence of these lipid-rich source rocks.

Maturity

Levels of organic maturity based on vitrinite and confirmed by G.S.C. analysis from the Humble, Santa Fe Pacific No. 1 range from a probable level of 12.5 to 13 at 3,200 m (10,500 ft) in the objective Cretaceous sediments, to a level of 12 to 14 at 3,840 m (12,600 ft). Levels of organic maturity greater than this are suspected at the Dakota level in the Shell SFP #2 well, drilled in 1974 3.2 km (2 mi) south of the Humble well.

Anthraxalite was common in the Humble well in the Cretaceous section. Destruction of liquid hydrocarbons in this area is probable. By contrast, levels of organic maturity as low as 8.0 were reported to have been present in the Dakota in Shell's SFP No. 1 well and in the Shell SFP No. 3 at the north end of the basin. If true, these low levels may account in part for the lack of hydrocarbon accumulations in these wells.

Optimum levels of organic maturity were probable in the Shell Isleta No. 1 in the center of the basin so it is not surprising that this well had confirmed oil- and gas-bearing sands in the Cretaceous section.

Levels of maturity from 9.0 to as high as 12.0 have been determined for outcrop samples on the west flank of the basin. Levels as high as 12.0 occur in Triassic outcrops on the east side of the basin, in the vicinity of the Hubbell bench. Medium to high levels of maturity are indicated in Cretaceous sediments elsewhere in the Albuquerque basin because of outcrop control, Btu values of the Cretaceous coals on both the east and west rims of the basin, and a high present-day geothermal gradient in the basin.

Except in the northwestern portion of the basin where the Cretaceous rises to the surface, reconnaissance gravity data suggest that the majority of Cretaceous rocks are nearly as deep as their occurrence in the Shell Isleta well. The deeper Paleozoic and Mesozoic sections may well have levels of organic maturity in excess of 15 in many areas of the basin. Exceptions should occur where these sections have been less deeply buried because of intra-basin horsts.

It is evident that in large areas of the basin, the lower portions of the Tertiary basin-fill sediments are deeper than 3,658 m (12,000 ft) and could have levels of organic maturity in excess of 10. Source rocks in the Tertiary, if present, could be mature locally.

Reservoirs

Reservoir quality in Cretaceous rocks of the Albuquerque basin is similar to that of like rock types in the San Juan Basin. The primary objectives for exploration are Cretaceous nearshore marine sands and possibly coarser fluvial channel sands. Well control and the Cretaceous stratigraphy, as mapped on both rims of the basin, indicate that the objectives of Cretaceous sections present in the San Juan Basin are also present in the Albuquerque basin (fig. 7).

Thin-section examination of the Humble, Santa Fe Pacific No. 1 well indicates a possible early phase of calcite cementation in Cretaceous sandstones. Cementation has preserved much of the early depositional fabric but has produced a relatively tight, well-cemented sandstone. In contrast, the Shell Laguna Wilson No. 1 appears to have 1,067 m (3,500 ft) of Cretaceous sediments, with over 150 m (500 ft) of potential reservoir-quality sands. Porosities range from 16 to 24 percent in both this well and in the Shell SFP No. 3.

The Jurassic Entrada Formation is a clean, well-sorted, eolian sand with excellent reservoir characteristics. It should be a primary objective in the basin. Porosities up to 30 percent are reported in this sand in the San Juan Basin. Where this sand is overlain by the Todilto fetid limestones in the north half of the basin, it should be considered a primary objective. It was apparently not present in the Shell Isleta No. 1 due to faulting.

On intermediate fault blocks where the Cretaceous and Jurassic sandstone reservoirs have not been subjected to extremely deep burial, their

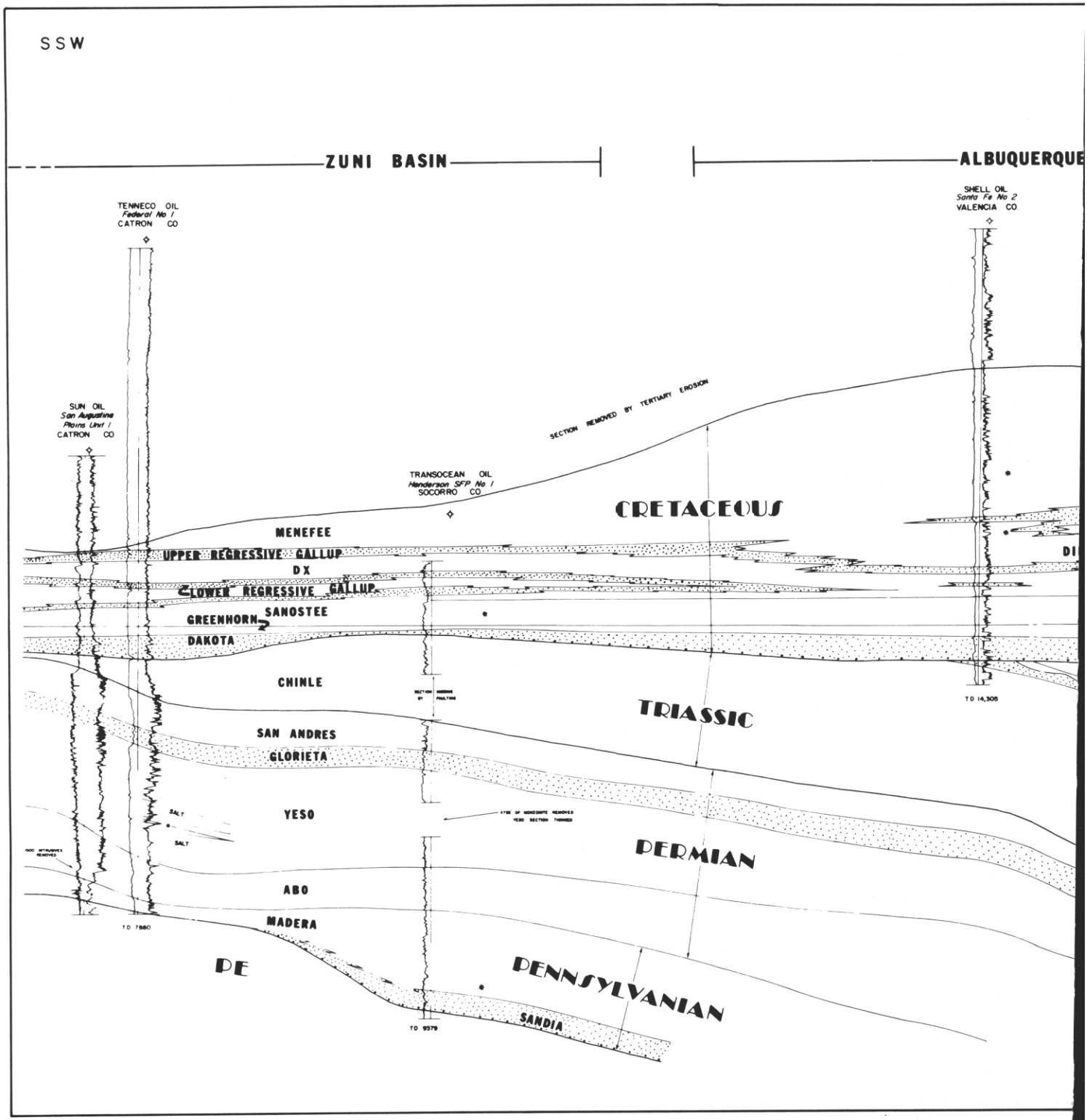
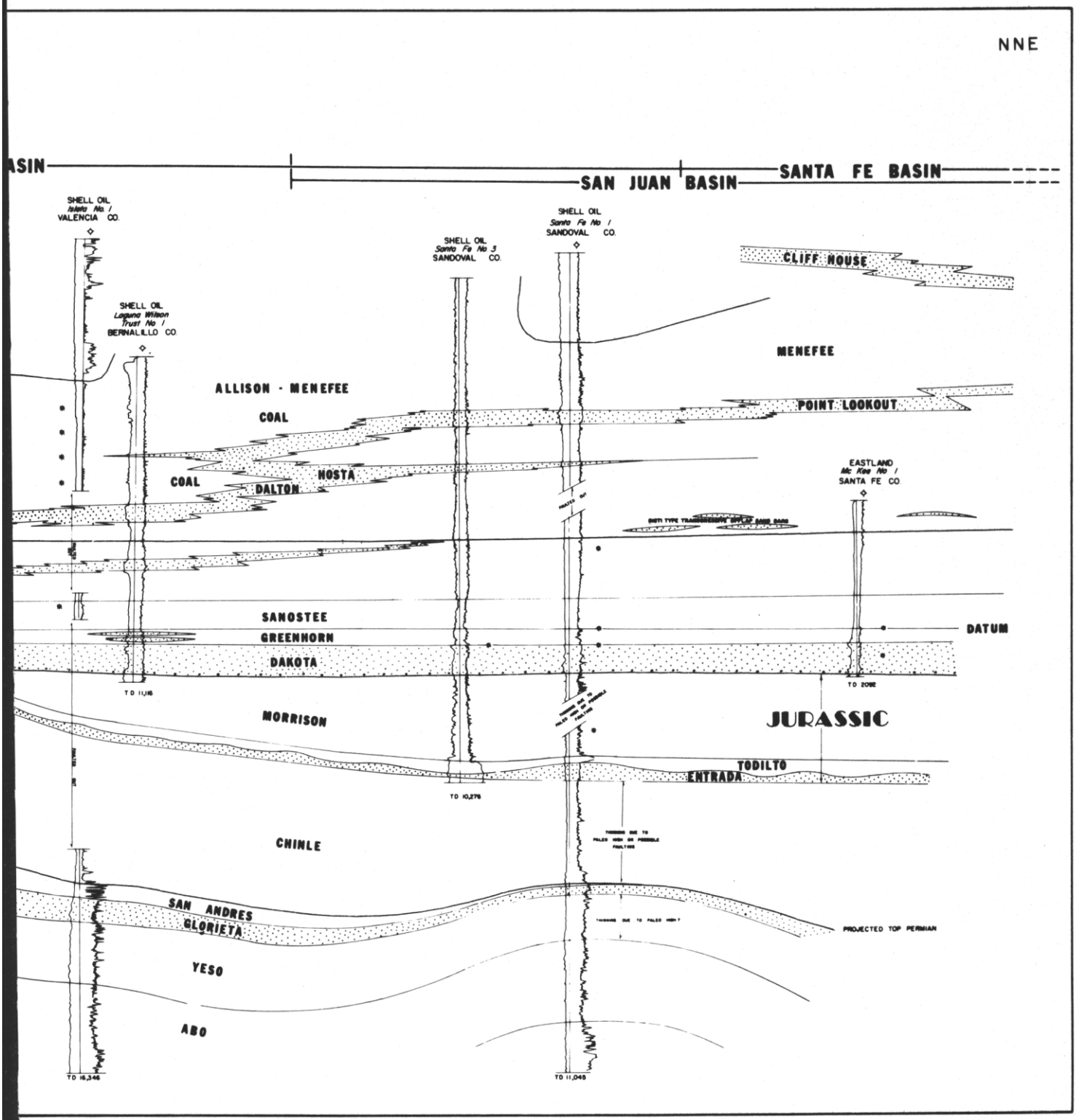


Figure 7. Stratigraphic section showing facies relationships from Zuni basin



north through Albuquerque basin to Santa Fe embayment of the Espanola basin.

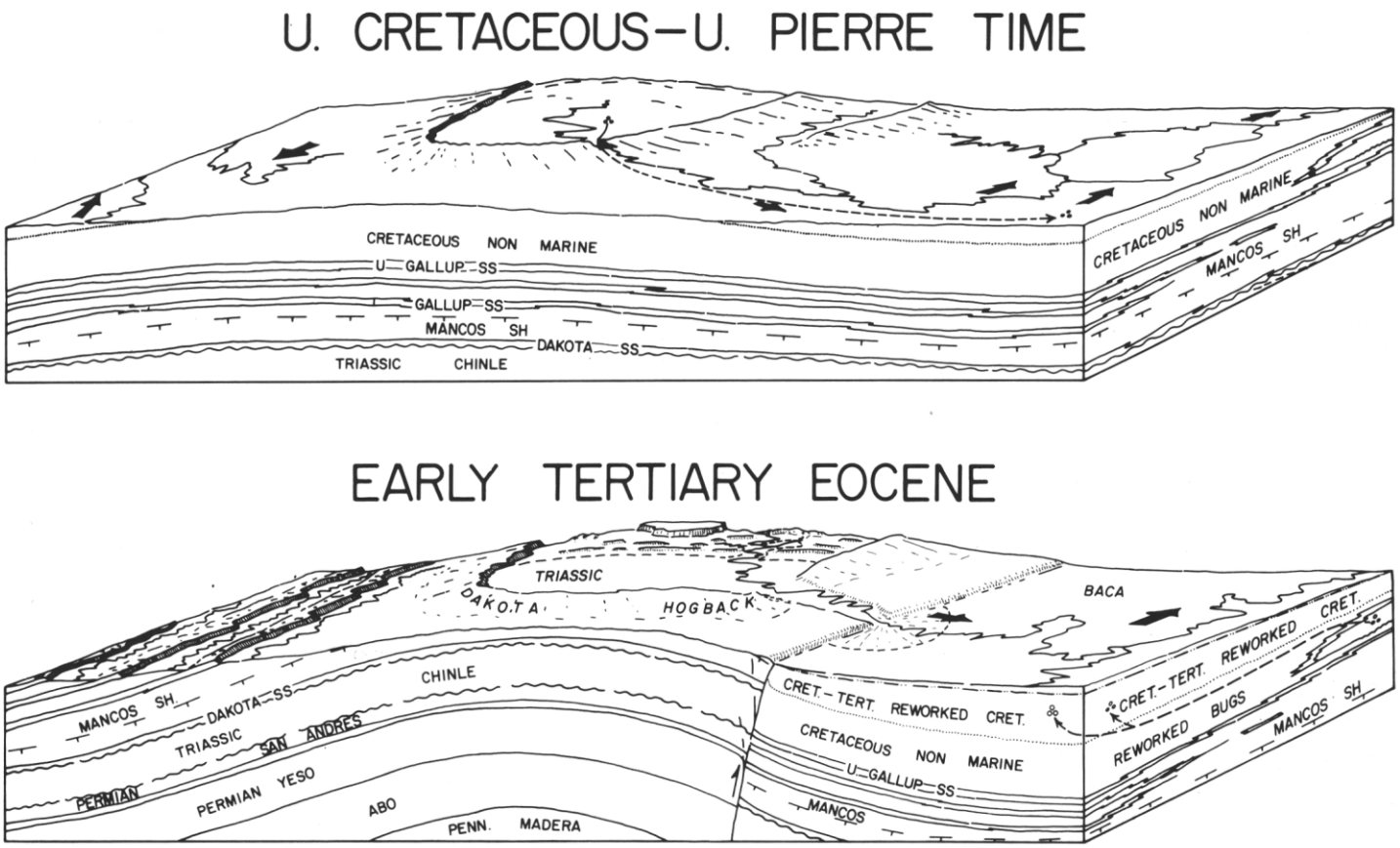


Figure 8. Block diagram of the west flank of the Albuquerque basin illustrating Laramide and early Tertiary tectonics and basin filling.

reservoir quality should be comparable to reservoirs of the same depth and environment in the San Juan Basin.

The deeper Paleozoic sandstone and carbonate reservoirs are secondary objectives, and their reservoir characteristics generally are not documented. Significant reservoirs may exist in high-energy carbonate and sandstone sections, particularly in the basal Pennsylvanian strata.

Traps

Both structural and stratigraphic traps are undoubtedly present in the basin. While structures are the prime traps to investigate in the initial phase of exploration, recent well control has helped delineate stratigraphic trends as well.

Seismic exploration by Shell has undoubtedly delineated faults and folded structures within the basin. Large faulted anticlines are probably present and may be associated with central-basin, horst blocks. The TransOcean Isleta No. 1 well was drilled on the faulted northern plunge of one of these large structures. Indicated closure exceeded 300 m (1,000 ft) and encompassed more than 26 km' (10 mi.") within the closing contours.

Timing Considerations

At least five tectonic events are recognized near the Albuquerque basin. Kelley and Northrop (1975) recognized possible Precambrian movement along the Tijeras fault (see Connolly, this guidebook). Late Paleozoic uplift and tectonic activity probably associated with the Pedernal uplift to the east affected sedimentation and the structural grain in the Albuquerque area. Pre-Late Cretaceous regional uplift and resulting erosion in southwestern New Mexico caused an undetermined amount of stripping of pre-Cretaceous rocks in the south end of the Albuquerque basin. Late Cretaceous to early Tertiary Laramide deformation appears to have affected at least part of the northwestern portion of the basin as evidenced by a pronounced angular unconformity between Cretaceous and lower Tertiary rocks. Laramide structures may be developed across the area and could be important localizers of oil and gas accumulations beneath the Tertiary cover (fig. 8).

At least two episodes of Tertiary deformation appear to be present (fig. 9). The first accompanied rifting in Late Miocene time and formed the basin, which was then contemporaneously filled with the Santa Fe Group deposits. The second is Pleistocene deformation which produced folding and some faulting. This last period of deformation has continued to the present, deforming earlier Tertiary basin-fill deposits (see Black, 1979a).

CONCLUSIONS

An objective analysis of critical data regarding the Albuquerque basin play by Shell can be summarized as follows:

1. Adequate source rocks are available in Cretaceous shales, in Jurassic Todilto limestones, and locally in Pennsylvanian shales.
2. The maturity history of the basin is favorable over large areas, particularly in the deeper central and eastern portions.
3. Reservoir-quality rocks are present in the Cretaceous, Jurassic, and probably in the Pennsylvanian sections of the basin.
4. Migration of hydrocarbon into the Cretaceous rocks in central portions of the basin evidently has been proven.
5. Large structures may be present in the basin and in conjunction with the Cretaceous stratigraphy should provide excellent trapping mechanisms.
6. Significant shows of oil and gas were reported by the Shell Isleta No. 1.

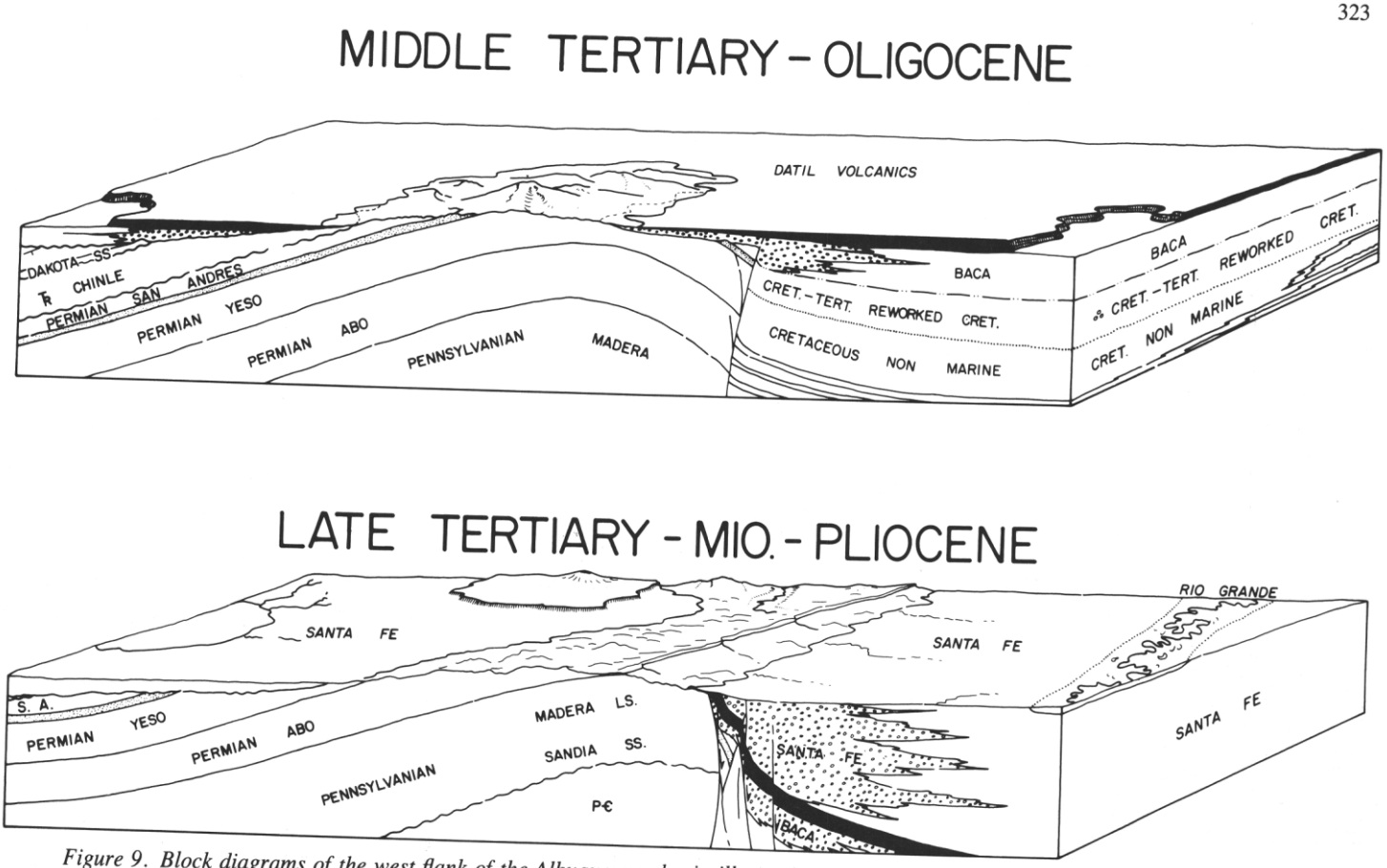


Figure 9. Block diagrams of the west flank of the Albuquerque basin illustrating Tertiary deformation, volcanism, and basin filling.

7. Exploration to date has tended to confirm early speculation oi the potential of the basin and has set the stage for additional tests whicl are justified under the present economic conditions.

The discovery of oil or gas in commercial quantities in the Albuquerque basin would, in reality, be much more significant than a simplc new-field discovery itself. A discovery would imply not just a field bui a new oil- and gas-producing basin and would forecast possible additional oil- and gas-field discoveries in the other Rio Grande rift basins.

Table 2 is a comparison of the present knowledge of the critica parameters for oil and gas accumulations in the basin. comnared knowledge in 1960 and 1970. It is apparent that the state of knowledge strongly suggests that production from the Albuquerque basin is only a matter of economics and time. In the writer's opinion, the question is not if production can be established, but rather when it will be established.

Table 2. Requirements for oil and gas accumulations, exploration, and exploitation.

Factors	Availability in Albuquerque Basin		
	1960	1970	1982
Source rocks	Unknown	Probable	Yes
Maturity	Probable	Probable	Yes
Migration paths	Unknown	Unknown	Unknown
Reservoirs	Unknown	Unknown	Yes
Traps	Unknown	Unknown	Probable
Timing	Unknown	Unknown	Yes
Explorability	Unknown	Unknown	Yes
Exploration expertise	Yes	Yes	Yes
Wildcat wells (Cretaceous tests)	1	1	9 & drilling
Production expertise	Probable	Yes	Yes
Economic environment favorable	No	Probable	Yes

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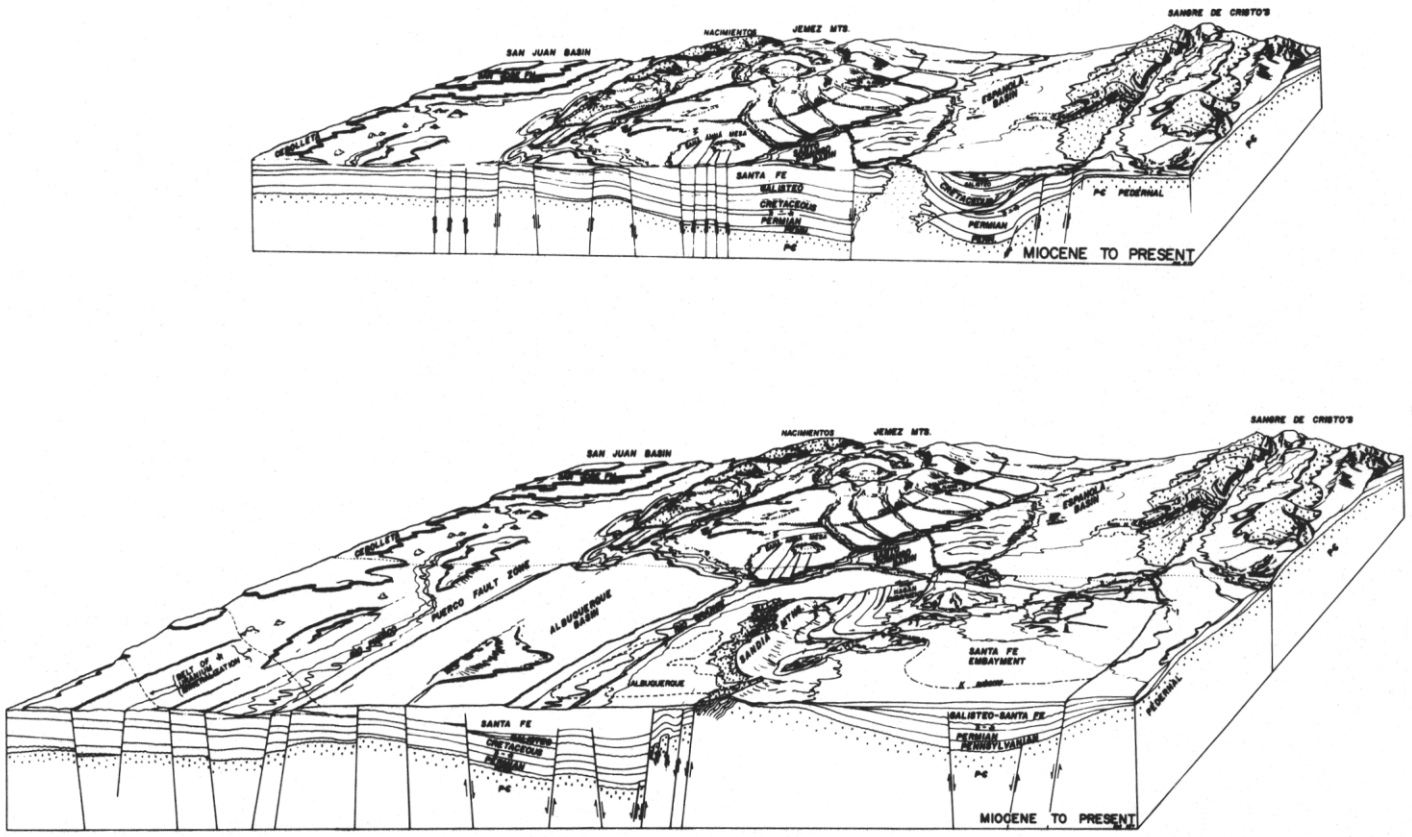
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Cut-away block diagrams of central New Mexico, showing sections through Albuquerque, Estancia, and Bernalillo-Lamy areas (see preceding article by B. Black).