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OIL AND GAS EXPLORATION IN COLFAX COUNTY

By

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Colfax County is bordered on the west by the Sangre de Cristo Mountains and on the north by the deeply dissected Raton and the basalt-capped Johnson Mesas (Fig. 1). The remainder of the county is a plain of low relief, dotted by numerous eruptive centers. Altitudes range from a low of 5,600 feet on the Canadian River at the Mora County line to more than 12,000 feet in the Cimarron Range. General altitudes in the plains are between 6,000 and 7,000 feet and on the mesas, 8,000 to 9,000 feet. The county embraces an area of approximately 3,800 square miles.

STRATIGRAPHY

Sedimentary rocks of Cretaceous age underlie most of the plains area, exposures of older rocks being limited to isolated outcrops of Triassic and Jurassic on some of the anticlinal structures and in the canyon walls of the Cana-

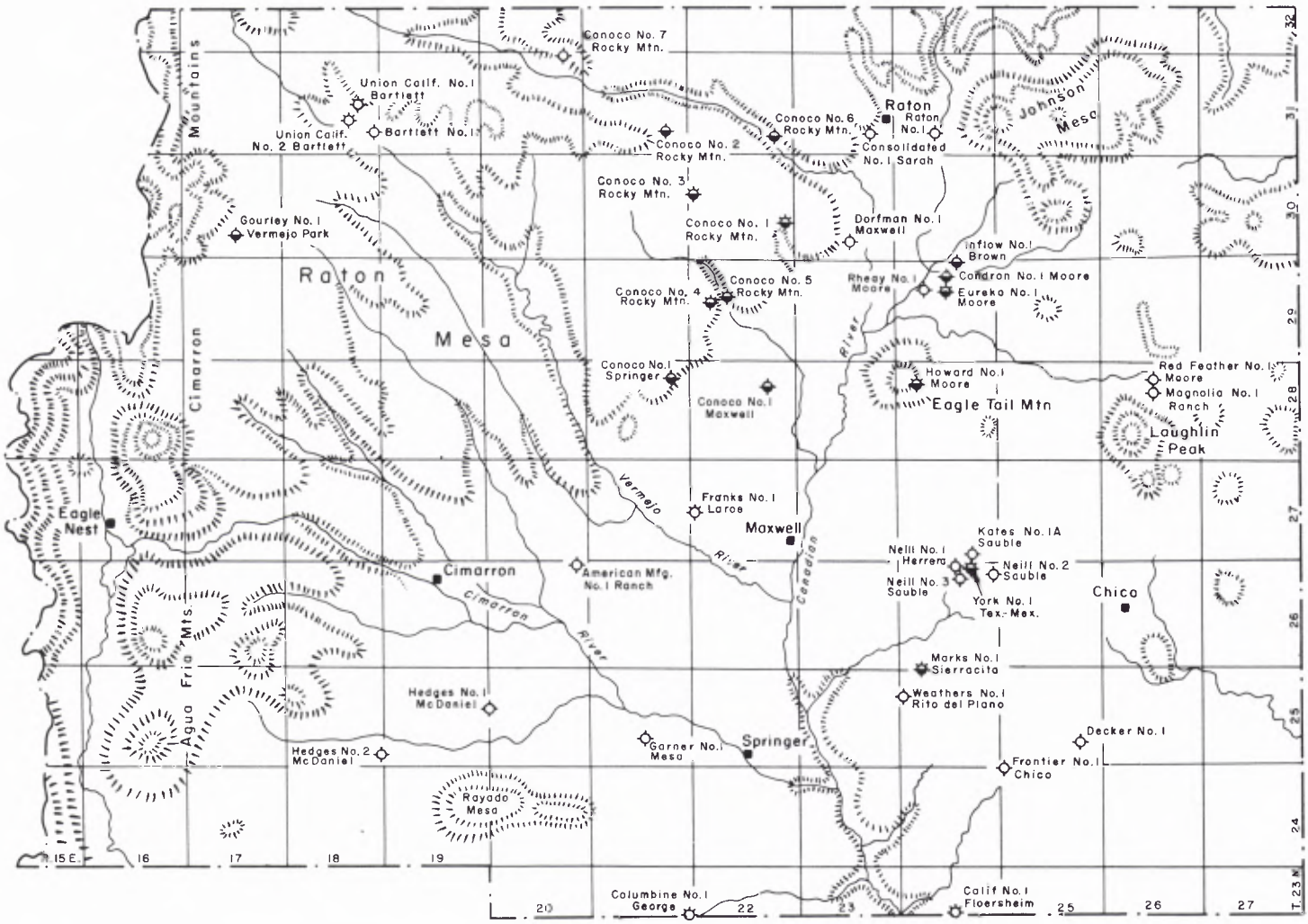


FIGURE 1

Index map of Colfax County showing location of oil tests.

dian River. Precambrian igneous and metamorphic rocks and Late Paleozoic, Triassic, Jurassic, and Cretaceous strata are exposed in the mountains to the west.

Thirty-nine oil tests and several stratigraphic tests have been drilled in Colfax County. Data are sparse for many of these wells and often are limited to a driller's log. Available stratigraphic information decreases rapidly below the Dakota Sandstone, the primary target for oil and gas exploration.

Precambrian

Based on interpretation of samples and well records, Precambrian rocks may have been drilled in eleven tests (Table 1 and Fig. 2). Cuttings of the Precambrian were available for six of these wells. Rock types encountered were granite in the Kates No. 1-A Sauble and Conoco No. 1 Maxwell; gneissic granite in the Condron No. 1 Moore and Conoco Nos. 1 and 2 Rocky Mountain; and quartzite in the Conoco No. 4 Rocky Mountain. Granite was reported for the California No. 1 Floersheim-State, Frontier No. 1 Chico, American Manufacturing No. 1 W. S. Ranch, Magnolia No. 1 T. O. Ranch, Conoco No. 3 Rocky Mountain, and Union of California Nos. 1 and 2 Bartlett. Granite is commonly used as a synonym for Precambrian, and without supporting evidence of some sort, this designation cannot be relied on as implying a specific rock type. The granite designation in the California No. 1 Floersheim-State is verified by a sample log of the cuttings supplied the Bureau by Pan American Petroleum Corporation. A scout report for the American Manufacturing No. 1 W. S. Ranch gives the following information: "6 inches of solid granite cored at 3824½-25 feet." Core and cuttings from the lower part of the Magnolia No. 1 T. O. Ranch are from a Tertiary sill or dike of monzonitic composition intruded into the upper part of the Morrison Formation. The oldest rocks cut in the Conoco No. 3 Rocky Mountain are of Permian age,

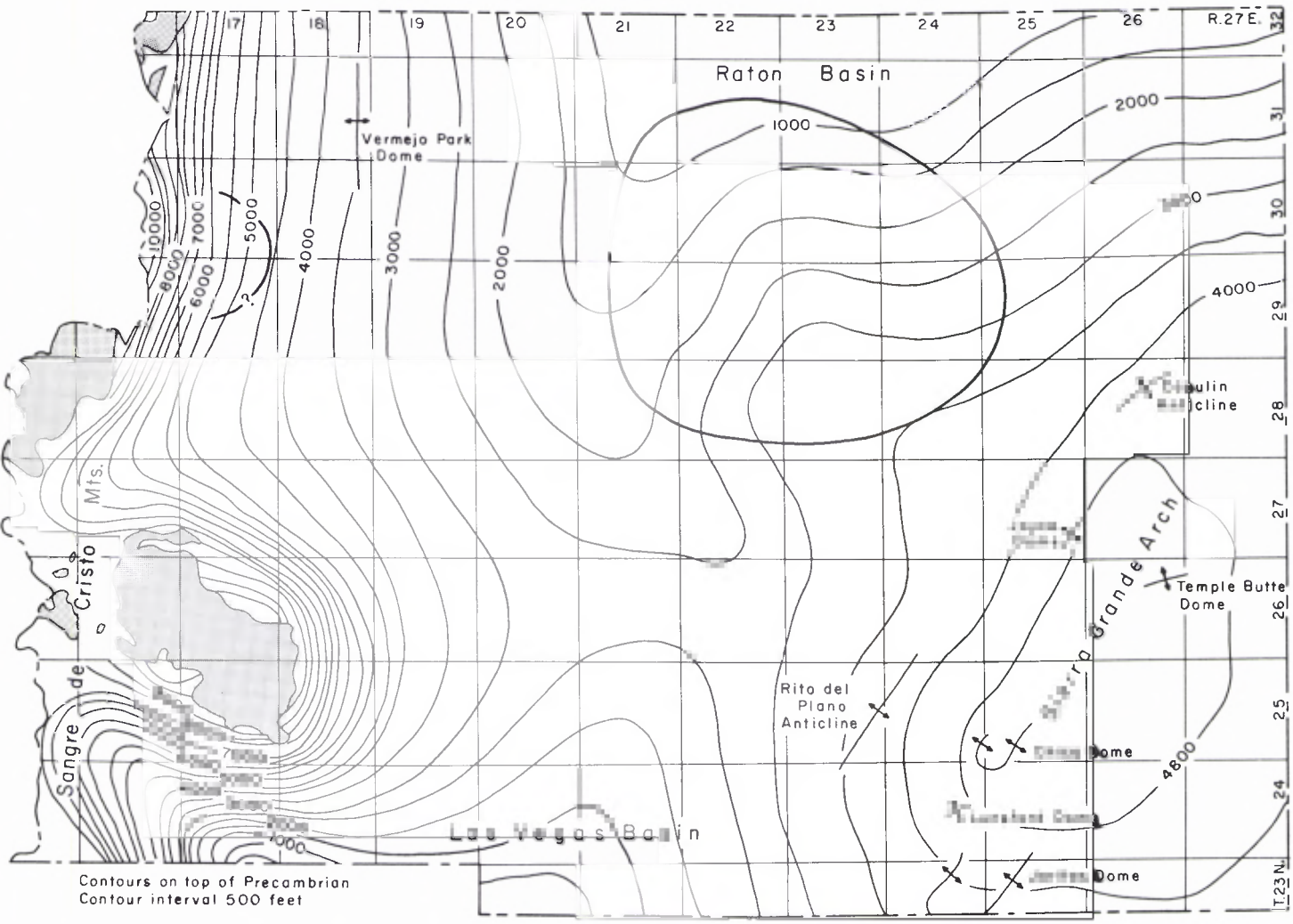


FIGURE 2

Structural features of Colfax County

(Heavy lines enclose areas of oil shows in Dakota Ss.)

TABLE 1. OIL TESTS DRILLED IN COLFAX COUNTY

Well	Location	Plugged	Elev.	Total Depth	Lowest Tested	Remarks
Columbine No. 1 George	1980S, 1980E sec. 13, T. 23 N., R. 21 E.	1958	?	1607	Dockum Group	Sulfur gas, Dakota Ss.
California No. 1 Floersheim-State	250S, 250W sec. 15, T. 23 N., R. 24 E.	1925	5823 est.	2556	Precambrian	Carbon dioxide, Glorieta Ss. Jaritas Dome
Frontier No. 1 Chico	1250N, 600W, sec. 6, T. 24 N., R. 25 E.	1927	6186	1326	Precambrian?	Chico Dome
Hedges No. 2 McDaniel	660N, 660E sec. 36, T. 25 N., R. 18 E.	1956	6891	657	Dakota Ss.	
Hedges No. 1 McDaniel	2740S, 338W sec. 18, T. 25 N., R. 20 E.	1956	6735	1423	Dakota Ss.	
Garner No. 1 Mesa Ranch	1650N, 990W sec. 27, T. 25 N., R. 21 E.	1957	6000?	1186	Morrison Fm.	
Marks No. 1 Sierracita-State	1980N, 1980W sec. 5, T. 25 N., R. 24 E.	1939	6109	1650	Glorieta Ss.	Rito del Plano Anticline
Weathers No. 1	SE SW sec. 7, T. 25 N., R. 24 E.	1927	6050	1097	Exeter Ss.	Rito del Plano Anticline
Decker No. 1	NW SE sec. 26, T. 25 N., R. 25 E.	1924	?	640	Morrison Fm.	Chico Dome
American Mfg. Tex. No. 1 W. S. Ranch	975N, 802W sec. 1, T. 26 N., R. 20 E.	1946	6400	3825	Precambrian	
Neill No. 2 Sauble	1980S, 1980E sec. 1, T. 26 N., R. 24 E.	1947	6418	1755	Glorieta Ss.	
York No. 1 Tex-Mex	400N, 400W sec. 2, T. 26 N., R. 24 E.	1939	6264	1525	Glorieta Ss.?	Carbon dioxide, numerous oil shows Glorieta Ss.?
Neill No. 1 Herrera	660N, 1980E sec. 3, T. 26 N., R. 24 E.	1948	6242	1552	Dockum Group?	
Neill No. 3 Sauble	1980S, 660E sec. 3, T. 26 N., R. 24 E.	1947	6203	1560	Glorieta Ss.?	Carbon dioxide, Glorieta Ss.?
Franks No. 1 Laroe	1980N, 1980W sec.19, T. 27 N., R. 22 E.	1965	?	1825	Dakota Ss.	
Kates No. 1-A Sauble	330S, 1650W sec. 35, T. 27 N., R. 24 E.	1945	6254	2520	Precambrian	
Conoco No. 1 Springer	1980N, 660E sec. 11, T. 28 N., R. 21 E.	1955	6523	2900	Dakota Ss.	Oil and gas shows, Dakota Ss.
Conoco No. 1 Maxwell	660S, 660W sec. 11, T. 28 N., R. 22 E.	1954	6181	2947	Precambrian	Oil show, Dakota Ss.
Howard No. 1 Moore	? sec. 8, T. 28 N., R. 24 E.	1958	?	1478	Dakota Ss.	Oil show, Dakota Ss.
Magnolia No. 1 T. O. Ranch	1930S, 660W sec. 10, T. 28 N., R. 26 E.	1954	7114	715	Tertiary Intrusive	Capulin Anticline
Red Feather No. 1 Moore	NW SW sec. 10, T. 28 N., R. 26 E.	1926	?	975	Morrison Fm.	Capulin Anticline
Conoco No. 5 Rocky Mt.*	1980N, 660W sec. 16, T. 29 N., R. 22 E.	1955	6464	2890	Morrison Fm.	Oil and gas shows, Dakota Ss.
Conoco No. 4 Rocky Mt.*	2320S, 1780W sec. 17, T. 29 N., R. 22 E.	1954	6539	4709	Precambrian	Oil show, Dakota Ss.
Inflow No. 1 Brown	NE NE NE sec. 3, T. 29 N., R. 24 E.	1920's	6275 est.	260	Niobrara Fm.	
Rheay No. 1 Moore	660S, 656E sec. 8, T. 29 N., R. 24 E.	1955	?	243	Niobrara Fm.	
Condron No. 1 Moore	660N, 657E sec. 10, T. 29 N., R. 24 E.	1956	6550	4075	Precambrian	Oil show, Dakota Ss.
Eureka No. 1 Moore	NW SW sec. 10, T. 29 N., R. 24 E.	1927	6275 est.	4083	Sangre de Cristo Fm.	Numerous oil and gas shows reported
Gourley No. 1 Vermejo Park	2603S, 330W sec. 27, T. 30 N., R. 17 E.	1962	8351	6012	Dockum Group	Oil show, Dakota Ss.
Conoco No. 3 Rocky Mt.*	660N, 550W sec. 18, T. 30 N., R. 22 E.	1954	7972	5500	Glorieta Ss.	Oil and gas shows, Dakota Ss.; noninflammable gas Dockum and Glorieta Fms.

* Lease name shortened from St. Louis, Rocky Mt. and Pacific R.R.

TABLE 1. OIL TESTS DRILLED IN COLFAX COUNTY (continued)

Well	Location	Plugged	Elev.	Total Depth	Lowest Tested	Remarks
Conoco No. 1 Rocky Mt.*	750S, 2300E sec. 24, T. 30 N., R. 22 E.	1954	7215	5185	Precambrian	Oil and gas shows, Dakota Ss.
Dorfman No. 1 Maxwell	1650S, 2310W sec. 27, T. 30 N., R. 23 E.	1962	6417	2312	Dakota Ss.	
Union Calif. No. 1 Bartlett	775N, 2640W sec. 23, T. 31 N., R. 18 E.	1926	7200?	4411	Precambrian?	Vermejo Park Dome
Union Calif. No. 2 Bartlett	1000S, 80W sec. 23, T. 31 N., R. 18 E.	1926	?	3265	Precambrian?	Vermejo Park Dome
Bartlett No. 1	2525S, 325E sec. 25, T. 31 N., R. 18 E.	1908	?	2535	Dakota Ss.?	Vermejo Park Dome
Conoco No. 7 Rocky Mt.*	660N, 660E sec. 2, T. 31 N., R. 20 E.	1955	7991	6081	Morrison Fm.	
Conoco No. 2 Rocky Mt.*	2600N, 700E sec. 26, T. 31 N., R. 21 E.	1954	7751	7268	Precambrian	Oil show, Dakota Ss.
Conoco No. 6 Rocky Mt.*	660S, 660E sec. 26, T. 31 N., R. 22 E.	1955	6762	3650	Exeter Ss.	Oil show, Dakota Ss.
Consolidated No. 1 Sarah "S"	2634S, 2123E sec. 26, T. 31 N., R. 23 E.	1956	?	708	Pierre Sh.?	
Raton City No. 1	? sec. 28, T. 31 N., R. 24 E.	1924?	?	2700	Dakota Ss.?	

* Lease name shortened from St. Louis, Rocky Mt. and Pacific R.R.

probably part of the Glorieta Sandstone. Reports of Precambrian granite in the two Union of California wells at Vermejo Park have not been substantiated. As suggested by Bates (1942), it appears likely that these wells bottomed in a Tertiary intrusive. No evidence is available for the rock type in the Frontier No. 1 Chico test.

Pre-Pennsylvanian Rocks

Marine sediments of Cambrian and Ordovician age are found in the subsurface of eastern Union County but are not known to occur anywhere in Colfax County. Silurian and Devonian rocks either were not deposited or were removed by erosion in northeastern New Mexico. Thin intervals of Mississippian strata, such as those found in eastern Union County, may be present west of Moreno Valley but apparently are absent in the subsurface of Colfax County.

Pennsylvanian System

Marine sediments of Pennsylvanian age crop out in the Moreno Valley area and were penetrated in two wells drilled in the north-central part of the county. In the Conoco No. 2 Rocky Mountain, Pennsylvanian sediments consist of 647 feet of medium light gray, very finely crystalline limestone; very light gray, silty, micaceous sandstone; dark gray to black silty shale; and red shale, sandstone, and arkosic conglomerate. In the Conoco No. 4 Rocky Mountain, located about ten miles southeast of the No. 2 test, the Pennsylvanian is represented by 305 feet of light gray shale and sandstone and red arkosic conglomerate. Approximately eight miles east of these two wells in the Conoco No. 1 Rocky Mountain, arkosic conglomerates of the Sangre de Cristo Formation directly overlie the Precambrian. In part, these conglomerates may be of Pennsylvanian age, but near the base of the section there is a conglomerate of large, angular limestone pebbles apparently derived from nearby Pennsylvanian sediments.

Permian System

Permian rocks are divided into two units: an upper interval consisting of clean sandstone and a lower part of red shale, sandstone, and arkosic conglomerate. The lower interval is correlative with the Sangre de Cristo Formation and directly overlies the Precambrian in most of Colfax County. As noted, this unit may contain beds of Pennsylvanian age, but it is believed to be entirely Permian in eastern Colfax County. The formation consists of coarse arkosic conglomerate interbedded with red shale and sandstone. The thickest section drilled was in the Condron No. 1 Moore, where 1,390 feet were penetrated above the Precambrian. To the west and south, the thickness ranges from 0 to 700 feet, being absent over parts of the Sierra Grande arch.

Uppermost Permian beds may be correlative with either the Glorieta or Yeso Formations. Wood, Northrop, and Griggs (1953) assigned these beds to the Santa Rosa Sandstone, but they are lithologically unlike this interval and are similar to known Permian sands to the east and south. Bachman (1953) shows the Yeso Formation pinching out at Lucero in west-central Mora County and the Glorieta Sandstone overlying the Sangre de Cristo Formation almost to the Colfax line. Robinson and others (1964) did not recognize the Glorieta Sandstone in the Agua Fria Mountains, nor is it present on the east side of the Cimarron Range where Triassic sediments overlie the Sangre de Cristo Formation (Dane and Bachman, 1965). The interval consists of orange to white quartz sandstone, fine grained in the lower part and fine to medium grained

above. Locally, there is a fairly high percentage of heavy minerals, but for the most part, the sands are much cleaner than those of the underlying Sangre de Cristo Formation or the overlying Dockum beds. In the Condron No. 1 Moore, the sandstone is highly quartzitic; elsewhere, it is weakly cemented. In certain respects, these sands are similar to sands in the Yeso Formation, but based on Bachman's mapping, they are tentatively assigned to the Glorieta Sandstone.

Bachman reports a thickness of 266 feet for the Glorieta in the Ocate area just south of Colfax County. In the subsurface, the thickness ranges from 200 to more than 400 feet, apparently thinning to the west into the Raton basin. Examination of a rather poor set of samples from the Conoco No. 1 Maxwell test indicates that this interval directly overlies the Precambrian in sec. 11, T. 28 N., R. 22 E.

Triassic System

The entire Triassic interval is assigned to the Dockum Group. The basal sandstone of this group, the Santa Rosa, does not appear to be developed in the subsurface of Colfax County. The lower 100 feet of the Dockum Group consists of varicolored shales and sandstones containing minor amounts of agate [chalcedony] similar to those of the Morrison Formation. This interval is probably correlative with the Baldy Hill Formation exposed in the Dry Cimarron Canyon in western Union County (Baldwin and Muehlberger, 1960). The upper part of the Dockum Group is composed of red shale and sandstone. The sands are commonly poorly sorted, containing considerable material in the clay- to silt-size fraction. Limestone-pebble conglomerates are common in the upper part of the section, and a persistent bed of this material underlies a distinctive white sandstone also recognized in samples from several of the oil tests. The Dockum Group thins to the north from 1,065 feet east of Ocate to 310 feet in the Conoco No. 2 Rocky Mountain test, located about seven miles south of Colorado.

Jurassic System

Jurassic sediments are subdivided into the Exeter Sandstone and the overlying Morrison Formation. The Exeter Sandstone is correlative with the Entrada Sandstone of northwestern New Mexico and with the Ocate Sandstone named by Bachman for exposures in Mora County. The interval consists of white and pale orange, sub- to well-rounded, fine- to coarse-grained, quartz sandstone. Based on well data, the Exeter ranges in thickness from 40 to 75 feet.

The upper part of the Morrison Formation consists of white, silty, fine- to coarse-grained sandstone, pale green, sandy shale, and white limestone. The lower part is made up mostly of red, brown, and purple shale and sandstone. Agate [chalcedony] occurs both near the middle and near the base of the formation, but the lower agate bed appears to be thicker and more persistent. Just below the lower agate, there is an interval of brown shale and sandstone containing inclusions of granular gypsum and discontinuous beds of gypsum and impure limestone. This part of the section is equivalent to the Wanakah Formation. Although recognizable in cuttings, the Wanakah is quite thin and any meaningful thicknesses would be difficult to assign. The combined Morrison and Wanakah Formations vary only slightly in thickness across Colfax County from a minimum of 354 feet in the American Manufacturing No. 1 W. S. Ranch to a maximum of 460 feet in the Gourley No. 1 Vermejo Park.

Cretaceous System

The bulk of the sediments underlying western and central Colfax County are of Cretaceous age. These sediments attain a thickness of approximately 4,200 feet in the structurally deeper parts of the Raton basin. The shales of the Pierre and Niobrara Formations account for between 2,500 and 3,200 feet of this thickness. Beginning at the base of the section, Cretaceous rocks have been subdivided into the Dakota Sandstone, Graneros Shale, Greenhorn Limestone, Carlile Shale, Niobrara Formation, Pierre Shale, Trinidad Sandstone, and Vermejo Formation. The lower part of the overlying Raton Formation is considered Cretaceous in age, the upper part, Tertiary. Subsurface data on the Cretaceous rocks are, for the most part, limited to the Niobrara and older formations.

The Dakota Sandstone consists of light gray to white, very fine- to coarse-grained and conglomeratic sandstone interbedded with dark gray to black carbonaceous shale. The lowest shale and sandstone interval is generally considered to be equivalent to the Purgatoire Formation of Early Cretaceous age. The combined thickness of the Dakota and Purgatoire Formations ranges from 110 to 206 feet, the thinner sections occurring on the Sierra Grande arch.

Dark gray to black silty shale makes up the bulk of the Graneros Shale. The shales are calcareous except near the base, where they become quite sandy. Also near the base of the section there are a few very thin beds of light gray sandy bentonite. The Graneros ranges in thickness from 130 to slightly more than 200 feet. The thinner intervals are found on the Sierra Grande arch, and there appears to be a slight thinning to the north. Tests conducted on the Graneros show that the shales are capable of yielding oil by destructive distillation and, therefore, may represent source beds for the oil that occurs in the Dakota Sandstone (Foster, 1966).

The Greenhorn Limestone is composed of thin beds of medium gray argillaceous limestone and dark gray calcareous shale. Although these limestones form a useful marker for separating the Graneros and Carlile Shales, it is often difficult to recognize the interval from well cuttings without the aid of an electric log. The Greenhorn Limestone appears to range from 20 to 45 feet in thickness and limited evidence suggests a slight northward thinning.

The Carlile Shale maintains a uniform thickness of about 200 feet. Robinson and others (1964) report a thickness of 500 feet in the Agua Fria Mountains, a short distance west of the two Hedges wells where the Carlile ranges from 200 to 220 feet in thickness. In the Gourley

well near the western edge of Raton Mesa, the Carlile is 220 feet thick. The unit consists of light to dark gray, silty to sandy calcareous shale.

Two members comprise the Niobrara Formation, a lower thin unit called the Fort Hays or Timpas Limestone and an upper thick interval called either the Smoky Hill Marl or the Apishapa Shale. The Fort Hays Limestone Member is made up of medium light gray silty limestone with thin interbeds of shale. This member is about 25 feet thick. The Smoky Hill Marl Member is composed of medium to dark gray, silty, calcareous shale and argillaceous fine-grained sandstone. Sandstones are particularly prevalent in the middle and upper parts of the member. As on the surface, it is difficult to separate the Niobrara Formation from the overlying Pierre Shale. However, what appears to be a reliable break can be picked with the use of electric logs. By this means, a thickness of approximately 850 feet is assigned to the upper member.

The Pierre Shale ranges in thickness from 1,700 to more than 2,300 feet. The thicker sections are in the western part of the county. Shales in the Pierre interval are similar to the underlying Niobrara beds but are less calcareous and contain smaller percentages of sand.

Very few data were obtained for the Trinidad Sandstone or Vermejo Formation from a study of well samples. The section was penetrated in only a few tests and sample quality was generally quite poor. The Trinidad Sandstone is about 115 feet thick in the Conoco No. 2 Rocky Mountain test, where it consists of silty, very fine- to fine-grained, feldspathic sandstone. Griggs (1948) reports a thickness of 100 feet and Lee (1922) a range from 50 to slightly more than 100 feet. The Vermejo Formation consists of carbonaceous shale, sandstone, and coal. It ranges in thickness from 50 to 200 feet and locally is absent because of erosion prior to the deposition of the Raton Formation (Wanek, 1963). The Vermejo is about 70 feet thick at the Conoco No. 2 Rocky Mountain test.

Tertiary System

The Raton Formation includes beds of light gray to white sandstone, and conglomerate, medium to dark gray shale, and coal. Brown (1943) placed the boundary between the Cretaceous and Tertiary in the lower part of this unit. Wanek (1963) notes that the thickness of the Raton Formation ranges from 0 to about 1,400 feet. The Poison Canyon Formation consists of coarse-grained to conglomeratic, arkosic sandstone and carbonaceous shale. It ranges from 0 to 1,500 feet thick. Along the Cimarron River, the Poison Canyon unconformably overlies the Vermejo, Trinidad, Pierre, and older Cretaceous formations.

Summary

The thickest sedimentary section drilled in Colfax County was in the Conoco No. 2 Rocky Mountain test in sec. 26, T. 31 N., R. 21 E. in the Raton basin. This well penetrated 7,225 feet of sediments above the Precambrian. A summary of the tops of the formations penetrated is as follows: surface, Raton Formation; 1,454 feet, Vermejo Formation; 1,525 feet, Trinidad Sandstone; 1,640 feet, Pierre and Niobrara Shale; 4,400 feet, Fort Hays Limestone; 4,440 feet, Carlile Shale; 4,620 feet, Greenhorn Limestone; 4,640 feet, Graneros Shale; 4,785 feet, Dakota Sandstone; 4,940 feet, Morrison Formation; 5,310 feet, Exeter Sandstone; 5,370 feet, Dockum Group; 5,680 feet, Glorieta Sandstone; 5,900 feet, Sangre de Cristo Formation; 6,578 feet, Pennsylvanian; 7,225 feet, Precambrian. Over the Sierra Grande arch, the sedimentary cover is only 2,000 to 3,000 feet thick.

STRUCTURE

The major structural features in Colfax County include part of the Sangre de Cristo Mountains, the southern part of the Raton basin, the Sierra Grande arch, and the northern edge of the Las Vegas basin. These features are shown in Figure 2 by contours on the Precambrian surface (Foster and Stipp, 1961). The Sangre de Cristo Mountains are a narrow north-south uplift with an exposed Precambrian core. Paleozoic and Mesozoic rocks crop out along the east base of the uplift and as isolated exposures in the Moreno Valley area. The New Mexico part of the Raton basin is a broad, shallow syncline with its lowest point less than 1,000 feet above sea level. From the limited data available, the deepest part of the basin lies north and west of Raton. The Las Vegas basin is separated from the Raton basin by an east-west saddle of low relief. The presence of this saddle was suggested by Foster (1959) and verified by data obtained with an airborne magnetometer (Dempsey and others, 1963). The buried Sierra Grande arch is an elongate northeast-trending uplift. Based on fragmentary well data, the crest of the uplift is in southeastern Colfax County.

Superimposed on the larger structures are several small anticlines and domes. The majority of these anticlines occur in the eastern part of the county in the area underlain by the Sierra Grande arch. The trend of the anticlines, based on maps by Winchester (1933), Bates (1942), and Griggs (1948), is shown in Figure 2.

Jaritas Dome

Jaritas dome is located in T. 23 N., Rs. 24 and 25 E. According to Winchester, this structure has a closure of about 40 feet. The oldest rocks exposed are part of the Dakota Sandstone. The only test that has been drilled on the structure is the California No. 1 Floersheim-State, located in sec. 15, T. 23 N., R. 24 E. Based on an interpretation of the sample log, Graneros Shale is at the surface and the Dakota Sandstone is at a depth of 35 feet. Other formation tops for this well are 190 feet, Morrison Formation; 580 feet, Exeter Sandstone; 640 feet, Dockum Group; 1,395 feet, Glorieta Sandstone; 1,920 feet, Sangre de Cristo Formation; and 2,095 feet, Precambrian. Carbon dioxide was found in the Glorieta Sandstone.

Lunsford Dome

This structure, located in T. 24 N., R. 24 E., has about 10 feet of closure. No oil tests have been drilled.

CHICO DOME

The highest point on this structure is located in sec. 6, T. 24 N., R. 25 E. Bates notes a structural closure of about 80 feet. The Frontier No. 1 Chico test, drilled in 1927 in sec. 6, was reported to have bottomed in Precambrian granite at a total depth of 1,326 feet. An interpretation of the driller's log indicates the following tops: surface, Greenhorn Limestone; 26 feet, Graneros Shale; 180 feet, Dakota Sandstone; 290 feet, Morrison Formation; 695 feet, Exeter Sandstone; 760 feet, Dockum Group; and 1,302 feet, Precambrian. Although this indicates Dockum sediments resting on the Precambrian, there is a possibility that the well bottomed in a Tertiary intrusive.

RITO DEL PLANO ANTICLINE

This structure is a northeast-trending anticline located in T. 25 N., Rs. 23 and 24 E. The crest of the structure is in sec. 7, T. 25 N., R. 24 E. Two oil tests have been drilled, both in T. 25 N., R. 24 E. The first well was the Weathers No. 1, plugged in 1927 after penetrating to the Exeter Sandstone. Formation tops based on a driller's log and the paper by Wood, Northrop, and Griggs are surface, Carlile Shale; 188 feet, Greenhorn Limestone; 227 feet, Graneros Shale; 431 feet, Dakota Sandstone; 613 feet, Morrison Formation; and 1,012 feet, Exeter Sandstone. The second well, the Marks No. 1 Sierracita-State, was drilled in 1938 and 1939. The following tops are based on spotty samples and a driller's log: 45 feet, Carlile Shale; 245 feet, Greenhorn Limestone; 290 feet, Graneros Shale; 420 feet, Dakota Sandstone; 545 feet, Morrison Formation; 990 feet, Exeter Sandstone; 1,029 feet, Dockum Group; and 1,520 feet, Glorieta Sandstone. Shows of oil were reported for the Morrison and Exeter Formations and gas for the Glorieta Sandstone.

Five tests were drilled on what apparently is a continuation of the structural trend of the Rito del Plano anticline in Tps. 26 and 27 N., R. 24 E. A typical section, as drilled in the Kates No. 1-A Sauble, is as follows: surface, Niobrara Formation; 48 feet, Fort Hays Limestone; 70 feet, Carlile Shale; 280 feet, Greenhorn Limestone; 320 feet, Graneros Shale; 460 feet, Dakota Sandstone; 590 feet, Morrison Formation; 990 feet, Exeter Sandstone; 1,030 feet, Dockum Group; 1,570 feet, Glorieta Sandstone; 1,960 feet, Sangre de Cristo Formation; and 2,480 feet, Precambrian. Other tests drilled in this area are the Neill Nos. 2 and 3 Sauble, Neill No. 1 Herrera, and York No. 1 Tex-Mex. Carbon dioxide was encountered in the Glorieta Sandstone in the York and No. 3 Sauble wells.

TEMPLE BUTTE DOME

This untested structure is located in T. 26 N., R. 26 E. According to Griggs, there is a closure of at least 600 feet. Rocks exposed along the axis of the anticline are part of the Dockum Group.

JOYCE DOME

Located in T. 27 N., R. 25 and 26 E., Joyce dome has a closure of about 300 feet. Exeter Sandstone is the oldest formation exposed. No tests have been drilled.

CAPULIN ANTICLINE

Capulin anticline is a small dome with a closure of approximately 200 feet. It is located in T. 28 N., R. 26 E. Surface rocks are part of the Carlile Shale. A shallow test, the Red Feather No. 1 Moore, was drilled in 1926 in sec. 10. No additional information is available for this well. In 1954, Magnolia drilled the No. 1 T. O. Ranch in the same section. The test was abandoned in a Tertiary intrusive. Sample tops are surface, Carlile Shale; 35 feet, Greenhorn Limestone; 70 feet, Graneros Shale; 220 feet, Dakota Sandstone; 340 feet, Morrison Formation; and 700 feet, monzonite. Capulin anticline, Temple Butte dome, Joyce dome, and possibly other structures on the Sierra Grande arch may have been formed by small laccolith-like intrusions during Tertiary time.

CARBON DIOXIDE-NITROGEN-HELIUM

Carbon dioxide was first discovered in the California No. 1 Floersheim-State well, located on Jaritas dome. The approximate yield was 500,000 cubic feet of noncombustible gas a day from 1,510 to 1,560 feet in the Glorieta Sandstone. The gas contained 67.2 percent carbon dioxide, 28.7 percent nitrogen, 4.1 percent oxygen, and 0.46 percent helium. Other reports give a helium content as low as 0.2 percent. Carbon dioxide also was discovered in the York No. 1 Tex-Mex and Neill No. 3 Sauble tests in T. 26 N., R. 24 E. The York well yielded an estimated 250,000 cubic feet a day and the Neill well, 133,000. In both wells, the gas was recovered from the Glorieta Sandstone. Gas from the York well was reported to contain 99.85 percent carbon dioxide.

PETROLEUM

Crude oil and natural gas shows have been reported from numerous tests in Colfax County. Often it is difficult to substantiate these "shows" and to separate the real from the imagined. Most of the reported shows are listed in Table 1 without any thought to authenticity. Oil stains were observed in the Dakota Sandstone during examination of the cuttings of the Conoco No. 1 Maxwell, Condron No. 1 Moore, Conoco No. 4 Rocky Mountain, and Gourley No. 1 Vermejo Park. Data from tests and core analyses verify the presence of oil in the Dakota Sandstone in the Howard No. 1 Moore, Conoco No. 1 Springer, and Conoco Nos. 1, 2, 3, 5, and 6 Rocky Mountain. The two areas where wells have encountered oil in the Dakota Sandstone are shown by heavy lines in Figure 2.

Additional testing at least through the Dakota Sandstone is warranted in the Raton basin and on the west flank of the Sierra Grande arch. Cretaceous shale reservoirs similar to the El Vado, Chromo, and Florence fields represent possible, although less attractive, targets for drilling in the Raton basin area. Pre-Cretaceous strata, with the exception of the limited Pennsylvanian section, do not appear favorable for petroleum but might be tested for helium and carbon dioxide.

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