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GEOLOGY OF THE DEXTER OIL AND GAS FIELD AND VICINITY, COWLEY COUNTY, KANSAS

By

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SUBSURFACE GEOLOGY [1]

Pre-Cambrian rocks

Below the sedimentary rocks in all parts of the world are igneous and metamorphic rocks that are referred to as being pre-Cambrian in age. Two wells have been drilled to the granite in the area included in this report. In the Doric #1 Smith well in the SE¼ NW¼ sec. 18, T. 33 S., R. 7 E., the pre-Cambrian was encountered at a depth of 4,005 feet (2,815 feet below sea level). Pre-Cambrian rocks were found at a depth of 4,545 feet (3,300 feet below sea level) in the Phillips #1 Eckhart well in the SW¼ sec. 9, T. 35 S., R. 6 E. The pre-Cambrian rocks are composed chiefly of granite and schist, but also include quartzite, quartz porphyry, diabase, and other rock types.

Cambrian and Ordovician systems

The thick series of interbedded dolomite, limestone, sandy limestone, sandstone, and minor amounts of shale that lie below the "Burgen" sandstone and above the pre-Cambrian rocks are of Cambrian and Ordovician age, and are referred to as the "Arbuckle". Numerous wells have been drilled into the Arbuckle in this area, but only the Doric #1 Smith well and the Phillips #1 Eckhart well have penetrated its entire thickness. The Arbuckle is reported to have a total thickness of 920 feet in the Smith well, and 1,060 feet in the Eckhart well.

The Wilson pool in secs. 4 and 9, T. 33 S., R. 6 E. produces oil from the Arbuckle.

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1. Much of the following subsurface geology was taken directly from Bass (Kansas Geological Survey, Bulletin 12).

Several formations of Ordovician age overlie the Arbuckle except in areas where they have been removed by erosion (See Bass, Bulletin 12, figure 3).

The lowest of these formations is the "Burgen" sandstone which consists of tightly cemented and glassy white sandstone. Above the "Burgen" sandstone is the Tyner formation, which is composed of green sandy shale, thin beds of sandstone, some sandy dolomite, and thin beds of red shale near the middle. The "Wilcox" sand, which overlies the Tyner formation, is described as a much more uniform fine-grained sand than the "Burgen" sand, and is characterized by a high percentage of fine angular grains accompanied by a few large rounded etched grains and more small rounded grains. The total thickness of these three formations in this area probably does not exceed 100 feet.

Mississippian Sub-System

Chattanooga shale. -- Black carbonaceous fissile shale ranging between 50 and 100 feet in thickness, lying unconformably on older strata, and locally entirely absent, composes the Chattanooga shale of Mississippian age. This formation is notably absent in many places on the crest of the Dexter-Otto anticline. Some geologists consider the lower part of the Chattanooga shale to be of Devonian age.

Mississippian limestone. -- The series of beds, composed largely of limestone, that occurs unconformably between the Pennsylvanian sub-system and the Chattanooga shale is known as the "Mississippi lime." The unit is readily traceable by means of well records. In Cowley County it ranges in thickness from 225 to 400 feet and lies at depths ranging from 2,850 feet in the northeastern part of the area to 3,100 feet in the southwestern part.

The "Mississippi lime" is divisible into several formations. A gray dense relatively thin limestone may or may not be present just above the Chattanooga shale. This limestone unit is probably of Osagian age. Above this limestone is a thick section which includes practically all the "Mississippi lime," con-

sisting of gray and dark-colored silty cherty and dolomitic limestones known as the Cowley formation. Above the Cowley formation is 50 to 100 feet of white crystalline cherty limestone. These beds are referrable to the Warsaw formation.

Pennsylvanian Sub-System

Interbedded limestone and shale and minor amounts of sandstone having an aggregate thickness ranging from 1,200 to 1,300 feet, make up the Pennsylvanian rocks in the area included in this report.

Cherokee group. -- Overlying the irregular surface of the Mississippian limestone is a relatively thick unit composed largely of dark gray shale beds known as the Cherokee shale. This shale thickens from about 200 feet in the northern part of the area to 300 feet in the southern part. It is thin over the prominent structures. Locally sandstone beds which may serve as reservoirs for the accumulation of oil and gas are present. A relatively thick sandstone near the basal part of the Cherokee contains the "Burgess" sand. The "Bartlesville" sand occurs in the middle of the Cherokee shale.

Marmaton group. -- Rocks belonging to the Marmaton group overlie the Cherokee shale. These rocks are composed mostly of limestone with interbedded gray and black shale. The thickness of this group of rocks is rather uniformly about 150 feet.

Bourbon group. -- The Bourbon shale occurs above the Marmaton group. This sandy shale varies in thickness from 50 to 80 feet. In places the formation is almost entirely sandstone. This shale serves as a prominent break between the base of the Hertha limestone and the top of the Marmaton group.

Bronson-Kansas City-Lansing groups. -- Above the Bourbon group is a section of predominantly calcareous and sandy shale with a relatively thick sandstone, the "Layton", near the middle. A series of persistent limestones and interbedded shales occur in the basal part. The lowermost limestone of this

section is correlated with the Hertha limestone of eastern Kansas. This series of beds belongs to the Bronson, Kansas City, and Lansing groups. The average combined thickness of the groups is 500 feet.

Douglas group. -- Overlying the Bronson, Kansas City, and Lansing groups is an assemblage of rocks composed largely of sandy shale, red shale, and sandstone belonging to the Douglas group. A rather persistent limestone that may be correlated tentatively with the Haskell limestone is present near the middle of the group. Part of the lower portion of this section may belong to the Pedee group. These rocks thicken from 375 feet in the northern part of the area to 500 feet in the southern part.

Shawnee group. -- The Shawnee group is a section of interbedded limestone and shale with a few beds of sandstone (in all, about 650 feet thick) and contains a much greater percentage of limestone than the underlying Douglas and Lansing groups. The lowermost formation of this group is the Oread limestone. It is separated from the next overlying persistent limestone, the Lecompton limestone, by the Kanwaka shale. The Kanwaka shale varies in thickness from 180 feet in the northern part of the area to 250 feet in the southern part. The Elgin sandstone, a relatively thick sandstone unit, may appear locally in the upper one third of the Kanwaka shale.

Wabaunsee group. -- The Wabaunsee group constitutes the uppermost group of the Pennsylvanian sub-system. The upper beds of the Wabaunsee group crop out in the area included in this report. The formations of the Wabaunsee group are shown in figure 2.

EXPOSED ROCKS

The oldest geologic formation exposed in Cowley County is the Dover limestone which occurs in the upper part of the Wabaunsee group of Pennsylvanian age. This formation crops out only in the southeast corner of the county. Rocks above the Dover limestone and extending up to and including the lower 30 feet of

the Wellington formation of middle Permian age are exposed in Cowley County. Alluvium deposits of Quaternary age occur along the major streams. Bass (Bulletin 12, State Geological Survey of Kansas) has described these outcropping formations in detail.

In general, the Pennsylvanian and Permian rocks dip approximately 30 feet per mile to the west; thus the oldest rocks are exposed in the eastern part of the county. Most of Cowley County is located in the Flint Hills region. The topography is relatively rough and there are numerous good exposures of all the formations, especially the limestones from the Dover limestone to the Herington limestone. Many of these limestones are good markers and lend themselves readily to surface structure mapping.

Much of the underlying structure is reflected in the surface rocks. The Dexter anticline (shown in part in figure 7) has the most pronounced expression in the surface beds. The other two prominent structural features of the area, the Winfield anticline and the Nemaha granite ridge, are also discernible in the surface beds.

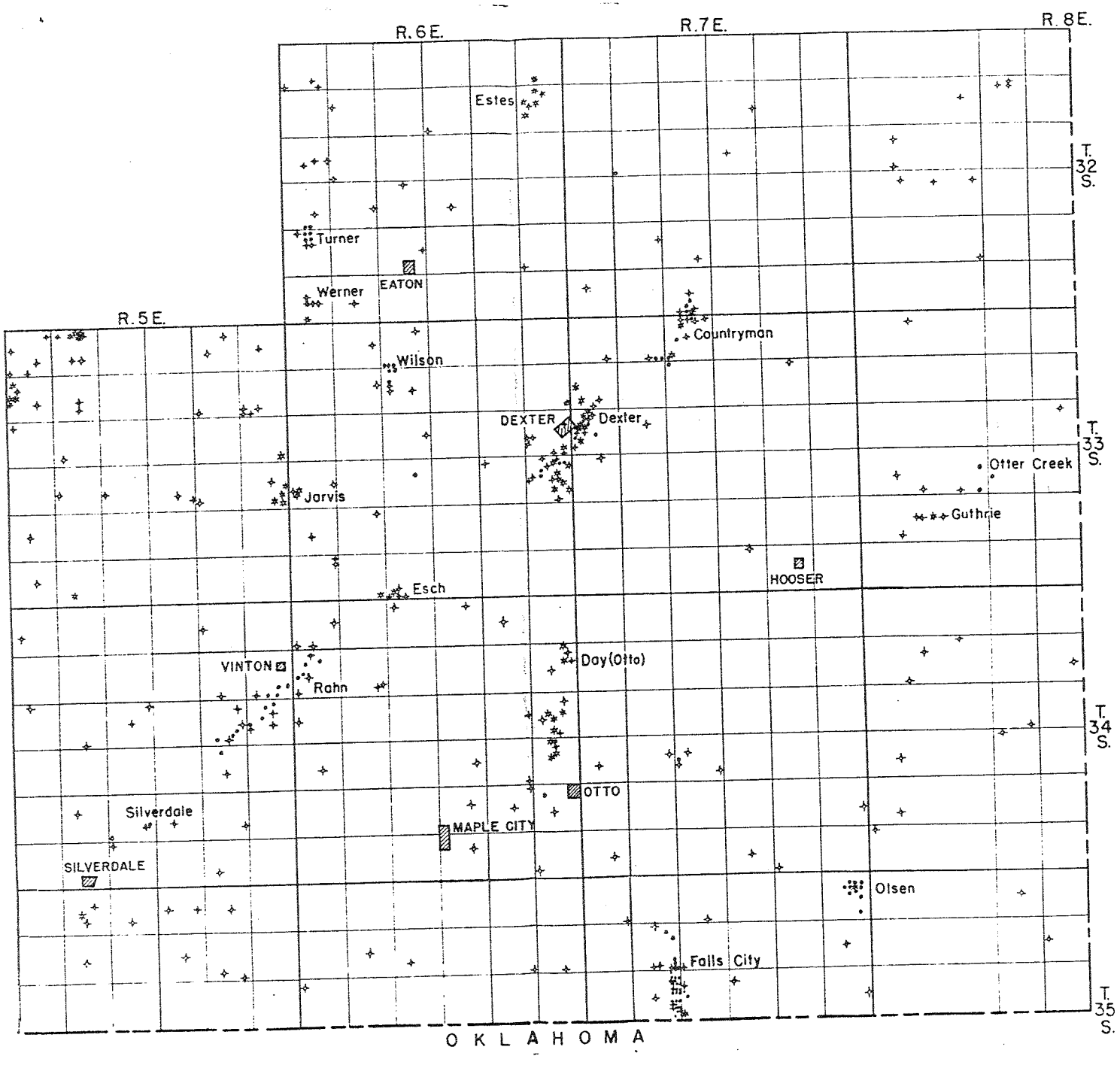

Figure 1. -- Map showing the portion of Cowley County, Kansas included in this report. Oil and gas fields and dry hol are shown.

Oil well ●

Gas well ☼

Dry hole ☼

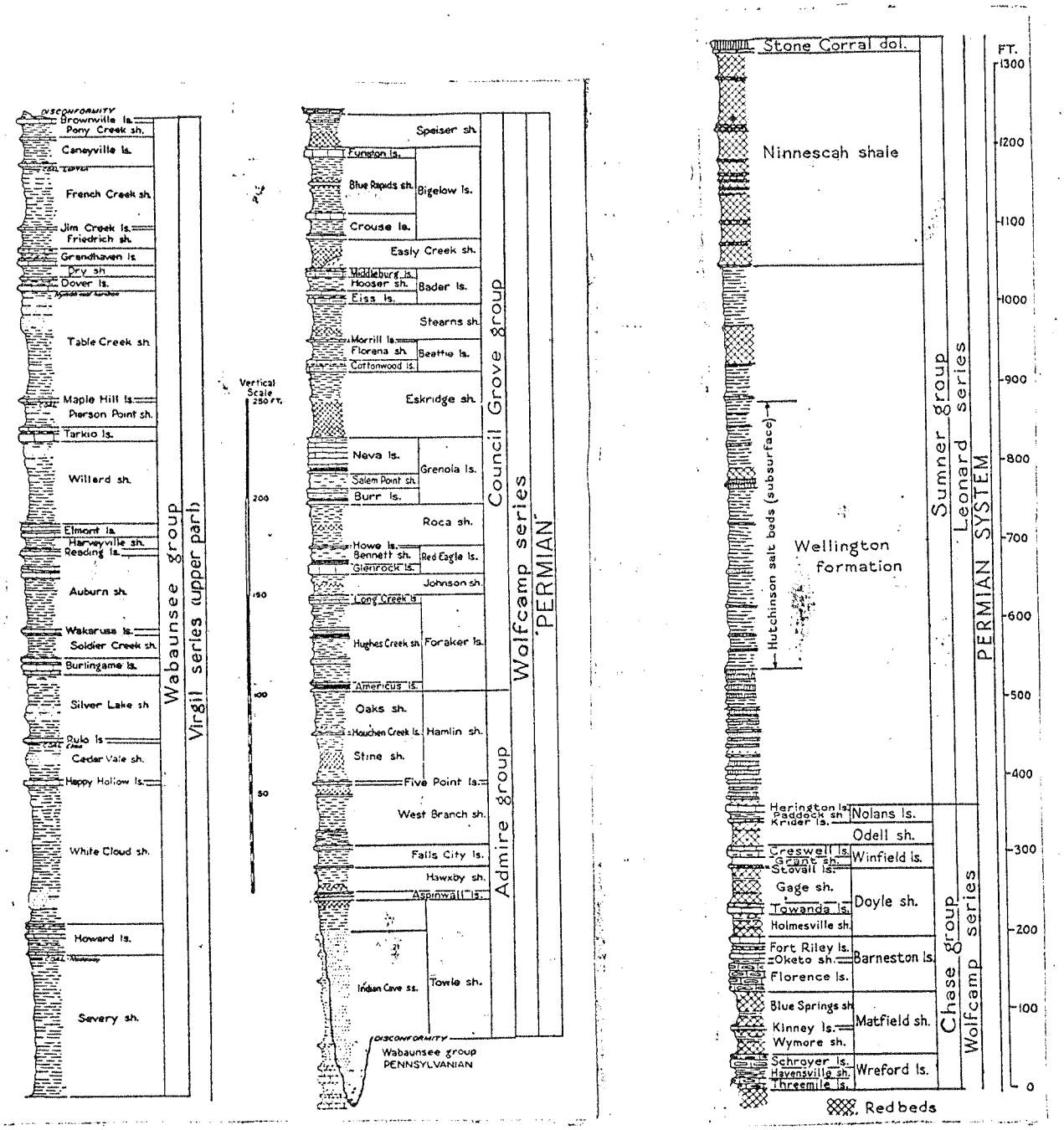

Figure 2. — Generalized section of Middle and Lower Permian and Upper Pennsylvanian rocks for the state of Kansas. The stratigraphic position of outcropping formations in Cowley County is shown by these sections.

(After Moore, pp. 42 and 44, Bulletin 27, State Geological Survey of Kansas)

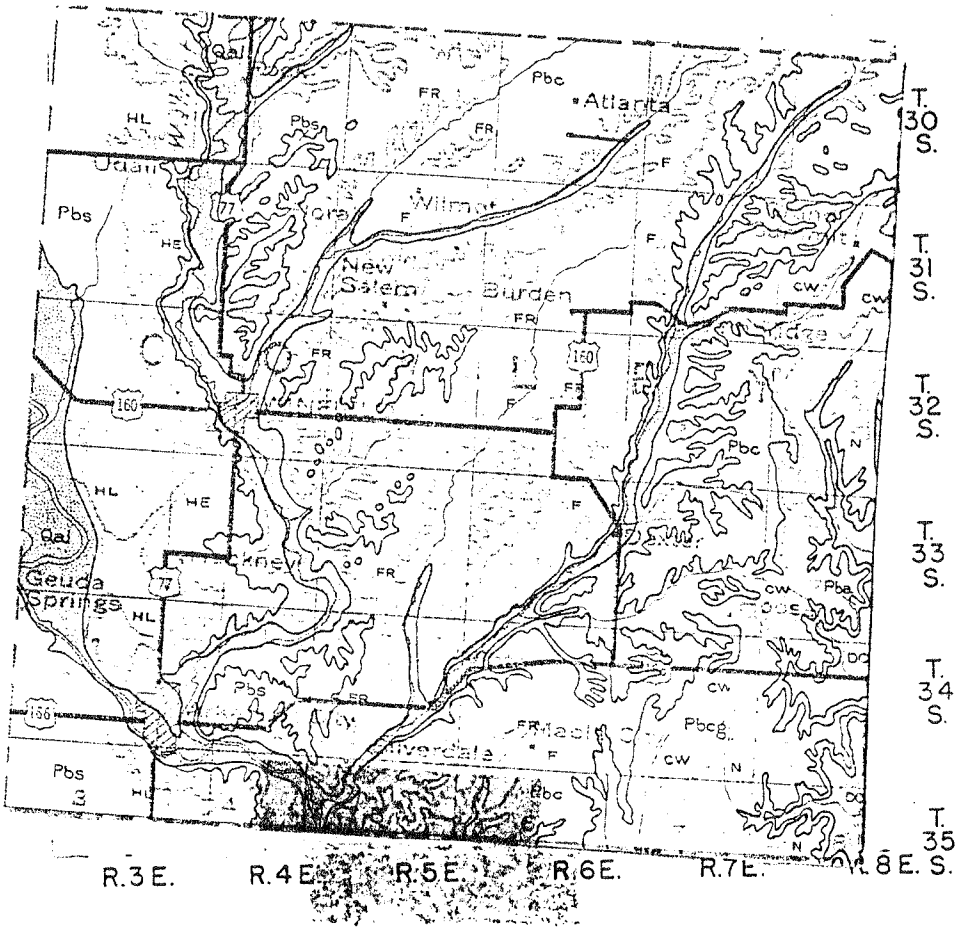

Figure 3. — Map showing areal geology of Cowley County, Kansas. Explanation is shown at the left. This map is part of the Geologic Map of Kansas prepared by the State Geological Survey.

EXPLANATION

QUATERNARY

Qal

Alluvium

Qds

Dune sand

Qt

Terrace deposits

(Includes McPherson formation in central Kansas, Gerlane formation in southwestern Kansas, and approximately equivalent terrace deposits of gravel, sand, and silt of the Arkansas River valley. Probably mostly Pleistocene in age.)

PERMIAN

Cimarron series

Pcu

Upper Cimarron undifferentiated

Pcb

Blaine formation

Pce

K *(Kingman sandstone)*

SC *(Stone corral dolomite)*

Enid formation

(Explanation continued at the right)

EXPLANATION—CONTINUED

Big Blue series

CA

Pbs

HL

HE

Sumner group

(Includes Wellington shale containing Carlton limestone member, CA; Donegal limestone, containing Hollenberg limestone member, HL; Pearl shale, Nolans limestone, containing Herington limestone member, HE; and Odell shale.)

FR

Pbc

F

Chase group

(Includes Winfield limestone, outcrop of which coincides essentially with mapped upper boundary of the group; Gage shale, Towanda limestone, Holmesville shale, Barneston limestone, containing Fort Riley limestone member, FR; and Florence flint member, F; Blue Rapids shale, Kinney limestone, Wymore shale, and Wreford limestone.)

CW

Pbcg

N

Council Grove group

(Includes Speiser shale, Bigelow limestone, Easly Creek shale, Bader limestone, Stearns shale; Beattie limestone, containing Cottonwood limestone member, CW; Eskridge shale, Grenola limestone, containing Neva limestone member, N; Roca shale, Red Eagle limestone, Johnson shale, and Foraker limestone.

Pba

Admire group

(Includes Hamlin shale, Fivepoint limestone, West Branch shale, Falls City limestone, Haskell shale, Aspinwall limestone, and Towle shale.)

Virgil series

DO

TA

Cvw

R

B

H

Wabaunsee group

(Includes Brownville limestone, outcrop of which coincides essentially with mapped upper boundary of the group; Pony Creek shale, Caneyville limestone, French Creek shale, Jim Creek limestone, Friedrich shale, Grandhaven limestone, Dry shale, Dover limestone, DO; Table Creek shale, Maple Hill limestone, Pierson Point shale, Tarkio limestone, TA; Willard shale, Elmont limestone, Harveyville shale, Reading limestone, R; Auburn shale, Wakarusa limestone, Soldier Creek shale, Burlingame limestone, B; Silver Lake shale, Rulo limestone, Cedar Vale shale, Happy Hollow limestone, White Cloud shale, Howard limestone, H; and Severy shale.)

Figure 3

STRUCTURE

The most prominent structural feature of the area is the Dexter-Otto anticline, on which the Dexter, Day, and Countryman pools are located. This anticline is shown by generalized geologic structure maps (figures 4, 5, 6, and 7). To the southeast of the Dexter pool is a prominent low syncline. The general structural features of the region are shown by generalized geologic structure maps of the base of the Lecompton limestone (figure 4), the base of the Hertha limestone (figure 5), and the top of the Mississippian limestone (figure 6). The interval from the base of the Lecompton to the base of the Hertha thickens from 1,200 feet in the northern part of the area to 1,370 feet in the southern part of area. The "Mississippi lime" and the Cherokee shale are thinner over the prominent structural features, especially over the Dexter-Otto anticline. The Chattanooga shale is absent in many places on the crest of the Dexter-Otto anticline.

All of the producing fields in the area included in this report are located on anticlines or domes. All of these structures do not show on the generalized geologic structure maps because of insufficient control around the individual pools.

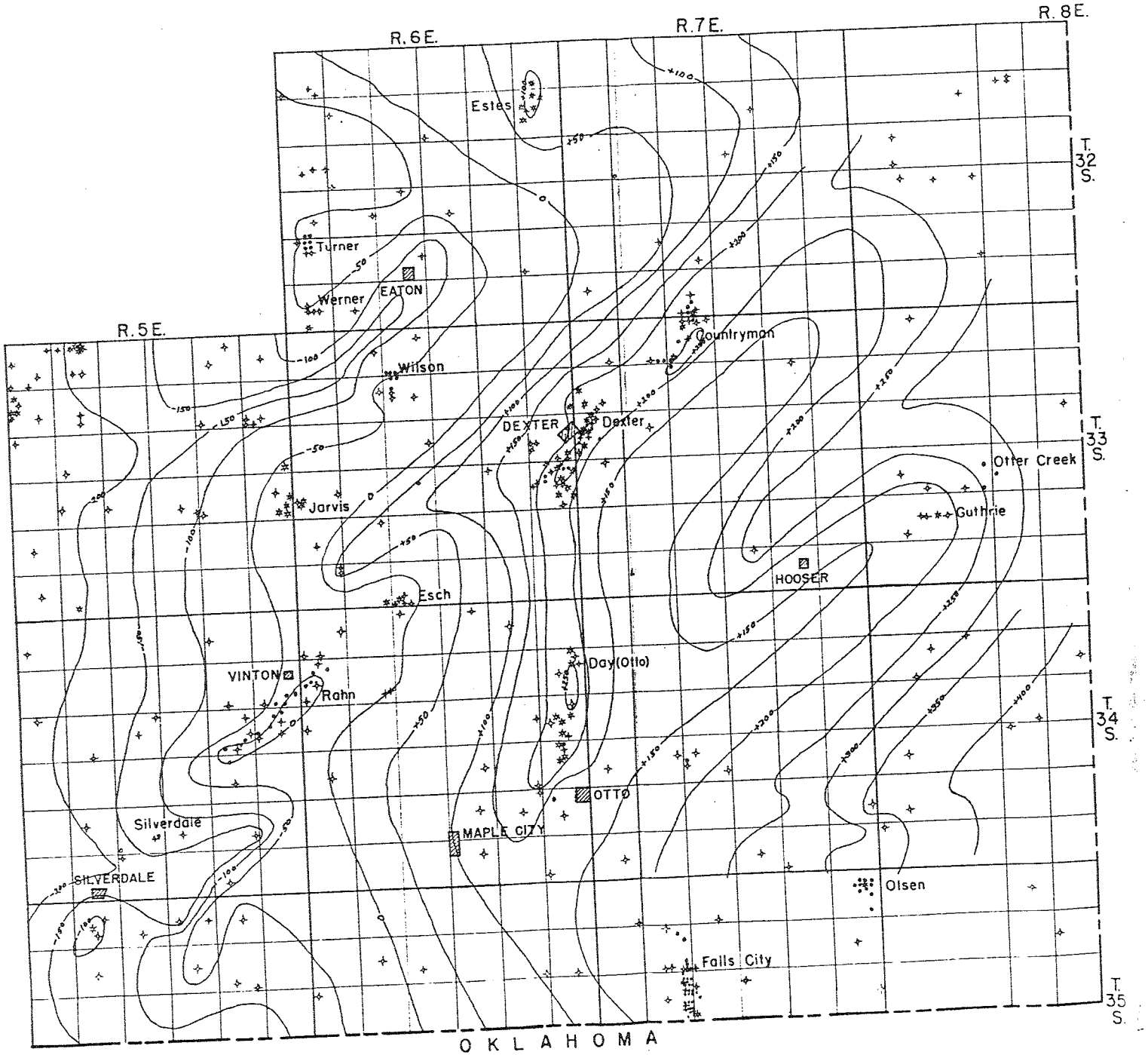

Figure 4. -- Generalized structural geol
map showing the structure of the base of
the Lecompton limestone.

Contour interval, 50 feet.

+ Contour lines represent altitude ab
sea level

- Contour lines represent depths belo
sea level

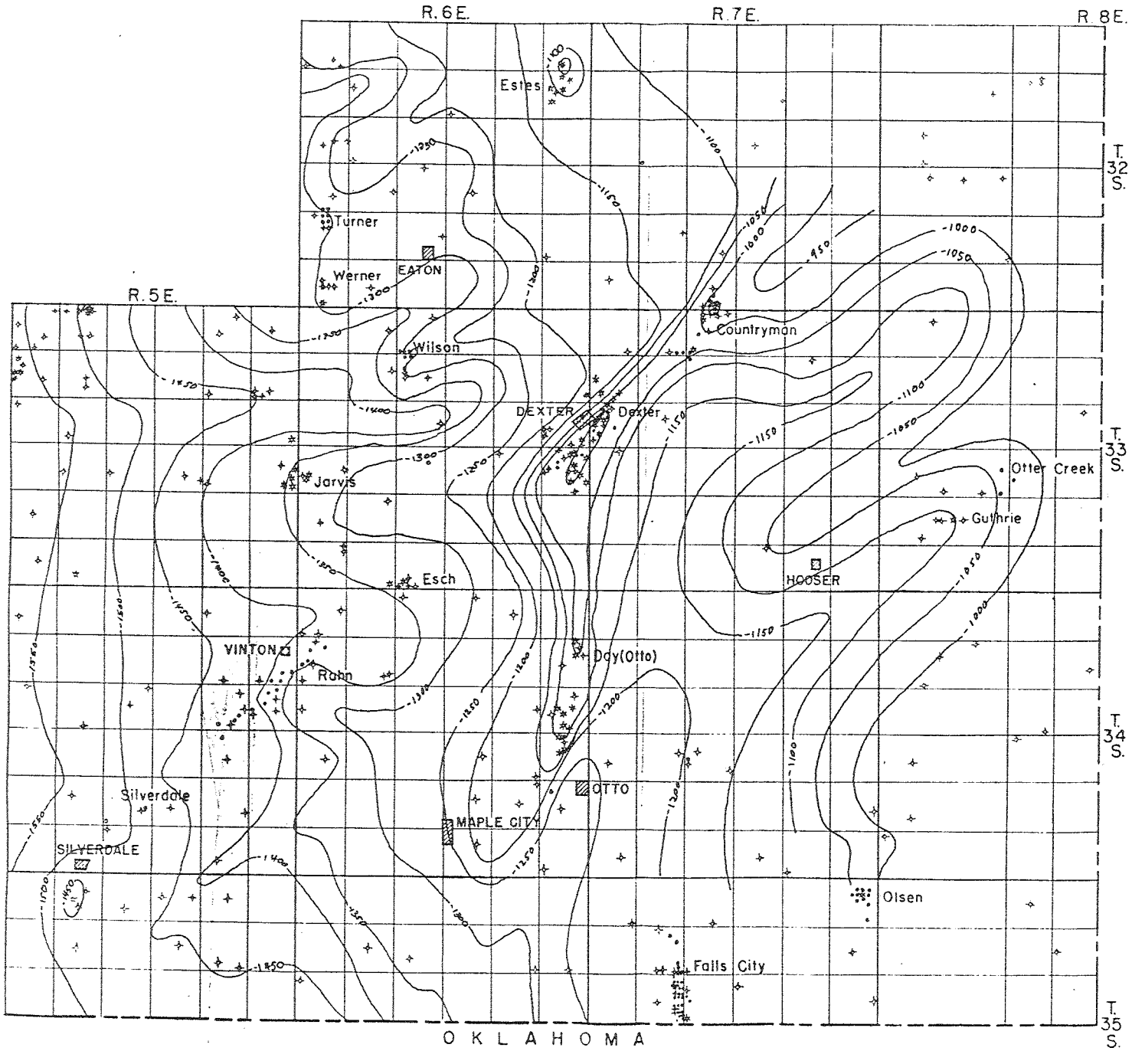

Figure 5. -- Generalized structural geologic map showing the structure of the base of the Hertha limestone.

Contour interval, 50 feet

Contour lines represent depths below sea level.

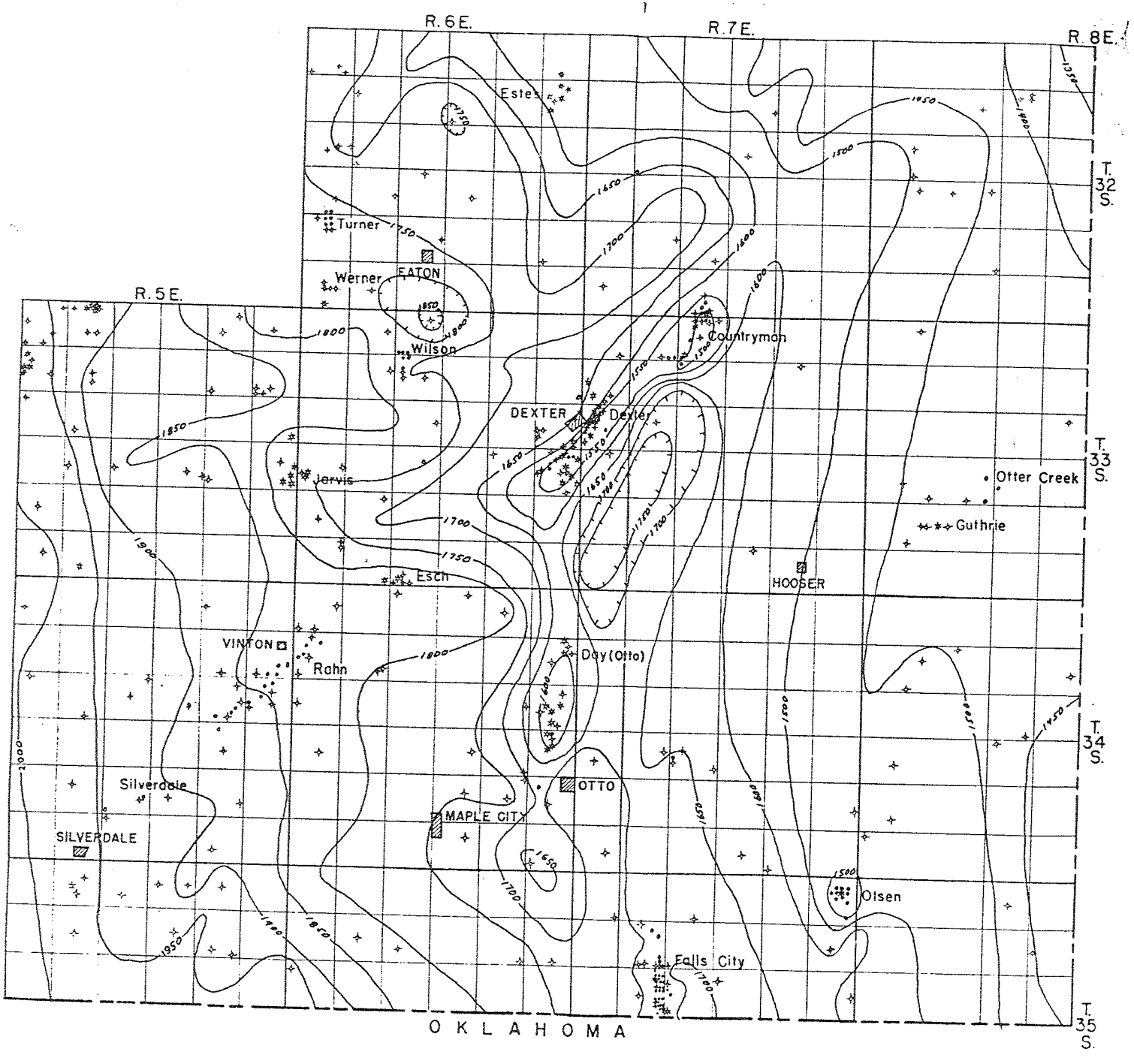

Figure 6. -- Generalized structural geologic map showing the structure of the top of the Mississippian limestone.

Contour interval, 50 feet.

Contour lines represent depths below sea level.

(Eastern portion of map is taken essentially from Pass, H. R., Bulletin 12, State Geological Survey of Kansas)

2

OIL AND GAS

Dexter-Otto District

"Location. [2] -- The most pronounced structural feature in Cowley county is an extensive anticlinal fold that passes northward near Otto and Dexter, in the southeastern part of the county, and thence trends northeastward, passing near Grand Summit. (See Pl. XI and Fig. 18.) [Figure 7 in this report.] Small amounts of oil and gas have been produced on parts of this fold, the principal areas being a relatively small tract about a mile northwest of Otto, a larger area near Dexter, and a third about 3 miles northeast of Dexter. These three areas are designated herein respectively the Otto, Dexter, and Countryman fields.

"History and Production. -- The Dexter field proper was one of the early gas pools of this part of the state and one which attracted wide interest because of the discovery by Cady and McFarland [Cady, H. P., and McFarland, D. F.; The composition of natural gas with special study of the constituents of Kansas gases; Kansas Univ. Geol. Survey, vol. 9, pp. 223-302; 1908.] of helium in the gas from the discovery well, this being the first helium found in natural gas. Gas was discovered at Dexter early in 1903 at a depth of 325 feet, and by the end of 1908, 22 producing wells had been drilled. Later drilling discovered more gas at depths near 1,000 feet, and oil was found at about 2,750 feet. Subsequent to the discovery of gas at Dexter wells were drilled a short distance northwest of Otto. Gas was found in fair abundance at a depth of about 1,100 feet and small amounts of oil near a depth of 3,000 feet. In recent years oil has been produced about 3 miles northeast of Dexter, in the Countryman field.

"The shallow wells near Dexter had an average open-flow capacity of about 3,000,000 cubic feet of gas with an initial rock pressure of 110 pounds to the square inch. The discovery well had an initial open flow of 8,000,000 cubic feet of gas, and a few other wells had an open-flow capacity of 5,000,000 cubic feet. The wells near Otto that found gas at depths averaging about 1,100 feet had an initial production of less than 2,000,000 cubic feet each, with rock pressures of about 250 pounds to the square inch. The original wells near Dexter were abandoned years ago, but recently additional wells have been drilled to furnish gas to a plant erected to extract helium. The deep wells drilled for oil near Dexter and Otto have met with only slight success. The daily yield is extremely small, and several wells have been abandoned because the small production did not pay for the cost of operation. It is reported that the wells 3 miles northeast of Dexter, in the Countryman field, yield paying quantities of oil.

"Helium content of gas. -- The gas of this district is noteworthy for its high content of helium. Commonly natural gas contains less than 0.3 percent of helium, but the helium content of the gas from the Dexter-Otto district ranges from 1 to 2.1 per cent. ...

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2. This section has been copied directly from N.W. Bass ("The Geology of Cowley County, Kansas", State Geological Survey of Kansas, Bulletin 12, 1929, pp. 167, 168, 171-174, 176-178.

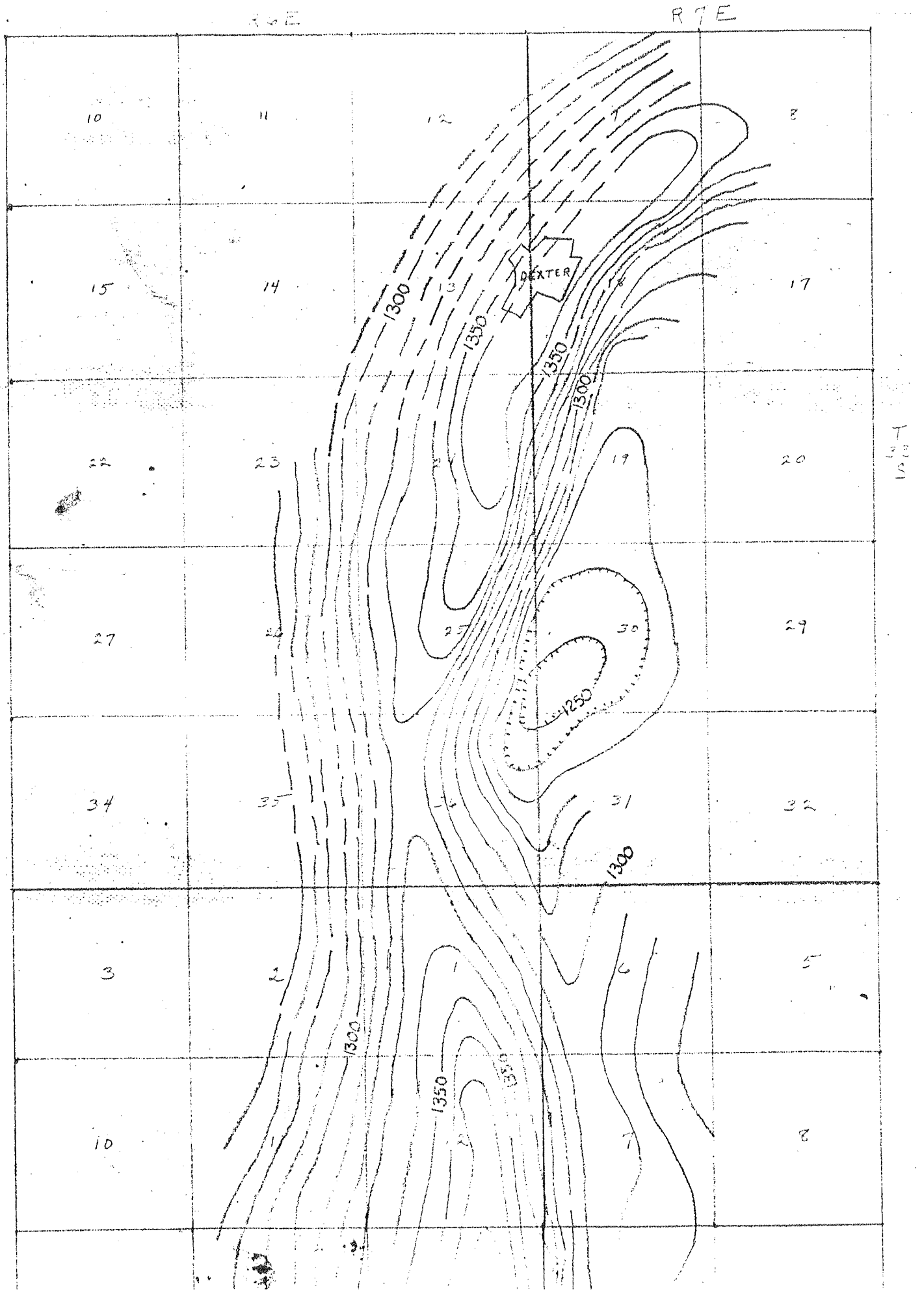
Fig 7. Map of the Dexter anticline
after Bpet, page 172, Bull 12 S.D.S.K.

"Rocks productive of oil and gas. -- The discovery gas well, drilled ~~in 1903, and the wells drilled immediately afterward produced gas~~ in 1905, and the wells drilled immediately afterward produced gas from a sandstone in the Admire shale at a depth of about 525 feet. Beds at this general horizon, although probably not the same beds, have produced gas elsewhere in Cowley county, particularly near Winfield and Arkansas City. Fairly strong flows of gas were struck at this horizon in the wells drilled in theCountryman field, 3 miles northeast of Dexter. It was in the gas from this sand that Cady and McFarland discovered helium gas, and so large a percentage of the gas produced from this sand at Dexter is noninflammable that users found it difficult to ignite. A series of sands in the lower part of the Shawnee group, about 150 feet above the Oread limestone, yielded appreciable flows of gas near Dexter and near Otto. These beds lie at a depth of about 1,000 feet near Dexter and a little more than 1,100 feet near Otto. Shows of gas were encountered at this horizon in the wells drilled in the Countryman field. Gas shows were found in sandstone beds in the Douglas group in wells drilled in the Countryman and Dexter fields. Sandy zones in the Lansing group produced shows of gas and oil in several wells near Dexter and in the Countryman field. The sandy upper part of the Kansas City group has produced oil in one well in the Countryman pool and supplied good shows of oil in other wells. Shows have been reported from this horizon in the Dexter pool. Shows of oil and gas have been reported from the lower part of the Marmaton group in the Countryman and Dexter pools, and a small production of oil was obtained from a bed at this horizon in one well near Otto. Another well near Otto has a show of oil in a sandstone in the lowermost part of the Cherokee shale; but no sand occurs at this horizon throughout most of the Dexter-Otto district.

"The upper part of the Mississippian limestone is the chief oil-producing zone in the district. Sandy streaks in the limestone yield oil in the Dexter and the Countryman fields, and shows, together with some small production, are obtained from these beds near Otto. The production is so small, however, that it has never been of great importance. A few wells started off with a fair yield but quickly dropped to a very low daily production.

"Several wells near the crest of the anticline in the Otto field are believed to have reached the upper part of the Ordovician strata, and three wells near Dexter have penetrated some distance into the Ordovician rocks, but yielded only disappointment. These beds have not been tested in the Countryman pool.

"Structure. -- The Dexter-Otto anticline is the most extensive pronounced fold to be seen expressed in the surface rocks in Cowley county. A structure-contour map of the surface beds in the southern and central parts of the district was kindly supplied by M. W. Baden, of the Trees Oil Company, and is reproduced in Figure 18. [Figure 7 of this report.] ... Dome-shaped folds superposed on the major anticline and constituting only local features of it are shown on the structure map. ... The anticlinal fold is asymmetric in cross section, dips on the east side being greater than those on west. According to Baden's map (Fig. 18) [Figure 7 of this report], the surface rocks have a maximum dip eastward of about 100 feet in half a mile and a maximum dip westward of about 50 feet in half a mile. The average rate of dip is slightly less steep than the maxi-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mum, but throughout is steeper on the east side of the fold than on the west side. Wells that penetrate the Mississippian limestone are not so distributed as to afford much information for a comparison of the amount of dip in the surface beds with that of the buried Mississippian rocks, but such information as is disclosed by two wells southeast of Dexter, the Sinclair Oil and Gas Company's J. W. Searle well No. 1, in the the SW¼ sec. 18, and the Devonian Oil Co.'s Radcliff well No. 1, in the NE¼ sec. 19, T. 33 S., R. 7 E., show the surface rocks to dip about 30 feet southeastward in two-thirds of a mile and the upper surface of the Mississippian limestone to decline 155 feet in the same distance. To ascertain the true amount of dip in the Mississippian beds the amount of erosion of the uppermost Mississippian rocks should be known. On the basis of logs of wells drilled in this general region that show the Mississippian limestone thinner over the crest of the Dexter-Otto anticline than it is east and west of the crest, a conservative assumption of thinning by erosion between these two wells would be 25 feet, making the true dip of the Mississippian beds about 130 feet in two-thirds of a mile. Similar study of wells south of Dexter on the west flank of the fold indicates that the slope of the Mississippian surface adheres closely to the dip of the surface beds; but if a thinning of the Mississippian series by erosion is assumed to have taken place toward the crest of the fold the actual dip of the Mississippian rocks is slightly greater than that of the surface beds. Because no deep wells have been drilled far down the west flank, however, few definite data relative to the dip of the Mississippian rocks there are available.

Oil and gas possibilities. — Although several wells in the vicinity of Dexter and Otto have been drilled into the Ordovician rocks and found them water bearing, not all the possible oil-bearing beds have been tested in all the structurally favorable areas on this fold. No deep wells have been drilled in the Countryman pool, and none have gone more than a few feet into Ordovician beds near Otto. The productive possibilities of stratigraphically higher beds have been determined in the principal parts of the district."

Falls City Field

"Location. — The Falls City field is in the southeastern part of Cowley county, in secs. 8, 9, 16 and 17, T. 35 S., R. 7 E. It extends southward across the state line into Oklahoma, but it is principally the Kansas part that is considered herein.

History, production, and character of gas and oil. — The Falls City field was opened in 1915 by the discovery of an initial production of 7,000,000 cubic feet of gas at a depth of 1,480 feet in the Falls City Land and Cattle Company's well No. 1, in the center of the north line of the NE¼ sec. 17, T. 35 S., R. 7 E. Well No. 2, near the center of the NE¼ sec. 17, followed in the same year with an initial production of 6,000,000 cubic feet of gas having a rock pressure of 500 pounds to the square inch, derived from the same sand as that producing in well No. 1. The field was later taken over and developed by the Phillips Petroleum Company. Beds deeper than the gas sand were found to contain oil, one producing bed occurring at a depth of 2,000 feet and a second at a depth of 2,700 feet. A total of 33 wells have been drilled in the Kansas part of the field, 7 of which have been dry holes. Eight producers and 3 dry holes have

been drilled in the Oklahoma part of the field. The total oil production of the field to June 1, 1927, was 780,000 barrels; the total gas production to the same date is estimated by the Phillips Petroleum Company as a little more than 15,000,000,000 cubic feet. In June, 1927, the field was producing 10 barrels of oil a day from 21 wells. The oil has a gravity of 41.2° Baume....

"The gas in this field has a high content of helium, according to the analyses of samples of gas from two wells in section 17, producing from a depth of 1,475 feet. The gas from one well contained 1.047 per cent of helium, and that from the other contained 0.94 per cent.....

"Productive beds. -- Beds of economic importance because of their yield of oil and gas occur near the top of the Kansas City group, in the upper part of the Cherokee shale, and in the Lansing group. Most of the oil wells obtain their oil from sandstone in the upper part of the Kansas City group, encountered at a depth of about 2,000 feet. Wells Nos. 1, 3, 6, 13, 12, 9, 5, 4, 10 and 14, in the NE¼ sec. 17 (see Fig. 20) [Figure 9 in this report], Nos. 26, 21 and 24, in the SE¼ sec. 17, and Nos. 26 and 19, in the W½ sec. 16, have produced oil from this horizon; their aggregate initial production was about 1,000 barrels of oil a day. A few wells have produced oil from a lenticular sandstone, which is not present in all wells. This sandstone occurs in the upper part of the Cherokee shale and was encountered at a depth of about 2,700 feet. It has yielded oil in well No. 7, near the center of the E½ sec. 17; a show of oil in well No. 1, in the northeast corner of the SW¼ sec. 17; and gas in wells Nos. 20A and 29A, in the SE¼ sec. 17. Two gassers -- well No. 17, near the southwest corner of sec. 16, and well No. 6, in the NE¼ sec. 17 -- derive their gas from a sandstone in the lower part of the Lansing group lying a little more than 1,300 feet beneath the surface. The sand body is extremely lenticular in habit. No sand is recorded at this horizon in wells Nos. 10 and 12, on the crest of the fold. Other wells encountered a considerable thickness of sand that contained water. Gas is produced from a sandstone that is about 350 feet above the bed just described and is believed to be near the contact of the Lansing and Douglas groups. It was the discovery of gas in this sand that opened the field. The sand body is lenticular. In the NE¼ sec. 17, well No. 1 had an initial production of 7,000,000 cubic feet of gas from this sand, and wells Nos. 2, 4 and 7 each had an initial production of 5,000,000 cubic feet. A number of shows of gas and oil were reported from the uppermost part of the Lawrence shale, a sandy zone close beneath the Oread limestone, in many wells drilled in the NE¼ sec. 17, the SE¼ sec. 3, and at scattered localities elsewhere in the field.

"Structure. -- According to the surface structure map shown in Figure 19 [Figure 8 of this report], supplied by the Phillips Petroleum Company, the Falls City field is developed on an anticlinal nose trending southwestward through the NE¼ sec. 17.

"Production from the principal producing zone (the uppermost part of the Kansas City group) appears to be controlled by the attitude of the rocks, inasmuch as it is confined to the higher parts of the fold. The lenticular shape of the sand bodies, coupled with the structure, appears to be the factor that controls production in the other producing beds. Possible producing zones beneath the upper part of the Cherokee shale have not been tested with the

drill on the higher part of the fold. Three holes -- the E. C. Lemaster No. 1, in the SW¼ SE¼ sec. 8; the Easly No. 1, in the northeast corner of the SW¼ sec. 17, and the Falls City No. 16, in the SW¼ NW¼ sec. 16, have been drilled into rocks that lie beneath the Pennsylvanian beds. The Lemaster and Easly holes are far down the west flank of the fold and so do not constitute adequate tests of the lowermost Pennsylvanian nor of the Mississippian and Ordovician rocks, all of which produce oil elsewhere in the Midcontinent region. The Falls City No. 16 well is on the east flank of the fold, as shown by the subsurface map, and it was not drilled to a sufficient depth to test the Ordovician rocks, but it did penetrate the lowermost Pennsylvanian and the uppermost 100 feet of the Mississippian beds. In this well a sand body only 3 feet thick was logged at the base of the Cherokee shale, and one 15 feet thick was logged 140 feet above the base. The Cherokee shale was reported to contain no beds of sandstone in the Lemaster and Easly wells mentioned above. Consequently it appears unlikely that reservoir beds are present in the lower part of the Cherokee shale on the highest part of the fold. The "2,700-foot" producing sand, which is a sandstone in the upper part of the Cherokee shale, has been shown to be present and contain oil in a few wells in the northeast one-fourth and southeast one-fourth of section 17 and is probably present on the highest part of the fold. The Mississippian rocks are not known to contain oil in close proximity to this field, but commonly produce at a number of localities in this general region of Kansas and Oklahoma. Beds of Ordovician age yield an abundance of oil in fields not remote from the Falls City field. Should these lower beds be tested with the drill here the test well should be located on the highest part of the dome, which is near the site of well No. 12, in the northeast one-fourth of section 17, according to the subsurface map shown in Figure 30 [figure 9 of this report], and drilling should continue through a thickness of at least 150 to 200 feet beneath the base of the Chattanooga shale. A total depth of 3,300 feet should be ample. Production from the lowermost Cherokee or the Mississippian beds appears unlikely, but the possibility of obtaining oil in the Ordovician rocks cannot be positively eliminated until such a test is made."

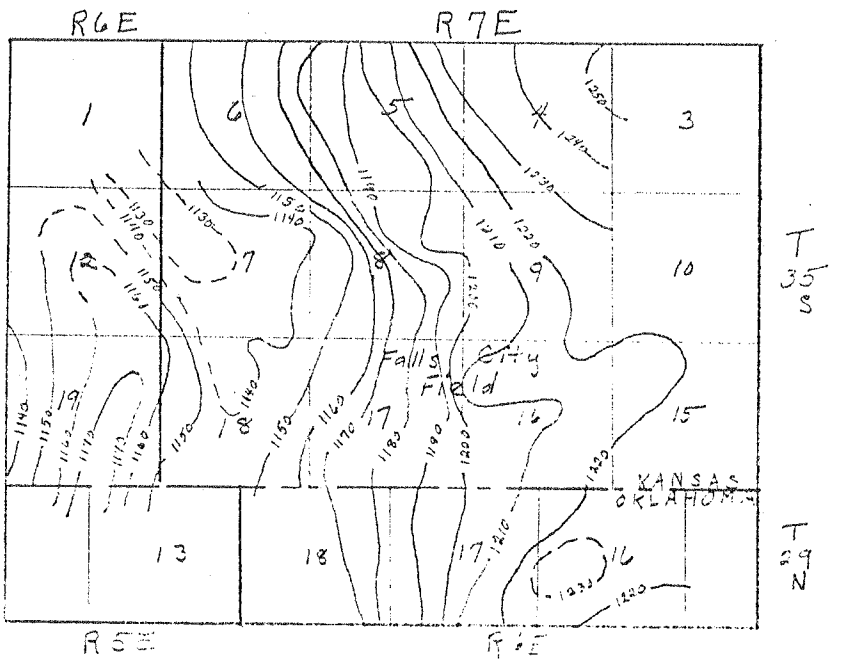

Figure 8. — Map showing attitude of surface beds in Falls City field and vicinity. Structure contours drawn on Cottonwood limestone. Contour interval, 50 feet. (After Bass, p. 177, Bull. 12, State Geological Survey of Kansas. Original map made by the Phillips Petroleum Company.)

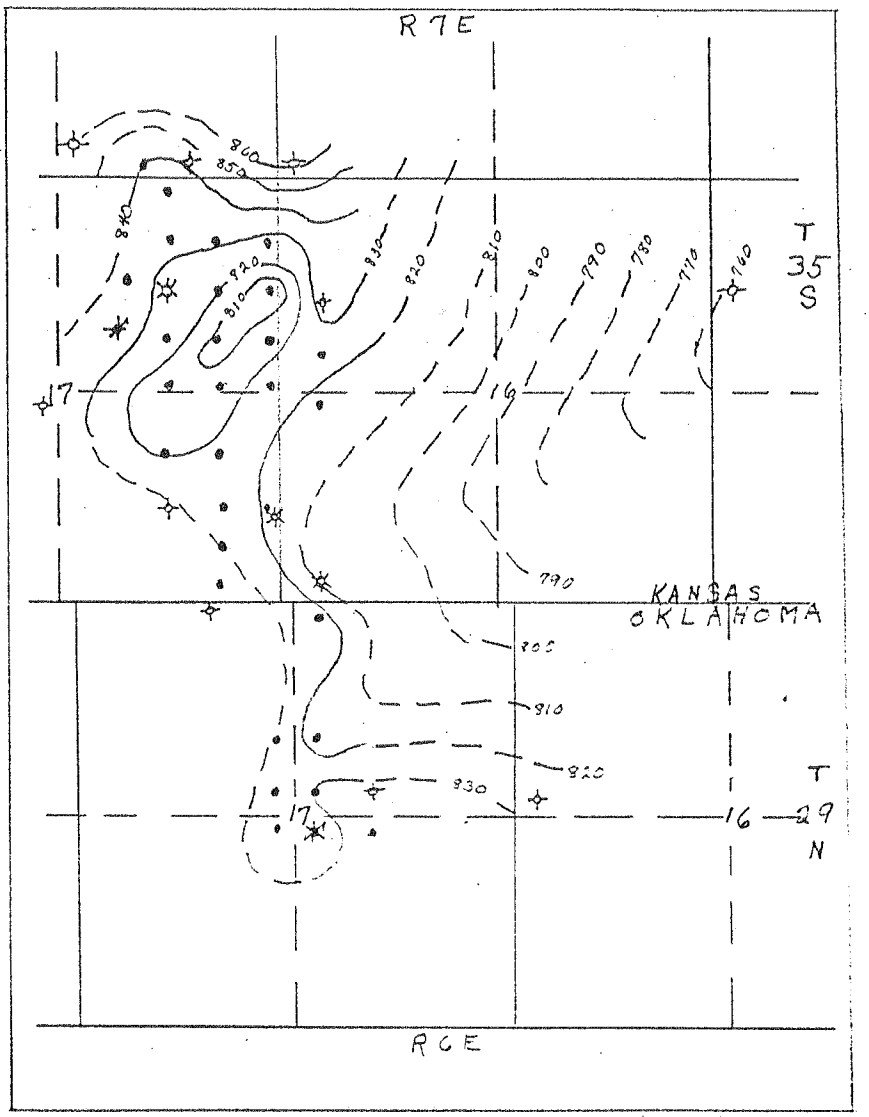

Figure 9. -- Subsurface structure-contour map of Falls City field. (After Bass, p. 179, Bull. 12, State Geological Survey of Kansas.)