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SUBSURFACE STUDY OF THE MARMATON GROUP IN SOUTHWESTERN KANSAS

by

James B. Osborn

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B.S., University of Illinois, 1959

Submitted to the Department of Geology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Science.

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For the department

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CONTENTS

ILLUSTRATIONS

ABSTRACT

The Marmaton Group, except for the upper three formations, can be identified in the subsurface from near the outcrop area in southeastern Kansas to and throughout the principal area of investigation in southwestern Kansas. Marine and nonmarine sediments are present in nearly equal amounts in the outcrop area, but in the area of principal investigation the group appears to be entirely marine and consists of limestones with thin shales. The group is thinest on the southwestern flank of the Central Kansas Uplift and thickest in the Hugoton Trough. It grades into a sandy shaly facies on the flanks of Keyes Dome in Morton County.

Oil is found in Marmaton strata in structural, stratigraphic, and combination type traps. The greatest Marmaton production is from a pool in the Novinger Field.

INTRODUCTION

Purpose

The purpose of this report is to determine whether or not the Marmaton Group or any of its formations are continuous across southwestern Kansas, to investigate its general character, and to study the oil fields which produce out of Marmaton units in the area of study.

Principal Area of Investigation

The area is limited on the north by T. 20 S., on the south by the northern border of Oklahoma, on the east by R. 20 W. of the 6th Principal Meridian, and on the west by the eastern border of Colorado (Fig. 1). Contained within these bounds are 14 Kansas counties: Hamilton, Kearny, Finney, Hodgeman, Stanton, Grant, Haskell, Gray, Ford, Morton, Stevens, Seward, Meade, and Clark. The counties occupy a total land area of approximately 11,800 square miles.

Previous Work

Early studies of the Marmaton Group in the principal area of investigation were carried on by Roth (1930), and Gordon (1938).

Roth investigated the regional extent of the Desmoinesian Series by correlating well samples after he had first correlated outcrops by comparing their paleontological content.

Gordon (1938) was primarily interested in correlation on the basis of black shales in the wells of western Kansas.

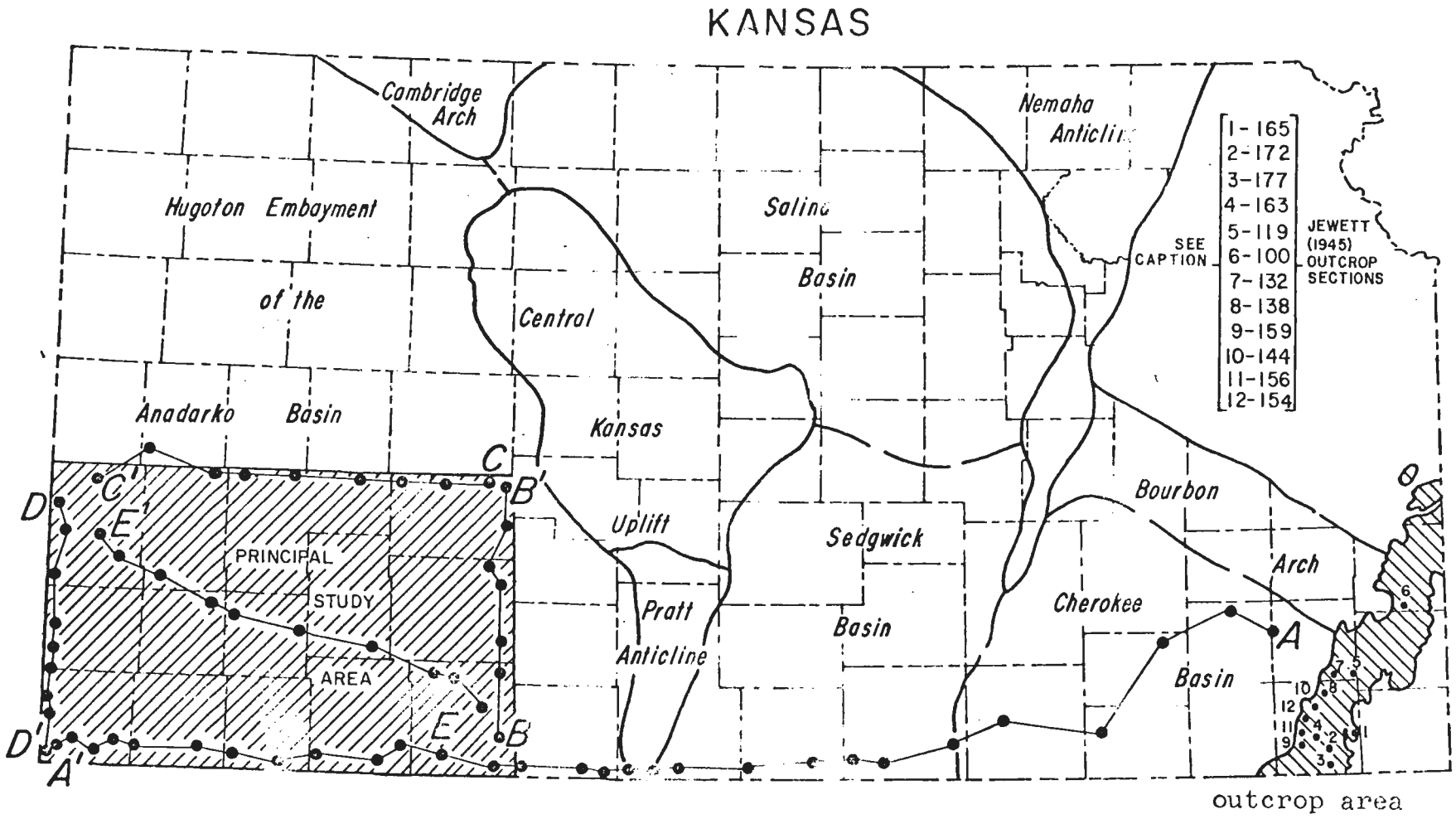

Fig. 1. Map showing location of: principal study area, service log cross sections, major Kansas post-Mississippian structures and outcrop area of Marmaton Group with location of sections (1 through 12) of the composite section.

According to him, the Marmaton and the underlying Cherokee could be correlated by using fusulinids, and the thickness of the Marmaton ranged from zero to 300 feet, of which about one-fourth was thought to be black shales. He concluded that black shales were too abundant to be useful in correlating the Desmoinesian Series from western Kansas with the outcrop area in southeastern Kansas.

Various preliminary cross sections in southwestern Kansas and southeastern Colorado have been published by the State Geological Survey of Kansas (Maher, 1946, 1947; Lee, 1953), the Kansas Geological Society (1950), the Liberal Geological Society (1958), and the U.S. Geological Survey (Maher and Collins, 1949).

Jewett (1941, 1945) correlated and described Marmaton units where they crop out in southeastern Kansas. He found four limestone formations, dominantly marine in origin, and four shale formations, dominantly normarine, which could be subdivided into members. The group is traceable throughout the outcrop area and into the adjacent states of Missouri and Oklahoma.

Lemmons (1946) made a subsurface study of the group in southeastern Kansas. He observed that the uppermost limestone formation, the Lenapah, and bounding shale formations were apparently absent, either through erosion or more probably, nondeposition. He also noted that the group gradually became more marine as the units were traced westward

to the Nemaha Ridge where the group became dominantly limestone with thin shale units.

Moore (1951) defined the present limits of the Marmaton Group. The upper limit is the unconformity below the Hepler Sandstone of the Pleasanton Group; the lower limit is the base of the Fort Scott Limestone.

Moore and Jewett (1942) pointed out the major structures in Kansas. Post Mississippian structural provinces were designated primarily to outline convenient petroliferous provinces. Jewett (1951), and Jewett and Merriam (1959), further described geologic structures in Kansas. Koester (1935) investigated the geologic history of the Central Kansas Uplift. The Hugoton Embayment and its structural development have been discussed by Merriam (1955). Other investigators of the Hugoton Embayment include Maher and Collins (1948), who suggested the present name to replace the term Dodge City Basin originally proposed by McClellan (1930).

Methods of Investigation

The initial investigation involved a review of library material. Various regional cross sections were studied in addition to publications and theses related to the problem.

Following the library study, the outcrop area in southeastern Kansas was visited and various rock units of the Marmaton Group sampled. Identification and location of the Marmaton outcrops were accomplished through the use of Jewett's (1945) publication.

Next, electric logs from wells near the outcrop area were compared with a composite section constructed primarily from information in Jewett's (1945) publication. For the location of the sections used to construct the composite section see Figure 1.

After a satisfactory correlation was made between the composite section and the service logs from nearby wells, a well to well correlation of the units was carried westward across the southern tip of the Nemaha Anticline, through the Sedgwick Basin, over the southern tip of the Pratt Anticline, and into the Hugoton Embayment of the Anadarko Basin to the Colorado border (Pl. 1). For convenience, electric logs and radioactivity logs will be referred to as service logs throughout the remainder of this paper. Additional service log cross sections were made within the area of investigation (Pls. 2, 3, 4, and 5). The base of the Kansas City Group was used as the datum for the cross sections.

Structure contour maps (Pls. 6 and 7) were prepared that show the present configuration of the upper surface and base of the Marmaton Group. Control was unbalanced owing to the greater density of drilling in some areas as compared to others. Consequently, only the general structural features could be shown in some instances, while in others detailed studies could be made.

Thicknesses obtained for the group were used to construct an isopachous map (Pl. 8).

A percent carbonate map is shown on Plate 9.

Acknowledgements

I wish to express my thanks to Dr. J. M. Jewett for advising the preparation of this report, and to Drs. F. C. Foley and H. A. Ireland for their suggestions and criticisms in reviewing the report. I would also like to thank Dr. D. F. Merriam who suggested the problem and Mr. E. D. Goebel who instructed the writer in the use of Survey facilities.

STRATIGRAPHY

General

In Kansas, rocks of Desmoinesian age include the Marmaton Group and the underlying Cherokee Group. Along the outcrop in southeastern Kansas nonmarine and marine shales are the dominant lithology of rocks deposited during Desmoinesian time, but the abundance of limestone and the more marine character of the upper units in comparison to the lower units allows a natural lithologic division into two groups (Jewett, 1941, p. 297).

In southwestern Kansas, marine limestones and shales comprise almost the entire Marmaton Group with limestone as the dominant rock type. The Cherokee Group, also, is more marine than in southeastern Kansas. These findings indicate that in southwestern Kansas during the Desmoinesian a marine environment of deposition was present much more of the time than in southeastern Kansas.

Marmaton rocks crop out along a narrow band that extends from the Arkansas River valley, through northeastern Oklahoma, southeastern Kansas, western and northern Missouri, and into Iowa. The proportion of marine sediments decreases to the northeast along the outcrop (Jewett, 1945, p. 53), while, as mentioned above, marine sediments increase in importance to the west where these rocks are in the subsurface.

The type section of Desmoinesian rocks is along Des Moines River in central Iowa.

Generalized Stratigraphy of the Marmaton Group

The generalized stratigraphy of the Marmaton Group both in the outcrop area and in the area of study is illustrated in Figure 2.

The Marmaton Group, as defined by Moore and others (1951), includes units upward from the base of the Fort Scott Formation to a major unconformity at the base of the Hepler Sandstone of the Pleasanton Group. In this report, the top of the first major limestone below the base of the Hertha Limestone of the Kansas City Group is chosen as the top of the Marmaton Group. This procedure is necessary because the upper three formations are apparently missing throughout most of southeastern and all of southwestern Kansas. In the area of principal study the uppermost Marmaton unit is identified as the Altamont Formation.

The four dominantly marine limestone formations, each overlain by a dominantly nonmarine shale formation, which make up the Marmaton Group in the outcrop area, are suggested by Jewett (1945, pp. 55-70) as being parts of cyclic units. Four megacyclothems of four or more cyclothems each are believed to be present in the group. The only cyclic nature apparent in the subsurface in the area of study is restricted to vertical changes from marine limestone to marine shale.

The type locality of the Marmaton Group is along the Marmaton River, from Uniontown to Fort Scott in Bourbon County, Kansas. The thickness along the outcrop averages 250 feet.

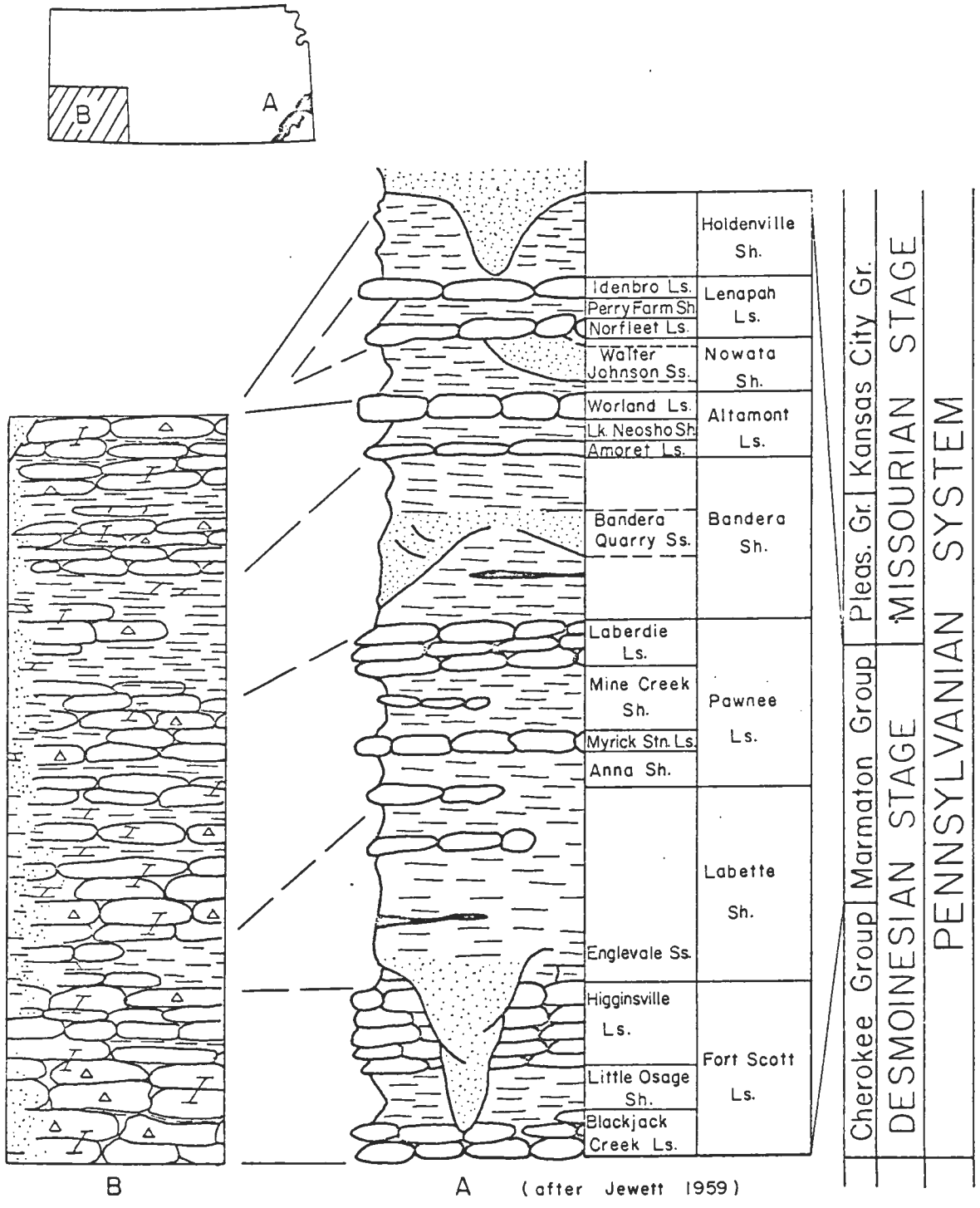

Fig. 2. Generalized stratigraphy of Marmaton rocks in (A) the area of outcrop, and (B) the subsurface in southwestern Kansas. Approximate vertical scale: 1 inch = 40 feet.

Correlation of the Marmaton Group

A number of cross sections (Pls. 1, 2, 3, 4, and 5) were constructed using service logs. The datum for each section is the base of the Hertha Limestone of the Kansas City Group. For the location of each well represented on the cross sections see Figure 1.

Cross Section A-A'

For the construction of cross section A-A' (Pl. 1) a composite section of the Marmaton Group was correlated with service logs from wells immediately west of the outcrop area.

Section A-A' extends from near the outcrop area in southeastern Kansas westward over the southern end of the Nemaha Anticline, through the Sedgwick Basin, over the southern tip of the Pratt Anticline, and into the Hugoton Embayment to the Colorado border. In wells 1 through 4 the group averages 215 feet in thickness. In well 6, near the crest of the Nemaha Ridge, the thickness decreases to 125 feet. The greatest thickness reached in the Sedgwick Basin is 150 feet. Over the Pratt Anticline, the Cherokee Group appears to pinch out and the Marmaton Group thins to 90 feet. Both groups then thicken again to the west, and in well 24 in the Hugoton Trough, the Marmaton reaches a maximum thickness of 275 feet. Finally, the Marmaton thins on the flanks of Keyes Dome and in well 29 is 80 feet thick.

From R. 11 E. to the outcrop area, and from T. 32 S. to the Oklahoma border, the Hertha Limestone (datum) is

identified by service log "kicks" representing a very thin limestone; ordinarily it is much thicker. According to Lemmons (1946, p. 7), positive identification of the Hertha on driller's logs from wells in the area defined above is difficult. Wells to the west of R. 11 E. show that the Hertha increases in thickness.

The uppermost limestone formation of the Marmaton Group, the Lenapah, could not be identified west of well 5. Lemmons (1946, p. 26) relates that the Lenapah appears to be absent over much of southeastern Kansas, even where post-Desmoinesian erosion is not in evidence. The unit which marks the top of the Marmaton Group along most of cross section A-A' and in the area of principal study in southwestern Kansas is identified as the Altamont Formation. It usually consists of two or three limestone beds separated by thin shales.

The gross lithology of the Altamont in southwestern Kansas was determined through study of sample logs. It is a cream to buff, or gray, dense to fine crystalline, fossiliferous limestone with thin shales. Locally it is cherty, dolomitic, and occasionally oolitic. In some areas an oocastic porosity is present and the unit serves as a reservoir for oil. On the flanks of Keyes Dome the Altamont becomes thiner and the limestone is partially replaced by a sandy-shale facies. In some places it may have been partly removed by erosion at the end of Desmoinesian time.

The Bandera Shale, which is 35 to 75 feet thick where it crops out in southeastern Kansas, decreases in thickness

westward as shown on cross section A-A'. In well 6, on the southern end of the Nemaha Anticline, it is not more than 10 feet thick. The Bandera remains thin across the Sedgwick Basin. In well 16, in southwestern Kansas, a new limestone appears in the shale between the Altamont and the Pawnee formations. It is probably best regarded as a part of the Bandera Formation. This limestone unit is present throughout the southern and western parts of the area of study and its characteristics are about the same as the overlying limestones of the Altamont Formation.

The Pawnee Limestone is present along the cross section from eastern Kansas to Keyes Dome where it apparently changes to a sandy shale. It is thinest over the southern tip of the Pratt Anticline where it is between 15 and 20 feet thick. In the Hugoton Trough it thickens to more than 70 feet and usually consists of two or three limestone beds separated by thin shales. The formation typically consists of gray to buff, dense to fine crystalline, cherty, dolomitic, oolitic limestone separated by thin shales. In a number of the oil fields investigated the limestones serve as reservoirs for oil.

The Labette Shale, which is 35 feet thick in well 1, thins to the west and remains thin throughout the area of study. In the Hugoton Trough it sometimes contains a thin limestone unit.

The Fort Scott Formation is readily identified on service logs from wells near the outcrop area, along cross

section A-A', and throughout the area of study. The thickness averages between 30 and 40 feet to the area of principal investigation; in the Hugoton Trough it increases to 70 feet. The gross lithology of the Fort Scott throughout the area of study is similar to the limestone formations discussed above.

Cross Section B-B'

This section is along the eastern border of the principal area of investigation (Pl. 2). The group is 128 feet thick in well 1 and thins to the north where, in well 7 on the southwestern flank of the Central Kansas Uplift in Hodgeman County, it is 80 feet thick. No pinching out appears to occur, and units which were identified in section A-A' from the outcrop area can be identified along this cross section.

Cross Section C-C'

Cross section C-C' follows the north border of the principal area of investigation (Pl. 3). The Marmaton Group thickens westward from the flank of the Central Kansas Uplift into the Hugoton Embayment where, in well 8, the group is 145 feet thick. All of the main units identified in cross section A-A' can be seen in section C-C'.

Cross Section D-D'

Cross section D-D' shows the Marmaton units along the western border of the principal study area (Pl. 4). It is tied in with section A-A' in Morton County, thus completing an identification of the Marmaton units along each boundary

of the area of investigation. In section D-D' the group thickens southward to a maximum between 180 and 190 feet in wells 4 and 5. It then thins to 85 feet in well 9 on the flanks of Keyes Dome in Morton County.

Cross Section E-E'

Cross section E-E' (Pl. 5) reveals the units between the base of the Kansas City Group and the top of Mississippian rocks across the central part of the study area. In wells 1 through 5 the thickness averages 110 feet. It increases gradually to 160 feet in well 10.

STRUCTURE

Regional Setting

The principal area of study has remained relatively stable throughout geologic time. It was part of the shelf area for the Anadarko Basin to the south.

Early Pennsylvanian seas invading the shelf area were restricted by the Central Kansas Uplift, the Cambridge Arch, the Siouxia Uplift, and the Sierra Grande Uplift (Fig. 3). These elements supplied sediments to Morrowan, Atokan, Desmoinesian, and possibly early Missourian seas. By Missourian time the topographic expression of the above features was largely destroyed by erosion and buried under sediments deposited in the encroaching seas. Following Morrowan time the Sierra Grande Uplift, and Pennsylvanian structures in the position of the present Wet Mountains and Front Range were elevated. These features, too, supplied sediments to the seas until late in Pennsylvanian time (Merriam, 1955). Major structures associated with the area of investigation are shown in Figure 3.

Hugoton Embayment

The embayment (Fig. 3) may have initially been downwarped in Precambrian time. The greatest structural development in the Kansas part of the embayment area was post-Mississippian--pre-Pennsylvanian (Jewett and Merriam, 1959). Within the embayment area are several minor structural

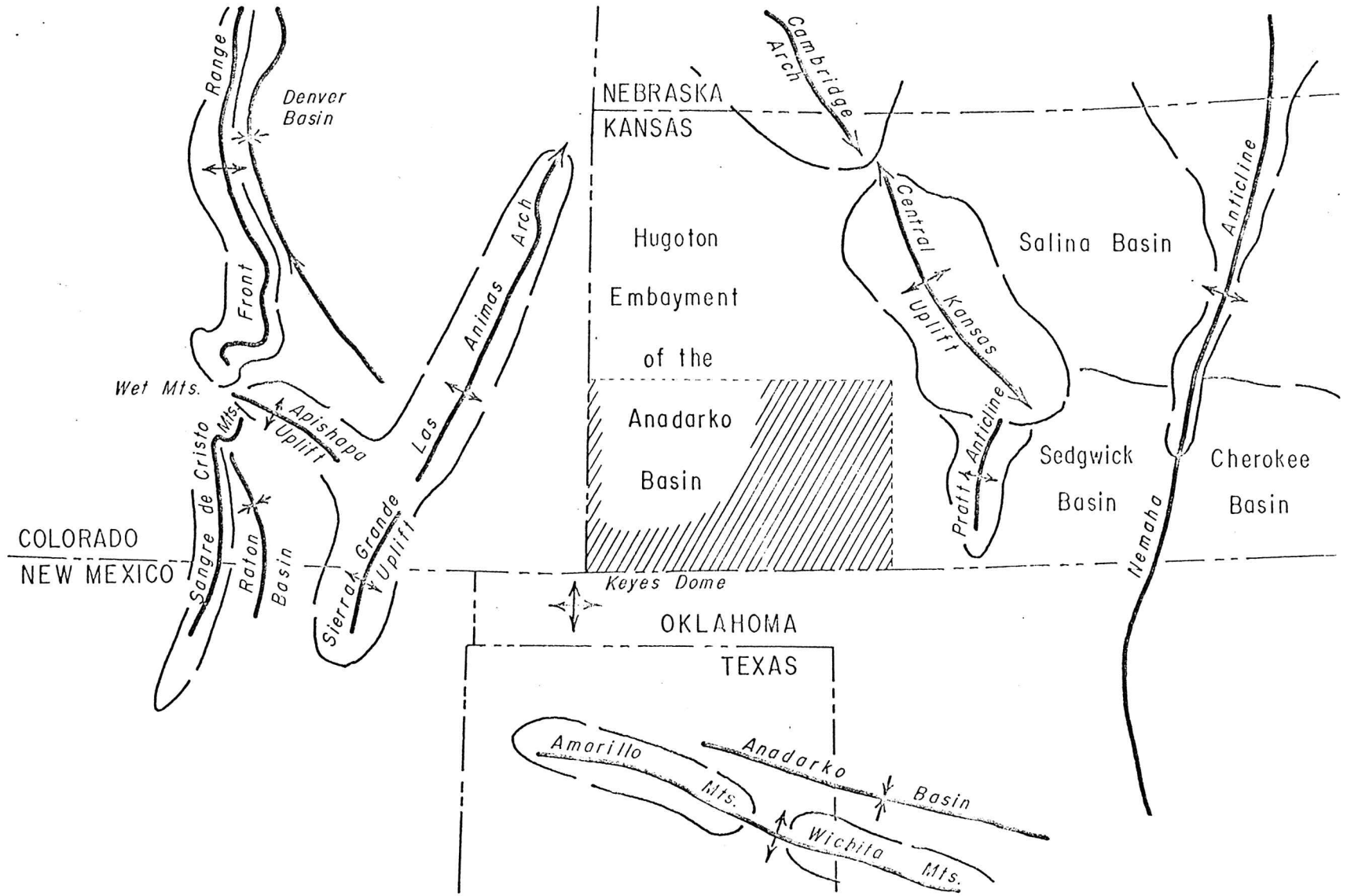

Fig. 3. Area of study in relation to regional tectonic elements (modified after Merriam, 1955). The age of the various structures is different and discussed in the text.

features of which Keyes Dome, in Cimarron County, Oklahoma, is the most prominent (Maher and Collins, 1949). The embayment was buried under the sediments of Late Pennsylvanian seas.

Pratt Anticline

To the east of the Hugoton Embayment and approximately parallel to the trend of the Nemaha Anticline is the Pratt Anticline (Fig. 3). It is regarded as the smallest "major" structural element in Kansas and is designated as a post-Mississippian--pre-Pennsylvanian structure (Jewett and Merriam, 1959).

Central Kansas Uplift

Northeast of the embayment area, and included within a northwest trend of prominent structures which extends from the west flank of the Ozark Dome to the Black Hills, is the Central Kansas Uplift (Fig. 3). It may have been initiated in Precambrian time as a series of parallel batholiths (Koester, 1935). Major movement of the uplift occurred during post-Mississippian time. A map outlining Mesozoic structural provinces (Jewett and Merriam, 1959, p. 44) shows that the area of the Central Kansas Uplift later became part of the basinal area.

Las Animas Arch

The earliest structure in the area of the Las Animas Arch was probably present in post-Mississippian--pre-Pennsylvanian time. The arch was well defined by the end of Desmoinesian

time and, although minor uplifts occurred later in Pennsylvanian and Permian times, the greatest upward movement took place after the beginning of Mesozoic sedimentation (Maher, 1945). The effect of the arch on the embayment area was to interrupt a narrow deep trough which was present in Morrowan, Atokan, and Desmoinesian times (Merriam, 1955).

Sierra Grande Uplift

The first indication of the uplift was probably as part of a gentle upwarp in central southeastern Colorado in early Ordovician time. It was further defined after the close of Ordovician time. In post-Mississippian--pre-Pennsylvanian time, the uplift was a low-lying positive area, but at the end of Morrowan time it, along with Pennsylvanian structures in the position of the present Wet Mountains and Front Range, experienced major uplift and remained high throughout the rest of Pennsylvanian time (Maher, 1953b).

Structure of the Marmaton Group

Structure contour maps and an isopach map were prepared using the data from approximately 1000 service logs (Pls. 6, 7, and 8). The Marmaton tops on driller's logs and top cards were used sparingly. All of the data used was obtained from the State Geological Survey of Kansas.

In the area of study, later structural movements have masked the structure present at the close of Desmoinesian time.

Compressional forces from the west during the Laramide Orogeny in late Mesozoic and early Cenozoic time were probably instrumental in the formation of many of the minor folded structures in the area of study. Two of the most prominent folded structures appear as structural noses plunging to the south. They are in Kearny and Hodgeman counties. The exact time of their origin is not known.

Among the latest structural movements that affected Kansas was a gentle regional upwarp "that brought the Rocky Mountains to about their present elevation in late Pliocene and early Pleistocene time (Jewett and Merriam, 1959, p. 36)." Additional movements occurred later in Pleistocene time.

Detail structure maps of the Marmaton upper surface were prepared of the two larger faulted areas. The faults are probably the result of recurrent movement along old fault planes that may have originated in Mississippian time.

Structure of the Upper Surface of the Marmaton Group

A structure contour map (Pl. 6) was prepared that shows the configuration of the upper surface of the Marmaton Group in the area of study at the present time. The maximum structural relief is 3,534 feet. The highest elevation on the surface, 155 feet above mean sea-level, is in the southwestern corner of Morton County; the lowest elevation, 3,379 feet below mean sea-level, is in the southeastern corner of Clark County.

The most noticeable structural feature on the map is the gently sloping surface that dips eastward in the western part of the map, southeastward in the central part, and almost directly south in the southeastern portion.

The second most prominent feature is the large synclinal structure in the southwest quarter of the map. This general area was occupied by the Hugoton Trough, the deepest part of the Hugoton Embayment. The limits of this structure on the map are vague, but it appears to trend in a northwesterly direction. By the time Marmaton rocks were deposited in the trough, earlier Pennsylvanian deposits had almost filled it.

In Morton County, Marmaton rocks were uplifted on the northeastern flank of Keyes Dome. Totten (1956, p. 1964) suggests that the dome was originally uplifted during late Mississippian time and then rejuvinated several times during the Pennsylvanian. Marmaton rocks become progressively thiner and grade into a sandy-shale facies on the flanks of the dome. This change in Marmaton units suggests that the dome was being uplifted during their deposition. Marmaton units in eastern Morton County display the maximum gradient in the area of study. It is approximately 126 feet per mile.

The average gradient of the Marmaton upper surface from the northwestern corner of the map to the southeastern is about 16 feet per mile.

Structure of the Base of the Marmaton Group

A structure contour map of the base of the Marmaton Group (Pl. 7) shows, almost feature for feature, the same regional and local structure present on the upper surface. Apparently all significant deformation of Marmaton units occurred after the deposition of the entire group. However, the limits of the Hugoton Trough are more clearly defined which suggests that it may possibly have been subsiding at the outset of the deposition of Marmaton rocks.

The slope of the area of maximum gradient in eastern Morton County is approximately 128 feet per mile. It is about 1.5 feet per mile greater than the slope between the same two points on the upper surface.

The slope of the base of the Marmaton Group from the northwest to the southeast corner of the principal study area is about 15.8 feet per mile which shows an increase of only 0.5 feet per mile over the slope of the upper surface along the same line.

Isopachous Map of the Marmaton Group

An isopachous map of the principal area of study (Pl. 8) shows that a stable shelf environment probably existed in the northern, central, and eastern portions of the area, while in the south-central and southwestern portions subsidence appears to have accompanied deposition. The greatest thickness of sediments, 280 feet, is in the southernmost part of the Hugoton Trough. The thinest section, 70

to 80 feet, is in the northeastern corner of Hodgeman County on the southwestern flank of the Central Kansas Uplift.

According to Lee (1954), an isopachous map showing the thickness of rock units between surfaces that were relatively flat at their time of origin, also relates the configuration of the lower surface when deposition of the upper surface ceased. If either or both of the surfaces have undergone extensive or partial erosion, a true picture of the structure of the lower surface will not be revealed. The Marmaton Group in the area of study does not display any positive indications of erosion, except perhaps on the flanks of Keyes Dome.

In the same article (1954, p. 72), Lee suggests that all thickness maps may indicate the place and amount of folding but they do not reveal the sequence of events nor the actual time of folding. Considering the upper Marmaton surface a plane, the isopachous map would then be a paleo-structure map of the base of the Marmaton at the close of Desmoinesian time. Cross sections in the area of study show that practically all units are present throughout. This fact suggests that the deforming forces which caused a maximum of about 200 feet of "structural relief" on the Marmaton paleogeologic surface were active during deposition of most of the overlying Marmaton units. Compaction of sediments, especially shale, is probably responsible for some of the relief displayed on the base of the Marmaton Group. Shale usually averages between 20 and 30 percent of the group.

Map of the Upper Surface of the Marmaton Group in Northeastern Morton County, Kansas

The most logical explanation for the great difference in elevation between wells along the center line of the map (Fig. 4) is the presence of a fault zone. The faults are probably the result of recurrent movement along planes of weakness associated with the western boundary of the Hugoton Trough. The apparent throw of the faults can be traced into Mississippian rocks.

Service logs indicate that apparently none of the wells close to the fault have penetrated the fault plane. The 800, 900, 1,00, 1,400, and 1,500 foot contours show that the faulted area is a structural nose.

Oil and gas are produced out of Morrowan strata in the Kinsler Southeast Field east of the fault zone in the eastern part of Township 32 South. This is a new field that was opened in 1960 (Goebel, et al, 1961).

Map of the Upper Surface of the Marmaton Group in the Area of Pleasant Prairie Field

Recurrent movement along a fault, which Roby (1959, p. 131) suggests may be early Pennsylvanian or late Mississippian, has probably resulted in the faults shown on the map (Fig. 5). The apparent throw of the Marmaton surface is 57 feet between two wells on opposite sides of the fault zone. The well observed on the upthrown side is in the SW 1/4 sec. 19, T. 26 S., R. 34 W. The well on the downthrown side is in the NE 1/4 sec. 25, T. 26 S., R. 35 W. In sec. 8, T. 27 S.,

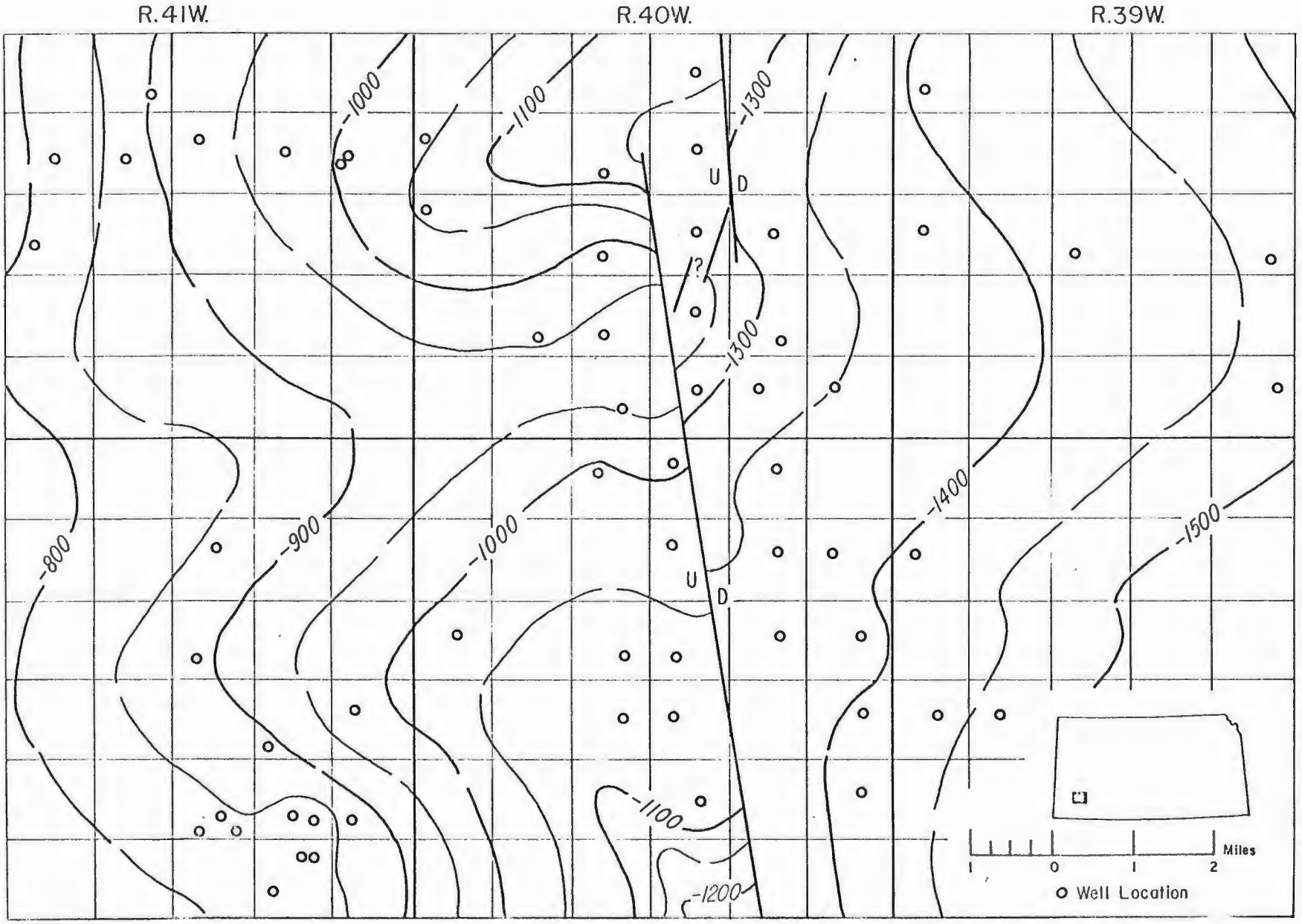

Fig. 4. Map of the upper surface of the Marmaton Group, northeastern Morton County, Kansas. Contour Interval 50 Feet

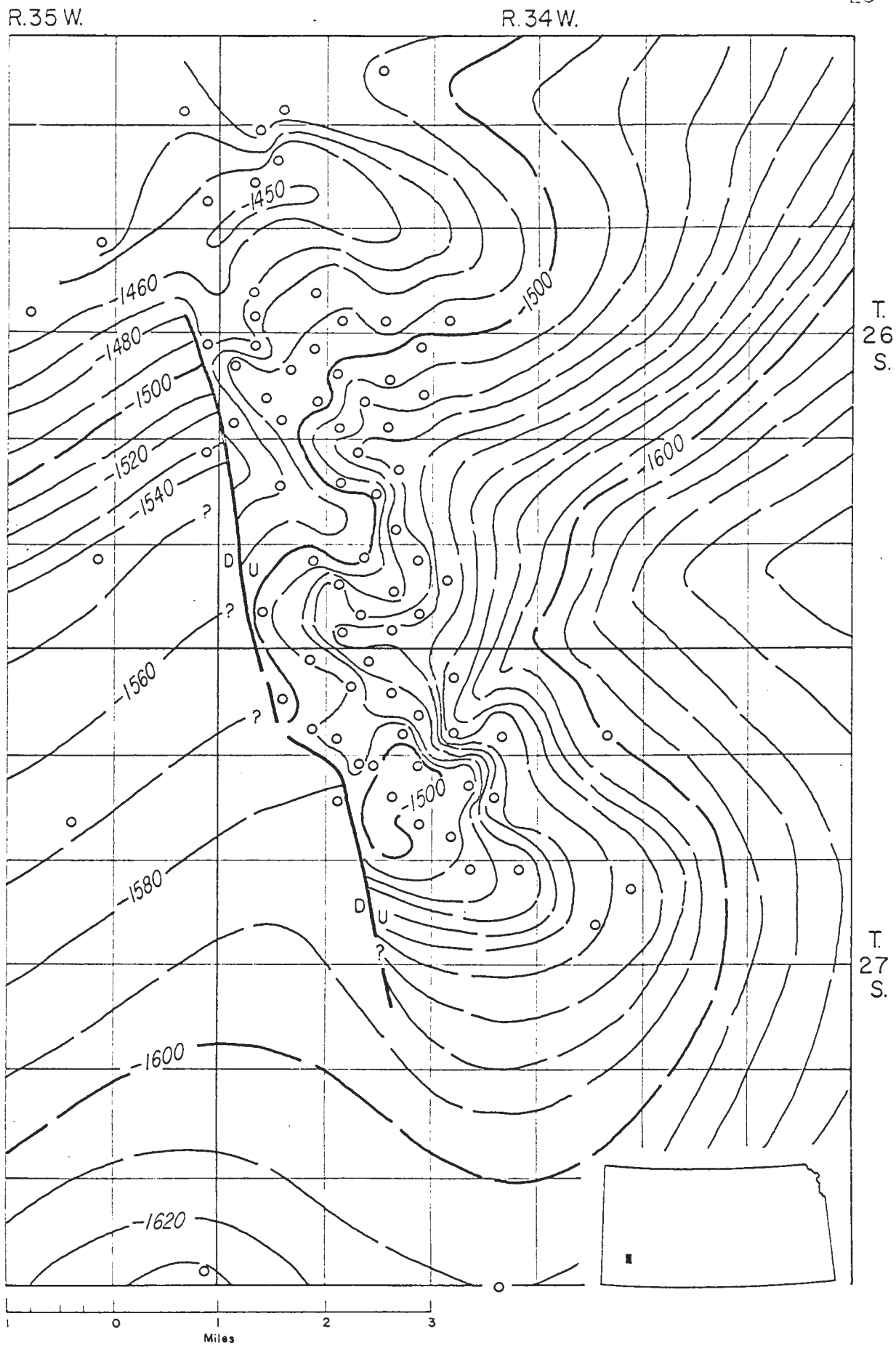

Fig. 5. Map of the upper surface of the Marmaton Group in the area of Pleasant Prairie Field. Contour Interval 10 Feet

R. 34 W., apparent throw of 72 feet is present between two relatively close wells on opposite sides of the fault.

In both of the above areas, the well on the downthrown side of the fault has a greater thickness of Morrowan sediments. This fact suggests that the fault was buried during Morrowan time. Later rock units were deposited on the relatively flat Morrowan surface, and show no thickening on the downthrown side of the fault.

Projection of the contours in areas of little control near the edges of the map is based on the regional trend seen on the small scale structure contour map of the entire area of study (Pl. 6).

OIL FIELDS PRODUCING FROM MARMATON STRATA

General

The oil fields investigated in the area of principal study were these: Adams Ranch, Damme, Eubank, Finnup East, Kismet, Massoni, Novinger, Munn, Munn North, Saw Log Creek, Wampler, and Willroads (Fig. 6). The geographic limits of the fields are indicated by dashed lines on the detail structure maps.

All information regarding location, companies, discovery well locations, acerage, producing zones, and production was obtained from Kansas Geological Survey bulletins. Data for the lithologies of the producing zones was obtained from sample logs which had been compiled using both the samples and electric log. Driller's logs were referred to when nothing else was available.

Structure maps of the upper surface of the Marmaton Group were constructed to determine if closure, folding, or faulting were possibly responsible for the entrapment of oil. Where little control was available, the structure contours were adjusted to most logically agree with the regional trend.

In certain fields, such as the Pleasant Prairie and Eubank, little oil production is obtained from Marmaton units. The primary purpose for detail contour maps in these areas is to investigate the anomalous structural pattern displayed on the smaller scale structure maps (Pl. 6 and 7).

Fig. 6. Location of ...

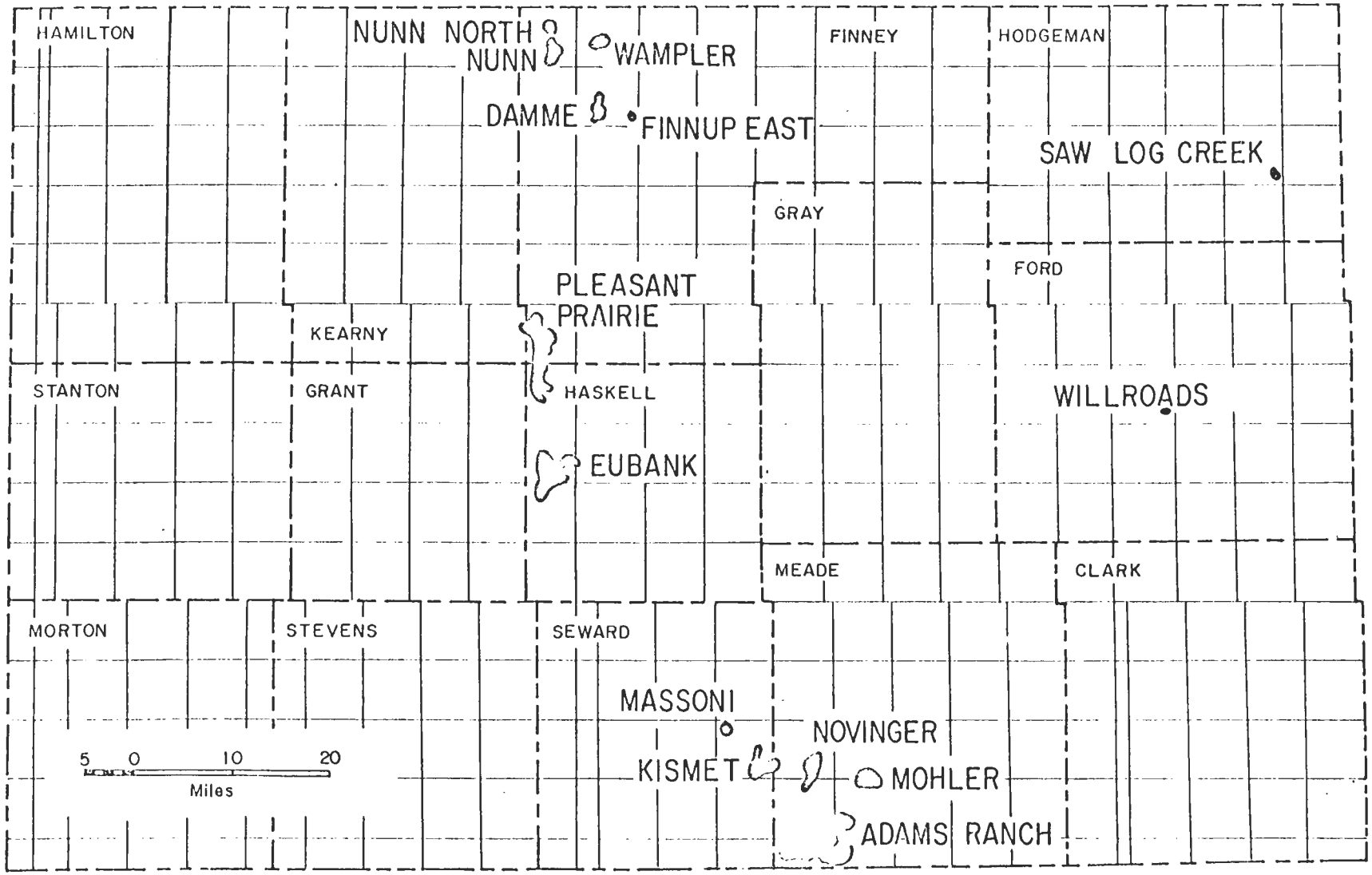

Fig. 6. Location of oil fields producing from Marmaton strata in southwestern Kansas.

Adams Ranch Field

The Adams Ranch Field is in the southwestern corner of Meade County, Kansas. As of 1960 it occupied an area of 6800 acres.

The discovery well, in the SW 1/4 SW 1/4 sec. 8, T. 35 S., R. 30 W., was drilled in 1948 by the Stanolind Oil and Gas Company. Gas was produced from a Mississippian zone (Ver Wiebe, and others, 1949). Today the field is important for both gas and oil. During 1960, there were 67,301 barrels of oil produced from 21 wells in Marmaton and Chesteran rocks (Goebel and others, 1961).

A structure contour map of the upper surface of the Marmaton Group (Fig. 7) shows a structural high with greater than 20 feet of closure in the area of Marmaton production; it does not appear on the base of the group. The high, apparently, was not caused by structural movements, rather it seems that the Marmaton upper units were draped over the reservoir rock, a thick limestone unit in the relative position of the Pawnee Formation.

The group, in the area of the high, reaches a maximum thickness of 230 feet, while in surrounding areas it averages 185 feet.

Neither sample logs nor driller's logs were available to study the detailed lithology of the group in the Marmaton producing area. The reservoir rock could possibly be a reef or "reef type" unit similar to that present in the

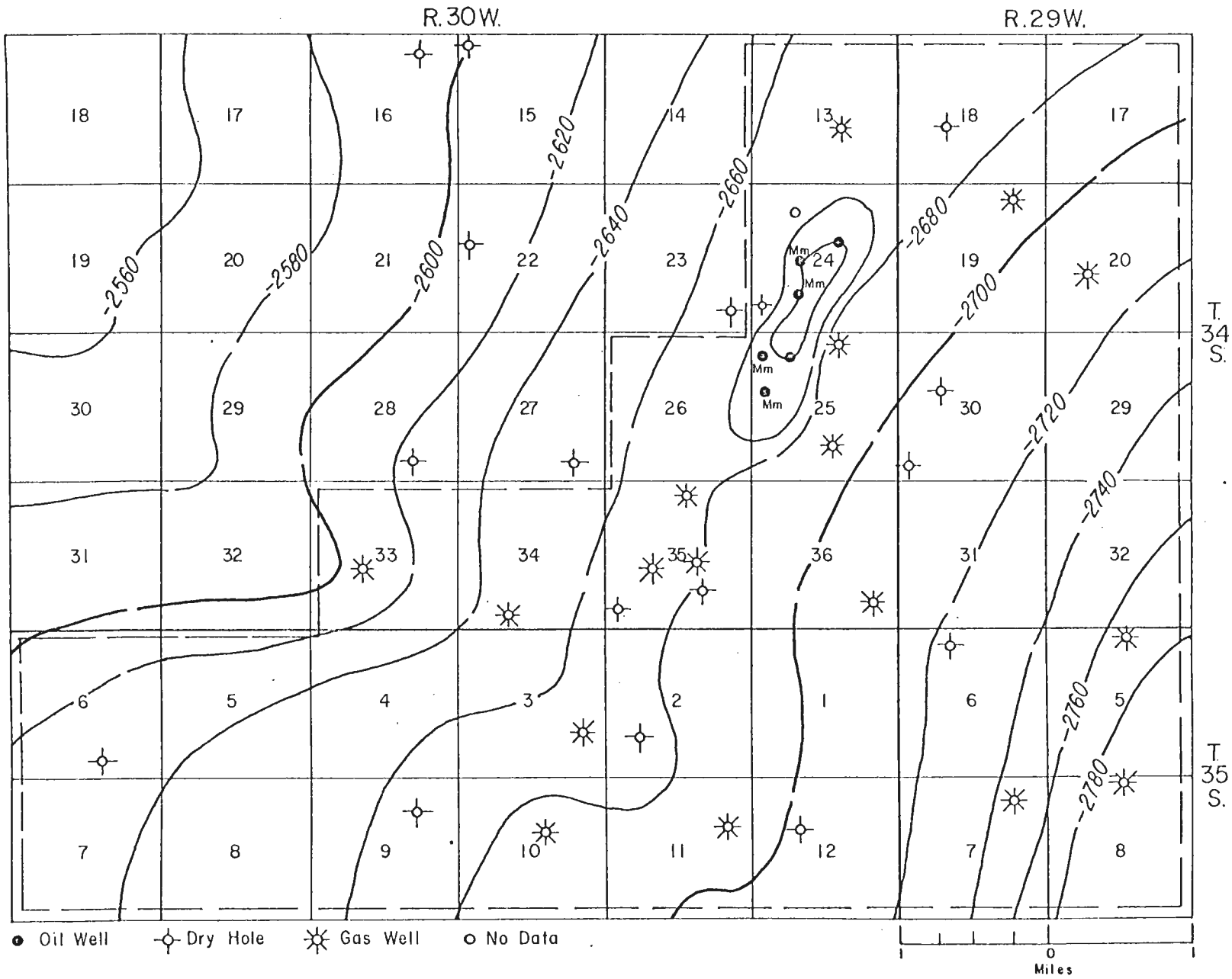

Fig. 7. Structure of the upper surface of the Marmaton Group, Adams Ranch Field, Meade County, Kansas. Contour Interval 20 Feet

Hovinger Field to the northwest (see Renfroe, 1954), and the nature of entrapment is probably stratigraphic.

Damme Field

The Damme Field is in the northwestern part of Finney County, Kansas and, as of 1960, contained 1,520 acres.

The field was opened in 1951 by W. L. Hartman's discovery well, No. 1 Damme, in the SE 1/4 SE 1/4 NW 1/4 sec. 21, T. 22 S., R. 33 W., (Ver Wiebe, and others, 1952). During 1960 there were 136,572 barrels of oil produced from 22 wells. The greatest production is obtained from Mississippian producing zones (Goebel, and others, 1961).

A producing zone within the Marmaton Group was discovered in 1957 as a result of a developmental program in the field. Well No. 1 Damme of the National Cooperative Refinery Association in the NE 1/4 NE 1/4 SW 1/4 sec. 21, T. 22 S., R. 33 W. was plugged back and reworked. The initial production was 14 barrels of oil per day. During 1960 the well produced 6,979 barrels of oil from a producing zone 5 feet thick.

The depth of the Marmaton producing zone, 4,417 feet to 4,422 feet, is within a rock unit identified in the subsurface from near the outcrop area in southeastern Kansas to the area of study as the Fort Scott Formation. The thickness of the Marmaton Group in the well is 96 feet, and its base is at a depth of 4,426 feet.

A structure contour map (Fig. 8) of the upper surface of the Marmaton Group shows that the Marmaton producing well penetrates the crest of a south-plunging anticlinal structure. According to Schmidlapp, with Hartman Oil Operator (1958, p. 9), production "appears related to structure and is controlled to some extent by the distribution of porosity on the structure." The porosity of the producing limestones is described as interfossiliferous or interoolitic.

Another well has been completed in Marmaton strata since 1960. It is E. P. Ward No. 1 of Texaco Incorporated in the C SE 1/4 SW 1/4 sec. 16, T. 22 S., R. 33 W. The original Marmaton producing well has apparently been abandoned. Other Marmaton producers will probably result as more of the older wells are reworked.

Finnup East Field

The Finnup East Field is in the northwestern part of Finney County, Kansas. It contains an area of 40 acres.

The discovery well, No. 1 Holsted-Thomason, in the SW 1/4 SW 1/4 sec. 25, T. 22 S., R. 33 W. was drilled by W. L. Hartman in 1953 (Ver Wiebe, and others, 1954). During 1960 the pool produced 846 barrels of oil. Total production of the pool to the close of 1960 was 13,104 barrels of oil, all of which was produced from one well (Goebel, and others, 1961).

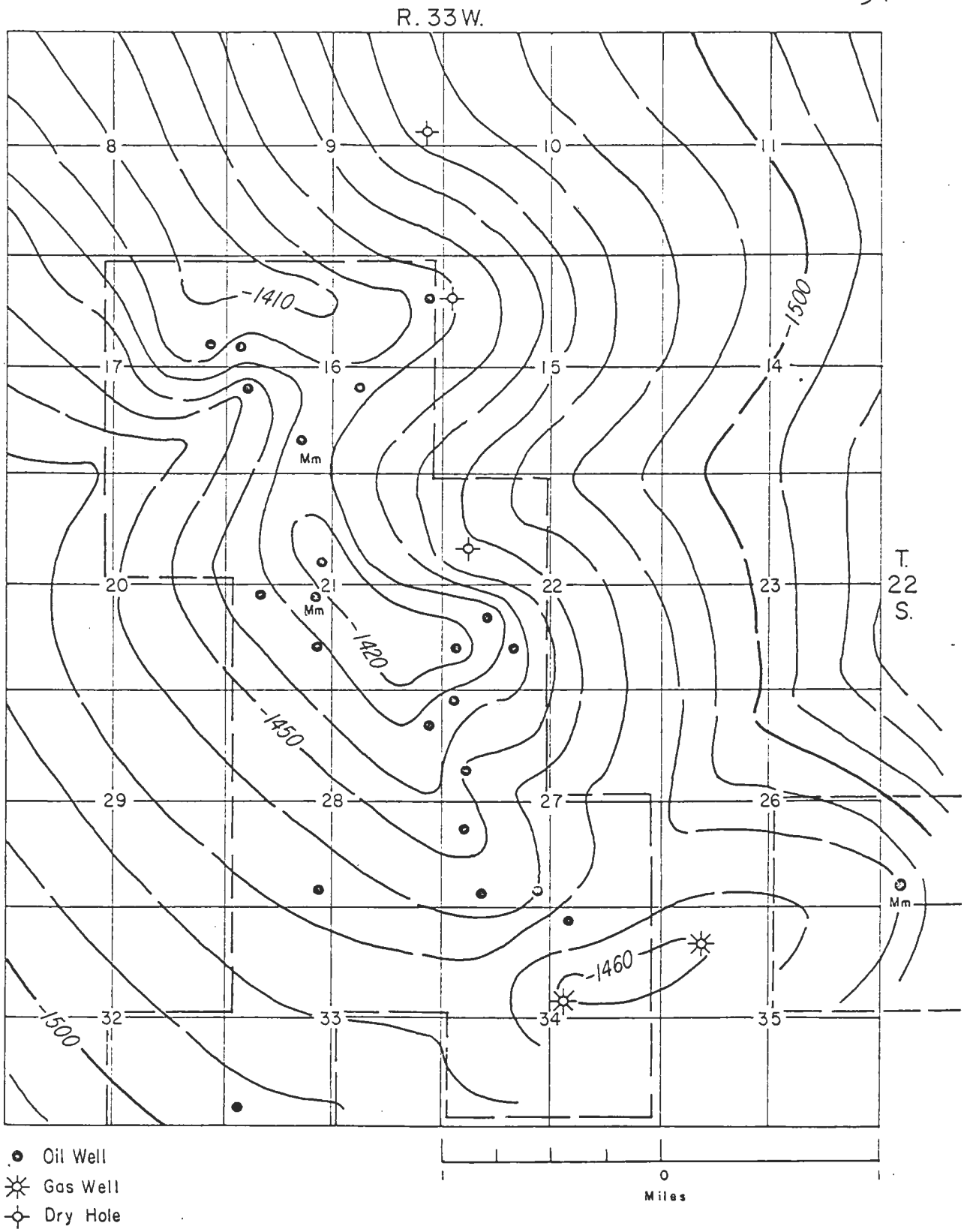

Fig. 8. Structure of the upper surface of the Marmaton Group, Damme and Finnup East Fields, Finney County, Kansas. Contour Interval 10 Feet

The producing zone is within the Marmaton Group, and is found at a depth of 4,442 to 4,458 feet in the discovery well. An electric log is not available for the well, but the top card lists the top of the Marmaton at a depth of 4,350 feet. The producing zone, according to these data, is most probably in the Fort Scott Formation. The average thickness of the Marmaton Group in the area is 90 to 100 feet.

The structure of the upper surface of the Marmaton Group in the Finnup East Field may be seen on the structure contour map for the Damme Field (Fig. 8). Causes for the entrapment of oil cannot be satisfactorily determined owing to the small amount of information available concerning the area. Possibly, the structure which is suggested by the contour lines in the area of the Finnup East Field may be a continuation of the anticlinal nose evident in the area of the Damme Field, and according to the depths, the producing units probably are the same. The favorable reservoir conditions of porosity and permeability present in the Damme Field may also carry into the Finnup East Field.

Eubank Field

The Eubank Field is in the west-central part of Haskell County, Kansas. It contains 1,280 acres. Data for the Eubank East and Eubank Southeast Fields have been included with the Eubank Field figures.

The discovery well, No. 1 Eubank, in the NW 1/4 NW 1/4 NW 1/4 sec. 28, T. 28 S., R. 34 W. was drilled by Helmerich

and Payne Incorporated in 1958 (Goebel and others, 1959). Initial production was from Mississippian units. During 1960 there were 506,428 barrels of oil produced from 32 wells which penetrated zones in Lansing, Marmaton, Cherokee, Morrowan, and Mississippian rocks (Goebel, and others, 1961). The greatest production is from Mississippian rocks. Marmaton rocks probably produce the least of any zone in the field; five wells are known to produce out of Marmaton units.

The Marmaton producing zone is in a limestone reservoir in the Altamont Formation. Information from strip logs describes the unit as a gray-buff, dense to fine granular, dolomitic limestone with scattered oocastic porosity. According to Pugitt and Wilkinson (1959, p. 15), the unit is considered to be a reef-type limestone. A structure contour map (Fig. 9) of the upper surface of the Marmaton Group shows that closure occurs in at least two places.

The above information suggests that the nature of entrapment of oil in Marmaton rocks is a combination of both structure and stratigraphy.

Apparent throw of the fault present is 60 feet. None of the wells appear to penetrate the fault plane.

Kismet Field

The Kismet Field is in Seward County, Kansas; a small portion of it extends eastward into Meade County and, as of 1960, the field contained 420 acres. Data from the Kismet South and Kismet East Fields have been included with that of the Kismet Field.

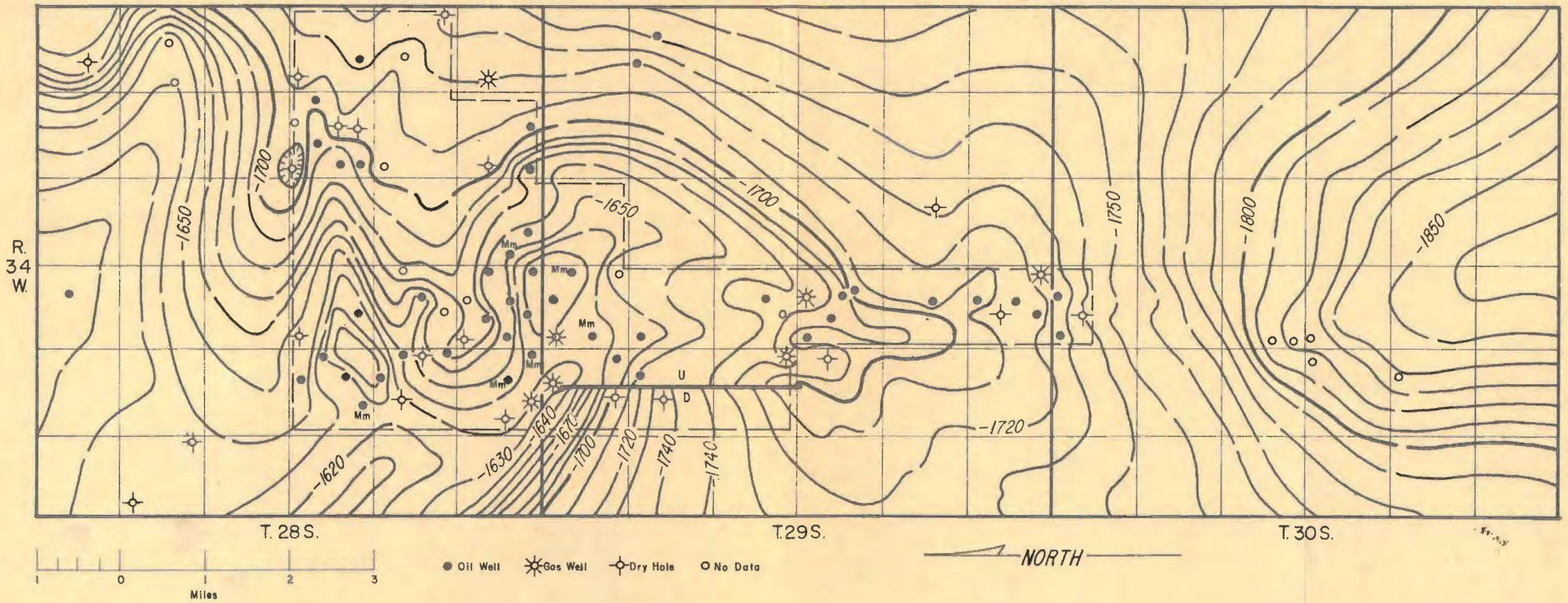

Fig. 9. Structure of the upper surface of the Marmaton Group, Eubank Field, Haskell County, Kansas. Contour Interval 10 Feet

The discovery well, No. 1 Wheatly, in the C NE 1/4 SW 1/4 sec. 23, T. 33 S., R. 31 W. was drilled by the Stanolind Oil and Gas Company in 1948 (Ver Wiebe, and others, 1949). During 1960, twelve wells produced 22,514 barrels of oil out of producing zones in Marmaton, Morrowan, and Mississippian rocks (Goebel, and others, 1961).

Production from a Marmaton reservoir in the discovery well is between depths of 5,095 and 5,100 feet. This reservoir is a limestone unit identified as part of the Altamont Formation. Information on sample logs describes the producing unit as a light gray to buff, dense to fine crystalline, cherty limestone.

A structure map (Fig. 10) of the upper surface of the Marmaton Group shows that 50 feet or more of closure occurs in the field. The thickness of the group averages about 155 feet, or about the same as in surrounding areas.

The dome now present probably did not stand as a high at the time of deposition of Marmaton rocks, but was uplifted at a later time. According to Renfroe (1954, p. 114), there "is post-Mississippian--pre-Pennsylvanian folding present in the Kismet Dome, ...[but] this feature was not positive during Marmaton times."

The nature of entrapment is apparently structural.

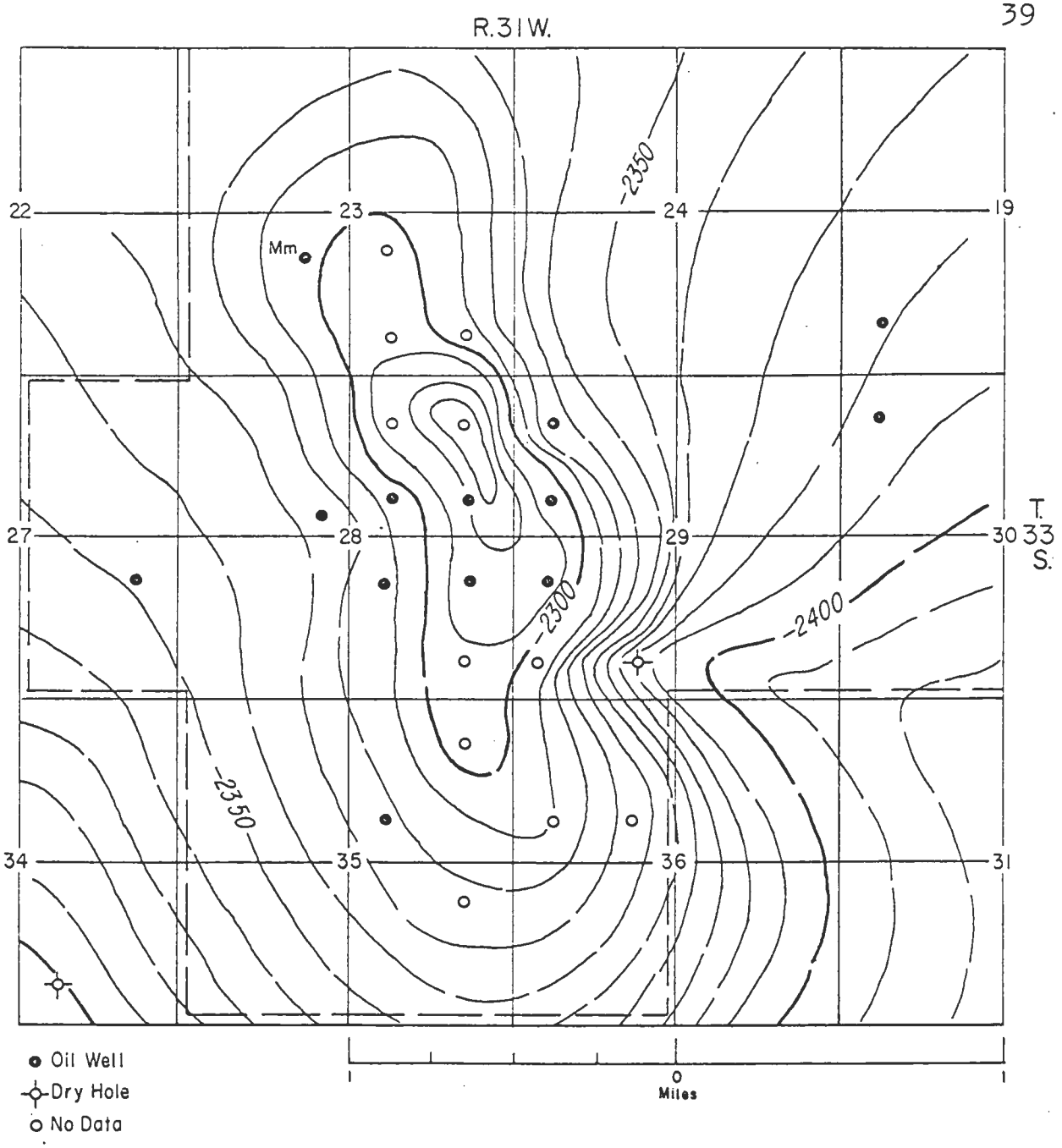

Fig. 10. Structure of the upper surface of the Marmaton Group, Kismet Field, Seward and Meade Counties, Kansas. Contour Interval 10 Feet

Massoni Field

The Massoni Field is in the east-central part of Seward County, Kansas. As of 1960 it contained 100 acres.

The discovery well, No. 1 Burr, in the C SE 1/4 NW 1/4 sec. 4, T. 33 S., R. 31 W., was drilled by the Cabot Carbon Corporation in 1958 (Goebel, and others, 1959). Total production to the end of 1960 was 8,024 barrels of oil. During 1960, three wells produced 612 barrels out of a Marmaton reservoir which, as of 1960, was the only oil producing zone in the field (Goebel, and others, 1961).

Marmaton production in the discovery well is between depths of 5,031 and 5,041 feet, or from a limestone unit identified as part of the Altamont Formation. Information on the driller's log describes the rocks at this depth as gray cherty lime and broken shale.

A structure map of the upper surface of the Marmaton Group (Fig. 11) suggests that the major structures present are an anticline and syncline.

The nature of entrapment cannot be satisfactorily determined with the small amount of data available.

Mohler Field

The Mohler Field is in the southwestern part of Meade County, Kansas, and, as of 1960, contained 140 acres.

The discovery well, No. 1 Mohler, in the SW 1/4 SW 1/4 SW 1/4 sec. 35, T. 33 S., R. 29 W. was drilled by the Skelly Oil Company in 1957 (Goebel, 1958). During 1960, Marmaton

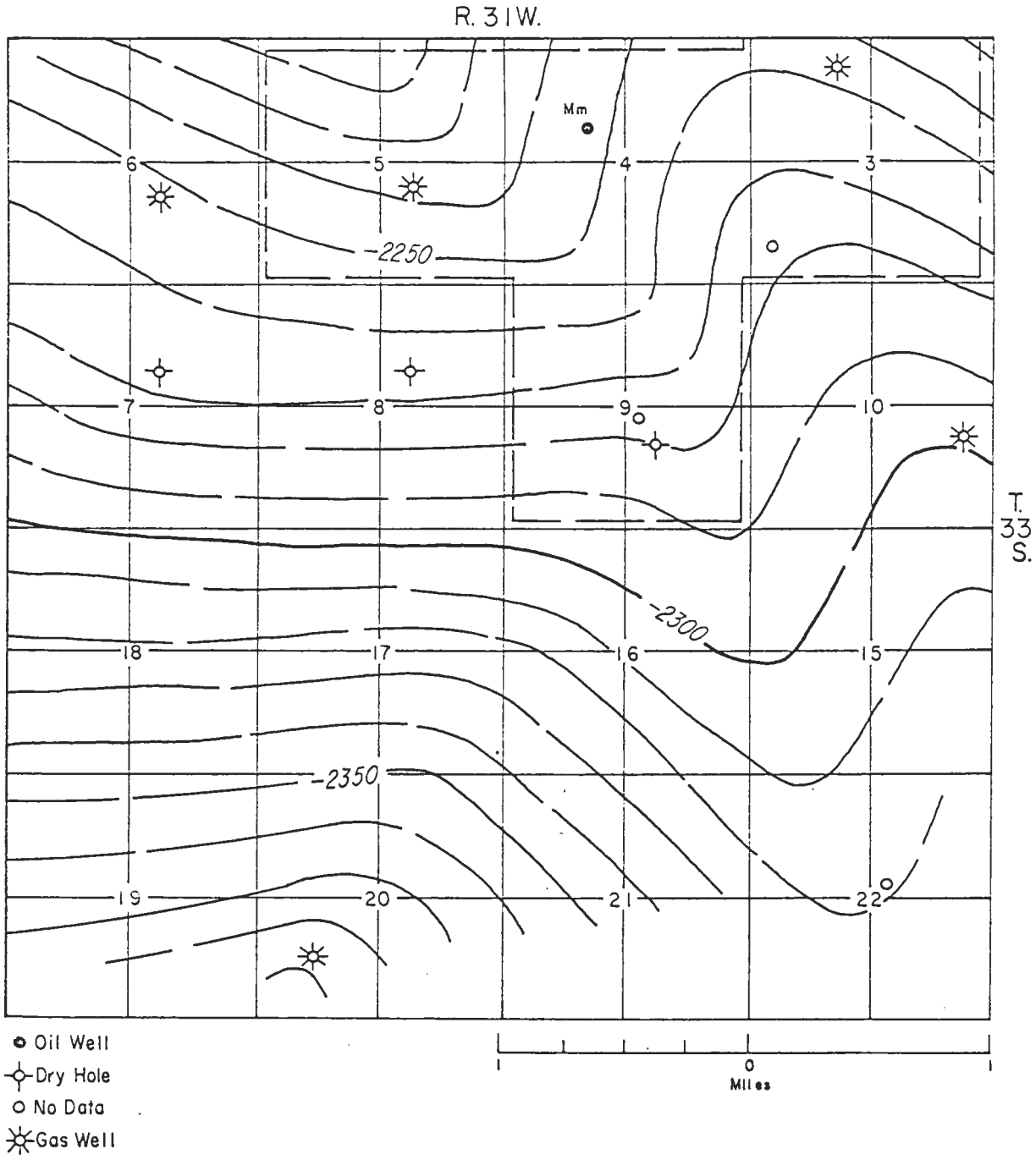

Fig. 11. Structure of the upper surface of the Marmaton Group, Massoni Field, Seward County, Kansas. Contour Interval 10 Feet

zones yielded 11,534 barrels of oil to four wells. Four Morrowan wells accounted for about the same volume of production (Goebel, and others, 1961).

The Marmaton producing zone in the discovery well is between depths of 5,259 and 5,267 feet, or in the upper part of a rock unit identified as the Pawnee Formation. The producing zone is the same in all four of the Marmaton wells. Information from a strip log describes the rocks in the area of the producing zone as gray, soft, fossiliferous, porous, oolitic, slightly cherty limestone with light and dark oil stains.

A structure map (Fig. 12) shows the present configuration of the upper surface of the Marmaton Group. Thicknesses for the group in the field are about the same as in adjacent areas.

Entrapment is probably related to both structure and stratigraphy. Dry holes north of the producing area penetrate what appears to be the same structure from which oil is obtained, and electric logs show that the producing unit is still present. Possibly there has been a decrease in porosity and permeability northward thus limiting the extent of the reservoir.

Munn Field

The Munn Field is in the northwestern part of Finney County, Kansas, and, as of 1960, occupied an area of 1,300 acres. Data for the Munn North Field have been included with that of the Munn Field.

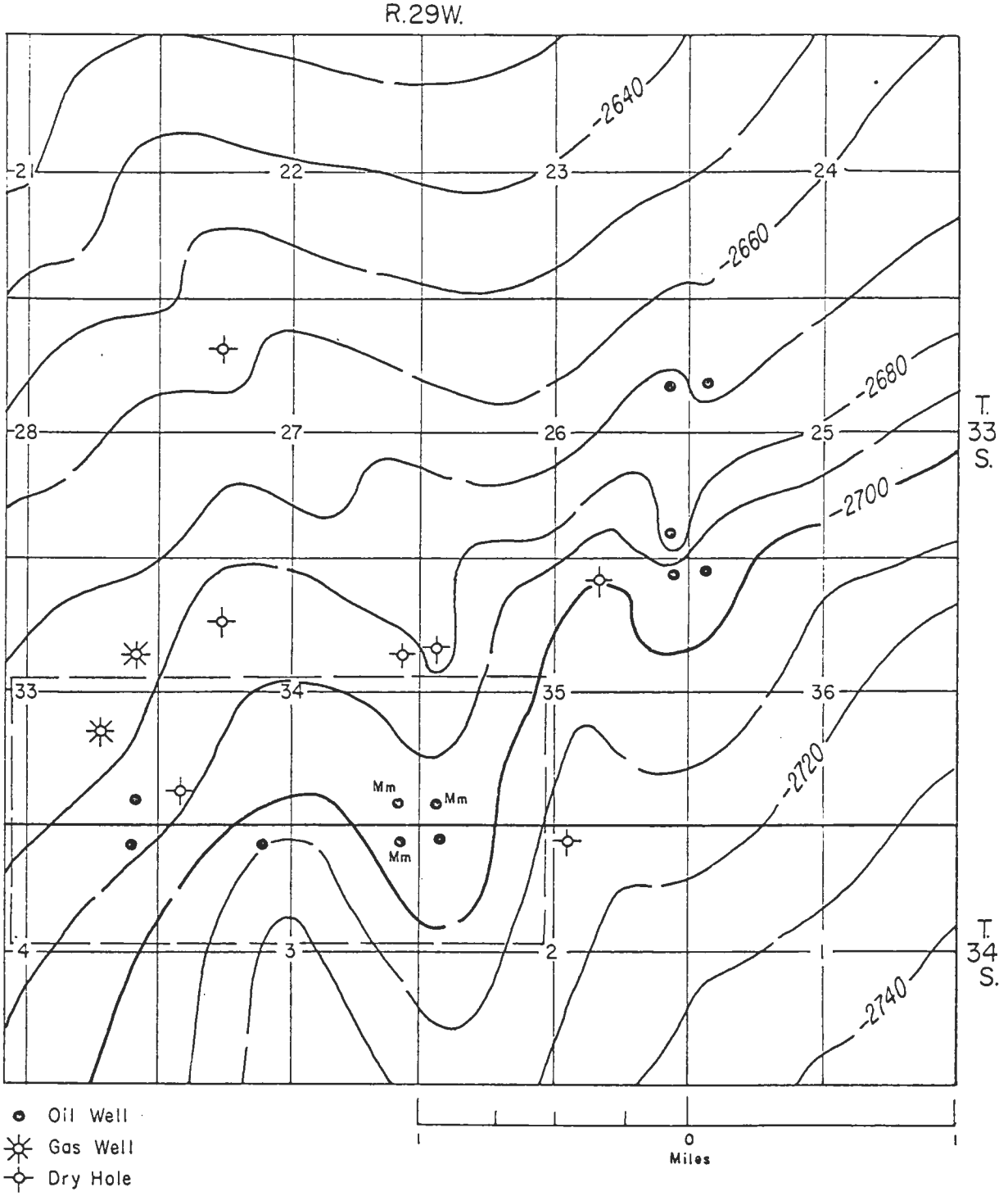

Fig. 12. Structure of the upper surface of the Marmaton Group, Mohler Field, Meade County, Kansas. Contour Interval 10 Feet

The field was opened in 1938 by the Atlantic Refining Company. The discovery well, No. 1 Eva Nunn, in the C SE 1/4 NE 1/4 sec. 27, T. 21 S., R. 34 W. produced out of a porous zone in the "Mississippi lime" (Ver Wiebe, 1939).

In 1946, the Shallow Water Refining Company reworked an Atlantic Refining Company well, the No. 1 Patrick McHugh, in the C SW 1/4 SW 1/4 sec. 23, T. 21 S., R. 34 W. The well was perforated between 4,303 and 4,312 feet, and after treatment with acid was given a well rating of 779 barrels of oil per day (Ver Wiebe, 1947). The zone of production occurs in the upper part of a rock unit identified as the Pawnee Formation in an electric log correlation from near the outcrop area to the area of investigation. The second well to be reworked was the No. 2 Davis in the C NW 1/4 NW 1/4 sec. 26, T. 21 S., R. 34 W. It was perforated between 4,286 and 4,293 feet, and 4,301 and 4,312 feet, and produced oil. The latter of these two zones is the same zone as was perforated in the No. 1 Patrick McHugh discussed above. The other zone is within a limestone unit identified as part of the Bandera Formation.

By 1948 there were thirteen wells producing from the Marmaton zones and six from the Mississippian which was originally the most productive zone (Ver Wiebe, and others, 1949).

To the end of 1960 the total production of the field was 2,646,153 barrels of oil. During 1960, the production

from 28 wells was 97,569 barrels. Reservoirs in Kansas City, Marmaton, Cherokee, and Mississippian units accounted for the production (Goebel, and others, 1961).

A structure contour map (Fig. 13) was constructed of the upper surface of the Marmaton Group in the area of the field. The most prominent structure observed is a doubly plunging asymmetrical anticline the axis of which is concave to the west. Closure upon this structure is greater than 30 feet in the northern part, and greater than 20 feet in the south-central part.

Entrapment of the oil is in part due to the structural closing and in part due to better development of the reservoir beds in different parts of the area. The producing units are fossiliferous crystalline limestones with small vugular and intercrystalline porosities (Aukerman, and others, 1959, p. 118).

Munn North Field

The Munn North Field was opened in 1957 by the Shallow Water Refining Company. The discovery well, No. 1 Lang, was drilled in the C NW 1/4 NE 1/4 sec. 22, T. 21 S., R. 34 W (Goebel, and others, 1958). Its original area was given as 40 acres, but as of 1958 both its area and production have been included with that of the Munn Field.

The producing zone in the discovery well is in the upper part of the Fort Scott Formation, or between depths

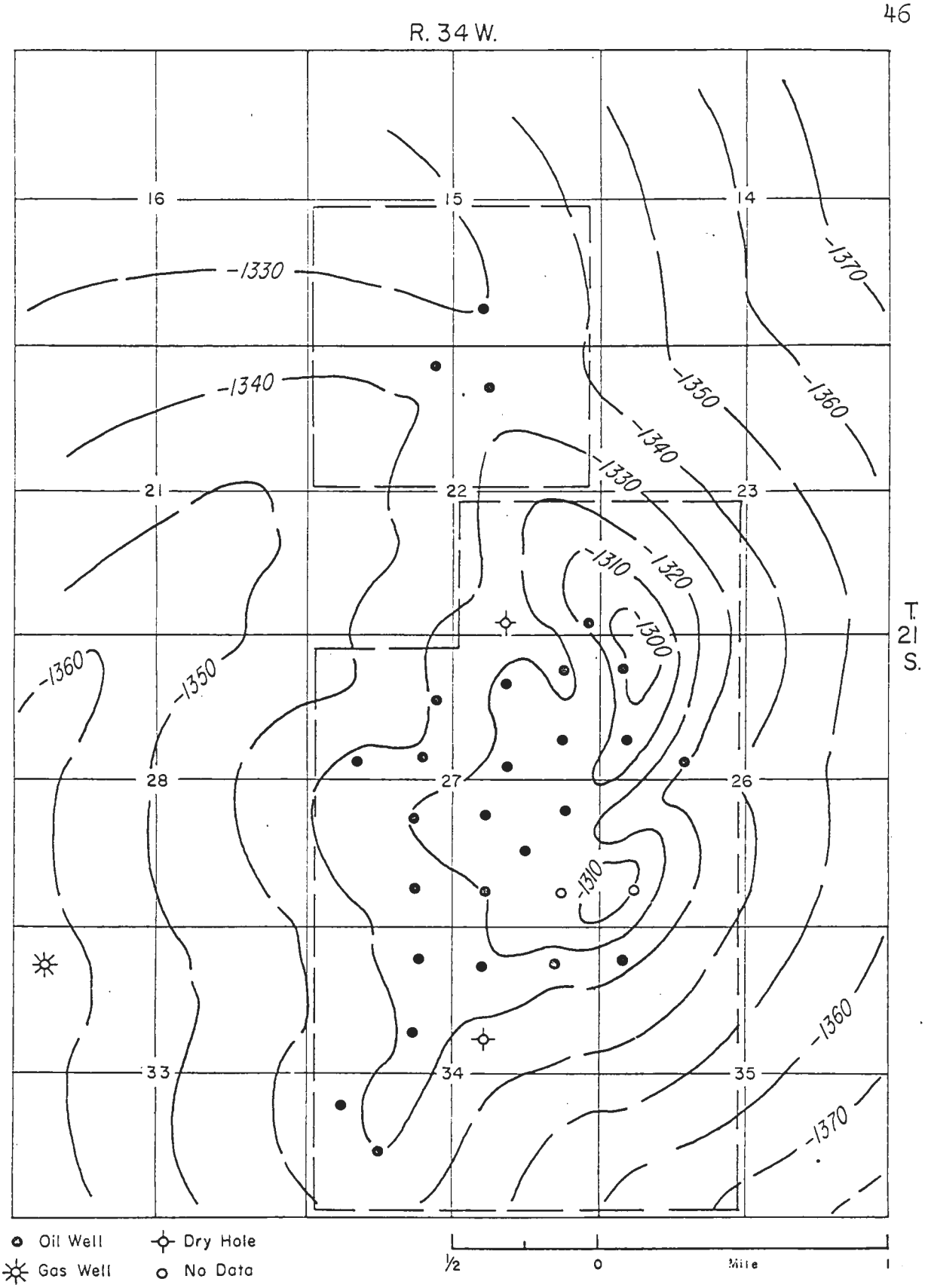

Fig. 13. Structure of the upper surface of the Marmaton Group, Nunn and Nunn North Fields, Finney County, Kansas. Contour Interval 10 Feet

of 4,382 and 4,394 feet. No. 1B Lang of the Shallow Water Refining Company in the C SW 1/4 SE 1/4 sec. 15, T. 21 S., R. 34 W. has been perforated between depths of 4,315 and 4,322 feet in a rock unit identified as Altamont; it also was perforated between depths of 4,344 and 4,352 feet in a rock unit identified as Pawnee. Lang No. 3 of the Shallow Water Refining Company in the NE 1/4 NE 1/4 NW 1/4 sec. 22, T. 21 S., R. 34 W. is reported on the driller's log as having an oil zone at 4,303 feet, or at the top of the Marmaton Group.

Data given above show that there are several producing units within the Marmaton Group in the Munn North Field, and the production of any particular well will depend on how completely the reservoir beds penetrated are developed. A cross section by Aukerman, and others (1959, p. 124) shows the porous zones in the Marmaton units in the Munn Field. These are the same zones that are found in the Munn North Field.

Structure contours on top of the Marmaton Group in the Munn North Field are on the Munn Field contour map (Fig. 13). All three of the wells shown produce oil. They are located on the lowest part of the arch, suggested by the contours, that comes in from the northwest and then trends southward.

Novinger Field

The Novinger Field is in the southwestern part of Meade County, Kansas. It contains 2,400 acres.

The discovery well, No. 1 Novinger, in sec. 26, T. 33 S., R. 30 W. was drilled by the Columbian Fuel Corporation in 1951 (Ver Wiebe, and others, 1952). Total production to the end of 1960 was 2,838,121 barrels of oil. During 1960 there were 411,409 barrels produced from 34 wells (Goebel, and others, 1961). The greatest production comes from Marmaton units.

The producing zone is in "a 'reef type' limestone reservoir of organic debris, transported and deposited by waves and currents (Renfroe, 1954, p. 120)." The unit is between rock units identified as the Altamont and Pawnee formations and reaches a maximum thickness of approximately 40 feet. The thickness of the Marmaton Group in the area of the Novinger Field reaches a maximum of 200 feet; in surrounding areas the thickness averages between 150 and 160 feet. Detailed cross sections by Renfroe (1954) indicate that the producing unit thins and grades into a section of limey shales and lithographic limestones in all directions except south.

A structure contour map of the field (Fig. 14) shows the upper surface of the Marmaton Group at the present time.

The nature of entrapment is stratigraphic. Excellent reservoir conditions are present in the porous "reef type"

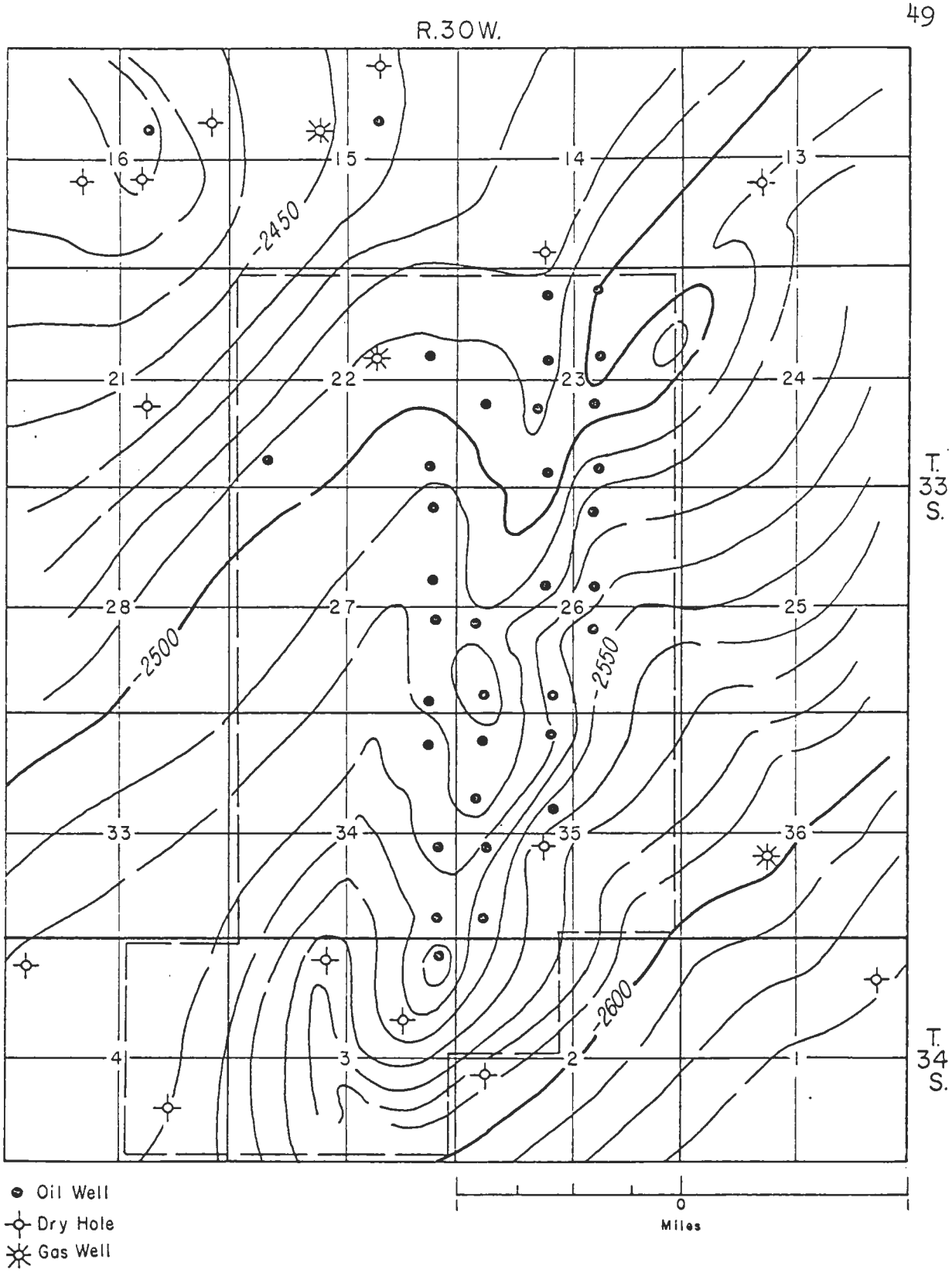

Fig. 14. Structure of the upper surface of the Marmaton Group, Novinger Field, Meade County, Kansas. Contour Interval 10 Feet

body. According to Renfroe (1954, p. 116), the structure of the Marmaton upper surface in the Novinger Field is caused by draping of the upper beds over the rigid "reef like" mass.

Saw Log Creek Field

The Saw Log Creek Field is in the southeastern part of Hodgeman County, Kansas and, as of 1960, occupied 180 acres.

In 1953, the Atlantic Refining Company drilled the discovery well, No. 1 Ross E. Hall, in the NW 1/4 SE 1/4 sec. 36, T. 23 S., R. 22 W. (Ver Wiebe, and others, 1954). Total production to the end of 1960 was 167,856 barrels of oil. During 1960 five wells produced 15,953 barrels from producing zones in the Marmaton and Cherokee groups (Goebel, and others, 1961).

The depth of the Marmaton producing zone in the discovery well is between 4,284 and 4,295 feet in a unit identified as the Altamont Formation. Another Marmaton producing zone in the field is present in the Pawnee Formation.

In the No. 2 Ross E. Hall, in the C NE 1/4 SE 1/4 sec. 36, T. 23 S., R. 22 W., the producing zone in the Pawnee is at a depth of 4,349 and 4,354 feet. The thickness of the Marmaton Group in the field averages 88 feet, or about the same as in adjacent areas.

The structure contour map (Fig. 15) presented agrees most favorably with the regional pattern. It shows the upper surface of the Marmaton Group.

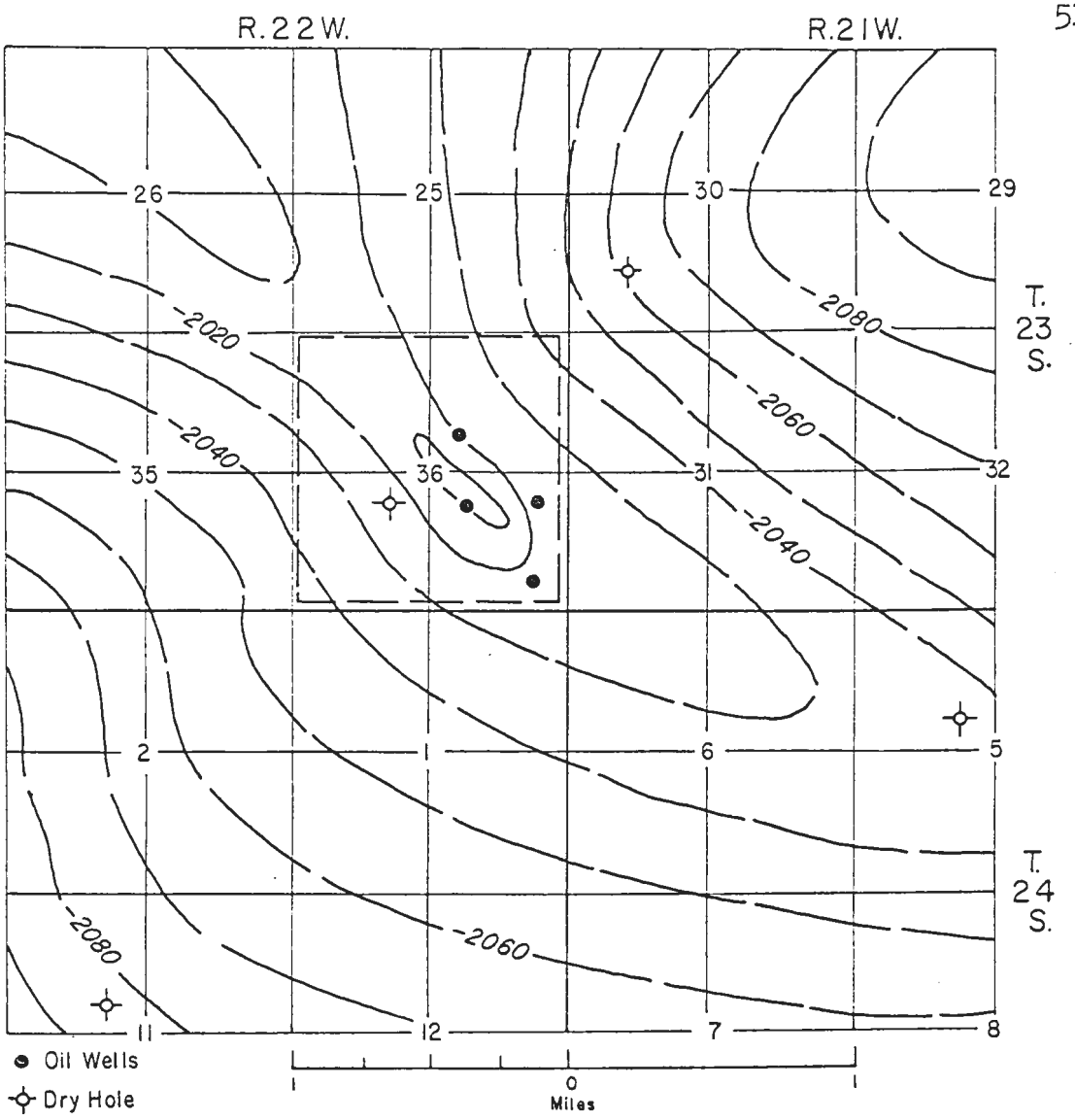

Fig. 15. Structure of the upper surface of the Marmaton Group, Saw Log Creek Field, Hodgeman County, Kansas. Contour Interval 10 Feet

Entrapment of the oil appears to be the result of favorable structural conditions allowing the oil to migrate in the permeable zones to the crest of the anticline suggested by the structural contours. There may be closure of 10 feet or more in the area of production.

Wampler Field

The Wampler Field is in the northwestern part of Finney County, Kansas, and, as of 1960, occupied 200 acres.

The field was opened in 1959 by Imperial Oil of Kansas, Incorporated. The discovery well, No. 1 Wampler, is in the C SE 1/4 SE 1/4 sec. 17, T. 21 S., R. 33 W. To the end of 1960 the total production of the field was 38,411 barrels of oil. Three Marmaton wells produced a total of 20,733 barrels; two Morrowan producers accounted for the remainder of the production (Goebel, and others, 1960, 1961).

The Marmaton reservoir is 12 feet thick. It is at a depth of 4,278 feet in the discovery well, or 2 feet below the top of the Marmaton Group which is 106 feet thick in the well; the group shows about the same thickness in adjacent areas. The producing unit is a light gray, fine crystalline or dense, slightly cherty, dolomitic limestone with oocastic porosity.

A structure contour map was prepared of the Marmaton upper surface in the area of the Wampler Field (Fig. 16). The interpretation presented on the contour map fits most logically into the regional trend. The most prominent

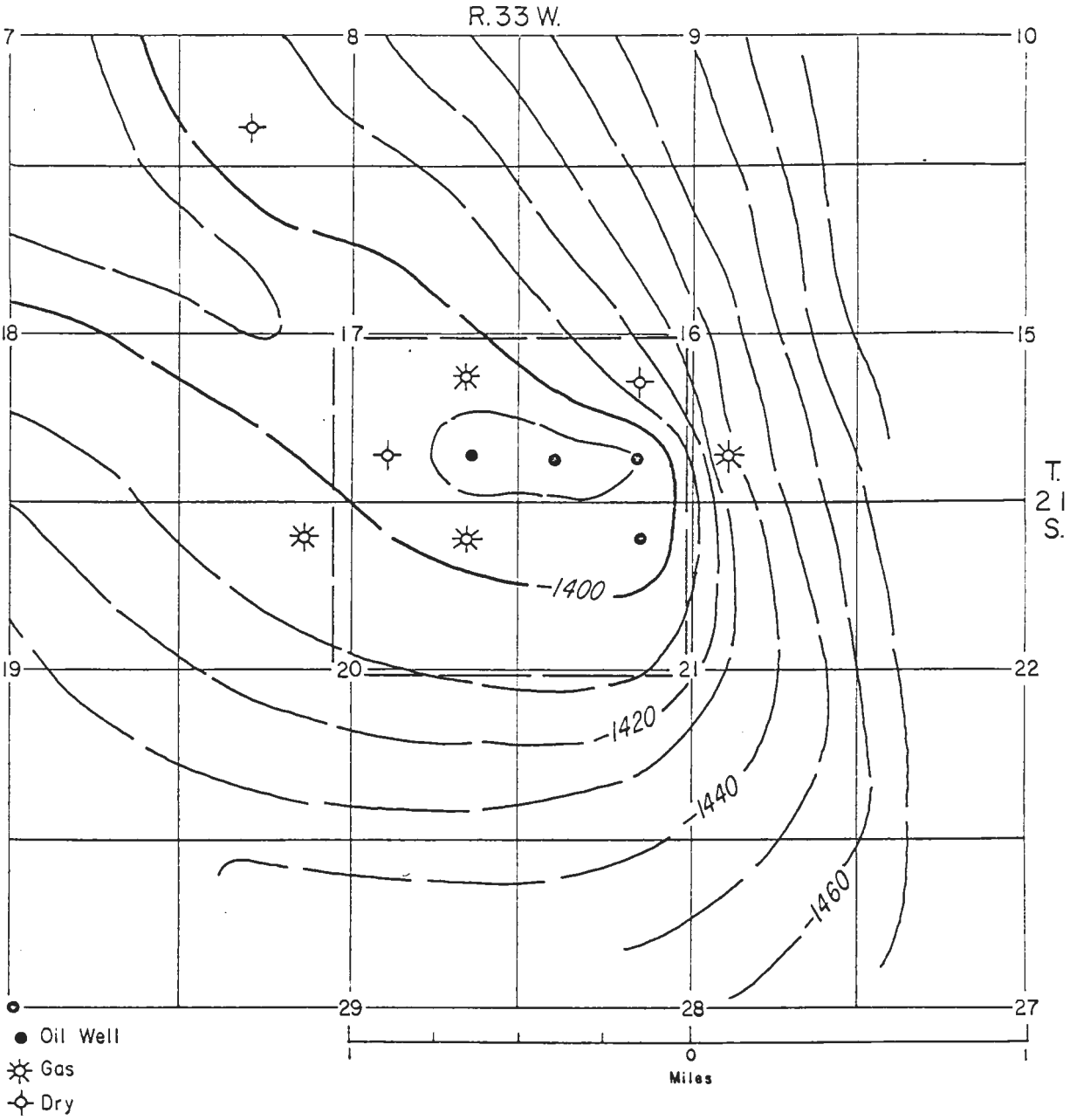

Fig. 16. Structure of the upper surface of the Marmaton Group, Wampler Field, Finney County, Kansas. Contour Interval 10 Feet

structures suggested are the anticline and syncline which plunge to the southeast. Entrapment of the oil appears to be structurally controlled in the nose of the anticline where closure of 10 feet or more may occur.

Willroads Field

The Willroads Field is in Ford County, Kansas and, as of 1960, occupied an area of 40 acres.

The discovery well, No. 1 Barngrover in the NE 1/4, SE 1/4, SW 1/4 sec. 26, T. 27 S., R. 24 W. was drilled by the Tennessee Oil and Gas Company in 1960 (Goebel, and others, 1961). The total production of the field to the end of 1960 was 8,444 barrels of oil all of which was produced from one well.

The producing zone in the discovery well is between depth of 4,874 and 4,883 feet in a limestone unit in the upper part of the Fort Scott Formation.

Owing to the small amount of control available a structure contour map was not prepared.

LITHOFACIES MAP

Percent Carbonate Map of the Marmaton Group

A percent carbonate map was prepared using data from strip logs and electric logs. The carbonate content of the group ranges between 40 and 90 percent. The lowest percentage is in Morton County where the limestone units are replaced by sand and shale on the flanks of Keyes Dome. Over the remainder of the map the carbonate percentage varies with no particular pattern between 60 and 90 percent.

SUMMARY

1. The upper three formations of the Marmaton Group (Holdenville Shale, Lenapah Limestone, and Nowata Shale) are absent in the subsurface in southwestern Kansas. Cross section A-A' shows that the above units cannot be identified west of well 5.
2. The seas were present much more of the time in southwestern Kansas than in southeastern Kansas during the deposition of Marmaton rocks.
3. Marmaton limestone units in southwestern Kansas display somewhat different lithologic characteristics than those in southeastern Kansas. Cherty and oolitic units are more comm
4. It appears doubtful that any significant amount of erosion took place in the principal area of study at the close of Desmoinesian time. In the southern part of the area, especially in the Hugoton Trough, deposition of marine sediments appears to have gone on continuously between Desmoinesian and Missourian times.
5. The Hugoton Embayment, an extension of the Anadarko Basin to the south, was subsiding during Desmoinesian time.
6. The Marmaton Group becomes sandy and more shaly on the flanks of Keyes Dome which was probably rising during Desmoinesian time.
7. Oil in Marmaton units in the principal area of study is found in stratigraphic, structural, and combination type traps.

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