The Geology of Northwestern Missouri

By

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LETTER OF TRANSMITTAL

November 14, 1938.

Honorable Lloyd C. Stark,
Governor of Missouri,
Jefferson City, Missouri.

Dear Governor Stark:

I have the honor and pleasure to transmit herewith a report covering the Geology of Northwest Missouri.

During past years the Geological Survey has made extensive studies of North Missouri and has published three volumes largely devoted to that portion of the state. These volumes describe in some detail the Coal Resources of Missouri; the Stratigraphy of the Pennsylvanian Series; and a general description of the Oil and Gas Possibilities of the state, in which it was pointed out that the northern portion of the state was considered by this Survey as favorable territory for the occurrence of oil and gas.

Since 1933, one assistant has spent the greater portion of his time in Jackson and adjoining counties, advising with regard to the shallow pools developed in that area. In addition a number of local structures have been mapped and published in the last three Biennial Reports. The location and elevation of all important wells were also determined and a magnetic map of over 7,000 square miles has been prepared to aid as a general guide for leasing.

For the past two months intense interest has been shown by the oil men of the Mid-Continent fields, and at the present time extensive leasing is being done. During this period many geologists have visited the Survey office, and practically the entire time of the staff has been consumed in answering requests for information covering the northern part of the state. In answer to this demand the present bulletin has been prepared. The report will be very timely, and we believe will be a material help to those interested in the possible oil and gas resources of northwestern Missouri.

Respectfully submitted,

H. A. BUEHLER,
State Geologist.

INTRODUCTION.

PURPOSE OF THE REPORT.

The Missouri Geological Survey has long been interested in the surface and subsurface geology of the counties in northwestern Missouri, and has undertaken and completed a considerable amount of field and office work; and recently progress has been made toward assembling the data into a detailed report.

Within the last few years there has been increased interest manifested in the northwestern counties of the State with regard to the possibilities of oil and gas. This interest has been increasingly evident, however, in recent months and rather than delay the publication of the detailed report until a later date, the factual information contained herein is presented in the hope that it will assist those interested in the area in making the proper analysis with regard to oil and gas possibilities.

SCOPE OF THE REPORT.

This report is presented as a preliminary guide to the geology of northwestern Missouri and includes data pertaining to the surface and subsurface stratigraphy of the area.

The structural features are discussed and presented in Plate I, and the data from which this map was compiled are summarized in Table II. The map (Pl. I) shows the locations of all important wells of record. The total depth of each is indicated and in addition each well is numbered, the numbers in each county beginning with one (1). These numbers also appear on the data sheets, Table II.

A magnetometer map of the area is also included in this report (Pl. II) and the results and interpretation of the anomalies are discussed in a subsequent chapter.

The map (Pl. III) indicates the pre-glacial topography of northwest Missouri, and the areas in which some outcrops may be found.

A map of importance with respect to definition of the Forest City Basin is presented as Plate IV—it shows the thickness of the interval between the base of the Hertha limestone and the top of the Mississippian limestones.

The stratigraphy of the Pennsylvanian is graphically portrayed in Plate V.

Numerous maps of developed pools, undeveloped areas, and areas mapped by plane table surveys are also included.

PREVIOUS WORK.

The outstanding early geological work in northwestern Missouri was that of G. C. Broadhead, the results of which were published as a generalized section and reports on Clay, Platte, Buchanan, Holt, Atchison and Nodaway counties.[1]
The accurate and detailed nature of Broadhead's work is too well known to need comment here. It has been the basis for all subsequent work in northwestern Missouri by members of the Missouri Geological Survey.

In 1910 The Missouri Bureau of Geology and Mines entered into a cooperative agreement with the U. S. Geological Survey which resulted in three publications, "The Coal Resources of Missouri" by Henry Hinds, "The Stratigraphy of the Pennsylvanian Series in Missouri" by Henry Hinds and F. C. Greene and the Leavenworth-Smithville folio by Henry Hinds and F. C. Greene. The first two reports were published by the Missouri Bureau of Geology and Mines and the third by the U. S. Geological Survey.

In the report on Pennsylvanian stratigraphy the results of all known previous work were summarized and a bibliography of publications on the Pennsylvanian was included.

Northwestern Missouri as well as the remainder of the State was covered in a report on oil and gas, by M. E. Wilson.[2] This report contained structure maps of the Breckenridge area by C. W. Studt and C. O. Reinoehl; of the Princeton area by M. E. Wilson, W. J. Nolte and C. O. Reinoehl, and of the north Kansas City area by G. A. Muilenburg and H. H. Armsby.

An unpublished report in the files of the Missouri Survey on the underground waters of Missouri by M. E. Wilson contains much information on the wells drilled in northwestern Missouri. The present report contains logs of all the deeper wells mentioned in this manuscript.

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[1]Broadhead, G. C., Geology of northwestern Missouri. Geol. Survey of Missouri, Rept. 1872, pt. 2, pp. 1-402, 1873.

[2]Wilson, M. E., The occurrence of oil and gas in Missouri, Mo. Bur. Geol. and Mines, Vol. XVI, 2nd ser., 1922.

In the period between the completion of work done under the Cooperative agreement and 1932, considerable mapping has been done in northwestern Missouri by members of the Survey, but the reports have not been published. The principal reports are:

The Geology of Platte County by F. C. Greene and M. Albertson.

The Geology of Grundy and Mercer Counties by F. C. Greene and M. Albertson.

Structure mapping near Denver by G. A. Muilenburg.

Structure mapping of the Bethany Falls escarpment by C. W. Studt and C. O. Reinoehl.

The Geology of the Gallatin and Chillicothe Quadrangles by R. B. Rutledge.

Structure Mapping north of Cameron by Joseph M. Thiel and C. O. Reinoehl.

Maps of all the areas covered by plane table mapping mentioned above as well as more recent work near Cameron, Gower, Savannah, Fillmore, Forest City, and Camden Point are published in the present report.

The "Oil and Gas Pools of Western Missouri" and other brief reports on oil and gas development[1] in Missouri have contained information on northwestern Missouri to the time of their respective dates of publication. The maps contained in these reports have been revised to date and are contained in the present publication.

During the period 1933 to 1938 magnetometer surveys have been carried on by the Missouri Geological Survey, and it is believed that the results will be helpful in determining structural trends.

Within the past few years, all samples of cuttings and cores from wells drilled in this area have been carefully restudied and the results embodied in this report. This material is available for examination in the subsurface laboratory of the State Geological Survey.

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[1]See appendices to Biennial Reports of the State Geologist to 57th, 58th, 59th General Assemblies.

TOPOGRAPHIC AND HIGHWAY MAPS.

A considerable part of northwest Missouri has been mapped topographically, and many of the maps are on a scale of 1:62500 with a 20-foot contour interval. This work has been done to a large extent under a cooperative agreement between the Missouri Geological Survey and the United States Geological Survey and the maps may be purchased at either office.

The Missouri State Highway Commission has prepared an excellent set of county highway maps which may be purchased at the office of that department at Jefferson City, Missouri.

During the past few years the Missouri Geological Survey, in cooperation with the United States Geological Survey; the Federal Emergency Relief Administration and the Works Progress Administration has completed the third order level net work of the state. Bench marks have been established and the elevations of them in northern Missouri will be of great help in surface mapping and geophysical work. The results in note form may be consulted in the office of the State Survey at Rolla. Results for northwestern Missouri will be published during the early part of 1939.

GENERAL DESCRIPTION OF AREA.

Within the area under consideration is the Forest City basin, which has attained well established usage in the terminology of Mid-Continent structural provinces. As to the exact status of the term, from a strictly technical standpoint, there is some question. The area has the aspects of both a structural and depositional basin, and these factors make difficult a close definition of the limits of this regional feature. Broadly considered, it occurs in the area in northwestern Missouri, southwestern Iowa, southeastern Nebraska and northeastern Kansas into which the Pennsylvanian and Permian beds dip. On the southeast is the Ozark region and to the east is the Lincoln Fold[1], a broad uplift extending to the north along the Mississippi River. On the west is the buried uplift generally termed the Nemaha Mountains. The basin is terminated on the north by the Wilson-Thurman[2] structural feature in south-

[1]Krey, Frank, Structural Reconnaissance Upper Mississippi Valley Area, Missouri Bureau Geol. and Mines, vol. XVIII.

[2]Tilton, John L., The Thurman-Wilson Fault Through Southwestern Iowa, and its Bearing. Jour. Geology, Vol. XXVII, p. 389.

Tilton, John L., Missouri Series in Iowa, Iowa Geological Survey, Vol. XXIX, pp. 306-307, 1920.

western Iowa. The southern boundary is poorly defined and can be drawn only on the basis of a zone in which drilling has revealed the Cherokee formation to be thinner than in the Forest City basin to the north and the Oklahoma basin to the south.

The Pennsylvanian beds are probably largely responsible for the general use of the name "Forest City basin" among geologists and if a definition is to be closely drawn, it will be drawn on the basis of the thickness of the pre-Ardmore limestone portion of the Cherokee. The presence in this area of increased thickness of lower Cherokee, together with the prevailing non-marine character of the sediments, suggests that at least in early Cherokee time, the Forest City area was a depositional basin.

The pre-Pennsylvanian sediments, discussed elsewhere in this report, indicate that the area received deposits somewhat thicker than those of the same age in adjacent areas, and finally in summary, it appears that at different times, the Forest City basin has been both a structural and depositional basin.

For the purposes of this report, which discusses only that part of the basin in Missouri, the area has been expanded to include all that part of the state west of the eastern boundaries of Ray, Caldwell, Daviess and Harrison counties. The area extends north to the Missouri-Iowa state line and south and west to the Missouri River. In the classification of the U. S. General Land Office, Range 26 West to Range 42 West, and Township 50 North (in part) to Township 67 North define the area discussed (Fig. 1). A companion volume covering the counties east of this area has just been issued.

In general the region is undulating to rolling, with a few narrow strips of hilly land along the larger streams, particularly the Missouri. The greater part of the land is under cultivation. The entire area drains into the Missouri River. The river bottoms in southeastern Platte County are a little more than 740 feet above sea level. The highest known point is the tringulation station designated "Rome" and located in the NW. ¼ NW. ¼ sec. 33, T. 67 N., R. 33 W., in the northeast corner of Nodaway County, with an elevation of 1,224 feet. While the general altitude of the region rises to the north, no generalizations of value can be made. In many places the tops of the loess-capped hills along the Missouri River are higher than any point for several miles to the east.

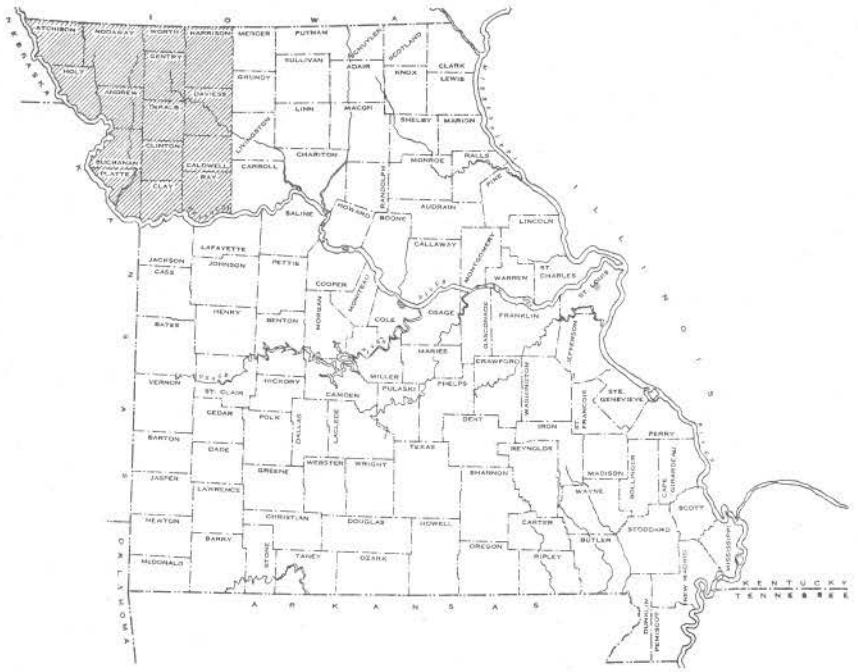

FIG. 1. Map showing location of area.

The average annual rainfall ranges between 30 and 40 inches, but in the eight years ending with 1938, there has been a deficiency. As a result ground water level has dropped and running water is confined to the larger streams. This deficiency in rainfall has resulted in the construction of many lakes and ponds, and therefore lack of water for drilling should not be a serious handicap in some localities.

The region is served by a network of Federal, State, Farm-to-Market and other improved roads, and nearly all sections of the region are accessible except after prolonged periods of rain or snow. Railroad facilities are available throughout.

SUMMARY OF SURFACE GEOLOGY.

The upland surface of the region is covered with a greater or less thickness of glacial clay and along the Missouri River loess caps most of the hills, whether of glacial material or Pennsylvanian beds. The bedrock surface of the region consists of Pennsylvanian beds, limestones, shales, sandstones, minor amounts of conglomerate and a few layers of coal. The thickness of glacial material and the presence of outcrops of Penn-

sylvanian rocks are intimately connected. Prior to glaciation, it must be assumed that a series of valleys, upland plains and escarpments, similar to those now existing in southwestern Missouri and southeastern Kansas, were present in northwestern Missouri. At the close of glaciation, the till sheet covered most, if not all of these features, probably sloping gently to the south. The effect of this was to bury all the Pennsylvanian rocks beneath a sheet of till which was rather thick even over the pre-glacial uplands in the northern counties, decreasingly thick over the uplands toward the south and of great thickness over the old valleys throughout the area.

The erosion which started with the melting away of the glacial ice, began removing the till. It is the combination of pre-glacial topography, glaciation and post-glacial erosion which is responsible for the distribution of outcrops of Pennsylvanian rocks in northwestern Missouri. Some of the larger present valleys have been eroded along the lines of pre-glacial valleys because of the softer material occupying them. This is apparent in a comparison of the drainage shown on Plate III with the modern drainage. Where the present valleys, or parts of them, occupy pre-glacial lowlands, outcrops are absent, and where present streams have cut down into pre-glacial uplands, outcrops are present. Over many of the old uplands in the southern part of the area, the drift has been reduced to a relatively thin veneer, but in the northern part of the State even the higher escarpments, such as that capped by the Oread limestone, are completely buried. Pl. III shows areas in which outcrops can be found or in which the drift covering is sufficiently thin to permit prospecting by shallow drill holes.

The Pennsylvanian beds are included in the Pleasanton, Kansas City, Lansing, Pedee, Douglas, Shawnee and Wabaunsee groups, with relatively small areas of lower beds in Ray County. The strike of the outcrops is slightly east of north and the dip of the beds slightly north of west. The dip is so low that it is apparent only when distant points are compared. In every area in western Missouri where close structural control is available, either through surface or sub-surface control, the local dips or undulations eliminate the effect of the regional dip to a large extent. The nature of the outcropping beds and their availability for surface mapping and structure test drilling are considered further in the description of the Pennsylvanian.

ACKNOWLEDGMENTS.

The work incorporated in this report was undertaken and completed under the direction of Dr. H. A. Buehler, State Geologist. The writers are indebted to him for his usual sound advice and constructive criticism.

The writers' associates in the Geological Survey have assisted materially in the preparation of this report. Miss Mary Hundhausen, Mr. John Grohskopf, and Mr. Earl McCracken furnished subsurface details incorporated herein. Joseph R. Clair and Kenneth Cox did considerable plane table work in areas described in this report. Mr. Clair also assisted in certain phases of the incidental office work. Mr. Kenneth Aid and Mr. Joseph Denton obtained the locations of all wells in the area outside of the developed areas, and also assisted in phases of the office work. Mr. Kenneth Cox obtained by stadia traverse the locations and elevations of all wells in the developed pools.

The magnetic surveys have been made over a period of several years and by the following observers: C. O. Reinoehl, J. G. Grohskopf, G. T. McIntyre, C. F. Walker, Mackay Coleman, Hale Gillespie, and Truman Dempsey. The interest and carefulness in which this work was done has added materially to its value.

Don Scroggins and Clyde Boulson deserve credit for the careful drafting of the accompanying maps. Miss Mary Houston and Mrs. Lucy Boas did the required and at times difficult stenographic work.

The chemical analyses contained herein were made by Mr. R. T. Rolufs.

Grateful acknowledgment is hereby made of the assistance of various Federal Reemployment agencies, among them being the Civil Works Administration, Federal Emergency Relief Administration and Works Progress Administration. A portion of the work incorporated herein was made possible through the various projects financed by those agencies. Special mention should be made of the Works Progress Administration project sponsored by the Survey, through which many of the details of this report were assembled.

STRATIGRAPHY OF THE AREA.

PLEISTOCENE SERIES.

The Pleistocene of northwestern Missouri consists mainly of glacial till and loess. The loess is thickest along the bluffs bordering the Missouri River and thins rapidly away from the river. In the remainder of the area described in this report practically all of the uplands are covered by glacial till, boulder clay of bluish-gray color in the unweathered state, which upon weathering becomes the familiar yellow clay of northern Missouri. Beds of sand, gravel and boulders occur but are not common. Pebbles and boulders are common throughout the boulder clay and range in size up to several cubic yards. The boulders consist of many types of igneous, metamorphic and sedimentary rocks, and while Pennsylvanian limestones actually predominate, red Sioux quartzite boulders are the most conspicuous because of their size and color.

As mentioned above, the loess is thickest along the bluffs of Missouri River, and in its typical form, does not extend more than 12 or 15 miles away from the bluffs. It appears to be nearly 100 feet thick in places. The texture is uniform except for secondary calcareous concretions and occasional shells of land snails. It is cut by vertical joints and, in artificial cuts, exhibits columnar jointing.

The present thickness of the glacial drift is the result of a combination of geologic processes. Originally spread over a surface of Pennsylvanian beds, which presumably had been eroded into a type of topography similar to that now prevailing in southeastern Kansas, the upper surface of the till probably was rather even after the ice sheet disappeared. As thus deposited, the drift was thickest over the pre-glacial valleys and thinnest over the uplands. One exception to this should be noted, the general thickness of the drift almost certainly decreased southward.

Erosion since the glacial stage has greatly modified the topography of the surface of the drift. In places where the present drainage coincides with pre-glacial valleys, outcrops of Pennsylvanian beds are absent or rare, and where recent drainage has developed over pre-glacial uplands, outcrops are abundant.

In many parts of Platte, Clay and Ray counties, the combination of thin glacial drift and recent erosion has resulted in a type of topography largely influenced by the Pennsylvanian beds. Over all of northwestern Missouri erosion has progressed to the stage that no flat uplands, such as prevail in parts of Iowa and Illinois, and in parts of northeastern Missouri, can be found.

An attempt has been made to show graphically some of the features described. On Plate III, the topography of the pre-glacial surface is shown by 100-foot contours. It should be borne in mind that this is a progress map, based on rather meagre data. On the same map the stippled areas denote those in which some outcrops can be found and those in which the glacial covering is in general less than 50 feet thick.

It will be noted that outcrops are fairly abundant in Ray, Clay, Platte and southern Buchanan counties, and in parts of Caldwell and Clinton counties, becoming progressively scarcer northward to the state line. The two large pre-glacial valleys shown on Plate III, as well as the northward increase in the original thickness of the drift, are the chief factors causing this.

The main drift sheet of northwestern Missouri has usually been termed the Kansan and a lower sheet, which is not well known, due to burial beneath the upper and more extensive sheet, has been termed the Nebraskan, but students of glacial geology are not agreed on this terminology. Further study will be needed to clarify the situation.

PENNSYLVANIAN SYSTEM.

General Description.

All the outcropping rocks in the area considered in this report belong to the Pennsylvanian system. One very small possible exception is the outcrop of the Indian Cave sandstone a few miles west of Rockport in Atchison County, which is considered to be "Permian" by the Kansas Geological Survey. The Pennsylvanian section is represented by all members from the top of the Cherokee to the youngest. Due to the northwest dip, the oldest beds are exposed in Ray County and the youngest in Atchison County.

In the Forest City basin, beds of Cherokee age have been encountered in drilling that possibly are older than any exposed in southwestern Missouri where the oldest known Cherokee, the Bluejacket sandstone and Dederick shale, may be studied. However, the Cherokee in the Forest City basin contains few

diagnostic fossils below the Ardmore limestone to afford a direct determination of the age of the lower beds.

The Pennsylvanian consists of shales of various types, sandstones, mostly fine-grained and micaceous, limestones of many types, coal beds and black fissile shales. Conglomerates are rare, but are represented locally by conglomeratic limestones and by true conglomerates in a few places. Gray or drab is the prevailing color of the shales, but reds, maroons, greens and blacks are present at many levels. Of chief importance to the field geologist are the limestones. In most beds the lithologic features are fairly constant and beds may be recognized in widely separated outcrops with certainty. In any given locality, a section of two or more limestones and the accompanying beds, will enable one familiar with the Pennsylvanian to correlate the members correctly.

Regional variation affects much of the section, but in different directions and with different types of lateral changes. These may be noted briefly in the following summary. The Cherokee below the Ardmore limestone thickens into the Forest City basin; above the Ardmore there is a tendency to thin eastward. The limestones, as well as the intervening shales of the Henrietta, exhibit a fairly regular tendency to thin from the southwestern part of the State to the north. Channels filled with shale or sandstone of Warrensburg age are more prevalent in the southern part of the area, while thick sandstones in the upper part of the Pleasanton are prevalent in the north-central counties of the State.

The beds from the base of the Hertha to the top of the Raytown are remarkably constant throughout the area of their outcrop and westward under cover, as shown by drilling. This applies to both thickness and lithology. The Argentine (Iola of former reports) thins northward at a fairly uniform rate of approximately one foot per mile. The formations between the top of the Argentine and top of the Stanton thin northward at a very low rate. The Weston shale makes some erratic changes in the southern part of its area, but northward it decreases almost to allow the Iatan to rest on the Stanton.

The Lawrence shale as now restricted to exclude the Haskell limestone and Vineland shale at the base, thins to the north steadily. The formations above the Oread occupy so small an area in the State that observations are limited. The changes are relatively small, but in general indicate a thinning of the thicker limestones to the north.

Nomenclature and Grouping.

A purpose of this report is to furnish a working description of the Pennsylvanian beds which will enable the field geologist to identify them at the surface, and to help correlate properly the results of drilling. No extended discussion of nomenclature will be given. The very nature of the beds as summarized in the foregoing general description leads to an intricate subdivision and naming of the individual beds. As many of the thinner beds are persistent over wide areas, sound arguments can be advanced for such procedure. However, when so many units are named, a little confusion in the correlation of beds from one area to another, causes endless confusion in the published nomenclature.

The grouping of the smaller units is largely a matter of paleontologic differentiation and regional study. The grouping which seems best for one area may not apply to another. Again the grouping which appears to be best fitted to express the local conditions of practical mapping, may not be in accord with paleontologic evidence.

The nomenclature used in this report is based on that in current use by the Missouri Geological Survey and established among geologists and drillers, but modified in cases where it is known the name formerly used was based on erroneous correlations, or where unconformities have been established. When extensive regional studies show that the grouping here used should be changed in the interest of best scientific practice, the changes will be made.

In the case of applying geographic names to the individual beds of the Stanton, Oread or Deer Creek or other zones of multiple lithology, the persistence of the beds justifies this procedure and these names are useful in both surface and subsurface work.

In the table of formations (Pl. V) is given a general description of the individual units, their grouping as used by the Missouri Geological Survey and most of the changes advocated by the surveys of the adjoining states.

The Cherokee is divided at a plane near the base of the Ardmore (Rich Hill) limestone by a probable unconformity but the exact line of division awaits further study. No geographic names will be given to these units at present.

The upper boundary of the Henrietta has been placed at the approximate position of the unconformity which separates the Des Moines and Missouri, and the base of the Pleasanton has

been raised to correspond. This unconformity and the problems presented are discussed in connection with the descriptions of the Henrietta and Pleasanton. The Henrietta as modified is almost the exact equivalent of the Marmaton of the Kansas Geological Survey.

The terms "Kansas City" and "Lansing" are retained in their present usage, which is well established in Missouri and in the terminology of sub-surface workers in the Mid-Continent oil and gas field. Changes proposed by the Kansas Geological Survey are to segregate the Hertha, Bethany Falls and Winterset limestones and included shales as the Bronson group, while the Kansas City, thus restricted at the base, is extended upward to include the shale zone at the base of the Lansing. While it is entirely possible that interstate investigations may demonstrate the advisability of making these changes in the future, the present usage will be retained in this report.

Irregularities in the Douglas have been described in the earlier reports of the Missouri Geological Survey and it has since been demonstrated that the Douglas included beds above and below an unconformity which affects the stratigraphy over a wide area. The Kansas Geological Survey now groups the beds below the unconformity as the Pedee and restricts the term "Douglas" to the beds above it. This change is shown in Pl. V. The Weston shale and Iatan limestone comprise the Pedee group, and the thick sandstone found in parts of Platte and Clay counties, replacing the Weston and Iatan, is at the base of the Douglas.

The Kansas Geological Survey removed the Oread limestone from the Douglas and placed it at the base of the Shawnee, while the present usage of this Survey is to place the Oread at the top of the Douglas. The writers are inclined to the belief that the Oread belongs with the zone of fairly persistent limestones which begins with the Oread and extends upward to the top of the Howard, but this involves changes in all the present systems of classification.

The present classification of the Missouri Survey differs in a few other places from that proposed by the Kansas Survey. The Shawnee is restricted at the top of the Topeka and the Wabaunsee includes all beds from the top of the Topeka to the base of the Indian Cave sandstone. The latter is made the base of the "Permian". The beds in Missouri from the top of the

Topeka upward are so restricted in area, and even in the restricted area, so obscured by loess and glacial drift, that they furnish no real information as to the proper grouping of the beds.

DES MOINES SERIES.

Cherokee Group.

Pre-Ardmore Beds.

The main feature of the pre-Ardmore section of the Cherokee is the scarcity of marine fossils. A thin marine limestone has been found outcropping near Deerfield in Vernon County. A detailed examination of the Forest City (Sec. 4, T. 58 N., R. 38 W.) and Saxton (Sec. 27, T. 57 N., R. 34 W.) cores indicates only a few marine invertebrates. Along with the largely non-marine conditions of deposition, there is little regularity of stratification. The thickest coal beds occur in this terrane, and while they are largely discontinuous, there is evidence that some of them lie at about the same stratigraphic level.

There are many sandstones in the lower Cherokee, among them the Bartlesville and Burgess sands of drillers, but there is no evidence that either is continuous. In fact it is known that the name "Bartlesville" has been applied to several different beds. In Vernon County, the Bartlesville sand (Bluejacket sandstone) has produced both oil and gas. In Bates, Cass and Jackson counties gas has been found in the so-called Bartlesville sand.

Some of the irregularity of the sandstones and other beds possibly may be explained as the result of a study of well cuttings by Miss Mary Hundhausen in the laboratory of the Missouri Geological Survey. It is generally considered that much of the clastic material of the Pennsylvanian was transported from some southern source. Miss Hundhausen has examined cores and cuttings of the Lower Cherokee from wells in the Forest City basin and as far south as Jackson County, Missouri, and in several cases found coarse arkosic sands which appear to have been derived from some near-by source, which in this case, would have been the granite core of the Nemaha ridge of Kansas and Nebraska. The distribution of the wells in which the arkosic sand has been found suggests that it is one of the channel type deposits, replacing the normal succession of dark to black shales, thin sandstones and coal beds. This zone of arkosic sand began to be formed during or shortly after the formation of the Nemaha Granite Ridge.

Near the top of the Lower Cherokee there is a fairly continuous coal bed. This bed has been named the Tebo in Henry County and the Lower Ardmore in the north central counties. At this time, it is not certain whether these beds are at the same stratigraphic level or not. At nearly the same level, but probably not present in the localities where the coal is found, there is a wide-spread red shale horizon. This red shale constitutes a valuable marker as it is usually noted even in rather carelessly kept logs.

In Vernon and Barton counties the Lower Cherokee is 275 to 300 feet thick. Northeastward the interval thins and in central Missouri there are probably places in which it is less than 100 feet thick. In Putnam County it is about 200 feet thick. In the Forest City basin it attains a thickness of 550 feet, or possibly more.

There are some indications that the Pennsylvanian sea reached its greatest extent at about this stage. It is believed the purple and maroon shales in the north-central part of the Ozark region represent the red shale horizon previously mentioned as marking the approximate top of the lower Cherokee.

Upper Beds of Cherokee.

The upper part of the Cherokee includes, in ascending order, the Ardmore (Rich Hill of Vernon and Bates Counties, Missouri or Verdigris of Oklahoma) limestone, Bevier coal, Lagonda shale and sandstone (Squirrel sand zone of drillers) and the Mulky (Macon City or Fort Scott) coal at the top. Locally another coal bed, the Bedford, is present a few to 15 feet above the Bevier. The relations of the two beds are not entirely clear and there is some evidence that the thick bed mined in the Bevier and Novinger districts (Macon and Adair counties) is a coalition of the two beds.

All the members of this division of the Cherokee are present over a wide area in the Mid-Continent region. They are by no means continuous, but are fairly persistent. The thickness of all the members is variable. The Ardmore may consist of a single bed one or two feet thick or of several beds, each much thicker. The Lagonda ranges from argillaceous to arenaceous shale and to massive sandstone. In places the base extends downward in a channel, replacing the coal and limestone below.

The average thickness of the interval is about 100 feet of which the Lagonda is by far the greater part. The interval thins

into the east central counties of the State, taking place mostly in the Lagonda.

The Missouri Geological Survey has taken no official action on the reclassification of the Cherokee, but it is suggested that the upper part from a plane a short distance below the Ardmore should be placed with the Henrietta and the group given a new name. It is believed that this line of demarcation will approximate that separating the Pottsville and Allegheny groups.

Henrietta Group.

The term Henrietta, as used in Missouri, is applied to the lower part of the Marmaton as used in Kansas. The Marmaton group includes the upper part of the Des Moines to the unconformity which separates the Des Moines and Missouri series. The higher beds of the Marmaton which are present in Kansas are replaced by this unconformity in Missouri, presenting both a scientific and a practical problem. The type of beds above and below the unconformity causes poor surface outcrops and the accompanying difficulty in delineating the contact on a map. The same difficulty applies to drawing the contact in stratigraphic sections and well logs.

It is believed the most practical division point is at the top of the highest limestone below the Warrensburg zone, although it is realized that this may not be the same stratigraphic plane in all cases. The selection of this point is further complicated by the tendency of the thinner phases of the Warrensburg to be highly calcareous, and consequently to be reported as "lime" in well logs.

In the southwestern counties of Missouri the beds included in the Henrietta are the Fort Scott limestone, Labette shale, Pawnee limestone, Altamont and Worland limestones and included shales. From Missouri River northward, both the upper and lower boundaries as used in former reports differed materially from those used in the southwestern counties. Later studies have shown a general tendency of the limestones of this zone to thin northward and both the limestones and intervening beds show considerable change in lithologic character. This applies both to the outcrop area and the region covered by this report where these beds are encountered in drilling. From Missouri River northward red shales, absent in the southern area, appear near the top and bottom of the group.

Certain members of the group maintain rather uniform characteristics over wide areas and furnish valuable markers for both surface and subsurface work. The most prominent of these is the caprock of the Lexington coal seam. This bed has not been recognized in Kansas, but almost certainly it is the bed described by Moore[1] as constituting the lower part of the Pawnee, as follows: "In some places there is a thin bed of blue dense limestone with vertical joints at the base of the Pawnee, separated from the upper limestone beds by two or more feet of black slaty shale." It has received no geographic name. It has been traced entirely across Missouri. The average thickness is about five feet, but it thins to the north.

The Upper Fort Scott limestone is fairly continuous across Missouri. In central Missouri it has been termed the "Chaetetes" limestone or merely the "sump rock" of the Lexington coal seam. Like other members it thins northward.

The "Rhomboidal" limestone of central and northern Missouri is one of the most persistent markers in the section. Its maximum thickness is 2½ feet, but in the northern counties it is only ¼ inch thick. It is believed to belong in the interval between the Upper Fort Scott limestone and the black slaty shale below it in the type section at Fort Scott, but it can not be definitely stated that it is not a split-off of the Upper Fort Scott. It overlies the black slaty shale just mentioned entirely across Missouri. In many places a thin coal bed, the Summit, appears below the shale.

The Lower Fort Scott limestone is also fairly persistent across Missouri, but the underlying black shale and coal variously termed the Lower Fort Scott, Mulky or Macon City seam is non-persistent.

MISSOURI SERIES.

Pleasanton Group.

The Missouri Geological Survey has used the name "Pleasanton" for approximately the zone of beds included by the term "Bourbon" of the Kansas Geological Survey. As already mentioned in the discussion of the upper contact of the Henrietta, the physical nature of the beds in contact at the unconformity which separates the Des Moines and Missouri, makes it difficult to draw the actual contact either in the field or in logs.

[1]Moore, Raymond C., Stratigraphic Classification of the Pennsylvanian Rocks of Kansas, State Geol. Sur. Kans., Bull. 22, pp. 62-63, 1936.

In older reports of the Missouri Geological Survey, the irregularities of the "Pleasanton" were mentioned and the Warrensburg and Moberly channel sandstones were assigned to the Pleasanton. Because of these irregularities, attempts to construct a generalized section were rendered almost useless. Through subsequent work and the accumulation of a large number of well logs the section is now fairly clear in some areas, but still obscure in others. By means of well logs, it has been demonstrated that the channel sandstones belong in the lower part of the section below a wide-spread bed of black slaty shale which is believed to represent the Dawson coal horizon of Oklahoma. In areas where the channel sandstones are thin or absent, the zone is marked by red and green clays in many places.

As already mentioned the black shale at the Dawson coal horizon appears, from information available, to cover a large area. In places in northern Missouri, probably it has been confused with the Mulberry coal.

The Dawson coal horizon is followed by a bed of sandstone in Cass, Jackson, southern Platte and southern Clay counties. It has an average thickness of 10 feet and is known to drillers as the Wayside sand. A few feet above is a thin bed of dark calcareous fossiliferous shale, which has been found at widely separated points in northern Missouri, even where the underlying sand is absent. It is believed this bed will prove to be a valuable marker.

The upper part of the "Pleasanton" is 70 to 100 feet thick. In Clay, Platte, and Clinton counties there is a sandstone of variable thickness near the top of this zone, known to drillers as the Knobtown sand. In the north central counties, sandstone occupies most of the interval, and locally is unconformable at the base. The basal conglomerate is well developed in places and has been termed the "Chariton conglomerate". The relations of this sand and the "Knobtown sand" are not clear, but it is possible that the latter thickens northward. In the northwestern counties drilling shows very little sand at this horizon.

At the top of the "Pleasanton" there is locally a coal bed, the Ovid, and in places there is a layer of nodular limestone, a few inches to 3 feet thick. In other places red and green shale is present.

Kansas City Group.

The term "Kansas City" as used in this report conforms to the established usage of the Missouri Geological Survey, that is to include all beds between the base of the Hertha limestone and the top of the "Iola" limestone. It now appears that the bed designated the Iola at Kansas City by the early geologists is a higher bed than that which was named the Iola limestone at Iola, Kansas. According to the Kansas Geological Survey the true Iola can be traced into the Raytown limestone at Kansas City. Left thus without a name, the "Iola" in the vicinity of Kansas City has been given the name Argentine for the upper gray part and the name Frisbie for the basal yellowish beds by the Kansas Geological Survey. The outcrops upon which the changes in nomenclature have been based are in Kansas and the field work was done in that state.

There is little to be added to the published descriptions of the Kansas City formation as it occurs in Missouri. One new feature has been developed largely by the results of drilling. The beds from the base of the Hertha to the top of the Raytown are remarkably consistent in their aggregate thickness from Cass County to the north line of Missouri and beyond. The individual members vary somewhat, but on the whole are rather regular. In areas where the Raytown limestone can be reached by shallow prospect wells it provides an excellent datum for structure drilling.

The Argentine (Iola) limestone thins from about 75 feet in Cass County to about one foot in the vicinity of Cameron, Clinton County and may be entirely absent to the north. The shale below it is also rather variable in thickness and contains local sandstones in the vicinity of Hickman Mills, Jackson County and Elmira, Ray County.

Lansing Group.

The description of the beds of the Lansing shown in Pl. V, applies throughout the surface and subsurface area of the Lansing. There are very few outcrops north of Grand River, due to the covering of glacial drift, but aside from a slight thinning, there is no change. The Farley limestone is reported to be very irregular in Kansas and in places to be much thicker than in Platte County, Missouri. In Missouri it is somewhat irregular and does not make a good marker for structure mapping, but it is a relatively thin bed (or beds) throughout its known outcrop.

Pedee Group.

The Pedee, including the Weston shale below and the Iatan limestone above, was formerly included in the Douglas. In areas where the glacial covering is light, the Iatan caps an escarpment of the Weston shale. In part of Platte and Clay counties, these beds are replaced by the Tonganoxie sandstone and north of DeKalb County no outcrop has yet been found due to glacial material.

The Weston shale is one of the most variable beds in the upper Pennsylvanian of Missouri. In any given locality, the variation in thickness is not large, and the overlying Iatan may be used for structure mapping, but from the main area of outcrop in Platte and Buchanan counties, the Weston thins to a few feet in the northern counties, as revealed by well drilling.

Douglas Group.

The only important change in the status of the Douglas formation in recent years has been to establish the age of the channel sandstone in Platte and Clay counties. It seems to be fairly definite that its age is post-Iatan. On the basis of this unconformity, the boundary of the Douglas has been drawn at the base of the Tonganoxie sandstone where it is present, or at the base of the Vineland shale where the channel sandstone is absent.

The northern part of the area of the Douglas is heavily covered with glacial drift and very little is known about it north of Grand River. Drilling indicates that the shale above the Amazonia limestone thins considerably to the north and the Oread is somewhat irregular. The description of the beds in the main area of outcrop in Platte, Buchanan, Andrew and DeKalb counties follows closely that given in Pl. V.

Shawnee and Wabaunsee Groups.

The outcrops of the beds of the Shawnee and Wabaunsee are almost wholly confined to the bluffs of the Missouri River. The region to the east of the bluffs is occupied by some rather large pre-glacial valleys, and these together with the covering of glacial drift and loess, effectually conceal the bedrock surface in the area where these beds should normally outcrop. In addition there has been very little deep drilling in the area to supplement the scanty information furnished by the outcrops.

The succession of beds shown in Pl. V from the base of the Kanwaka shale to the top of the Howard limestone is fairly accurate and the beds are regular within the limits indicated.

Above the Howard limestone outcrops are so restricted and so widely scattered, that some errors may be present. There is no complete exposure of the White Cloud shale, but the thickness shown, 100 to 110 feet is believed to be about correct. However, in Kansas and Nebraska, it is reported 75 and 71 feet respectively. Above the White Cloud shale there are a number of beds, reported 76 feet thick in Nebraska and 84 feet thick in Kansas, which are represented by a much smaller interval in Missouri. The upper part of the succession, as first published by the Missouri Geological Survey, is correct as to lithology and succession of beds and the correlation of the beds from the Reading limestone to the top of the section is believed to be correct.

Between the top of the White Cloud shale and the Reading limestone there is a discrepancy in nomenclature, thickness and lithology, in the section in Pl. V and the sections published by the Kansas and Nebraska Geological Surveys. It is probable that it will be necessary to resort to drilling to obtain the correct relations of these beds.

PRE-PENNSYLVANIAN ROCKS.

Nowhere within the area under discussion do rocks older than those of Pennsylvanian age, outcrop. Information pertaining to them is therefore derived chiefly from the study of well samples, from which the following brief working descriptions have been obtained.

MISSISSIPPIAN SYSTEM.

From the few wells drilled within the area it appears that the three major divisions, and most of the minor stratigraphic divisions are present. In descending order they are as follows:

Chester Group (?)
Meramec Group
- Ste. Genevieve formation
- St. Louis formation
- Warsaw formation

Osage Group
- Keokuk-Burlington formation
- Sedalia formation

Kinderhook Group
- Chouteau-Gilmore City formations
- Kinderhook shale

Brief descriptions of the foregoing are as follows:

Chester Group.

Representatives of Chester formations have not been specifically identified in samples from wells drilled within the area. There appears to be present, however, throughout the present area, a section of rocks of varying thickness and character which may, with the accumulation and study of the present meagre and possible future data, prove to be of Chester age.

This section occupies the interval between the top of the limestones, distinctly of Mississippian age, and the base of the arkosic, coarse sandstone, which has been previously described as occurring in the Lower Pennsylvanian. This section is well developed in the diamond drill hole, locally known as the Saxton test, and formally as State of Missouri, et al., No. 1 Conett, SW. cor. NW. ¼ NW. ¼ sec. 21, T. 57 N., R. 34., Buchanan County, the complete log of which is given elsewhere. The section under consideration has been carefully described by Miss Hundhausen of the Missouri Geological Survey and consists of fairly hard, dark gray to black shales, and hard, very fine grained sandstone, the two being intimately interbedded. This section certainly predates the Nemaha granite ridge orogeny, and it definitely appears to be younger than the limestones of Mississippian age. Specific data relative to the age of the section is lacking. It is certainly no older than Chester (Mississippian) nor younger than earliest Cherokee Pennsylvanian. Nowhere within the area has the Chester, as it is developed in the Illinois basin, been identified.

Meramec Group.

This group of rocks appears to be consistently developed, although south of the area, it is absent by erosion and the Pennsylvanian rests upon older Mississippian limestones. The formations of the Meramec are described briefly as follows:

Ste. Genevieve formation: Recent studies by Miss Hundhausen, Mr. Grohskopf and the senior writer of the Missouri Geological Survey indicate that the Ste. Genevieve formation is represented in the area. It consists of light colored, fine grained, sub-angular, quartz sand, locally very calcareous, and light colored, dense to oolitic, very sandy limestone. Highly oolitic limestone, similar in lithology to the Fredonia ("McCloskey Sand") member as it is developed in Illinois, has not been observed. The Ste. Genevieve varies in thickness and locally is absent. The greatest thickness, known to date, 72 feet, appears to have been drilled in the city well at Lenox, Taylor County, Iowa, sec. 8, T. 70 N., R. 32 W., samples from which were obtained by the Missouri Geological Survey through the courtesy of Allan C. Tester of the University of Iowa.

St. Louis formation: Limestone is the dominant rock of this formation as it is developed in the subsurface of northwestern Missouri. It varies in lithology from a finely crystalline, to dense, lithographic limestone. Locally it has a pebbly to brecciated appearance with the limestones fragments occurring in a matrix of gray and green shale. Included within the limestones are scattered oolites. Chert is not common, although light colored chalk-like varieties have been noted. The St. Louis limestone varies in thickness regionally from nothing to at least 75 feet.

Warsaw formation: In the eastern counties of the State, and particularly St. Louis, Jefferson, and Ste. Genevieve counties, the Spergen (Salem) formation is well developed and intervenes between the St. Louis formation above and the Warsaw formation below. In the northwestern portion of the state, drill samples are not in sufficient abundance, nor so located geographically, that a definite correlation with eastern Missouri can be made. There is, however, an interval suggestive of the Spergen but on the other hand, it possesses characteristics of the Warsaw formation and until definite and confirming data have been obtained the interval will be included in the upper part of the latter.

The most characteristic feature of the upper Warsaw is the presence of pink to red, gray and white quartzose and fossiliferous chert which occurs associated with light colored, fine grained to finely crystalline limestone, magnesian limestone, or dolomite, or green and gray calcareous shale. There is the suggestion that the chert occurs as geodes. A characteristic outcrop of the

chert is reported by John Grohskopf and Norman Hinchey[1] as occurring near Lisbon, Howard County, in the NE. ¼ sec. 2, T. 49 N., R. 18 W.

The upper part of the Warsaw as determined in the Forest City diamond drill hole, sec. 4, T. 59 N., R. 38 W., Holt County, measures 45 feet in thickness.

The lower part of the Warsaw formation consists of limestone, varying in color from white, to light and dark gray, and brown, and in texture from fine grained to coarsely crystalline. Fossils are common to this interval as it is developed in the drill hole just mentioned and consist of crinoids, bryozoans, brachiopods and occasionally conodonts. Shale, ranging in color from light to dark gray to green, is present throughout. Chert light to dark gray, dense to mottled and fossiliferous is also common. Glauconite occurs sparingly.

Osage Group.

Keokuk-Burlington formations: These formations occupy the upper part of the Osage group. In the Diamond drill hole at Forest City the lithology of the formations as exhibited by the cores, consists of light tan to gray limestone and magnesian limestone. The texture varies from fine to medium grained, to coarsely crystalline and crinoidal. Styolites are not uncommon. Chert is also an important constituent, and in color is white, gray, or blue, and dense. Poorly preserved fossils and glauconite are common. The thickness of this interval in the Forest City hole appears to be limited to 38 feet. In this connection it is interesting to note that the interval occupied by these formations is considerably thicker to the southeast, and in certain wells in Jackson County attains a thickness of at least 150 feet. The details of the northward convergence are not fully understood and a positive statement should be withheld until further samples are available for study.

Sedalia formation: This formation is typically developed in west central Missouri. The characteristics are also expressed in well samples in Jackson and Clay Counties, in western Missouri. Dolomite and magnesian limestone, usually light in color, characterize the formation. Chert, white to gray, dense and porous is common. Fine grained sand, in aggregates, is also present. Northwestward the formation appears to become more

[1]Oral communication.

silty and the presence of siltstone in the insoluble residue is a characteristic.

Kinderhook Group.

Important changes in lithology and perhaps in stratigraphy mark the Kinderhook group in the area between central and west central Missouri and the deeper portion of the Forest City basin. The problem is not solved by any means but it is presented for consideration.

Chouteau formation: This formation is characteristically developed in central Missouri where it consists of limestone, lithographic to finely crystalline, usually bluish gray in color and fossiliferous. Westward, in the subsurface of Jackson and Clay counties it appears to be more dolomitic, particularly in the upper portion. An outstanding characteristic of the formation is the presence of slate gray dense chert, which usually is concentrated near the top of the formation. Sphalerite and masses of brown porous shale, and occasionally silicified foraminifera (?) are typical constituents of the insoluble residues. The typical expression of the Chouteau appears to extend north and basin ward to at least sec. 26, T. 58 N., R. 30, where it was drilled in McCain et al., No. 1 Frank Bermond, and had a total thickness of 58 feet. This figure is at or near the average for the formation.

Gilmore City formation: Between the location mentioned above however, and the Forest City diamond drill hole, sec. 4, T. 59 N., R. 38 W., an important change appears to take place, and the interval occupied by the Chouteau gives way to a limestone section, usually characterized in the upper and lower portions by white to light tan oolitic limestone. The individual oolites are round or ovate in shape, generally small in size, and sometimes with black centers. Because of the similar lithology, at least of the oolitic characteristic, the Gilmore City[1] formation of Iowa is immediately suggested. The middle section of the formation consists of finely crystalline to dense lithographic limestone. Chert is usually present and is smoky gray in color, and rough and speckled in texture. Certainly it possesses the characteristics of the Chouteau formation of central Missouri, and in this report the two are considered as correlatives.

[1]Laudon, L. R., The Stratigraphy and Paleontology of the Gilmore City formation of Iowa, University, Iowa, Stud. Nat. Hist., Vol. 15, No. 2. 1933.

Kinderhook Shale: In the eastern portion of the area of this report, hard black shale bearing the typical plant spore, *Sporangites huronense*, is present. Shale of this type was noted in Wilson et al., No. 1, Glick SE. ¼ NE. ¼ sec. 10, T. 57 N., R. 26 W., Caldwell County. Shale of this type was also present in Livingston County in wells near Chillicothe. Such shale is characteristic of the basal Mississippian and may be the Chattanooga Shale. In other portions of the area, gray or greenish gray spore bearing shales constitute this formation. The thickness of the shale varies greatly, from possibly a few inches or at best a few feet in the southern part of the area, to 120 feet in the Forest City diamond drill hole, sec. 4, T. 59 N., R. 38 W. In addition to the shale, above mentioned, an oolitic hematite and associated red shales occur throughout the deeper part of the Forest City basin. One or both have been found in the following wells:

State of Mo., et al. No. 1 Davis, sec. 4, T. 59 N., R. 38 W., Holt County.

McCain, et al., No. 1 Frank Bermond, sec. 26, T. 58 N., R. 34 W., Buchanan County.

W. F. Rankin, No. 2 Fee, sec. 11, T. 65 N., R. 40 W.

Iowa's First Oil Development Co., No. 1 Wilson, sec. 24, T. 68 N., R. 37 W.

This portion of the shale is readily distinguishable and serves as a marker. Although its exact age is not known it is here placed as a matter of convenience with the Kinderhook shale. In this connection the section associated with, but below the red Kinderhook shale, in the W. F. Rankin, Fee well No. 2, sec. 11, T. 65 N., R. 40 W., should be mentioned, because of its singular character. Samples from this interval, while apparently continuous, are in places widely spaced. The section may also contain beds of Devonian age and is as follows:

Log of W. F. Rankin No. 2 Fee.

	Thickness, feet	*Depth, feet*
Shale, greenish gray, some sand and pyrite	10	1930
Hematite, red, oolitic	5	1935
Hematite, red, oolitic, with red shale	20	1955
Shale, greenish gray with some oolitic hematite (caved)	5	1960
Limestone, gray, finely crystalline, slightly and finely sandy, with some green shale	5	1965
Chert, very calcareous, with large number of plant spores, and sponge spicules; gray is common color	55	2020
Limestone, brown, very earthy with abundant micro fauna consisting of Bryozoa, Ostracods, and crinoid segments; some brown chert and shale	4	2024

Log of W. F. Rankin No. 2 Fee—Continued.

	Thickness, feet	*Depth, feet*
Shale, gray	4	2028
Similar in detail to 2020-2024	4	2032
Chert, very calcareous, gray, spores and spines being abundant, fine grained sand is common	12	2044
Shale, gray with milky white quartz	16	2060
Shale, gray, calcareous, spore bearing	20	2080
Shale, gray, calcareous, spore bearing, with some spore and sponge spicule bearing chert	90	2170
Devonian system:		
Dolomite, dark brown, finely crystalline; some quartzose chert, apple green shale and sand	170	2340 Total depth

DEVONIAN SYSTEM.

In central Missouri, two formations are common to the Devonian; the upper, the Callaway of Upper Devonian age, and the lower, the Cooper of Middle Devonian age. Both formations have been described elsewhere in detail by Branson.[1]

They are here summarized as follows:

Callaway formation: Briefly the Callaway consists of finely to coarsely crystalline, usually, though not always, highly fossiliferous limestone, which in color ranges from white to gray, pink and brown. Locally the formation is sandy, the grains sometimes having a brown resinous color. Sphalerite and glauconite, white, quartzose chert and silicified fossil fragments are common to the insoluble residues, which in amount are usually small.

Locally as in Audrain County, Ts. 50 and 51, Rs. 8 and 9 W., and in other parts of central Missouri, a sandstone is developed at the base of the Callaway. This sand may be the equivalent of the Beauvais sand of Ste. Genevieve County, Missouri or the Hoing sand of western Illinois, from which oil has been produced in the Plymouth-Colmar pools in that state. This sand does not appear to be well developed in the area being described, although it may be present in the regional anticlinal area northwest of Chillicothe. It appears to have the characteristics of the St. Peter sand, and was no doubt derived from it. Because of this derivation its presence may be expected in areas such as the one mentioned where the St. Peter is structurally high and was possibly subjected to uplift, exposure and erosion prior to

[1]Branson, E. B., The Devonian of Missouri, Mo. Bur. Geology and Mines, 2nd Ser., vol. XVII, 1923.

Callaway deposition. The Callaway appears to retain its usual characteristic thickness of approximately 50 feet into Jackson County and continuing northward into the deeper part of the Forest City basin, for in the Forest City Diamond drill hole limestone highly suggestive of the Callaway occurs from 2040 to 2089 feet.

Cooper formation: As developed in central Missouri, the Cooper is composed of light gray to light brown, dense lithographic limestone. The texture is remarkably uniform over wide areas. Small crystals of calcite disseminated throughout the lithographic matrix are characteristic. Dark colored shale partings and pyrite and marcasite are common to the insoluble residues. The Cooper is also thought to be present in the Devonian section throughout the area, where it may have a thickness of approximately 25 feet or more.

Northwestward into the Forest City basin other divisions of the Devonian are present until a thickness of slightly more than 300 feet is attained. Whether or not the rocks of the expanded section are in part, Callaway and Cooper, or formations intervening between them, or older formations, is a question that cannot be answered definitely at this time.

Perhaps the most striking feature of the expanded Devonian sections, and one that may be of economic significance, is the occurrence of a poorly to well developed basal Devonian sandstone. It is nicely defined in some of the northeastern counties of the State, and is described in a report by Grohskopf, Hinchey and Greene of the Missouri Geological Survey[2], which has just been issued.

In the area of this report it is known to occur in the Wilson et al., No. 1 Glick well, NE. ¼ sec. 10, T. 57 N., R. 26 W., Caldwell County, where it rests upon the Ordovician, Kimmswick limestone. It was well developed in McCain, et al., No. 1 Frank Bermond well, sec. 26, T. 58 N., R. 34 W., Buchanan County, where the zone appeared to be 25 feet in thickness. A five-foot middle section of chert was associated with the sandstone, which here rests upon the Maquoketa shale of Ordovician age.

The sandstone was not developed as such in the Home Oil Company No. 1 Patterson well, sec. 8, T. 59 N., R. 35 W., although it was probably represented by sandy fine grained lime-

[2]Subsurface Geology of Northeastern Missouri, Mo. Geol. Surv., 60th Bien. Rept., App. I, 1939.

stone that marked the base of the Devonian in that well. It was in contact with Silurian dolomite.

The base of the Devonian was marked by light to bluish gray sandy chert in the Forest City diamond drill hole, sec. 4, T. 59 N., R. 38 W., again it was in contact with Silurian dolomite.

What is probably the basal member was found as a sandy limestone in the Keystone Oil and Gas Company well No. 1 Murphy School, sec. 5, T. 64 N., R. 26 W., Harrison County. Here the basal zone was not completely drilled, and its relations are unknown.

Samples from wells drilled in Jackson and Clay Counties do not show the presence of the basal sand and its southern limit is not defined. Its absence, also the absence of the section in the Forest City basin below what the senior author considers to be the Cooper, suggests that the limestones, dolomites and the basal sand are overlapped by the Cooper from north to south.

The problem of the subsurface stratigraphy of the Devonian can only be solved from studies of samples from wells in northern Missouri and their relation to outcrop sections in northeastern and central Missouri. In the interim the section of the Devonian as it is developed in the Forest City diamond drill hole, sec. 4, T. 59 N., R. 38 W. is presented for reference.

Devonian Section, Forest City Drill Hole.

Character	*Thickness, in feet*	*Depth, in feet*
Limestone, fine grained, earthy, fossiliferous with fine grained limestone conglomerate at base	8.5	2048
Limestone, fine grained, earthy, dark colored, fossiliferous, conglomerate and green shale at base. Uneven lower contact. Lithology is suggestive of the Callaway	42	2090
Limestone, gray, lithographic, with small disseminated, colorless, crystals of calcite, earthy and dolomitic from 2133-2136. The lithology is suggestive of the Cooper	46	2136
Dolomite, gray to brown, fine grained, porous, with dense gray speckled and quartzose chert	26	2164
Limestone, dark grayish-blue, very dense, almost lithographic, slightly earthy	11	2175
Dolomite, light to dark brown, very argillaceous	5	2180
Limestone, magnesian, bluish-gray mottled, dense to sub-lithographic. May be base of the Cooper	1	2181
Dolomite, brown, finely crystalline at top grading to more coarsely crystalline and porous at base. Earthy at 2218 and 2226 feet; chert rough white and fine sand at 2234 feet. Vugs and small cavities common from 2251-2256 feet	75	2256
Dolomite, gray, very argillaceous	36	2292
Dolomite, dark brown, white, finely crystalline, with quartzose chert	26	2318
Dolomite, light gray, argillaceous, distinct break with underlying dolomite	19	2337
Dolomite, dark brown, finely crystalline with many vugs and small cavities, argillaceous at base. Free oil obtained with ether from finely crystalline dolomite at 2356 feet	24	2361
Chert, white, bluish-gray, hard, glassy with abundance of rounded and frosted included sand grains. This is the wide spread zone at the base of the Devonian	4	2365

SILURIAN SYSTEM.

The lack of detail in the form of well samples, the distance the area of this report is removed from localities of outcrop and the lack of wells intervening between the two, are factors contributing to the lack of adequate knowledge of the Silurian in the northwestern counties of the State.

The best opportunity to study the rocks of this age as they are developed in the Forest City basin is from the cores of the Forest City diamond drill hole, sec. 4, T. 59 N., R. 38 W., Holt County. Here three lithologic divisions of the Silurian may be made and although not completely drilled the section is given below for reference:

Silurian Section, Forest City Diamond Drill Hole.

	Thickness, in feet	*Depth, in feet*
Devonian system:		
Chert, very sandy, conglomeratic	4	2265
Silurian system:		
1. Dolomite, bluish gray, crystalline, very vuggy to cavernous with holes up to 1¾ inches in diameter. Calcite is common. Casts of fossils are abundant	52	2417
2. Dolomite, bluish-gray, more finely crystalline and compactly grained than above. Vugs much smaller, and less numerous	56	2473
3. Dolomite, light grayish-brown, fine grained, very argillaceous	27	2500 Total depth

A few remarks regarding the section above may be appropriate. The cavernous nature of the dolomite in unit No. 1, suggests the work of solution prior to the deposition of the succeeding Devonian sediments. Near the base of unit No. 2, a silicified foraminifera was obtained during insoluble residue studies by John G. Grohskopf of the Missouri Geological Survey. Further studies have shown that this foraminifera may be widely distributed for Grohskopf has found it in the Silurian section in the Star Union Products Company well, T. 33 N., R. 1 E., at Peru, LaSalle County, Illinois, and again in the Atlas Powder Company well, sec. 4, T. 12 S., R. 3 W., at Wolf Lake, Union County, southwestern Illinois. In the well last mentioned it occurred in limestone, probably of the Sexton Creek (Brassfield) formation. Miss Mary Hundhausen of the Missouri Geological Survey has also noticed the occurrence of foraminifera in the cores from the Ada Belle Oil Company, No. 1 Hellman well, Trigg County, Kentucky.

Recently Dr. John R. Ball[1] of Northwestern University has made a study of specimens from the wells above cited and has tentatively identified the following:

Ammodiscus, possibly exsertus
Thurammina sp.
Psammosphaera ? or thurammina

Dr. Ball further states that these arenaceous foraminifera are found in the Brassfield and Bainbridge formations and that they occur in southeastern Missouri and southwestern Illinois. The foraminifera afford therefore a basis for a correlation of the Silurian rocks of the two areas.

The Silurian was also drilled in the Home Oil and Gas Company No. 1 Patterson well in sec. 8, T. 59 N., R. 35 W., but here the thickness was only 40 feet. The section in that well is given for reference:

	Thickness, in feet	*Depth, in feet*
1. Dolomite, very finely crystalline, slight show asphalt	10	2290
2. Dolomite, grayish-blue, crystalline	15	2305
3. As above, also fine grained and argillaceous; pyrite common	5	2310
4. Dolomite, dark colored, fine grained, earthy	10	2320
Maquoketa shale	..	....

It has not been possible to correlate definitely the section above with the section in the Forest City diamond drill hole. There is a suggestion, however, that the latter possibly penetrated the top of the basal beds of the Silurian as exemplified in the Patterson well. In any event, the overlap of the Silurian by the Devonian in the comparatively short distance between the two wells is emphasized.

It is interesting to note that a heavy asphaltic oil occurred in the samples representing the upper beds of the Silurian in the Home-Patterson well beneath the contact with the overlying Devonian. Outside of the area of this report, thick sections of the Silurian have been reported, and may be expected within the deeper portions of the Forest City basin. An interesting Silurian section was encountered in the city well at Bedford, Taylor County, Iowa, where Norton[2] originally reported the the presence of anhydrite. Grohskopf and the senior author have recently studied a set of samples from this well which

[1]Written communication to H. S. McQueen, June 18, 1938.

[2]Norton, W. H., Underground Water Resources of Iowa, Iowa Geological Survey, vol. XXI, pp. 1183-1185, 1912.

were furnished through the courtesy of Dr. A. C. Trowbridge, State Geologist of Iowa. The anhydrite section developed in the well has not been encountered to date in northern Missouri. It may occur, however, in structurally low areas in the north central counties.

ORDOVICIAN SYSTEM.

Maquoketa shale: Only two wells, McCain No. 1 Bermond, sec. 26, T. 58 N., R. 34 W., Buchanan County, and Home Oil and Gas Company No. 1 Patterson, sec. 8, T. 59 N., R. 35 W., Andrew County, have drilled the Maquoketa shale, the equivalent of the Sylvan of the Mid-Continent area. In the former it was 30 feet thick and in the latter 100 feet thick. It has also been drilled in Indian Mound Oil and Gas Company No. 1 Oak Mills, NE. ¼ sec. 13, T. 7 S., R. 21 E., Atchison County, Kansas, and in Iowa's First Oil Development Company No. 1 Wilson, sec. 24, T. 68 N., R. 37 W., Page County, Iowa.

As shown by the samples, the shale is gray to greenish gray, fissile, pyritic and fairly hard. A full sequence of samples from the Home-Patterson well is not available, but the drillers log indicates the lower part contained soft brown shale. The samples from the upper part of the shale section in that well contained small, hard, dark inclusions which may represent some organic matter. They have been classed as plant spores by some, and as a residual hydrocarbon by others. They are insoluble in ether.

Kimmswick formation: In this area, five wells have encountered the Kimmswick, which roughly corresponds to the "Viola" limestone in the Mid-Continent region. In eastern Missouri the formation is composed of three parts but consists of limestone throughout, with associated chert, the latter being particularly concentrated at the top of the middle member.

In this area limestone is present in the formation in the deep city well at Excelsior Springs, sec. 1, T. 52 N., R. 30 W., Clay County, and is also found in several wells in Jackson County. To the north and east, however, the formation changes to a crystalline dolomite, which when drilled and exhibited in well samples, shows the characteristic individual dolomite rhombs. Just where the change from limestone to dolomite takes place cannot be stated at this time, nor can any reasons for the change be ascribed.

The three divisions of the formation are also apparent in this area, although the upper division is often lacking. As in eastern Missouri, the top of the middle division is almost wholly composed of chert. In both portions of the State the senior writer believes the chert is the manifestation of an erosion surface, and in this instance marks the top of the Black River group of the Mohawkian series. The chert in western Missouri is darker than that in eastern Missouri and does not have the well developed red specks of the latter. Some of the chert is white, and suggests bleaching or leaching from weathering or solution. This chert zone is often recorded in drillers' logs as hard sand.

The upper zone or portion of the formation overlying the chert consists of bluish gray to white, or dark brown crystalline dolomite, which breaks down into individual crystals. Some white and brown chert is present, but never in large amounts. As in the eastern counties of Missouri, the insoluble residues from the upper member contain silicified cystid fragments. This part of the formation is probably Trenton in age.

The lower division is composed of more finely crystalline dolomite, varying usually in color from light to dark brown, although shades of gray are not uncommon. Small amounts of gray and brown chert and some shale are common. This division is of Black River age.

The entire formation is variable in its thickness, and the upper part is often absent, particularly when the Devonian is the overlying formation. The best development of the Kimmswick formation in northwestern Missouri is in the McCain No. 1 Bermond well, sec. 26, T. 58 N., R. 34 W., where the following figures were obtained from a study of the samples:

Member of Kimmswick	*Thickness, in feet*
Upper member	45
Middle (Chert) member	55
Lower member	90
Total thickness, in feet	190

Decorah formation: In this area the Decorah has not been drilled to the extent that a detailed description can be made of it. In the Bermond well, sec. 26, T. 58 N., R. 34 W., and the city of Excelsior Springs well, sec. 1, T. 50 N., R. 32 W., Clay County, it consisted of light to very dark brown limestone or dolomite. Chert, of like color, is sometimes sparingly present and dark green shale is present although not common to the

two wells mentioned. Bentonitic (?) gray shale occurred near the base of the formation in the Excelsior Springs well.

In the wells mentioned, the thickness varied from 35 to 56 feet respectively. Outside of the immediate area under discussion and particularly in the Union Stockyards Company well No. 3, at South Omaha, Nebraska, the formation reached a thickness of 105 feet, at least, and consisted of fossiliferous limestones and shale. Lithologically it was more like the section developed in the Upper Mississippi Valley. The Decorah formation was also present in the deep well at Nebraska City where Norton[1] reported it to be 29 feet in thickness and composed of "shale, dark green, hard, fissile, fossiliferous."

In eastern Missouri dark, reddish brown shales are found locally in the basal part of the Decorah. A similar shale was found in the Union Stockyards well at Omaha. The shale in the instances just mentioned will burn upon ignition.

St. Peter sand: The St. Peter has been reached in nine wells in the area, of which five penetrated it. Complete samples are available for study from only one well, McCain et al. No. 1 Bermond, sec. 26, T. 58 N., R. 34 W., Buchanan County. Here the sand was 105 feet in thickness and consisted of white, fine to medium grains; usually rounded and frosted. Some secondary enlargement was apparent. In some wells, outside the area, green shale is present in the middle zone, in some instances at the base of the sand. It may be of Everton age, as may certain sandy dolomites which often underlie it. The Everton and the St. Peter are intimately associated.

The available records suggest that the St. Peter sand may be present throughout the area. It will probably vary greatly in thickness, however, and may range from the 16 feet recorded in the Union Stockyards well at Omaha, Nebraska, to the outstanding and unusual thickness of 403 feet in the F. J. Kasper No. 1 James well, NW. ¼ NE. ¼ NW. ¼ sec. 8, T. 13 S., R. 25 E., Johnson County, Kansas. The writers are confident that the thickness of sand reported for that well is correct. A fine and complete set of samples was collected by the driller, Mr. B. Earl Smith, Olathe, Kansas, who also kept an accurate and detailed log. In addition the well was visited almost daily by the junior author, who observed the drilling of a considerable portion of the sand section. Insofar as the writers know, this

[1]Norton, W. H., Underground Water Resources of Iowa, Iowa Geological Surv., vol. XXI, p. 1107, 1912.

is the greatest thickness of St. Peter sand recorded in this area, although Thwaites[1] mentions a thickness of 460 feet in a well at Malta, DeKalb County, Illinois. In the Kasper-James well, the unusual thickness is attributed in part to channel filling. The entire sections of the Jefferson City and possibly Cotter formations of Canadian age, which are usually present beneath the St. Peter, are missing and a detrital zone of chert, shale and sand, 35 feet in thickness, intervenes between the St. Peter sand and the Roubidoux formation.

In eastern Missouri, the St. Peter sand is overlain by the Joachim dolomite, which in turn is followed by the Plattin limestone. The last mentioned is succeeded by the Decorah formation. In the northeastern part of the State, the Joachim and Plattin are greatly reduced in thickness as compared with southeastern Missouri. A study of well logs show that from eastern to western Missouri these formations are overlapped, and the Decorah and, in places, the Kimmswick formations are in contact with the St. Peter sand. These overlaps within the Ordovician may be of economic significance.

PRE-ST. PETER ROCKS.

The section below the St. Peter sand includes the Lower Ordovician and Upper Cambrian formations, or the Canadian, Ozarkian, and Upper Cambrian of E. O. Ulrich. In the central Ozark region this group of rocks, when fully developed, will attain a thickness of about 2,000 feet. In western Missouri (Jackson county) the section has thinned to approximately 1,000 feet. This regional thinning appears, from limited data, to continue in a northwestward direction, and involves each of the major divisions of the section under discussion.

The section probably has not been completely drilled in the area of this report although there is the possibility that the La Salle Oil and Gas Company No. 1 Hartsook well, NW. ¼ SW. ¼ sec. 29, T. 52 N., R. 34 W., Platte County was completed in the pre-Cambrian. If so, the section probably totalled 1,145 feet in thickness. Adjacent to the area, the section being described has been drilled in Indian Mounds Petroleum Co. No. 1 Oak Mills, NE. ¼ sec. 13, T. 7 S., R. 21 E., Atchison County, Kansas, where the total thickness of the section was 655 feet. This section in Iowa's First Oil Development Com-

[1]Thwaites, F. T., Stratigraphy and Geologic Structure of Northern Illinois, Illinois Geological Survey, R. I., No. 13, p. 20, 1927.

pany No. 1 Wilson, SE. ¼ SE. ¼ sec. 24, T. 68 N., R. 37 W., Page County, Iowa, had a total thickness of 567 feet. This well is commonly known as the Clarinda well.

The formation represented in the foregoing wells may be briefly described as follows:

CANADIAN SYSTEM.

The upper part of the Canadian system is represented by the Cotter and Jefferson City formations, both of which are composed of dolomite, with varying amounts of chert of different types. The lower portion of the Canadian is composed of dolomite and sandstone, which constitute the Roubidoux formation. The total thickness of the Canadian as developed in the Clarinda well is 145 feet, although the upper 55 feet of dolomite may be of Everton (Ordovician) age.

OZARKIAN SYSTEM.

The formations of this period consist of cherty dolomite representing in descending order the Gasconade-Van Buren, Eminence and possibly Potosi formations. These formations were represented in a poor set of samples from the well in sec. 13, T. 7 S., R. 21 E., Atchison County, Kansas, where they aggregated 275 feet in thickness. The same interval, according to Earl McCracken[1], is 143 feet in the Clarinda well.

CAMBRIAN SYSTEM.

The Bonne Terre formation, consisting of light to dark colored finely crystalline dolomite, with light green shale is present in a few deep wells. It is followed by the La Motte sand, which is much thinner than in the Ozark region. The thickness of the Cambrian in the Clarinda well was 257 feet.

That the northward overlap of the St. Peter continues, is suggested by well No. 3, Union Stock Yards Company, Omaha, Nebraska, where McCracken[2] reports the Canadian formations to be absent and the Ozarkian to underlie the St. Peter immediately. The entire pre-St. Peter sedimentary section was absent in the deep well at Nebraska City and the St. Peter is reported[3] to rest upon pre-Cambrian rocks. This relationship

[1]Personal communication.
[2]Personal communication.
[3]Condra, G. E., Schramm, Lugn, O. L., Deep Wells of Nebraska, Nebraska Geological Survey, Bull. 4, 2nd Ser., pp. 89-109, 1931.

probably occurs elsewhere, and is further evidence of the regional thinning of the section under discussion.

PRE-CAMBRIAN ROCKS.

Information pertaining to these rocks is limited as samples from only two wells adjacent to the area are available.

In Indian Mounds Oil Company No. 1 Oak Mills, sec. 13, T. 7 S., R. 21 E., granite was encountered at 2,855 feet.

In Iowa First Oil Development Company No. 1 Wilson SE. ¼ SE. ¼ sec. 24, T. 68 N., R. 37 W., Page county, Iowa, quartzite was found at 3,570 feet and was drilled to a total depth of 5,286 feet.

STRATIGRAPHIC SUMMARY.

The stratigraphy of the area is best summarized by the two cross-sections presented in this report. Cross-section No. 1 (Pl. VI) extends from the diamond drill hole, No. 1 Davis sec. 4, T. 59 N., R. 38 W., near Forest City, Holt County to a point within the city of St. Louis, and is designed to show general stratigraphic details and the variations in the sections in the western, central and eastern portions of the State. Briefly, the following significant features are brought out:

Eastward from the Forest City basin, thinning is apparent in the Cherokee formation. Similarly, the Silurian formation is overlapped by the Devonian which finally rests in comparatively short distances upon limestones of Ordovician age. This relationship prevails into east central Missouri. East of the general area of Centralia and Mexico, (T. 51 N., Rs. 8 and 11 W.) the Devonian rests on various formations of the Ordovician ranging from Joachim to Decorah. In this connection it is interesting to note that east of the general latitude of Mexico, T. 51 N., R. 9 W., the normal eastern Ordovician section is present, but to the west the lower formations of that section are absent and the higher beds (Kimmswick) are in contact with the St. Peter sandstone. This section also indicates very strikingly the fact that while all of the formations of the Mississippian known to the St. Louis area are present in western Missouri, they occur in diminished thickness.

This section also expresses the regional overlap of the Pennsylvanian-Cherokee formation upon formations of Mississippian age. It likewise demonstrates the structurally high area which prevails in central Missouri from a point near Chilli-

cothe, T. 58 N., R. 24 E., to a point near Wentzville, T. 47, R. 1 E., Warren County.

It should also be noted that this section shows in a general way the occurrence of sand and sandy limestone in formations of Devonian age. One sand is developed at the base of the Devonian limestones. This sand is indicated by a poor set of samples from the city well at Chillicothe, sec. 2, T. 57 N., R. 24 W., Livingston County, and from the well drilled by Wilson et al. No. 1 Glick, sec. 10, T. 57 N., R. 26 W., Caldwell County. It marks the base of the Devonian in the McCain No. 1 Bermond well in sec. 26, T. 58 N., R. 34 W., Buchanan County. It was only slightly developed in the diamond drill hole at Forest City.

This section also indicates the possible development of a younger sandstone of Devonian age which may mark the base of the Upper Devonian-Callaway limestone. If this interpretation is correct it is approximately the equivalent of the Hoing sand from which production has been obtained in the Colmar and Plymouth pools in western Illinois. This sand is particularly well developed in central Missouri. Its typical development within the area of this report however has not been positively determined.

Cross-section No. 2 (Pl. VII) is drawn at right angles to the axis of the Forest City Basin as it is developed and reflected by the Lower Cherokee formation of basal Pennsylvanian age. It extends from Nebraska City, Nebraska to a point near Kansas City, Missouri. It shows most significantly the thickening and thinning of the Cherokee shale, the regional thickening southward of all units of the Mississippian, the thinning of the Kinderhook shale of Mississippian age, the thinning of the Devonian limestones and their overlap upon rocks ranging from Silurian dolomite through Ordovician-Maquoketa shale, and finally direct contact with the underlying cherty limestones and dolomites of Ordovician age. A general thinning of the Ordovician is also indicated.

The section likewise demonstrates, as previously expressed, the absence of pre-St. Peter rocks in the deep well at Nebraska City. It will be noted that the scale employed in this section results in considerable horizontal and vertical exaggeration. This exaggeration has been employed in order to bring out the lithologic details along the line traversed by this section.

OCCURRENCE OF OIL AND GAS.

Within the area of this report, gas has been produced commercially in Platte, Clay, Ray and Clinton counties. A small amount of oil has been produced from one well in sec. 2, T. 50 N., R. 33 W., Clay County and one well in sec. 7, T. 50 N., R. 33 W., Platte County. Descriptions of the gas pools are given in another part of this report. This production has been from sands or black shales of Pennsylvanian age. In the Illinois basin and in the Mid-Continent area, both oil and gas have been produced from deeper and older beds.

In Illinois the most important sands are of Chester age, a group which is possibly thinly represented in northwestern Missouri. It can be stated rather definitely that the Chester is only a minor part of the section in northwestern Missouri, and probably nowhere within the area does it reach the development attained in the Illinois basin.

In the Mid-Continent region, pre-Pennsylvanian production is obtained, in descending order, from the "Mississippi lime", the "Hunton lime" (Siluro-Devonian) Viola (Kimmswick) limestone, various formations of the Simpson (Decorah-St. Peter) and the Arbuckle or "Silicious lime" (Canadian, Ozarkian and Cambrian). All of these beds have been found in drilling in western or northwestern Missouri and are discussed in detail in another part of this report.

In the meagre amount of drilling which has been done in northwest Missouri, aside from the producing areas already mentioned, drillers' logs report showings of oil or gas. It is not the purpose of this report to go into detail on the subject of reported showings although they are shown on the base map, Plate I, of this report. Such a wide variety of circumstances may be involved, that a reported showing can neither be verified or denied in many cases. Where cuttings or cores have been saved under circumstances with which the Survey is familiar, a much better conception of the importance of the showing can be formed. Some of the shows that can be listed with some certainty are given below:

Andrew County: Home Oil and Gas Co. No. 1, Patterson, sec. 8, T. 59 N., R. 35 W., samples of cuttings show asphaltic oil in Devonian limestone and dolomite, 2165-2180 feet, 2195-2200 feet. In the Silurian but immediately below the Devonian contact, from 2280 to 2290

feet. The Driller's log also reported asphalt from 1993 to 2080 feet in the Devonian; and in the Kimmswick (Viola) near the bottom of the hole, 2516 feet.

Buchanan County: McCain et al. No. 1 Frank Bermond, sec. 26, T. 58 N., R. 34 W. Samples show oil in coarse grained, angular sandstone in Lower Cherokee formation, depth 1035-1055 feet. Oil also shows in the samples of the basal Cherokee, fine grained sand from 1215-1235. There was also a slight trace of dead oil in the samples of the Upper Kimmswick (Ordovician) dolomite, 2130-2150 feet.

Showings of gas have been reported in the well of the Atchison Oil and Gas Syndicate in the northeastern part of Platte County.

In the vicinity of Cameron gas showings have been found in northwestern Caldwell County, T. 57 N., R. 29 W., and northeastern Clinton County, T. 57 N., R. 30 W.

The results of past drilling operations within the area of this report, which constitutes 7,384 square miles, are interesting to note. There have been a total of 158 wells drilled which penetrated the section as low as the Cherokee formation of Pennsylvanian age, or the underlying formations ranging from Mississippian to and through the St. Peter sand of Ordovician age. Of the total number of wells drilled, 107 of them were completed in the Cherokee formation and of these completions 78 of them were located in Clay, Clinton, Platte and Ray counties, or in those counties adjacent to or near the general areas in which gas and oil have been obtained from Lower Pennsylvanian beds at comparatively shallow depths. In the other counties drilling into the Cherokee has been extremely limited with the possible exception of Harrison County where 14 wells have been completed in this formation. Thirty-four of the total number of wells were completed in rocks of the Mississippian age and of that total, 21 were completed in the 4 counties just mentioned above.

Within the area outlined, drilling below the Mississippian has been extremely limited and only 6 wells have been completed in the Devonian; 1 in formations of Silurian age, the two constituting the Hunton formation of the Mid-Continent Region; 1 in limestones of Ordovician (Viola ?) age, 4 in the Ordovician-St. Peter sand, and 5 in the Canadian and Ozarkian

TABLE I. SHOWING WELLS OF RECORD COMPLETED IN CHEROKEE (PENNSYLVANIAN) OR OLDER FORMATIONS IN AREA OF THIS REPORT.

Does Not Include Producing Wells in Developed Areas.

Name of county.	No. wells completed in Cherokee Lower Pennsylvanian formation.	No. wells completed in Mississippian formations.	No. wells completed in Devonian formations.	No. wells completed in Silurian formations.	No. wells completed in Ordovician limestone above St. Peter sand.	No. wells completed in Ordovician-St. Peter sand.	No. wells completed below St. Peter sand.	Grand total.
Andrew	1	1			1			3
Atchison	1	1	1					3
Buchanan	1	3	1				1	6
Caldwell	1		1			1	1	4
Clay	43	12	1			1		57
Clinton	11	3						14
Daviess	3						1	4
DeKalb								
Gentry	1	1						2
Harrison	14	3	2					19
Holt	1 ?			1				2
Nodaway	4	2						6
Platte	13	4				1	1	19
Ray	11	2				1	1	15
Worth	2	2						4
Total number	107	34	6	1	1	4	5	158
% of total	67.72	21.52	3.80	0.63	0.63	2.53	3.17	100.00

dolomites which underlie the St. Peter sand. The latter wells in Practical Mid-Continent terminology, encountered the "Arbuckle" or "Siliceous lime." The statistical information presented is summarized in Table 1, which shows the total number of wells of record and the formation in which they were completed, the Cherokee formation of Lower Pennsylvanian being taken as the upper formation. In so far as the writers know, there have been no wells in this immediate area that can be definitely described as reaching pre-Cambrian rocks although one in Platte County possibly did so.

From the foregoing and from an analysis of Table I it is apparent that the area under consideration cannot be classed as one in which the possibilities have been definitely determined as the result of any great amount of drilling. Whether or not the deep tests drilled in this area were located favorably with respect to geologic structure is a question that cannot be answered in every case. An analysis, however, by the writers indicates that but few of them have been so situated. They are as follows:

Charles Petroleum Company No. 1 Clark, sec. 28, T. 60 N., R. 35 W., Andrew County. Total depth 1434 feet, completed in the top of the Mississippian limestones. Lower section is untested.

Wilson et al. No. 1 Glick, NW. cor. NE. ¼ SE. ¼ NE. ¼ sec. 10, T. 57 N., R. 26 W., Caldwell County; also Breckenridge Oil and Gas Company No. 2 Glick, 360 feet west of No. 1. Tested the Canadian (Arbuckle) dolomite. These wells were located on the Breckenridge anticline, a structural feature mapped by the Missouri Geological Survey.[1]

Unknown Company, No. 2 Penny, sec. 1, T. 65 N., R. 31 W., and same, No. 1 Porter, sec. 12, T. 65 N., R. 31 W. Dry. Tested the top of the Mississippian. Located favorably with respect to regional structure, but local detail is unknown.

In considering this summary of the results of drilling in northwestern Missouri, it would be interesting to know the facts bearing upon the location of some of the wells, but in too many cases this information is not available. In some instances wells have been drilled in areas with few or no rock outcrops and

[1]Wilson, M. E., Occurrence of Oil and Gas, Missouri Bureau of Geology and Mines, vol. XVI, Plate 10, 1922.

before core drilling and geophysical methods of exploration came into general use, and no reason is apparent for selecting the locations at which certain wells have been drilled.

The selection of many drilling sites in the gas producing counties, Clay, Clinton, Platte and Ray, was based on geologic work, as for example, the Paradise pool in Clay County. Wells at Breckenridge, Gower and the second test at Savannah were based on geologic mapping. The structural relation of the two holes near Grant City, Worth County, strongly suggest that geologic information was available in selecting the locations, but such is not known to be the case.

It is believed the drilling of two deep holes at Tarkio, Atchison County, was caused by the discovery of marsh gas in a shallow water well in Tarkio River bottoms.

The locations of the two deep holes near Quitman, Nodaway County, may have been determined by erroneous correlations of surface outcrops.

Some of the reasons for selecting the sites of the remaining holes may be grouped as follows:

(1) Drilled primarily as a coal prospect, oil and gas not considered or considered as a secondary objective.
(2) Drilled for water supply.
(3) No reason apparent as area has little or no surface control.
(4) No reason apparent as outcrops in area do not show any reverse dip.
(5) Site selected by reason of civic pride, topographic or other resemblance to some known procuding area, "doodle bug" or other type of pretended oil-finding device, promotion, or "hunch".

In conclusion it may be stated that the proportion of wild cat wells drilled in northwest Missouri on scientifically selected sites is probably very low.

DEVELOPED GAS FIELDS.

CLINTON COUNTY.

Hammond (North Plattsburg) Gas Pool.

Location and area. This pool was discovered in 1933 by Mr. R. M. Hammond. It covers approximately 320 acres in sections 18 and 19, T. 55 N., R. 31 W., and sec. 13, T. 55 N., R. 32 W., Clinton County, Missouri. A dry hole was drilled on the northwest edge of the pool in sec. 12, T. 55 N., R. 32 W.

Outcropping formations. The upland in this area is upheld by the Stanton and Plattsburg limestones of the Lansing group. Some of the valleys have been eroded into the upper part of the Lane shale.

Producing horizons. There are three producing horizons, in descending order, the Peru sand and the black shale at the Lexington coal horizon, both in the Labette shale and the Squirrel sand. In addition, showings have been found at several horizons in the Kansas City group. Most of the wells produce both the Peru sand and Lexington black shale gas, but two have been drilled to the Squirrel, and one of them, Porter No. 8, had an initial open flow of 2,149,000 cubic feet.

Log of R. M. Hammond No. 8 Porter, SE. 1/4 sec. 18, T. 55 N., R. 31 W., Clinton County, Missouri. Completed December 4, 1936. Located between Porter No. 3 and No. 4. Elevation, 1007 feet, P. T.

	Thickness, feet	*Depth, feet*
Quaternary:		
Dark soil	2	2
Yellow sandy clay—water	19	21
Pennsylvanian:		
Lansing formation:		
Lime	12	33
Dark blue shale	4	37
Lime	2	39
Dark shale	2	41
Lime	1	42
Gray shale	3	45
Lime	20	65
Gray shale	20	85
Lime hard	2	87
Light shale sandy	38	125
Kansas City formation:		
Lime	8	133
Light shale	1	134
Hard lime	2	136
Light shale	7	143
Lime	9	152

R. M. Hammond No. 8 Porter—Continued.

	Thickness, feet	*Depth, feet*
Dark shale	17	169
Lime	5	174
Shale	12	186
Lime	4	190
Gray shale sandy	24	214
Lime	9	223
Light shale	2	225
Lime	5	230
Light shale	15	245
Lime (Winterset)	25	270
Black shale—gas bubbles	8	278
Lime (Bethany Falls)	19	297
Shale dark—gas bubbles and a little water	2	299
Lime (Hertha)	15	314
Pleasanton formation:		
Light sandy shale—few gas bubbles at 333 feet	29	243
Lime	2	345
Gray sandy shale	60	405
Red bed	9	414
Green shale	10	424
Light shale, sandy	13	437
Lime	1	438
Light shale	12	450
Lime	4	454
Henrietta formation:		
Gray shale	23	477
Lime	6	483
Light shale	4	487
Peru sand—gas 33,000 cu. ft	3	490
Dark shale	6	496
Lime	2	498
Dark shale—no gas	6	504
Lime	2	506
Black shale—little water	3	509
Gray shale	5	514
Light shale	6	520
Lime	3	523
Dark shale	8	531
Lime	2	533
Light shale	2	535
Lime	2	537
Cherokee formation:		
Gray sandy shale	18	555
Sand—somewhat broken—gas	18	573
Sand—gas	17	590
Black sand—gas	5	595
Light sand, hard—no increase	3	598
		Total depth

Gauges: at 555 feet ..... 13,130 cubic feet
at 570 feet ..... 17,685 cubic feet
at 575 feet ..... 285,120 cubic feet
at 580 feet ..... 993,000 cubic feet
when tubed ..... 2,149,000 cubic feet

Casing: 8¼" at 23', 6¼" at 424', 4⅞" at 514'.

Structure. The data available are not sufficient to permit an accurate delineation of the structure (Fig. 2). There is a dome in sec. 18, elongated in a northwest-southeast direction, with two structural noses extending to the northwest. These

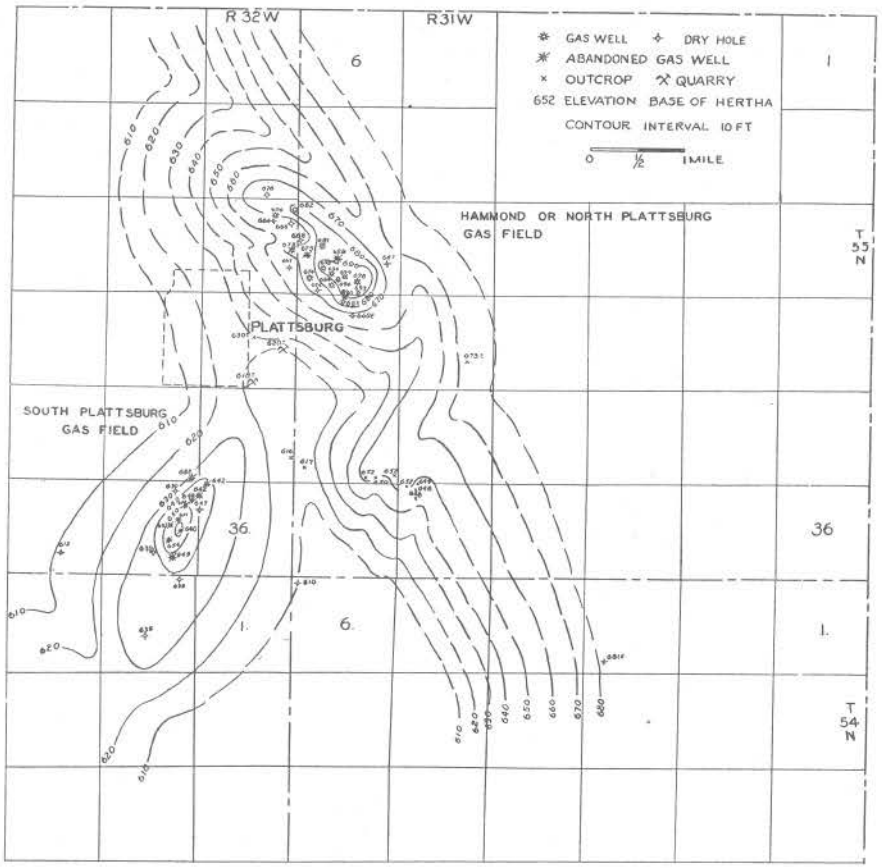

FIG. 2. Structure contour map, Hammond (North Plattsburg) and South Plattsburg gas pools.

features cause the entire pool to have a northwest-southeast trend.

Production. Porter No. 2, with an initial open flow of 2,332,000 cubic feet from the Peru sand, is the largest well ever recorded in northwestern Missouri, and Porter No. 8, mentioned above, is the second largest. The gas is piped into Plattsburg.

South Plattsburg Gas Pool.

Location and area. The South Plattsburg pool was discovered in 1930. It covers about 320 acres mainly in the east half of sec. 35, T. 55 N., R. 32 W., Clinton County, Missouri. At the northern end, the pool extends slightly into secs. 25, 26, and 36. An attempt to extend it south into sec. 2, T. 54 N., R. 32 W., resulted in a dry hole.

Outcropping formations. Wells in this area start in the Stanton or Plattsburg limestone, or in the upper part of the Lane shale of the Lansing group.

Producing horizons. The main gas sand is the one usually termed the Peru by drillers in western Missouri. It is a member of the Labette shale. Commercial amounts of gas have also been found in the black shale of the Lexington coal horizon and in the Knobtown sand. Good showings have been found in the top of the Winterset limestone and in the Galesburg and Ladore shale.

The Peru sand ranges in depth from 410 to 500 feet.

Structure. The South Plattsburg pool is on a small dome elongated in a NNE. and SSW. direction. The structure is shown on Figure 2. The probable closure is about 30 feet.

Production. Two of the early wells had an initial open flow of 800,000 and 1,175,000 cubic feet, respectively. This encouraged rather close drilling, which soon exhausted the gas. Ten producing wells and four dry holes have been drilled.

Lathrop Gas Pool.

(See Fig. 3)

Location and area. The Lathrop pool is in secs. 21, 22, and 28, T. 55 N., R. 30 W., Clinton County. There are seven producing wells in an area of approximately 400 acres. Gas was first found in this area in 1921, but most of the wells were drilled in 1930 and 1931.

Outcropping formations. In the immediate area of the pool the Pennsylvanian rocks are covered by 60 to 85 feet of glacial drift, below which structurally high wells enter the Lane shale. Wells to the north and south of the dome encountered the basal part of the Plattsburg limestone below the drift.

Producing horizons. The main production is obtained from the Knobtown sand, at a depth ranging from 275 to 325 feet. Showings of gas are reported in the Galesburg and Ladore shales.

Several wells have been drilled below the Knobtown sand. One well located structurally found a showing of gas in the upper Labette sand and a flow of 100,000 cubic feet at what is probably the Lexington coal horizon. An off-structure well was drilled to the "Mississippi lime" which was found at a depth of 1,037 feet (703 feet below Bethany Falls and 686 feet below Hertha). The log of the well is as follows:

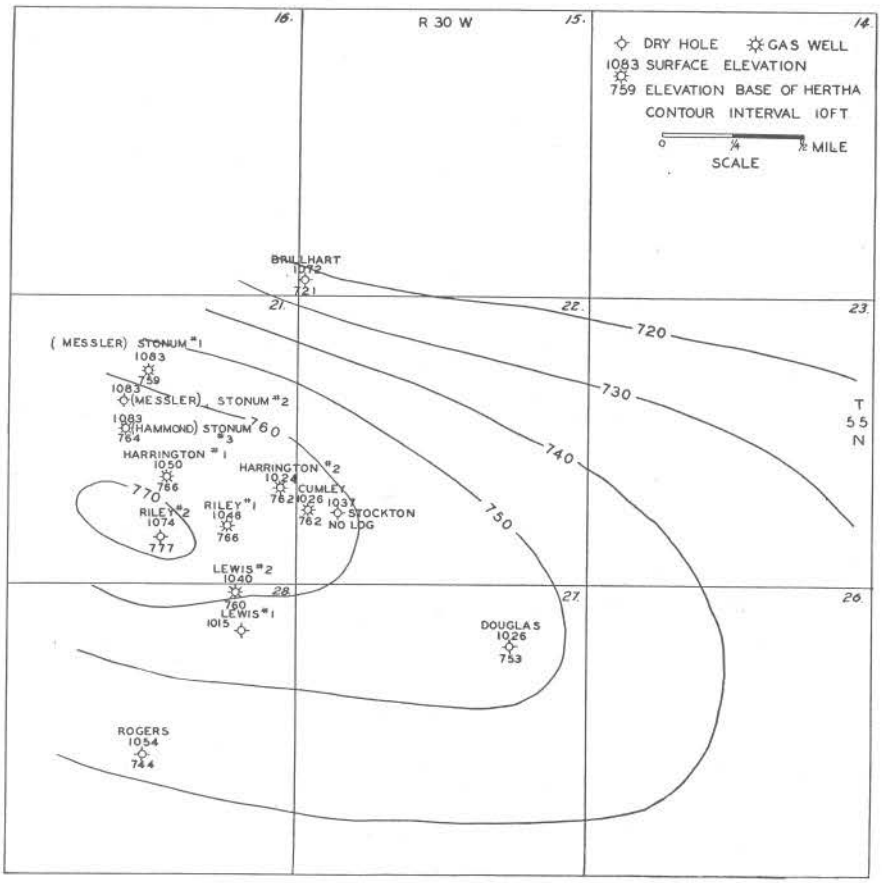

FIG. 3. Structure contour map, Lathrop gas pool.

Log of Messler Gas Company No. 1, Glen Brilhart. Location: SW. 1/4 SW. 1/4 SW. 1/4, sec. 15, T. 55 N., R. 30 W., Clinton County, Mo. Elevation: 1,072 feet. Completed in 1931. Well No. 12 on Map, Pl. I.

	Thickness, feet	*Depth, feet*	
Pleistocene series:			
Soil	2	2	
Clay, white	41	43	
Yellow clay and quicksand	22	65	(Water.)
Pennsylvanian system:			
Lansing group:			
Lime (Plattsburg)	18	83	
Gray shale	14	97	
Lime	2	99	
Gray shale	4	103	
Gray shale	6	109	
Lime, hard	4	113	
Gray shale	3	116	
Dark shale	17	133	
Lime	2	135	
Gray shale	30	165	

Messler Gas Company— Continued.

	Thickness, feet	*Depth, feet*	
Kansas City group:			
Lime (Iola)	5	170	
Gray shale	4	174	
Lime (Raytown)	7	181	
Gray shale	8	189	
Black shale	1	190	
Gray shale	10	200	
Lime (Cement City)	7	207	
Red bed	2	209	
Gray shale	16	225	
Lime	6	231	
Gray shale	28	259	
Lime	5	264	
Gray shale	13	277	
Lime	1	278	
Gray shale	4	282	
Lime (Winterset)	26	308	
Black shale	4	312	
Lime (Bethany Falls)	22	334	
Black shale	3	337	
Lime (Hertha)	14	351	
Pleasanton group:			
Gray shale	9	360	
Red bed	4	364	
Gray shale	3	367	
Sand	18	385	
Sandy shale	40	425	
Gray shale	25	450	
Green shale	10	460	
Sand	5	465	(Gas bubbles 464.)
Sand and lime	10	475	
Sand	8	483	
Brown shale	7	490	
Gray shale	10	500	
Henrietta group:			
Brown lime	8	508	
Sandy shale	17	525	
Lime (Pawnee)	5	530	
Water sand (water)	8	538	
Lime	3	541	
Black shale (Lexington horizon; water)	2	543	
Broken lime (Set 6¼ casing)	5	548	
Sandy lime (Light, showing oil)	7	555	
Green shale	9	564	
Black shale	1	565	
Sandy shale (gray shale)	11	576	
Lime	5	587	
Sandy lime (white)	6	593	
Sandy shale	27	620	
Sandy lime	7	627	
Cherokee group:			
Gray shale	15	642	
Sandy shale	8	650	
Gray shale	26	676	
Lime	2	678	
Gray shale	3	681	
Black shale	2	683	(Rich Hill.)
Gray shale	3	686	
Lime	6	692	
Sandy shale	22	714	
Lime	3	717	
Red bed	1	718	
Gray shale	16	734	
Black shale	2	736	

Messler Gas Company—Continued.

	Thickness, feet	Depth, feet	
Gray shale	11	747	
Lime	6	753	
Gray shale	27	780	
Dark shale, hard	25	805	(Cavy.)
Gray shale, shelly	122	927	
Lime	5	932	(Light oil showing.)
Sand, light	44	976	
Dark shale	4	980	
Sand	5	985	
Dark shale	2	987	
Lime	5	997	
Gray shale	7	1000	
Dark shale	37	1037	
Mississippian system:			
Hard lime	13	1050	(Miss. lime) T. D.

Structure. The Lathrop dome is elongated in a northwest-southeast direction. There is a closure of at least 25 feet and a northeast dip of 62 feet (Fig. 3).

Production. The initial open flow ranges from 75,000 to 200,000 cubic feet.

CLAY COUNTY.

Avondale Gas Pool.

Location and area. This pool covers the area of the Avondale townsite and the surrounding region in secs. 6 and 7, T. 50 N., R. 32 W., Clay County, Missouri. It covers nearly one and a half square miles. The total number of producers, as nearly as can be ascertained, is 56. The pool was opened in 1930.

Outcropping formations. In most of the area the top of the Winterset limestone is the first hardrock formation encountered below the thick blanket of loess and drift, and in the valleys the Winterset and Bethany Falls limestones appear at the surface. The thickness of the loess and drift corresponds closely to the height of the hills; wells on the hills in the SE. ¼ sec. 7, where the elevation is around 900 feet above sea level, penetrated about 100 feet of clay and sand.

Producing horizons. All the gas-bearing formations from the Knobtown sand to the Squirrel sand show gas in the Avondale pool, but the upper showings are usually passed up, and the wells completed in the black shale at the Lexington coal horizon or in the Squirrel sand. The Squirrel sand here occurs in the lower part of the zone at a depth of 400 to 500 feet. The Lexington black shale is about 200 feet below the Hertha limestone and the top of the Squirrel sand 300 to 325 feet below the Hertha.

Two holes, one on the east side of the pool and one on the west side, both structurally low, have been drilled below the Squirrel sand. The Williams well in the NE. ¼ NE. ¼ sec. 7, drilled to 530 feet, reported water in the so-called Bartlesville sand. The Fry well, in the SW. ¼ NW. ¼ sec. 7, was drilled to 618 feet, but did not find good sand in or below the Squirrel zone. The "Mississippi lime" is estimated to be about 625 to 650 feet below the base of the Hertha. The following is a typical log.

Log of Baker, Steenstry and Skinner's Shippe No. 1. Location: SE. 1/4 SW. 1/4 SE. 1/4 sec. 6, T. 50 N., R. 32 W., Clay County, Mo. Elevation: 874 feet. Commenced May 24, 1930.

	Thickness, feet	*Depth, feet*
Pleisotcene series:		
Soil and clay	35	35
Sand	20	55
Pennsylvanian system:		
Kansas City group:		
Lime	3	58
Black slate	2	60
Gray shale	5	65
Coal	2	67
Gray lime	28	95
Gray shale	6	101
Lime	21	122
Dark shale	3	125
Lime	2	127
Dark shale (gas bubbles)	1	128
Lime	15	143
Pleasanton group:		
Gray sandy shale	7	150
Sand (gas)	6	156
Gray shale	78	234
Sand (trace of oil and bubbles of gas)	11	245
Gray shale	2	247
Red bed	5	252
Gray shale	8	260
Lime	12	272
Gray shale	3	275
Red bed	7	282
Green shale	6	288
Gray shale	6	294
Henrietta and Cherokee groups:		
Lime	1	295
Light shale	12	307
Sand (gas, light showing of oil)	7	314
Gray shale	11	325
Black slate	1	326
Gray lime	4	330
Gray shale (S. L. M. 335)	15	345
Lime	5	350
Black slate (gas good)	3	353
Dark shale	7	360
Gray shale	20	380
Light shale	6	386
Lime	4	390
Light shale	5	395
Sandy shale	5	400

Log of Baker, Steenstry and Skinner's Shippe No. 1—Continued.

	Thickness, feet	*Depth, feet*
Gray shale	24	424
Black lime (S. L. M. 427)	3	427
Slate	3	430
Gray shale	15	445
Dark shale	7	452
Sand and lime	3	455
Sandy shale (S. L. M.)	20	475* Total depth

Packer set 347, 65′ casing.

*Base of Cherokee not reached.

Structure. The map of the Avondale pool (Fig. 4) is based on a restudy of the well locations and elevations by a plane table party. In a few instances there are inaccuracies in logs that can not be explained and interpreted, in other cases it has been necessary to recalculate the datum bed from a comparison of the plotted logs.

Although rather irregular in contour, the axis of the fold has a north-south alignment, dipping to the east and west, and plunging to the south. The control on the north is incomplete. As may be seen from the map, there is no definite dry-hole line.

Production. When the pool was first drilled in 1930, the larger wells had an initial open flow volume of 500,000 cubic feet, but rapid development and close spacing of the wells caused later wells to show much less, and ultimately to cause the volume of all the wells to drop off rapidly and shorten the life of the field. It should be noted again that the only deep tests of which the Survey has obtained records, were not located properly to test the lower sands. If deeper production exists here, it is most likely to be found in wells drilled within the 740-foot contour.

Liberty Gas Pool.

Location and area. The Liberty pool is situated in the southeastern part of T. 52 N., R. 32 W., Clay County in sec. 25, 26, 34, 35 and 36. Fifteen gas wells and nine dry holes have been drilled in the pool, which was first discovered in 1931.

Outcropping formations. In general this pool is on a high escarpment capped by the Plattsburg limestone. Some of the wells start below the Plattsburg in the Lane shale and in others on the highest points, some glacial drift overlies the Plattsburg. The surface elevation ranges from a little above 900 feet to 1,044 feet above sea level.

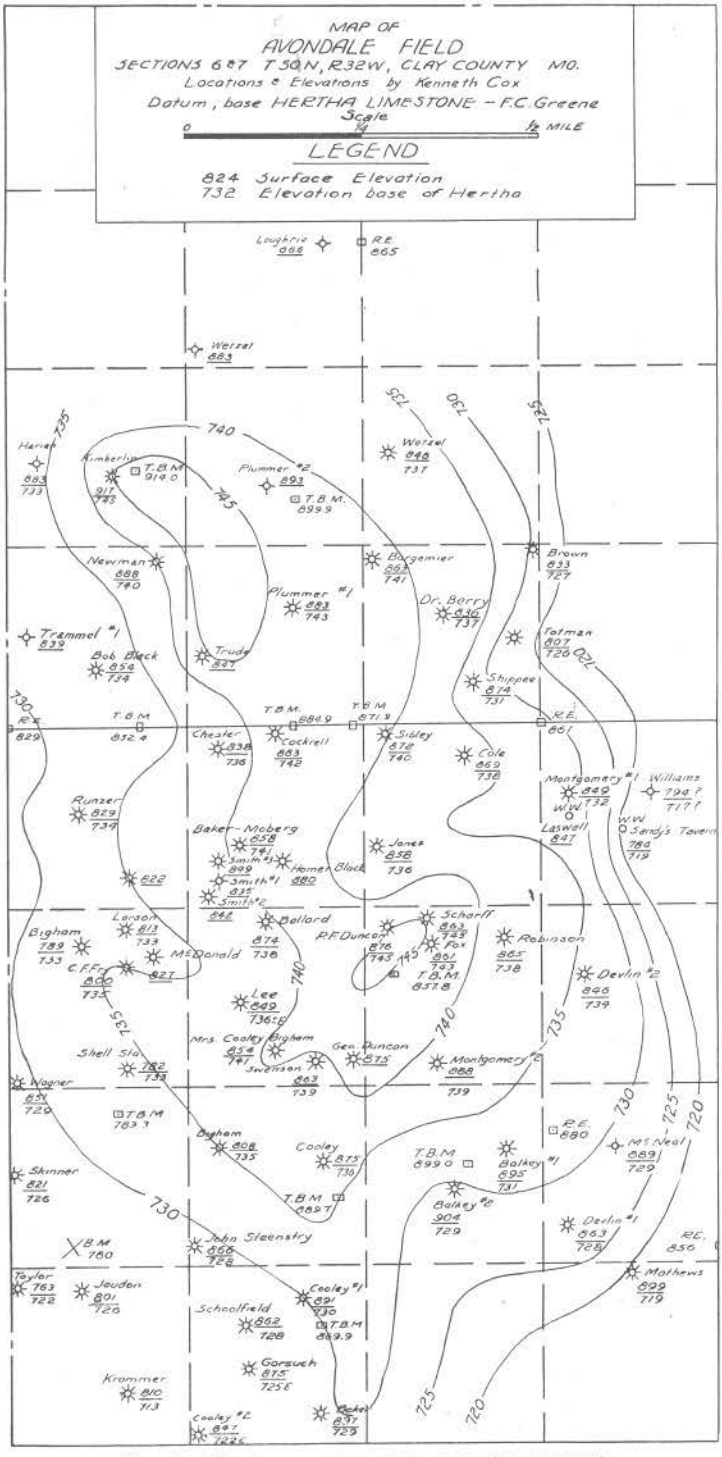

FIG. 4. Structure contour map, Avondale gas pool.

Producing horizons. The Hertha limestone at the base of the Kansas City group is found at an average depth of 300 feet, the Wayside sand at 400 feet and the Lexington shale gas horizon at 500 feet. Showings of gas are encountered in the black shale in the Galesburg, in the Knobtown sand and in other beds between the Wayside and Lexington, but these two are the main horizons. One well penetrated the black shales at the Summit and Mulky coal horizons and went into the Squirrel sand zone where only sandy shale was found. No gas showings are reported below the Lexington shale gas horizon. The following log is typical of the pool:

Log of Hall et al. Land No. 1. Location: Cen. NW. 1/4 SE. 1/4 sec. 35, T. 52 N., R. 32 W., Clay County, Mo. Elevation: 987 feet. Drilled May 3 to 15, 1931.

	Thickness, feet	*Depth, feet*
Recent series:		
Soil	3	3
Shale and boulders—water	7	10
Pennsylvanian system:		
Lansing group:		
Lime	10	20
Gray shale	23	43
Lime	3	46
Shale, gray	14	60
Sandy shale—water	30	90
Kansas City group:		
Set 6¼" at 91'.		
Water shut off O. K.		
Lime	22	112
Shale, gray	21	133
Lime	6	139
Black slate	2	141
Lime	1	142
Shale, gray	12	154
Lime	5	159
Shale, dark	5	164
Lime	14	178
Shale, dark	20	198
Lime	1	199
Shale, gray	2	201
Lime	2	203
Gray shale	9	212
Lime	7	219
Shale	2	221
Lime	18	239
Black slate, 4,000 gas	3	242
Gray shale	2	244
Lime	21	267
Slate, dark; show of gas	2	269
Lime	2	271
Shale, gray	4	275
Lime	10	285
Pleasanton group:		
Shale, gray	29	314
Sandy shale	9	325
Shale, gray	48	373
Sand, gas	4	377
Set 6¼" packer at 368'.		
200,000 gas.		
Dry—R. P. 85 lbs.		
Gray shale	3	380

Log of Hall et al. Land No. 1—Continued.

	Thickness, feet	*Depth, feet*
Sandy lime	2	382
Red rock	5	387
Shale, light gray	6	393
Sandy lime	15	408
Shale, gray	26	434
Henrietta group:		
Lime	7	441
Gray shale	15	456
Lime	5	461
Gray shale	7	468
Dark shale	7	475
Lime	5	480
Black shale	5	485
70,000 gas.		
Lime	4	489
Shale	12	501*
		Total depth
		498'-2"

Total volume 238,000. Wall packer set at 365'. Trip packer set at 482'. 500'-¾" tubing. Pony packer at 475'.

*Base of Henrietta not reached.

MISSOURI GEOLOGICAL SURVEY. VOL. XXV, SECOND SERIES, FIG. 5.

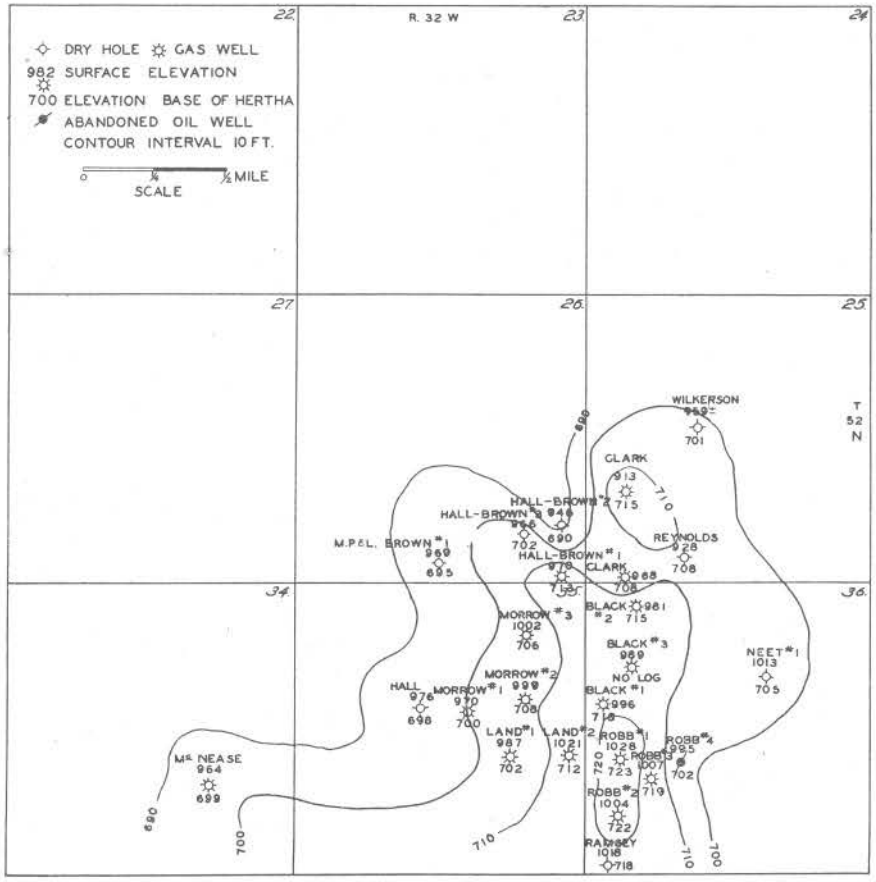

FIG. 5. Structure contour map, Liberty gas pool.

Structure. The structure shown in Figure 5 is the result of a survey by a plane table party. The outlines of the folding are irregular and the control on the south is incomplete. There is an east dip of 21 feet, but the amount of closure is not known.

Production. The initial open flow ranged from 130,000 cubic feet to 450,000 cubic feet, with a pressure of 94 to 105 pounds, but in most wells 98 pounds. The pipe line of the Missouri Power and Light Company serves the field.

Ellington Gas Pool.

Location and area. The Ellington gas pool covers less than one square mile in sections 11 and 14, T. 53 N., R. 32 W., Clay County. The pool was discovered in 1930, but was not fully developed until 1933. There are six producers in sec. 11, one in sec. 14 and a dry hole to the north in sec. 2. The Survey has no record of any drilling in secs. 1, 12 and 13 and no statement can be made as to the ultimate size of the pool.

Outcropping formations. The logs indicate a fairly heavy cover of glacial drift resting on various members of the middle or upper part of the Kansas City group. The dry hole in section 2, starting on a hill much higher than the pool itself, had 222 feet of clay, sand and gravel before reaching bed rock. This well had an elevation of 948 feet above sea level. In the pool the elevation ranges from 857 to 890 feet above sea level.

Producing horizons. Commercial gas is obtained from a rather thin sand in the lower part of the Squirrel zone with a maximum recorded thickness of 14 feet. Gas was found also in the black shale at the Lexington coal horizon, but the logs indicate that the packer was set below this in all the wells of which a log was obtained. The following is a typical log:

Log of Henderson and Holden No. 1 Ellington. Location: Cen. NE. 1/4 SW. 1/4 sec. 11, T. 53 N., R. 32 W., Clay County, Mo. Elevation: 857 feet. Completed September 4, 1930.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Surface and clay	18	18
Gravel	5	23
Soft sand (water)	21	44
Pennsylvanian system:		
Kansas City group:		
Light shale	6	50
Lime	29	79
Blue shale	7	86
Lime	31	117
Black slate (show of gas)	5	122
Lime	22	144
Blue shale	2	146
Lime	10	156

Log of Henderson and Holden No. 1 Ellington—Continued.

	Thickness, feet	*Depth, feet*
Pleasanton group:		
Gray shale	32	188
Blue shale	5	193
Gray sandy shale (4 B. W.)	32	225
Gray shale	29	254
Lime	4	258
Shale	3	261
Red	8	269
Shale	3	272
Lime	4	276
Gray shale	9	285
Green shale	5	290
Henrietta group:		
Lime	3	293
Gray shale	15	308
Lime	3	311
Gray shale	25	336
Lime	4	340
Sand	8	348
Dark shale	5	353
Lime	5	358
Black slate (900,000 cu. ft. gas)	9	367
Gray shale	18	385
Broken lime and shale	10	395
Lime	5	400
Cherokee group:		
Gray shale (reduced hole to 6¼ 434)	57	457
Black shale (405,000 cu. ft. gas)	8	465
Sand	12	477
Gray shale	13	490
Dark shale	5	495
Gray shale	5	500
Light shale	25	525
Black shale	5	530
Gray shale	9	539
Lime	2	541
Gray shale	9	550*
		Total Depth

*Base of Cherokee not reached.

Structure. Due to incomplete information on drilling and the fact that no wells are known to have been drilled to the east of the pool, a complete picture of the structure cannot be given. The accumulation appears to be on a dome elongated east and west. There is a dip of 54 feet to the dry hole in sec. 2 and a dip of 31 feet to a dry hole in sec. 24. There is probably a well developed syncline between the Ellington pool and the Paradise pool to the southwest in the same township (Fig. 6).

Production. The largest production recorded from the Squirrel sand is 405,000 cubic feet. In Ellington No. 2, the Lexington is reported to have made 300,000 cubic feet, but the packer was set just above the Squirrel sand and there is nothing in the log to indicate that the Lexington shale gas was saved.

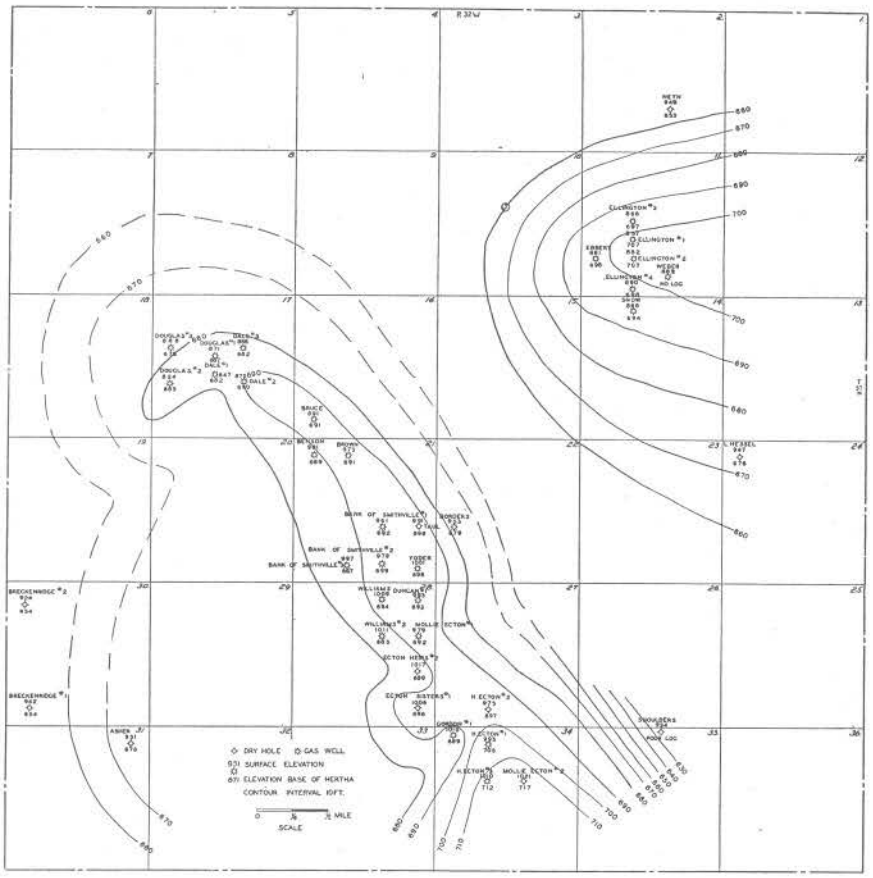

FIG. 6. Structure contour map of Paradise and Ellington gas pools.

Paradise Gas Pool.

Location and area. The Paradise (frequently termed the Smithville) pool is on a long narrow anticline extending from sec. 17, through sections 16, 21, 22 and 28 to sec. 34, T. 53 N., R. 32 W., Clay County. A total of 21 producers and 5 dry holes have been completed since the pool was opened in 1930 (Fig. 6).

Outcropping formations. Wells on the upland start in glacial drift and encounter the Plattsburg limestone of the Lansing group within a few feet. The wells in sec. 17 start in the lower part of the Lansing or the upper part of the Kansas City. The upland elevation is approximately 1,000 feet above sea level.

Producing horizons. Practically all the wells are drilled to a sand, which occurs in the lower part of the Squirrel sand

zone. Gas, as mere showings to commercial size, is also found in the black shale below the Bethany Falls limestone, the Knobtown sand, the Lexington shale and at various places in the Squirrel sand zone above the main sand. A type well log is as follows:

The Trees Oil Company Duncan No. 1. Cen. NE. 1/4 NE. 1/4 sec. 28, T. 53 N., R. 32 W. Drilled August 19 to 25, 1930. Elevation: 993 feet.

	Thickness, feet	*Depth, feet*	
Pleistocene series:			
Soil	2	2	
Clay	18	20	
Boulders	10	30	
Pennsylvanian system:			
Lansing group:			
Lime	6	36	
Shale	2	38	(Plattsburg.)
Lime	7	45	
Shale	4	49	
Sandy shale	21	70	
Shale	20	90	
Sandy shale	20	110	
Kansas City group:			
Limey flint	12	122	(Iola.)
Shale	20	142	
Lime	3	145	
Shale	7	152	
Lime	1	153	
Shale	2	155	
Limey shale	8	163	
Lime	10	173	
Shale	9	182	
Lime	7	189	
Shale	21	210	
Lime	7	217	
Shale	9	226	
Lime	6	232	
Shale	2	243	(Winterset.)
Lime	21	255	
Shale	5	260	
Lime	20	280	(Bethany Falls.)
Shale	3	283	Gas bubbles 280-283.
Lime	3	286	
Shale	2	288	
Lime	12	300	(Hertha.)
Pleasanton group:			
Shale	10	310	
Sandy shale	20	330	
Shale	25	355	
Sandy shale	20	375	
Shale	15	390	
Sand	6	396	(Wayside.)
Shale	3	399	
Red bed	5	404	
Sand	21	425	
Shale	6	431	
Henrietta group:			
Lime	3	434	
Limey shale	6	440	
Shale	5	445	
Lime	3	448	
Shale	3	451	

Log of The Trees Oil Company—Continued.

	Thickness, feet	*Depth, feet*	
Sandy shale	19	470	
Lime	6	476	(Pawnee.)
Shale	10	486	
Lime	7	493	
Shale	3	496	(Lexington coal horizon.)
Lime	5	501	
Sandy shale	15	516	
Shale	3	519	
Lime	7	526	
Limey shale	9	535	
Cherokee group:			
Sandy shale	29	564	(Top of Squirrel zone.)
Sand	3	567	
Sandy shale	13	580	
Lime	11	591	
Shale	9	600	
Sandy shale	15	615*	T. D.

*Base of Cherokee not reached.

No deep well has been drilled in the producing area, but 30 years ago one was drilled in section 35, only one mile east of production, to a depth of 1,032 feet, entering the Mississippi lime at 1,022 feet. Porous horizons in the lower part of this hole were as follows: Lexington shale gas horizon 513-525; sand, 525-537; sand (main Squirrel), 647-671; sand, 677-695; sand, 826-838; sand, 856-886, oil sand, 886-898; sand with traces of oil, 916-952; sand with salt water, 982-992.

Structure. The Paradise anticline was first made known when the western end was found and mapped in the course of field work on the Smithville quadrangle.[1] Subsequent field work indicated its extension to the southeast and the area was leased and drilled by the Trees Oil Company of Winfield, Kansas.

As shown by subsurface mapping, based on plane table elevations, but lacking control outside of the producing area, the Paradise anticline is about 4 miles long, with several small domes along the axis. The trend is northwest-southeast. The greatest amount of northeast dip known from the present development is 32 feet.

Production. The initial open flow capacity ranged from 75,000 cubic feet to 1,900,000 cubic feet. The rock pressure in the Squirrel sand ranged from 165 to 185 pounds. The gas is piped into Smithville, Liberty, and other nearby towns.

[1]Leavenworth-Smithville folio No. 206, U. S. Geol. Survey, 1917, (Mapped in cooperation with the Missouri Bur. Geol. & Mines).

PLATTE COUNTY.

Parkville Gas Pool.

Location and area. The Parkville pool was discovered in 1911, when the Tiffany Springs Oil and Gas Company drilled a well in the southeastern part of sec. 8, T. 51 N., R. 34 W., Platte County. Subsequently the Parkville Gas Company was organized and drilled several more wells in sec. 17. The gas was piped into Parkville for several years.

Outcropping formations. The Plattsburg and Stanton limestones of the Lansing formation are at the surface in this area, but some of the higher wells penetrate a few feet of sandstone above the Stanton limestone.

Producing horizons. The main gas sand is the upper Labette sand, but showings are found in the Wayside sand and the Lexington coal shale. One hole was drilled to 915 feet and although it was dry, it is a very complete section of the formations in the pool. It is as follows:

Log of E. W. Harrington No. 1, SW. cor. SE. 1/4 NE. 1/4 sec. 17, T. 51 N., R. 33 W. Commenced December 8, 1929. Elevation: 926 feet.

	Thickness, feet	*Depth, feet*	
Recent series:			
Soil, sandy	9	9	
Pennsylvanian system:			
Lansing group:			
Lime	12	21	(Stanton.)
Black shale	4	25	
Lime	4	29	
Blue shale	16	45	
Lime	18	63	(Plattsburg.)
Gray shale	22	85	
Blue shale	8	93	
Lime	3	96	
Blue shale	5	101	
Lime	3	104	
Gray shale	41	145	
Kansas City group:			
Lime	30	175	(Iola.)
Dark shale	4	179	
Lime shale	7	186	
Lime	9	195	
Light shale	12	207	
Lime	17	224	
Gray shale	14	238	
Lime	4	242	
Gray shale	4	246	
Lime	4	250	
Gray shale	4	254	
Lime	6	260	(Winterset.)
Lime shale break	5	265	
Lime	20	285	
Black shale	5	290	

Log of E. W. Harrington No. 1—Continued.

	Thickness, feet	*Depth, feet*	
Lime	20	310	(Bethany Falls.)
Light shale	3	313	
Lime	2	315	
Dark shale	2	317	Water.
Lime	10	327	(Hertha.)
Pleasanton group:			
Light shale	8	335	
Lime shale, broken	20	355	
Gray shale	13	368	
Gray sand	10	378	
Gray shale	56	434	
Sandy shale	8	442	
Red rock	5	447	
Green shale	1	448	6¼ casing at 449.
Sand	19	467	Show of gas.
Gray shale	7	474	
Gray sand	11	485	Show of gas.
Gray shale	13	498	
Henrietta group:			
Lime	4	502	
Black shale	2	504	
Br. lime	4	508	
Gray shale	9	517	
Br. lime	6	523	(Pawnee.)
Light shale	3	526	
Dark sand	8	534	Show of gas (upper Labette sand.)
Blue shale	11	545	
Lime	3	548	
Black shale	3	551	Show of gas (Lexington horizon.)
Dark shale	19	570	
Black shale	5	575	
Dark shale	13	588	
Lime	3	591	
Cherokee group:			
Dark shale	4	595	
Sandy white shale	27	622	
Light shale	5	627	
Dark shale	15	642	
Black shale	3	645	
Shale, black	5	650	Gas, none.
Gray shale	34	684	
Lime shale, dark, broken	5	689	
Black slate	6	695	No water; no gas.
Shale	5	700	
Lime	1	701	
Lime and shale	2	703	
Lime and shale	4	707	
Lime shale	8	715	
Sand	4	719	(Bartlesville.)
Shale	1	720	
Light shale	15	735	SLM.
Lime	3	738	
Dark shale	11	749	L. M. 749.
Black shale	3	752	
Dark shale	43	794	
Sandy shale	11	806	
Black shale	4	810	
Sand	8	818	
Shale, white, sandy	4	822	
Sand	18	840	
Shale, light	13	853	

Log of E. W. Harrington No. 1—Continued.

	Thickness, feet	*Depth, feet*	
Sand	5	858	Water.
Shale, dark	7	865	
Lime, dark	6	870	
Coal	1	871	
Sand and lime	3	874	SLM.
Sandy dark shale, shell	6	880	
Dark shale	5	885	
Dark shale	5	890	
Soft sand	25	915*	T. D. Water.

*Base of Cherokee not reached.

Structure. Logs have been obtained of a few wells. These show 22 feet of dip from the well in sec. 8 to the well in the SW. cor. sec. 9, about one-eighth mile east, 7 feet to a dry hole one-half mile south and 70 feet to a dry hole to the southwest in the SE. cor. NW. ¼ sec. 17.

Production. The only well on which production figures are available is the discovery well. This is reported to have flowed 1,000,000 cubic feet per day. The original rock pressure is reported to have been 145 to 147½ pounds.

STRUCTURE OF THE AREA.

The base of the Hertha limestone (base of Kansas City group) is the most useful key bed for depicting the structure of northwest Missouri because of the horizontal extent of the bed and the ease with which it can be recognized in well logs. In many cases it is the practice to run a steel line measure when it has been drilled. In the northern part of the area a limestone occurs a few feet below the base of the Hertha and possibly in some cases this bed has been logged with the Hertha as one bed, creating a small error in the datum.

On Pl. I an attempt has been made to present as complete a picture as possible at this time, of the structure of northwest Missouri as shown by the base of the Hertha. In assembling the data upon which this map is based, all wells penetrating the base of the Hertha as well as shallower wells from which a reasonably accurate estimate can be made, are used. Developed pools are shown on the same datum, usually with a smaller contour interval, justified by the closer control. The contouring in areas in which plane table work has been done, has been adjusted from the field datum, ranging from the top of the Bethany Falls limestone upward, to the base of the Hertha limestone.

A glance at the map will show instantly that the contouring varies greatly in different areas. In areas where the contours are nearly straight or in large sweeping curves, the control is insufficient and it may be assumed without hesitation, that detailed structure mapping where outcrops are available will make many changes.

The regional features indicated by the map are the northeasterly strike in the southern two-thirds of the area and the northwesterly strike in the northern third, with a poorly defined syncline between the two areas. In both areas the average trend of folding is northwest-southeast with few exceptions.

The seemingly favorable structural features that are indicated by the meagre subsurface control should be checked by surface work or some type of subsurface prospecting before being accepted. Some of these are as follows:

Ts. 56, 57 N., R. 30 W.; T. 57 N., R. 28 W., north and northwest to T. 62 N., R. 31 W.; Ts. 65 and 66 N., Rs. 30 and 31 W.

Another area to which the same remarks apply, not shown on Pl. I, due to lack of Hertha control, is that extending across southeastern Harrison County in Ts. 63, 64 and 65 N., R. 26 W. It is indicated by the top of the Mississippian as interpreted only from the available drillers' logs.

In any consideration of the area, attention should also be given to the regional structure. In pre-Cambrian time there was developed a regional grain, the strike of which was northwest and southeast. Broadly considered this grain was composed of parallel anticlines and synclines, which were subjected to recurrent uplift throughout the geologic history of the area, until at least early Cherokee (Pennsylvanian) time when the Nemaha granite ridge was formed and the Forest City basin to the east was finally outlined. The regional grain was noted in earlier reports of the Missouri Geological Survey.[1] Since the publication of the original maps, but little drilling has been done in this area which materially alters the original picture.

Within the area of the present report several of these regional anticlinal features occur, and super-imposed upon them are smaller "highs". The larger features are briefly described as follows. The Browns (T. 49 N., R. 12 W., Boone County)

[1]Hinds, Henry, and Greene, F. C., Stratigraphy of the Pennsylvanian Series in Missouri, Mo. Bureau of Geol. and Mines, vol. XIII, Pl. XXIII, 1915.

Denver (T. 65 N., R. 30 W., Worth County) anticline probably extends southeastward into the igneous area of the St. Francis Mountains of southeastern Missouri. North of the Missouri River its axis extends from near Fulton, Callaway County, T. 47 N., R. 9 W., where inliers of Devonian limestones and outliers of the Pennsylvanian, Henrietta formation, are shown on the State Geological Map. Northwestward near Browns, T. 49 N., R. 12 W., are inliers of Mississippian, the one prominently shown on the State Geological Map in Ts. 50 and 51 N., Rs. 12 and 13 W., being designated locally as the Browns anticline. This is one of the larger structural features of central Missouri. It is an assymetrical fold, the steep dip, up to 35°, being on the southwest side. The highest part of the structure and certainly the point of best observation, will be found in the NW. cor., NW. ¼ sec. 33, T. 50 N., R. 12 W., Boone County. The trace of this feature is again manifested by an inlier of Mississippian limestones in T. 53 N., R. 15 W., Randolph County; possibly by the abrupt change in strike of the Cherokee-Henrietta contact in Livingston and Linn Counties; the occurrence of an inlier of Cherokee between Laredo (T. 60 N., R. 23 W.) Grundy County and Chula, (T. 59 N., R. 23 W.), Livingston County; the change in strike of the base of the Kansas City group in northwestern Grundy and finally the inlier of Lansing beds near Denver, Worth County, T. 65 N., R. 30 W. The last mentioned local feature is described in the chapter devoted to undeveloped structural features. This feature can be detected by examination of the structure contour map of the area (Plate I), the magnetometer map of the area (Plate II), which in addition expresses prominently the southwest bordering syncline, and the Des Moines Isopach (Plate IV) which shows the thinning of that interval.

Another line of regional anticlinal folding is suggested as extending from approximately the southeast corner of T. 56 N., R. 26 W., Caldwell County, thence northwest through the northwest corner of Caldwell County, thence through King City, Gentry County, T. 61 N., R. 32 W., and continuing northwestward through Quitman, Nodaway County, T. 64 N., R. 37 W. This feature might be appropriately called the Hamilton-King City-Quitman axis. Although it is not prominently manifested on the State Geological Map, it is suggested by the structure contour map and the magnetometer map, both of which are a part of this report.

Another prominent structural trend, manifested magnetically by a long well-defined high and on the northeast by comparatively deep and closed lows, is the Savannah Trend. The structural features mapped by the Missouri Geological Survey in the Savannah-Fillmore areas, Ts. 59 and 60 N., R. 35, 36 and 37 W. are associated with this feature, and occur associated with the magnetic low. To the southwest of the Savannah magnetic high is a magnetic low, and to some extent an expression of a structural high, which trends from St. Joseph to near Richmond. The Gower structure, T. 56 N., R. 33 W., and possibly the gas producing areas at Plattsburg, T. 55 N., Rs. 31 and 32 W. are along this trend. This trend continues into the Oregon-Forest City area, Ts. 59 and 60 N., R. 38 W., in and near which prominent magnetic lows suggest possible structural features.

In addition to these trends, along which recurrent folding took place until early Pennsylvanian (Cherokee) time, there was developed a series of cross-trends, oriented in a northeast-southwest direction. These features cannot be definitely dated but they were certainly accentuated, if not developed originally, during the building in early Pennsylvanian (Cherokee) time of the nearby Nemaha Mountains, the trend of which is north-south, to northeast-southwest. This line of folding is manifested on the map of the Savannah structure, and is regionally pictured by the magnetically high anomalies striking northeast from the vicinity of Richmond, Ray County. What, if any effect, the crossing of the two dominant lines of folding will have on the possible production of oil and gas cannot be here stated. A partial answer may be obtained, however, when the Savannah structure is completely tested. Further data are afforded by an inspection of the trend indicated by the gas pools near Plattsburg, Clinton County, T. 56 N., Rs. 31 and 32 W., maps of which accompany this report.

The local structural features are indicated to some extent by the several structure contour maps of areas surveyed by the Missouri Geological Survey, and in addition contour maps of the producing pools.

Mention should be made at this time of local features of rather intense and complex structure which are known to occur throughout the area. Within the locale of them, steep dips, rapid and abrupt changes in strike, and considerable local structural relief are to be noted. The cause of these features is not specifically known and many reasons have been ascribed. Among

them may be mentioned the work of ground water, and resultant solution, which was manifested by collapsed or sink-hole type structures. Deep seated igneous activity, manifested by crypto-volcanic structure has been suggested, but this idea does not seem applicable. Another explanation also may be suggested. The two dominant structural trends have been mentioned. At the intersection of any two of them, simultaneous and possibly opposed movement would necessitate relief from stress, which might possibly be reflected in the local structures being described.

In any event these features, with their characteristics, should be kept in mind in surface mapping in the area, and properly interpreted in any structural analysis. They should be analyzed with great care prior to the beginning of drilling operations. Many of them will show very considerable structural relief for a local area but with only small closure for the structure as a whole.

Brief descriptions of those now known to occur in the area of this report are described below. Other such features will no doubt be found with additional detailed geologic work.

Area near Nodaway, Andrew County.

Location: NE. ¼ sec. 29, T. 59 N., R. 36 W.

Beds Involved: The main ledge of the Oread limestone has been quarried in the NE. ¼ NE. ¼ section 29. It and the beds above which have been stripped, are dipping to the northeast.

Breckenridge Area, Caldwell County.

Location: A large area of abnormal dips has been mapped in the northeastern part of T. 57 N., R. 26 W., centering around the townsite of Breckenridge. The area has been mapped in detail and the structure contour map has been published elsewhere.[1] It will be noted that the beds have been folded into a series of small domes, closed structural depressions, and synclines which diminish in the intensity of folding from the north to the south part of the area mapped. It should also be noted that the general trend of the folding is north and south.

Beds involved: The lower beds of the Kansas City outcrop over most of the area and the upper part of the Pleasanton is exposed in the deeper valleys. On the structure contour map the elevation of the top of the Bethany Falls limestone is shown.

[1]Wilson, M. E. Occurrence of oil and gas in Missouri, Mo. Bur. Geol. and Mines, Vol. XVI, 2d ser., 1917, Pl. X.

Wallace State Park Area, Clinton County.

Location: Between U. S. Highway No. 69 and Wallace State Park in secs. 14 and 23, T. 56 N., R. 30 W.

Beds involved: Along the road from the highway to Wallace State Park and in several ravines to the north, just east of U. S. 69 steep east dips may be seen on the Lansing limestones and shales, the lowest beds at the heads of the ravines and the Stanton limestone in the bed of the creek to the east. (See fig. 10.)

Where the road ascends the hill in the western part of Wallace State Park, there is a nearly completely exposed section from the Raytown to the Plattsburg, inclusive.

Magnetometer survey: A sharp magnetic anomaly is present in the area of this structural sink. (See Pl. II.)

Area at Cameron, Clinton County.

Location: Sections 15, 22, and 27, T. 57 N., R. 30 W.

Beds involved: Lansing limestones in the area around section 22 do not show any great departure from the normal level, but if the log of a core drill hole, in the SE. ¼ NE. ¼ sec. 22, is correct and accurately located, there is a structural sink of more than 100 feet depression at this place. The hole was drilled nearly 50 years ago.

This interpretation would be open to question were it not for the similar features shown by outcropping beds both to the north and south. (See fig. 10.)

Area Northwest of Pattonsburg, Daviess County.

Location: About 4 miles northwest of Pattonsburg at Mile Post 143 on Wabash Railroad. Detailed county base map not available at time of visit (October, 1911), but reference to Pattonsburg topographic map indicates the area to be in section 20 or 29, T. 61 N., R. 30 W.

Beds involved: Upper Kansas City and Lansing? Dips north of railroad are to southwest and south of the railroad they are to the northwest.

Area North of Cameron, DeKalb County.

Location: Southeast part of sec. 5, T. 57 N., R. 30 W.

Beds involved: Limestones of the Lansing dip steeply to the northwest into a rather irregularly outlined syncline which trends

slightly north of west across sections 4 and 5. In the vicinity of this syncline dips are erratic and other steeply dipping beds occur, though none as marked as those in section 5. (See fig. 11.)

Area Southeast of Bethany, Harrison County.

Location: This area is about 3 miles southeast of Bethany, in the NE. ¼ NW. ¼ sec. 2, T. 62 N., R. 28 W., where the following section may be observed.

Beds Involved	Thickness, Feet
1. Shale, buff, brittle, calcareous, sandy	10 + –
2. Unexposed; probably about	20
3. Limestone, gray; in three beds with shale between (Raytown)	5 + –
4. Shale; clayey at top; black and slaty below (No. 95)	3
5. Limestone, gray (No. 92)	½
6. Unexposed (No. 91)	13 + –
7. Limestone, gray; rough on top (Cement City)	5
8. Shale, red	.....

No. 1 is believed to be Lansing, the Argentine (formerly Iola) probably being thin or absent in this region.

Area Southeast of Iatan, Platte County.

Location: Southern part of sec. 29, T. 54 N., R. 36 W.

Beds involved: Upper part of Pedee and lower part of Douglas show a small syncline, probably with an east-west axis.

Area Southeast of Farley, Platte County.

Location: Along creek about on line between sections 35, T. 52 N., R. 34 W., and 2, T. 51 N., R. 34 W.

Beds involved: A sharply folded syncline with an east-west axis is shown by the limestones at the top of the Lansing and the lower part of the Douglas. The outcrop is in the area in which the Pedee is replaced by the Tonganoxie sandstone.

Area Near Allendale, Worth County.

Location: Sections 21 and 28, T. 66 N., R. 30 W., near Allendale. The description of the area and measured sections of the rocks exposed have been furnished by Mr. L. W. Wood, geologist of the Iowa State Highway Commission.

Beds involved: Mr. Wood's detailed description of the beds in this area indicates the presence of Douglas, Oread limestone and Lawrence shale, dipping steeply into a synclinal area, with beds of Lansing age, either dipping steeply or lying essentially flat in the surrounding area. As in other places, lack of outcrops prevents complete examination.

UNDEVELOPED AREAS.

In addition to the areas described in the chapter devoted to the structural features there are several areas which have been mapped with plane table by members of the Survey and copies of the maps and brief descriptions of the areas follow:

Fillmore-Savannah Area, Andrew County.

Fig. 7.

Area: Northern part of T. 59 N., R. 35 W., T. 60 N., R. 35 W., and parts of T. 60 N., R. 36-37 W.

Plane table work by F. C. Greene and C. O. Reinoehl in 1933. (Fig. 7.)

Beds exposed: Douglas and Shawnee.

Control: Good to fair in much of area, poor to insufficient near Savannah and Fillmore.

Remarks: Reports have been published on the Savannah and Fillmore areas. The maps have been combined for this report. The Savannah dome has been tested to the top of the Mississippian with no oil or gas showings. (See log in appendix.)

It should be noted that in the Clarke well, Sec. 28, T. 60 N., R. 35 W., drilled on the Savannah dome the base of the Hertha has an altitude of 443 feet above sea level as compared with 387 feet above sea in the Home Oil Company's Patterson well west of Savannah, Sec. 8, T. 59 N., R. 35 W., a difference of 56 feet. In the former hole the altitude of Cherokee-Mississippian contact is 439 feet below sea level and in the latter 528 feet below level, a difference of 89 feet. The age of the Mississippian in the well on the Savannah dome has been determined as St. Louis. It would be interesting to know what part of the Mississippian was in contact with the Cherokee in the Patterson well, but cuttings are not available. However, in the core

of the hole at Forest City, the uppermost Mississippian is Ste. Genevieve, a younger bed than that in the Clarke well.

MISSOURI GEOLOGICAL SURVEY. VOL. XXV, SECOND SERIES, FIG. 7.

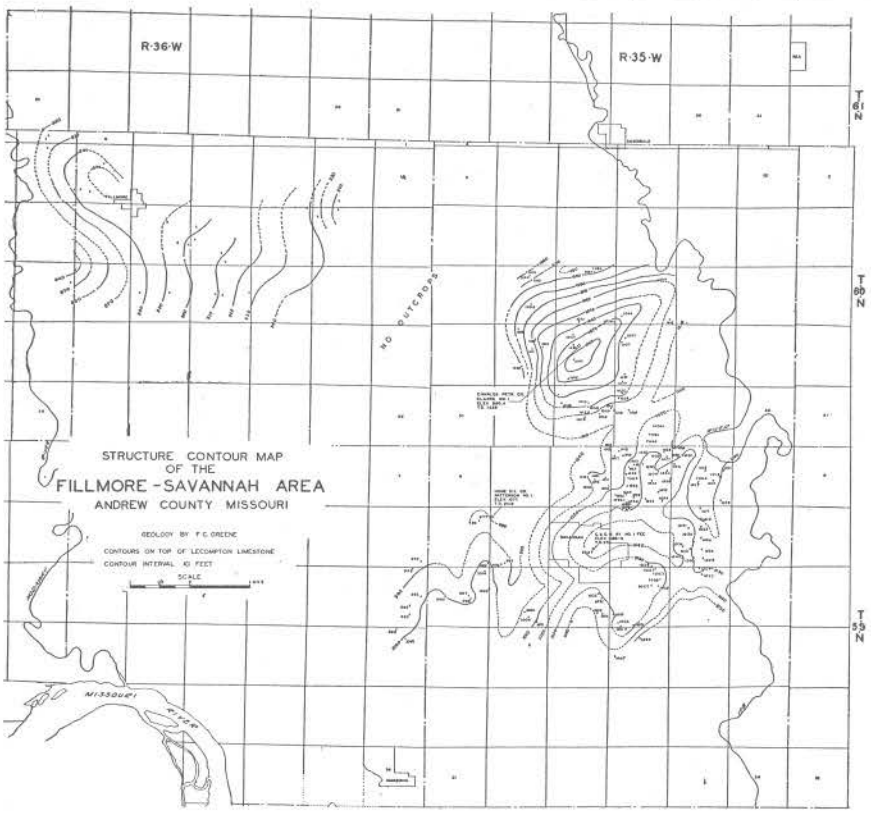

FIG. 7. Structure contour map of the Fillmore-Savannah area, Andrew County.

Forest City-Oregon Area, Holt County.

Fig. 8.

Area: Parts of Ts. 59 and 60 N., R. 38 W.

Plane table work by Joseph R. Clair assisted by F. C. Greene, in 1936. (Fig. 8.)

Beds exposed: Shawnee.

Control: Insufficient.

Remarks: A southeast dip is shown by one outcrop southeast of Oregon. The mapping indicates that the Forest City diamond drill hole is situated well down the flank of a plung-

ing structural nose. The widening of the highest contours in the eastern portion of the area mapped suggests that core drilling might be resorted to with some chance of outlining a structural feature.

MISSOURI GEOLOGICAL SURVEY. VOL. XXV, SECOND SERIES, FIG. 8.

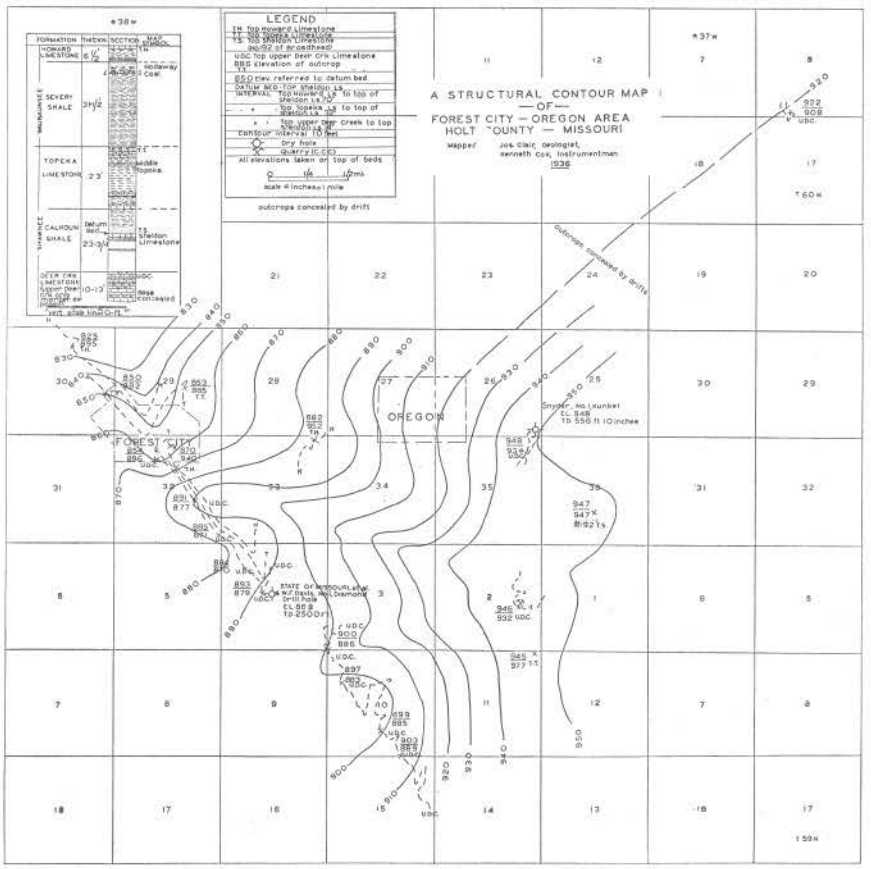

FIG. 8. Structure contour map of the Forest City-Oregon area, Holt County.

Denver Area, Gentry and Worth Counties.

Area: Ts. 64 and 65 N., Rs. 30 and 31 W.
Geology by G. A. Muilenburg in 1915.
Beds exposed: Lansing.
Control: Fair.
Remarks: Reconnaissance work has indicated the presence of a structural feature in this locality, but it has not been detailed. The presence of a structural feature in this general area is also indicated by the logs of several wells located in T. 65 N., R. 31 W., and T. 66 N., R. 30 W. (Pl. I.)

Camden Point Area, Platte County.

Fig. 9.

Area: Ts. 53 and 54 N., Rs. 33 and 34 N.

Plane table work by Joseph R. Clair assisted by F. C. Greene, in 1936.

Beds exposed: Lansing and Pedee.

Control: Good to fair.

Remarks: The principal feature of this area is the unusually low degree of folding. In this respect it differs from all other areas in northwestern Missouri where close structural control is available either from surface or subsurface data.

MISSOURI GEOLOGICAL SURVEY. VOL. XXV, SECOND SERIES, FIG. 9.

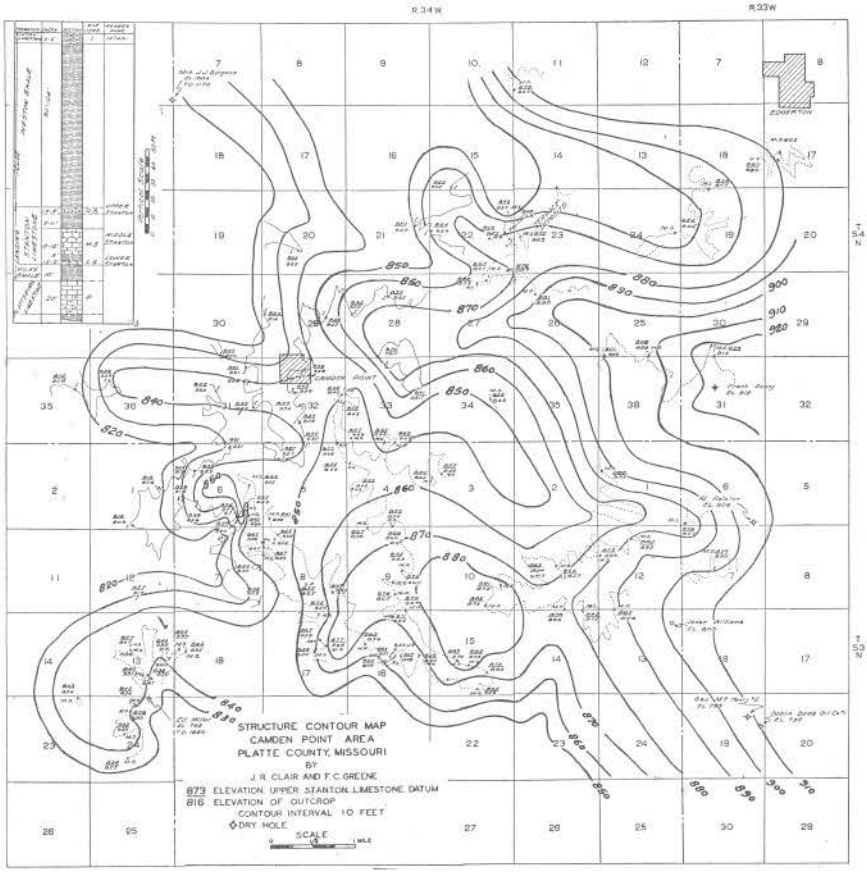

FIG. 9. Structure contour map of Camden Point area, Platte County.

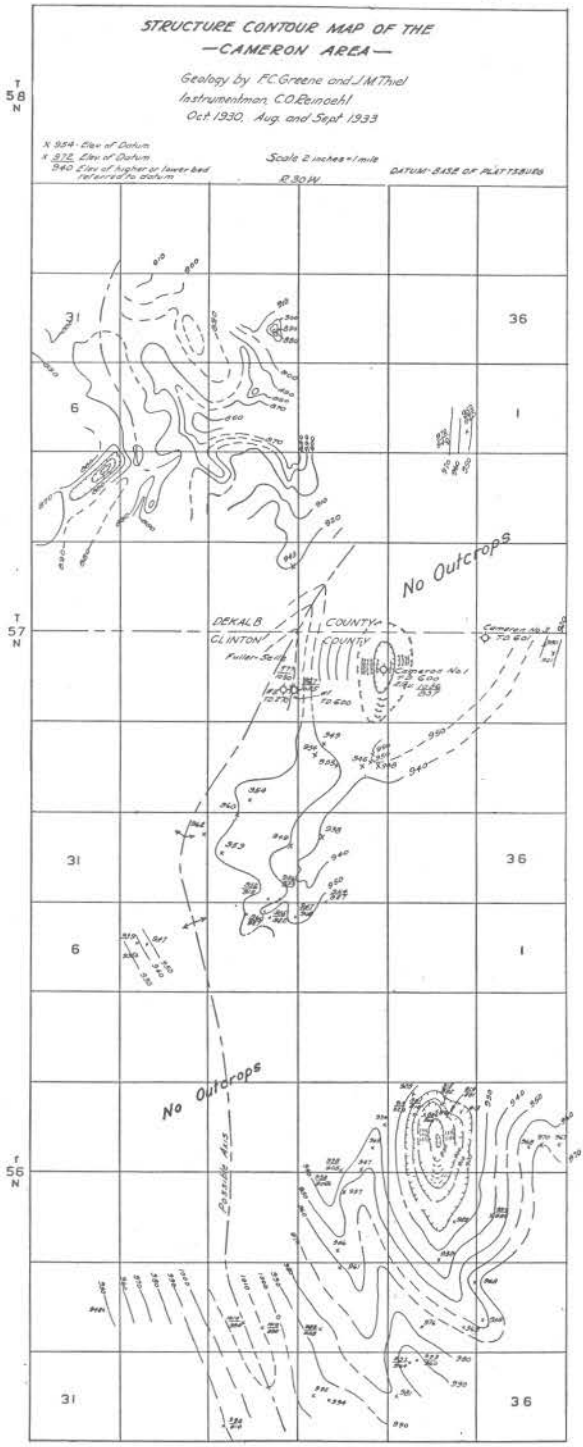

FIG. 10. Structure contour map of Cameron area, Clinton and DeKalb Counties.

Cameron Area, Clinton and DeKalb Counties.

Fig. 10.

Area: Ts. 56, 57, and south edge of 58 N., R. 30 W.

Plane table work by Joseph M. Theil and C. O. Reinoehl in 1930 and F. C. Greene and C. O. Reinoehl in 1933.

Beds exposed: Lansing with small areas of upper Kansas City.

Control: Good to fair in DeKalb County, fair to insufficient in most of remainder of area.

Remarks: The area is notable for the number of structural sinks and the irregularity of the folding. These factors and the lack of outcrops call for caution in appraising the area. The suggested areas of closure should be subjected to structure testing before a deep well is attempted.

MISSOURI GEOLOGICAL SURVEY. VOL. XXV, SECOND SERIES, FIG. 11.

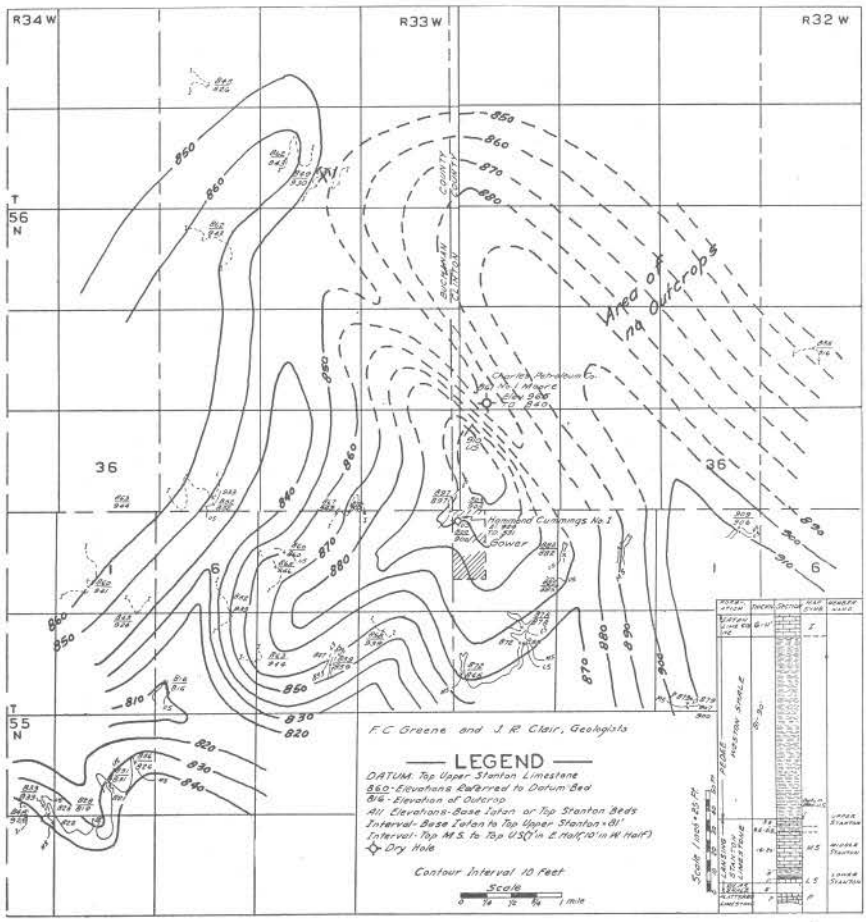

FIG. 11. Structure contour map of Gower area, Clinton and Buchanan Counties.

Gower Area, Clinton and Buchanan Counties.

Fig. 11.

Area: Centering around Gower in Ts. 55 and 56 N., Rs. 32, 33 and 34 W.

Plane table work by Joseph R. Clair assisted by F. C. Greene, in 1936.

Beds exposed: Lansing and Pedee.

Control: Good in southern part of area, poor to insufficient in northern part.

Remarks: This area has been tested (see logs in appendix) and no showings of oil or gas have been found. Prospect holes will be needed to determine details of structure.

Base of Kansas City Traverse.

Area: Outcrop of Bethany Falls limestone across Ray, Caldwell, Daviess, Livingston, Grundy and Harrison counties from T. 51 N., to T. 63 N.

Plane table work by Charles W. Studt and C. O. Reinoehl in 1919.

Beds exposed: Basal limestones of Kansas City. Top of Bethany Falls limestone mapped in detail.

Control: Good to fair.

Remarks: The general results of this work have been adjusted to the base of the Kansas City (base of Hertha) and are shown in Pl. I. The original work is on file at the office of the Survey and may be inspected by those interested.

RESULTS OF MAGNETOMETER SURVEYS.

For several years the Missouri Geological Survey has been engaged in making magnetometer surveys. As a result of this work, it has become apparent that certain definite relationships exist between magnetic anomalies and regional geologic structures. Within the Ozark region of southern Missouri, where this type of geophysical work was first undertaken, it became evident as data accumulated that structural highs, anticlines, and the upthrown sides of faults were expressed by magnetic highs. Also such surveys began to establish a regional structural grain. The satisfactory results obtained led to magnetic surveys of other areas, and particularly those where structural details were lacking, either from outcrops or subsurface data. The counties of this report fell into such a category and field work was undertaken in 1934 and has been carried on at various

periods until the present time. Among those students of the results of magnetic surveys in Missouri, it is believed that the rocks having the greatest influence upon the distribution of the magnetic lines of force are the rocks of pre-Cambrian age. The present area is probably no exception, and within it, the pre-Cambrian rocks are probably nowhere more than 5000 feet beneath the surface, and it is doubtful if even that figure will be reached. Therefore, magnetic anomalies of definition and size were anticipated. The first results showed that this was true. As the work progressed and as areas wherein gas and oil had been obtained were surveyed, it became apparent that a general relationship existed; namely, that the anticlines and domes, structural highs, occurred in areas marked by magnetic lows. It should be borne in mind, however, that this relationship is distinctly not a direct one or one of exact coincidence. Rather the two features exist in the same general area, and although a positive statement cannot be made at this time there appears to be some shift to the north or northeast of the magnetic anomaly with reference to the structural feature. This relationship should be kept in mind.

The magnetic map accompanying this report is presented not in any sense as a guide to the location of a well site, but rather as a guide to areas available for surveys, regardless of the manner in which they are conducted. Finally the magnetic map should be used in the sense in which it is offered, namely as an eliminator at the outset of areas that do not appear favorable for such surveys.

The present map shows certain well developed anomalies. Among those which are outstanding is the regional magnetic high extending from T. 54 N., R. 29 W., northwestward, through T. 59 N., R. 35 W., thence across Ts. 61 and 62 Rs. 38 and 39 W., and finally dying out in T. 63 N., R. 40 W. This regional high is named the Savannah trend.

Surface geologic work at and near Savannah, Ts. 59 and 60, Rs. 35 and 36 W., Andrew County indicates this regional feature might be synclinal in nature. At least the Savannah dome, T. 60 N., R. 35 W., is associated with the accompanying magnetic low to the northeast, and there appears to be a somewhat related occurrence of the local high suggested near Fillmore. The structural geology of this area is shown in Figure 7. The related magnetic lows bordering each side of this magnetic high are especially striking.

Other prominent magnetic trends are the St. Joseph—Forest City, which extends from T. 56 N., R. 35 W., northwestward through T. 59, R. 37 and 38 W. and terminating in T. 61 N., R. 40 W. A well-defined magnetic low lies on the northeast side of this anomaly and separates it from the Savannah magnetic high. Plane table surveys (Fig. 8) in Ts. 59 and 60 N., R. 38 W., in the general area of Forest City and Oregon, Holt County, show the presence of a westward plunging nose occupying, in general, a position between the magnetic high and low.

The most outstanding anomaly of the map is the magnetic high located in Ts. 62, 63, 64 and 65 N., Rs. 31, 32 and 33 W. This feature extends southeastward and apparently is associated with the Chillicothe-Denver regional structural feature.

Another anomaly that may be mentioned is the magnetic low occurring mainly in T. 63 N., R. 35 and 36 W., Nodaway County. Outcrops of Deer Creek limestone in T. 63 N., R. 35 W., are believed to be present possibly because of structure.

The comparative lack of magnetic relief in Atchison County is interesting, and may be related to the fact that this county appears to be the lowest part, structurally, of the Forest City basin as it is developed in Missouri.

The producing fields in the area of this report are shown on the magnetometer map, Plate II. Their relationship to the magnetic anomalies bears out previous statements that structural highs are associated with magnetic lows. An outstanding exception should be noted, however, namely, the Paradise gas field, T. 50 N., R. 32 W., Clay County, an elongated northwest-southeast trending anticline, which occupies the general area of a magnetic high. Other exceptions to the general rule may reasonably exist, and for that reason all prominent magnetic anomalies, whether they be high or low, should be eventually checked, to determine finally the nature of the structure.

CHEMICAL COMPOSITION OF THE GROUND WATERS

In any review or survey of Northwestern Missouri to determine the oil and gas possibilities, the chemical composition of the waters should be given consideration. The questions presented by this subject like so many others, cannot be specifically answered at this time because of the lack of analyses. In reviewing the available data, however, it is apparent that the water from any given formation is highly variable, and locally

appears to show great changes in chemical composition within comparitively short distances. This statement is borne out by the various water analyses accompanying this chapter.

Several factors of importance in determining the composition of ground waters are suggested, and some of the more important ones may be briefly mentioned.

The structural history of north Missouri as revealed by the available data is characterized by repeated or recurrent, perhaps periodic, uplift of certain areas, and related subsidence of associated areas. The master trend of these regional features is northwest-southeast.

In the area under consideration these features appear to plunge to the northwest. It is apparent that along the anticlinal axes certain formations have been land surfaces at recurrent times in the geological history of the area, or at least they have been relatively close to the surface. It follows, therefore, that those formations with sufficient porosity and permeability to collect and retain water were at times favorably situated to do so. No doubt they did take up fresh water which diluted the water contained in the formation at that time. This dilution and flushing may have extended for some distance into the accompanying syncline. Even though formations did not outcrop at some time subsequent to deposition and take up fresh water, there is the possibility that such water could have been introduced into a formation like the St. Peter sand, through cracks and crevices in the overlying limestones, in the case of this area, of Ordovician and Devonian age. Underground intake in this manner in the Ozark region appears to be an established fact.

If the foregoing suggestion (as to structural position, with recurrent exposure or surface connection being a determining factor in the character of a water) is correct, then subsequent data to be obtained from any future drilling may show a greater concentration of mineral salts in the ground waters obtained from synclinal areas, as opposed to a lesser degree of concentration for waters from wells located on regional anticlines.

The continuity of porous media may also be a determining factor; and the flushing of original or connate water from formations possessing porosity, by surface water taken up by the formation in the area of outcrop, is to be considered. Such flushing might occur in a continuous sheet of sand, such as the St. Peter or perhaps some of the more persistent sands of Lower Penn-

sylvanian age. Such a principle, however, would not be applicable to lenticular and discontinuous bodies of porous rock.

Depositional environment may be a further factor in determining the composition of ground waters. It seems reasonable to assume from the available facts that certain sands, perhaps lenticular in nature, were deposited in early Pennsylvanian time in fresh or brackish waters. The water obtained from the thick sand body drilled in the Charles Petroleum Company Wm. C. Clark well No. 1, T. 60 N., R. 35 W., Savannah structure, Andrew County is perhaps an example. These analyses of samples from Pennsylvanian sands are given in Table III.

The log of this well is published in the appendix of this report, but because of its location on structure and because of certain interesting details, the following summary is not out of place: The section drilled to a total depth of approximately 1000 feet was not unlike that found in other wells in northwest Missouri. In the Cherokee formation, below 1000 feet to 1380 feet, sample studies show an almost continuous section of very coarse sand which is characertized throughout by arkosic material, by the presence of some mica, some dark shale, pyrite and siderite. Water was obtained throughout this sand section and as shown by the analyses it was found to be not highly mineralized.

The sandstone section was followed by black and gray micaceous shale from 1380 to 1429 feet. No shows of oil and gas were obtained in the drilling of this well. In the opinion of the writers this well encountered an exceptional set of conditions which, while they may be expected to be again duplicated, certainly cannot be expected to occur normally. This statement refers to the sand section previously described.

Detailed microscopic studies of the lower Pennsylvanian Cherokee sediments in western Missouri by Miss Mary Hundhausen of the Missouri Geological Survey have shown the presence of much coarse sand and arkosic material throughout this interval. The rather exceptional thickness in the Charles Petroleum No. 1 Clark well being described suggests that following the initial uplift, in early Pennsylvanian time, of the Nemaha granite ridge, a great deal of granitic material was made available through erosion and was carried out to the newly formed basin by torrential streams and deposited to unusual thickness. If these suggested conditions were actually those prevailing when this abnormal thickness of sand was laid down, then it is not

difficult to conceive that the character of the water contained in this sand might reasonably vary from almost fresh, or of slight concentration, to only brackish, or more slightly concentrated with respect to total solids. This statement is borne out by the quality of the water. The same sand in some other locality might have been laid down under more marine conditions and consequently would yield a more highly mineralized water.

Although the variation in composition is not great, analyses of water samples collected from wells in the Paradise Gas Field may be considered. The water is reported to be coming from the Peru sand of Pennsylvanian age, and the analyses indicate an increase in salinity from the southeast to the northwest extremity of the pool. The results are given in Table III.

Several analyses of water samples from the Ladore shale member of the Kansas City group, collected in T. 50 N., 33 W., Clay County, and T. 51 N., R. 33 and 34 W., Platte County, have also been made, and again show a wide variation. These results are given in Table III.

Wide variations in composition of water from the Cherokee sand are also indicated by the deep wells drilled on the Rankin ranch, T. 65 N., R. 40 W., Atchison County. These were obtained from samples from about the same stratigraphic horizons, a fact not suggested certainly by the results. Rather highly mineralized waters in the Cherokee are indicated by analyses of samples from the Bailor well, Sec. 1, T. 6 S., R. 20 E., and Atchison Oil and Gas Syndicate, No. 1 Kidwell. Sec. 12, T. 5 A., R. 37 W., the results being given on Table III. This water is from approximately the same stratigraphic horizon as the samples in the Charles Petroleum Company No. 1 Clark well, sec. 28, T. 60 N., R. 35 W., Andrew County.

The analyses of the water from the pre-Pennsylvanian formations are also given in the table III; also analyses of the sample collected from various formations in the deep city well at Excelsior Springs, sec. 1, T. 52 N., R. 30 W., Clay County; in the Pallette No. 1 Triplett, sec. 19, T. 50 N., R. 31 W., Jackson County; the Pallette No. 1 Bannister, sec. 36, T. 48 N., R. 33 W., Jackson County; and the Kasper No. 1 James well, sec. 8, T. 13 S., R. 25 E., Johnson County, Kansas.

As many geologists are interested in the relationship between structure and chemical composition of water, the following data are given for the wells sampled.

Name of Well	*Location*	*Depth, top of St. Peter, in feet*	*Elevation, top St. Peter, in feet*
Excelsior Springs, city	1–52N–30W	1271	—450
Pallette-Triplett	19–50N–31W	1335	—416
Pallette-Bannister	36–48N–33W	1403	—374
Kasper-James	8–13S–25E	1371	—512

In any drilling operations in northwestern Missouri water samples for chemical analysis should be obtained wherever possible. These samples will be analyzed without charge by the Missouri Geological Survey.

TABLE III. PARTIAL RESULTS CHEMICAL ANALYSES, WATER SAMPLES.

R. T. ROLUFS, Analyst.

Formational source.	Depth sampled, in feet.	Name of well.	Sec.	T.	R.	County.	In parts per million.		
							Total dissolved solids.	Chloride radicle.	Sulphate radicle.
Kansas City (Ladore)	249 ?	Sutter	30	51	33	Platte	5745.0	2954.0	4.7
Kansas City (Ladore)	400	Reiger	16	51	33	Platte	5716.0	2973.0	0.8
Kansas City (Ladore)	344	Jones	29	51	34	Platte	17086.0	9342.8	5.1
Kansas City (Base)	524	Ashton	33	57	35	Buchanan	10292.2	6040.0	0.0
Kansas City (Base)	350	Artesian Ice	8	57	35	Buchanan	8302.2	4910.0	57.2
Kansas City		Tootle	32	56	36	Buchanan	802.7	373.5	81.8
Pleasanton	765	Atchison-Kidwell	12	54	37	Platte	45248.0	17159.0	102.7
Peru Sand	Gas Drip	Yoder	21	53	32	Clay	10237.0	5834.9	3.9
Knobtown-Peru	Gas Drip	Dale No. 2	17	53	32	Clay	12958.0	7376.2	1.2
Peru	Gas Drip	Ecton	34	53	32	Clay	9402.0	5367.0	0.0
Peru	Gas Drip	Hanks	2	54	32	Clinton	5542.0	2715.6	0.0
Peru, 40' below	Gas Drip	Porter No. 5	18	55	31	Clinton	10168.0	5761.5	0.0
Peru, 40' below	Gas Drip	Jones No. 1	13	55	32	Clinton	10254.0	6045.9	0.4
Lexington ?	Gas Drip	Porter No. 5	18	55	31	Clinton	10473.0	5537.0	0.4
Squirrel	550	McCleary	10	52	30	Clay	10117.0	5374.5	216.2
Bartlesville	576	Maurer	13	52	30	Clay	15313.0	8667.1	1.6
Lower Cherokee—Mixed	1450	Rankin No. 1	14	65	40	Atchison	2173.0	470.0	10.4
Lower Cherokee	1551	Rankin No. 2	11	65	40	Atchison	10237.0	5394.5	690.7
Lower Cherokee	1015	Clark No. 1	28	60	35	Andrew	4948.0	2399.5	238.5
Lower Cherokee	1215	Clark No. 1	28	60	35	Andrew	3599.0	1312.4	495.9
Lower Cherokee	1375	Clark No. 1	28	60	35	Andrew	3423.0	1118.0	556.8
Lower Cherokee	1008	Bailor	1	6S	20E	Atchison, Kan.	50177.0	23530.0	44.6
Lower Cherokee	1174	Ridgeway	3	64	27	Harrison	5257.0	1337.0	1822.5
Lower Cherokee	750	Eagleville	7	66	27	Harrison	4390.0	1803.8	526.9
Lower Cherokee	778	Johnson	17	63	29	Harrison	880.0	43.8	166.0
Lower Cherokee	460	Ventrump	22	53	26	Ray	9461.0	4388.7	1017.8
Lower Cherokee	318TD	Dana	30	54	28	Ray	6220.0	3391.7	0.0
Lower Cherokee	541TD	Harrison	10	52	28	Ray	7227.0	3365.0	603.0

TABLE III. PARTIAL RESULTS CHEMICAL ANALYSES, WATER SAMPLES—Continued.

Formational source.	Depth sampled, in feet.	Name of well.	Sec. — T. — R.	County.	In parts per million.		
					Total dissolved solids.	Chloride radicle.	Sulphate radicle.
Mississippian	1433	Clark No. 1	28 60 35	Andrew	3419.0	1365.4	462.3
St. Peter—Mixed		Baldwin	25 52 26	Ray	13634.0	6311.5	1295.0
Chouteau	900	Excelsior	1 52 30	Clay	8350.0	3782.9	1091.9
Devonian	1000	Excelsior	1 52 30	Clay	8242.0	3782.9	1038.8
Devonian	1075	Excelsior	1 52 30	Clay	8519.0	3963.9	1081.2
Kimmswick	1135	Excelsior	1 52 30	Clay	8485.0	3873.4	1083.9
Kimmswick	1175	Excelsior	1 52 30	Clay	8672.0	3873.4	1111.5
St. Peter	1300	Excelsior	1 52 30	Clay	9130.0	3963.9	1149.5
St. Peter (Pump)	1300	Excelsior	1 52 30	Clay	12194.0	5791.4	821.1
Pennsylvanian	670	Triplett No. 1	19 50 31	Jackson	17753.0	9946.1	11.1
Burlington	956	Triplett No. 1	19 50 31	Jackson	16039.0	8561.3	663.5
St. Peter	1341	Triplett No. 1	19 50 31	Jackson	19518.0	9013.8	642.4
St. Peter	1361	Triplett No. 1	19 50 31	Jackson	17388.0	9122.4	497.1
St. Peter	1400	Triplett No. 1	19 50 31	Jackson	22914.0	9853.6	125.5
Cotter	1481	Triplett No. 1	19 50 31	Jackson	22600.0	10617.1	1100.6
Penn.-Miss	850 ?	Bannister	36 48 33	Jackson	26430.0	14868.2	57.4
St. Peter	1400	Bannister	36 48 33	Jackson	40691.0	21069.4	1057.3
Jefferson City	1569	Bannister	36 48 33	Jackson	46119.0	22114.0	1161.0
Jefferson City	1625	Bannister	36 48 33	Jackson	40854.0	20964.2	943.6
Mississippian	785	James	8 13S 25E	Kansas	19237.0	10603.6	6.8
St. Peter	1385	James	8 13S 25E	Kansas	34406.0	18307.1	678.6
St. Peter	1540	James	8 13S 25E	Kansas	33248.0	17826.8	274.2
St. Peter	1714	James	8 13S 25E	Kansas	36217.0	18751.9	618.7
Canadian ?	1795	James	8 13S 25E	Kansas	49258.0	26255.6	1661.4
Roubidoux	1840	James	8 13S 25E	Kansas	49339.0	26061.8	1664.9
Van Buren	1939	James	8 13S 25E	Kansas	56810.0	26643.3	1741.7
Gunter	2045	James	8 13S 25E	Kansas	57598.0	27013.3	1748.7
Lamotte	2276	James	8 13S 25E	Kansas	53778.0	27711.1	1678.5

SUGGESTIONS FOR PROSPECTING.

Core Drilling.

The Pennsylvanian beds in northwestern Missouri are well suited for the drilling of shallow holes to determine structure in areas where outcrops are poor or absent. Many of the limestones and black, fissile shales are so persistent that a churn drill can be used as well as a core or rotary drill. Limestones are fairly well distributed through the section. (Pl. V.) Usually an area in which outcrops are found along streams will not have excessively thick drift on the adjoining interstream divides. Any geologist with drilling experience should have no trouble with this type of structure mapping.

In areas of extremely thick drift, boulders and sand and gravel beds are to be expected and may give trouble, but test holes have been drilled in glacial and alluvial deposits in many places in widely separated places in northern Missouri for water supplies and have been carried to the bed rock surface with no great difficulty.

Geophysical Methods.

The results of magnetometer surveys are presented in this report and show what may be expected with this geophysical instrument. Prior to the present oil and gas activity in the area, no other method of geophysical prospecting has been used in so far as the writers know, and the effectiveness of other methods cannot be demonstrated without trial. In the deeper portion of the basin, namely in Holt and Atchison Counties, seismic methods may be applicable.

The principle of the gravimeter suggests that it might be successfully used in this area, which as previously described is marked by regional features. Electrical methods of determining structure have been employed by the Missouri Geological Survey in this area, but varying results have been obtained. More experimental work is needed before this method can be specifically recommended as a guide in structural mapping.

WELL RECORDS.

The elevations and locations of the more important wells mentioned in this report were obtained by plane table traverse.

In the case of many wells located some distance from bench marks, the elevations were obtained by means of Paulin altimeters, the results being checked by two instruments. The locations of these wells were determined in the field by reference to some suitable base map. These wells are listed below, by reference number, which corresponds to the number given on the base map (Pl. 1), in table II, and on the published logs which are incorporated in this report.

Atchison County; Number 1.
Buchanan County; Numbers 4, 5, and 8.
Caldwell County; Numbers 1, 2, 3, 4, 5, 6, 9 and 11.
Clay County; Numbers 1, 19, 20, 21, 22, 23, 24, 25, 27, 28, 30, 40, 44, 51, 52, 53, 54, 55, 57.
Clinton County; Numbers 2, 3, 23, 24, 25, 26, 27.
Daviess County; Numbers 2, 4, 5, 6, 7, 8, 9, 10.
DeKalb County; Numbers 1, 3, 4, 5.
Gentry County; Number 3.
Harrison County; Numbers 1, 2, 3, 14, 15, 16.
Holt County; Number 3.
Nodaway County; Numbers 1, 2, 3, 4.
Platte County; Number 13.
Ray County; all wells except Number 21.

TABLE II. SYNOPSES OF DEEPER WELLS DRILLED IN AREA.

*Not Dr. = Not drilled. E = Elevation base of Hertha estimated. DDH = Diamond drill hole.

Map No.	Owner.	Farm.	Location, S. – T. – R.	Surface elevation, feet.	Total depth, feet.	Depth base, Hertha limestone, feet.	Elevation base, Hertha limestone, feet.	Formation completed in.
	Andrew County.							
1	Rochester Coal Mining & Prospecting Co.	Webb Kirby Estate	14 59 34	884	800	404–6″	480	Cherokee.
2	Home Oil & Gas Co.	W. E. Patterson No. 1.	8 59 35	1077	2516	690	387	Ordovician.
3	C. A. Wright	Fee	14 60 35	986	175	Not Dr.*	406 E	Douglas.
4	Charles Petroleum Co.	Clark No. 1	28 60 35	990	1434	547	443	Mississippian.
	Atchison County.							
1	Schooler Brothers	Fee No. 1	23 64 40	949	518	Not Dr.*	336 E	Douglas.
2	W. F. Rankin	Fee No. 1	14 65 40	911.3	1551	794	117	Cherokee.
3	W. F. Rankin	Fee No. 2	11 65 40	913.6	2340	800	114	Devonian.
4	Missouri Independent Oil and Gas Company	W. A. Bishop No. 1	20 65 41	1121.95	1718	1095	—27	Cherokee.
5	J. A. Beverly	H. E. Wyatt No. 1	33 65 41	1014.8	679	Not Dr.*	65 E	Douglas.
	Buchanan County.							
1	Ray Glaspell	Peel No. 1	32 56 35	1053.3	1995	590	463	Devonian.
2	Hall	Tootle Estate No. 1 Sampson	32 56 36	856	856	468	388	Cherokee.
3	State of Missouri	(Saxton D. D. H.)	21 57 34	837.5	1116	321	516	Mississippian.
4	Artesian Ice and Cold Storage Co.	Fee No. 1	8 57 35	825	350	350	475	Kansas City.
5	Turner Coal Co.	Jane Smith No. 1	29 57 35	844	1308	383	461	Mississippian.
6	Swift & Co.	Fee No. 2	30 57 35	817	350	350	467 + –	Kansas City.
7	F. D. McCain Goens-Owensby	Frank Bermond	26 58 34	1007	2375	460	547	Canadian.
8	County Farm	Fee No. 1	27 58 35	1024	449	Not Dr.*	449 E	Kansas City.
9	Frank Hopkins	Fee No. 1	31 58 35	880	1258	415	465	Mississippian.
10	Goetz Brewing Co.	Fee No. 1	8 57 35	858	1800			No log.

TABLE II. SYNOPSES OF DEEPER WELLS DRILLED IN AREA—Continued.

*Not Dr. = Not drilled. E = Elevation base of Hertha estimated. DDH = Diamond drill hole.

Map No.	Owner.	Farm.	Location, S. – T. – R.	Surface elevation, feet.	Total depth, feet.	Depth base, Hertha limestone, feet.	Elevation base, Hertha limestone, feet.	Formation completed in.
	Caldwell County.							
1	N. Missouri Mining & Dev. Co...	M. F. Davis.....	4 55 26	858	1410	24	834	St. Peter ?
2	Kingston Coal Co.....	O. V. Assell.....	15 56 28	818	231	.....	.....	
3	Kingston Coal Co.....	Smith.....	15 56 28	826	260	.....	.....	
4	Kingston Coal Co.....	Neblock & Bridgewater...	28 56 28	824	243–7″	53	771	Henrietta.
5	Messler Gas Co.....	Sloan No. 1.....	16 56 29	925	550	199	726	Cherokee.
6	Messler Gas Co.....	Sloan No. 2.....	16 56 29	980	225	199	781?	
7	Wilson et al.....	Glick No. 1.....	10 57 26	915	1600	70	845	Canadian.
8	Breckenridge Oil & Gas Co.....	Glick No. 2.....	10 57 26	918	1252	77	841	Devonian.
9	Caldwell Coal Co.....	Fee.....	17 57 27	947	650	.....	.....	
10	Tom Creek Coal Co.....	Fee.....	26 57 28	907	324 ½	149	758	Henrietta.
11	Cameron Mining Co.....	J. B. Russel.....	20 57 29	854	329	136	718	Henrietta.
	Clay County.							
1	Balkey & Taylor.....	Williams No. 1.....	8 50 32	779	530	77	702	Cherokee.
2	Randolph Coal & Oil Co.....	Randolph, Mo., No. 1....	10 50 32	741?	690	Not Dr.*	.....	Mississippian.
3	Randolph Coal & Oil Co.....	Randolph, Mo., No. 2....	10 50 32	793	810	Not Dr.*	.....	Mississippian.
4	McDougal.....	Fee No. 1.....	11 50 32	735	630	Not Dr.*	747 E	Mississippian.
5	Midwest Mushroom Co.....	Fee No. 1.....	11 50 32	774	214	24	750	Henrietta.
6	McDougal.....	Fee No. 2.....	14 50 32	731	577	Not Dr.*	719 E	Cherokee.
1A	James O'Neil Bruen.....	Rumble No. 1.....	1 50 33	914	1095	.....	.....	Mississippian.
2A	James O'Neil Bruen.....	Campbell No. 1.....	2 50 33	952	1052	.....	.....	Mississippian.
3A	R. W. Smith.....	Fee.....	10 50 33	920	620	213	707	Cherokee.
4A	Ted Gorman.....	Fee.....	11 50 33	829	141	141	688 + –	Kansas City.
5A	Russell Hodge.....	Fee.....	12 50 33	899	400	184	715	Henrietta.
6A	North K. C. Dev. Co.....	Fee.....	14 50 33	742	870	Not Dr.*	.....	Mississippian.
7	General Utilities Co.....	D. B. Fields.....	3 51 31	950	665	178	772	Cherokee.
8	Bell Motor Company.....	Fee No. 1, Liberty Mo...	7 51 31	858	548	209	649	Cherokee.

9	Arrow Oil & Gas Co	Peters No. 1	4	51	32	905	520	905	720	Cherokee.
10	Arrow Oil & Gas Co	Billings No. 1	8	51	32	916	680	212	704	Cherokee.
11	Lee Baker	Campbell	12	51	32	925	560	245	680	Cherokee.
12	Wittmeyer	Fee No. 1	16	51	32	820	660	87	733	Cherokee.
13	Lee Baker		28	51	32	859	615	143	716	Cherokee.
14		C. H. Rogers	34	51	32	862	500	137	725	Cherokee.
15	Davis Bros. & Bartle	Davidson	36	51	33	881	626	195	686	Cherokee.
16	City of Excelsior Springs	Fee No. 1	1	52	30	812	873	Not Dr.*		Mississippian.
17	City of Excelsior Springs	Fee No. 2	1	52	30	822	1300	Not Dr.*		St. Peter.
18	Gordon McCleary	Fee No. 1	10	52	30	896	732	100	796	Mississippian.
19	Maurer Brothers	Lake Maurer	13	52	30	765	576	Not Dr.*		Mississippian.
20	Rice Coal Co	Fee	17	52	30	778	237	11	767	Henrietta.
21	Mosby Coal Co	Barnes	18	52	30	752	331	Not Dr.*	757 E	Cherokee.
22	Missouri Power & Light Co	Pixlee No. 1	20	52	30	795	440	22	773	Cherokee.
23	John Harris	Fee No. 1	26	52	30	730	1036	Not Dr.*		Devonian.
24	J. E. Boothe	Fee No. 1	13	52	31	787	270			
25	John Desiderio	Louis Tapp	14	52	31	839	309–10″	103	736	Cherokee.
26	Missouri Power & Light Co	Mosby	14	52	31	802	435	77	725	Cherokee.
27	John S. Ludwick	Neth	23	52	31	880	328	109	771 + −	Henrietta.
28	Arrow O. & G. Co	Petty No. 1	31	52	31	934	815	195	739	Mississippian.
29	Trees Oil Co	Watkins No. 1	3	52	32	961	660	238	723	Cherokee.
30	Cullum and Arrow Oil & Gas Co.	Baum No. 1	7	52	32	964	625	301	663	Cherokee.
31	K. C. Gas & Oil Drg. Co	George W. Frick No. 1	14	52	32	945	560	219	726	Cherokee.
32	Raymond	Fee No. 1	17	52	32	997	654	325	672	Cherokee.
33	Wilson	D. J. Nutter	21	52	32	975	610	292	683	Cherokee.
34	Wilson	Kirk Hall No. 1	22	52	32	980	752	290	690	Cherokee.
35	General Utilities	N. H. Wagner	28	52	32	1000	575	292	708	Cherokee.
36	McDowell Shaft	Fee	11	52	33	900	250	246	654	Kansas City.
37	Humphrey et al	Kilgore No. 1	23	52	33	1034	930	384	650	Cherokee.
38	Humphrey et al	Kilgore No. 2	24	52	33	983	850	346	637	Cherokee.
39	S. W. Forrester	Hoover No. 1	26	52	33	1049	848	394	655	Cherokee.
40	J. D. Judd	Gow No. 1	9	53	30	965	665	185	780	Cherokee.
41	B. I. Hall	School Field	27	53	30	896	502		813 E	Cherokee.
42	Mo. P. & L. Co	Dorn	34	53	30	825	315	Not Dr.*	858 E	Cherokee.
43	Mo. P. & L. Co	J. Lynn	34	53	30	936	475	145	791	Cherokee.
44	Mo.-Ark. Petro. Co	Gilbert Barr	27	53	31	868	552	100	768	Cherokee.
45	Neth	Fee No. 1	2	53	32	948	601	295	653	Cherokee.
46	Southern States Gas Company	L. Hessel	24	53	32	947	600	271	676	Cherokee.
47	East-West Oil & Gas Company	Breckenridge No. 1	30	53	32	942	595	288	654	Cherokee.

TABLE II. SYNOPSES OF DEEPER WELLS DRILLED IN AREA—Continued.

*Not Dr. = Not drilled. E = Elevation base of Hertha estimated. DDH = Diamond drill hole.

Map No.	Owner.	Farm.	Location, S. – T. – R.	Surface elevation, feet.	Total depth, feet.	Depth base, Hertha limestone, feet.	Elevation base, Hertha limestone, feet.	Formation completed in.
	Clay County—Continued.							
48	East-West Oil & Gas Company...	Breckenridge No. 2.....	30 53 32	924	595	270	654	Cherokee.
49	Trees Oil Company.....	Asher No. 1.....	31 53 32	951	587	275	676	Cherokee.
50	F. L. and E. I. Morse.....	Shoulders.....	35 53 32	994	1032	.....	.....	Mississippian.
51	Trees Oil Company.....	Purdy No. 1.....	12 53 33	941	754	313	628	Cherokee.
52	Gordon & Martin.....	Smithville, Mo., No. 1....	23 53 33	815	804	189	626	Cherokee.
53	Gordon & Martin.....	Smithville, Mo., No. 2....	23 53 33	837	488	205	632	Cherokee.
54	East-West Oil & Gas Co., (J. D. Judd).....	Crow No. 1.....	26 53 33	940	600	298	642	Cherokee.
55	East-West Oil & Gas Co., (J. D. Judd).....	Lowman No. 1.....	27 53 33	932	746	294	638	Cherokee.
56	O. K. Herndon.....	Thatcher No. 1.....	34 53 33	952	1017	323	629	Mississippian.
57	J. D. Judd.....	McGee No. 1.....	36 54 31	905	674	159	746	Cherokee.
	Clinton County.							
1	Brawner Serum Co.....	Fee No. 1.....	9 54 30	1086	380	358	728	Pleasanton.
2	Doherty & Figgins.....	Fee No. 1.....	3 54 31	1000	165	Not Dr.*	681 E	Kansas City.
3	Barton, Willman, and Chestnut...	Atchison No. 1.....	6 54 31	1005	625	395	610	Henrietta.
4	Arrow Oil & Gas Co.....	Hanks No. 1.....	2 54 32	985	539	347	638	Henrietta.
5	Ladow.....	Weller.....	2 54 32	966	600	331	635	Cherokee.
6	H. J. Allen.....	G. W. McCulloch.....	8 54 32	939	760	293	646	Cherokee.
7	Gen. Utilities Co.....	John Tate No. 1.....	10 54 32	972	499½	318	654	Henrietta.
8	H. J. Allen.....	S. L. Carter No. 1.....	17 54 32	956	640	316	640	Cherokee.
9	Turner, et al.....	Pettit.....	20 54 32	847	605	234	613	Cherokee.
10	Messler Gas Co.....	Seaton No. 1.....	5 55 30	931	345	217	714	Pleasanton.
11	Messler Gas Co.....	Bert Gall No. 1.....	6 55 30	939	560	210	729	Cherokee.
12	Messler Gas Co.....	Glen Brilhart No. 1.....	15 55 30	1072	1050	351	721	Mississippian.
13	Messler Gas Co.....	Pollard No. 1.....	24 55 30	954	660	233	721	Cherokee.

14	Messler Gas Co	Douglass No. 1	27	55	30	1026	600	273	753	Cherokee.
15	Messler Gas Co	H. Rodgers No. 1	28	55	30	1054	581	310	744	Henrietta.
16	R. M. Hammond	Thomas Newby No. 1	4	55	31	995	487	297	698	Henrietta.
17	R. M. Hammond	Thomas Newby No. 2	4	55	31	988	585	283	705	Cherokee.
18	Messler Gas Co	Fred Gall	12	55	31	1034	419	336	698	Pleasanton.
19	Ladow & Kunkel	Eliza Chenowith	15	55	31	1008	1115	332	676	Mississippian.
20	Lathrop Coal Mining Co	Fee	36	55	31	1053	603	377	677	Henrietta.
21	W. G. Twyman	Max Jones	34	55	32	876	368	264	612	Pleasanton.
22	R. M. Hammond	Claude Cummings	3	55	33	924	531	338	586	Henrietta.
22A	Charles Pet. Co	Moore Est. No. 1	27	56	33	965	839	418	547	Cherokee.
23	Fuller	Truman Sells No. 1	21	57	30	1035	600	314	721	Cherokee.
24	Cameron Roller Mills	D. D. H. Fee No. 1	22	57	30	1036	648–2″	453	583	Henrietta.
25	Cameron	D. D. H., No. 3	24	57	30	1036	601	.....	.....	
26	A. H. Carver	Wiley No. 2 D.D.H.	20	57	32	950	791½	385	565	Cherokee.
27	Stewartsville Dev. Co	Robt. Pickett No. 1	23	57	32	985	1269	400	585	Mississippian.
28	Clay Clinton O. & G. Co	Unknown	30	54	31		1400?			No log.
	Daviess County.									
1	Winston Coal Co	Fee Shaft No. 2	4	58	29	1012	456	282	730	Henrietta.
2	Mrs. Andrew Stevenson	Fee	35	58	28	1032	826	.....	.....	
3	C. D. & J. K. D. Shaffer	A. J. Tingley No. 1	5	59	27	758.9	2332	Not Dr.*	.....	Canadian or Older.
4	Gallatin Coal Co	Fannin No. 1, D.D.H.	17	59	27	742	404	35.5	708	Cherokee.
5	Gallatin Coal Co	Johnson No. 1	17	59	27	722	416.9	.....	687	
6	Messler Gas Co	H. S. Robertson	27	60	26	959	596	149	810	Cherokee.
7	Messler Gas Co	S. E. Arnold	27	60	26	940	550	150	790	Cherokee.
8	W. G. Cline	Glasson No. 1 or (D.D.H.) Burton (Coal Test)	11	60	29	810	295	.....	676	Poor Log.
9	W. G. Cline	Glasson No. 2 (Coal test)	11	60	29	800	308	.....	736	Poor Log.
10	Messler Gas Co	Lou Lafollette	15	61	26	961	700 + −	.....	.....	
	DeKalb County.									
1	New Market Coal Co	J. L. Segrist (DDH)	11	57	30	963	430	240	723	Henrietta.
2	New Market Coal Co	Ellis & Klepper (DDH)	16	57	30	961	450	261	700	Henrietta.
3	McDonald	Hartman No. 1	35	59	30	941	750	.....	.....	
4	McDonald	Wilford No. 1	35	59	30	934	502	.....	.....	
5	R. B. Aniser	Fee No. 1	23	60	32	1051	418.11	.....	626 E	Kansas City.

TABLE II. SYNOPSES OF DEEPER WELLS DRILLED IN AREA—Continued.

*Not Dr. = Not drilled. E = Elevation base of Hertha estimated. DDH = Diamond drill hole.

Map No.	Owner.	Farm.	Location, S. – T. – R.	Surface elevation, feet.	Total depth, feet.	Depth base, Hertha limestone, feet.	Elevation base, Hertha limestone, feet.	Formation completed in.
	Gentry County.							
1	Berlin Coal, Oil & Gas Prospecting Co.	L. C. Loest No. 1.	22 61 31	854.8	1140	250	605	Mississippian.
2	Berlin Coal, Oil & Gas Prospecting Co.	L. C. Loest No. 2.	22 61 31	844.9	442	237	608	Henrietta.
3	A. Burdick.	Fee No. 1.	36 62 31	827	495.6	207	620	Cherokee.
4	City of Albany.	Fee No. 1.	24 63 31	857.79	400	284	574	Henrietta.
	Harrison County.							
1	L. D. Terry.	Fee No. 1.	25 62 26	766	503.6	.....	.....	Cherokee.
2	S. D. Peery.	Fee No. 1.	25 62 26	831.5	491.10	.....	.....	Cherokee.
3	W. O. Black.	Fee No. 1.	28 62 26	885.5	442.6	78	807	Cherokee.
4	James O'Neil Bruen.	Harrison Co. No. 1.	9 63 28	851.15	1258	65	786	Devonian.
5	James O'Neil Bruen.	E. H. Frisbie.	10 63 28	857.75	905	75	783	Mississippian.
6	Helborn Sanitarium.	Fee No. 1.	16 63 28	844.05	654	.....	.....	Cherokee.
7	U. S. Dept. of Agriculture.	Soil Erosion Station.	16 63 29	1034	570	368	666	Cherokee.
8	New Hampton Coal & Mineral Co.	Johnson Bros.	17 63 29	919	778	248	671	Cherokee.
9	Keystone Oil & Gas Co.	Murphy School.	5 64 26	873.1	1610	19	854	Silurian ?.
10	Fred Morck.	W. M. Ross.	12 64 26	822	997	Starts below Hertha	.....	Mississippian.
11	Town of Ridgeway.	Fee.	3 64 27	1057.4	1178	215	842	Mississippian.
12	Grand River Coal & Coke Co.	D.D.H. No. 2.	13 65 26	852	616½	.....	.....	Cherokee.
13	Keystone Oil & Gas Co.	Rogers.	13 65 26	852	1110	.....	.....	Mississippian.
14	Grand River Coal & Coke Co.	Graham.	14 65 26	828	372	.....	.....	Cherokee.
15	Grand River Coal & Coke Co.	Bush No. 4.	15 65 26	836	489.7	.....	.....	Cherokee.
16	Grand River Coal & Coke Co.	Reeves No. 5.	24 65 26	833	438	.....	.....	Cherokee.
17	U. S. Army Eagleville CCC Camp	Chas. Hunsaker.	7 66 27	1050	750	288	762	Cherokee.
18	Blytheville Prosp. Co.	J. W. Walton No. 1.	35 66 27	1031	800	203	828	Cherokee.
19	City of Blythedale.	Fee.	35 66 27	1077	725	.....	.....	Cherokee.
20	Blythedale Prospecting Co.	Elwood White No. 1.	35 66 27	957.07	629.1	113	844	Cherokee.
8A	Unknown.	Unknown.	17 63 29		2300?	Reported as	DDH.	

	Holt County.									
1	State of Missouri	W. F. Davis	4	59	38	868.9	2500	725.1	144	Silurian.
2	Kunkel	Fee No. 1	26	60	38	948	556	Not Dr.*	241 E	Kansas City.
3	Farmers Loan Co	Ben Terhune No. 1	30	62	38	1002	1015?	No Log	No Log	Cherokee ?.
	Nodaway County.									
1	Convent	Clyde, Mo	18	63	33	1046	400	Not Dr.*	391 E	Pedee.
2	St. James Industrial School	Conception	24	63	34	1112	1037	714 ?	323 ?	Cherokee.
3	Burman Wells	Fee No. 1	7	63	36	1039	353	Not Dr.*	253 E	Douglas.
4	A. K. Frank	Fee No. 1	30	63	36	1006	296	Not Dr.*	178 E	Douglas.
5	State Mo., et al	Alice Beal No. 1 DDH	17	64	35	1047.3	1003	728	319	Cherokee.
6	Quitman Oil & Gas Co	Cardin No. 2	15	64	37	940.2	1410	96	244	Cherokee.
7	Quitman Oil & Gas Co	Getta Karr No. 1	22	64	37	1046.5	1700	785	261	Mississippian.
8	Nodaway County Oil, Gas & Mineral Co	Burlington Junction	21	65	37	964.2	1903	?	?	Mississippian.
9	Hopkins Gas & Development Co.	D. A. Sargent No. 1	2	66	35	1036.8	1000	613	424	Cherokee.
	Platte County.									
1	Dr. Francis, et al	Brenner	4	50	33	769	435	117	652	Cherokee.
2	K. C. Ind. Land Co	Renner	4	50	33	759	620	92	667	Cherokee.
3	Hazlett, Decker & Wells	Park College No. 1	1	50	34	751	892	85	666	Mississippian.
4	Rieger Inv. Co	Rieger	16	51	33	.....	400	340	.....	Pleasanton.
5	Newcomb, Lloyd & Empire	Breen	29	51	33	961	958	295	666	Mississippian.
6	Wm. Wilson	Fee No. 1	1	51	34	1056	1150?	456	600	?
7	Palmer	Fee No. 1	22	51	34	791.9	842	212	580	Cherokee.
8	E. W. Campbell	Thompson	23	51	34	892	553	274	618	Cherokee.
9	Sutter	Fee No. 1	30	51	33	939	265	264	675	Pleasanton.
10	Joseph G. Kelley	Hide-Out	26	51	34	958	300	Not Dr.*	632 E	Kansas City.
11	R. S. Jones	Fee No. 1	29	51	34	952	344	Not Dr.*	593 E	Kansas City.
12	Park College	Fee	35	51	34	760	426	108.6	640	Cherokee.
13	J. B. Dillingham	Fee	24	51	35	773	537	220	553	Cherokee.
14	LaSalle Oil Co	E. Hartsook	29	52	34	883	2420	314	569	Canadian.
15	Danciger Bros	N. B. Anderson No. 1	11	52	35	813	955	286	527	Cherokee.
16	S. W. Forrester	Ralston No. 1	6	53	33	924	945	337	587	Cherokee.
17	Goblin Dome Oil Co	McHenry No. 1	19	53	33	795	924	216	579	Mississippian.
18	Galey, Hazlett, et al	Jesse Williams No. 1	13	53	34	803	531 ½	221	582	Cherokee.
19	Ed. and Gazelle Mitchell	Ed. Miller No. 1	24	53	35	792	1820	268	524	St. Peter.
20	Danciger Bros	J. B. Doran No. 1	2	53	36	871	1033	415	456	Cherokee.
21	R. A. Barton	Frank Denny	31	54	33	912	600	303	609	Cherokee.
22	Dusenberry Bros	Mrs. J. J. Burgess	12	54	35	1034	1370	505	529	Mississippian.
23	Atchison Oil & Gas Syndicate	Kidwell	12	54	37	792.5	811	420	372	Cherokee.

TABLE II. SYNOPSES OF DEEPER WELLS DRILLED IN AREA—Continued.

*Not Dr. = Not drilled. E = Elevation base of Hertha estimated. DDH = Diamond drill hole.

Map No.	Owner.	Farm.	Location, S. – T. – R.	Surface elevation, feet.	Total depth, feet.	Depth base, Hertha limestone, feet.	Elevation base, Hertha limestone, feet.	Formation completed in.
	Ray County.							
1	Baldwin Ranch	Fee No. 1	25 52 26	688	784	.....	?	St. Peter.
2	Mrs. J. B. Harrison	Fee	10 52 28	887	541	20	867	Cherokee.
3	J. D. Judd & Co	Myra Clevenger	5 52 29	992	665	168	824	Cherokee.
4	Mo.-Kans. Gas Co	Wyman	5 52 29	925	552	65	860	Cherokee.
5	Carl Hinn	Fee No. 1	6 52 29	986	300	152	834	Pleasanton.
6	Mo.-Kans. Gas Co	Smith or K. Rayan	7 52 29	963	366	80	883	Pleasanton ? (Warrensburg?)
7	Mo.-Kans. Gas Co	Clevenger No. 1	7 52 29	934	630	41	893	Cherokee.
8	Mo.-Kans. Gas Co	White or J. R. Morgan Est. No. 1	18 52 29	956	311	80	876	Pleasanton ? (Warrensburg?)
9	Mo.-Kans. Gas Co	Ryan No. 1	18 52 29	940	670	90	850	Cherokee.
10	Mo.-Kans. Gas Co	Ryan No. 2	18 52 29	918	645	53	865	Cherokee.
11	John F. Overman	D. K. Michaels	34 52 29	790	802	Starts below Hertha	.....	Mississippian.
12	Western O. & G. Co	Andy Wells	2 53 27	850	603	Starts below Hertha	.....	Mississippian.
13	M. C. Goodman	Fee No. 1 (Now Brown)	20 53 28	910	300	67	843	Henrietta.
14	Pioneer Oil, Gas & Prod. Co	Albert Adams No. 1	29 53 28	760	1263	Starts below Hertha	.....	Canadian ?.
15	Interstate Production Co	T. C. Smith	34 53 29	1045	730	228	817	Cherokee.
16	Donald Grove	Fee No. 1	9 54 27	924	720	100	824	Cherokee.
17	J. W. Dana	Fee No. 1	34 54 28	918	618	75	843	Cherokee.
18	James Blair	Fee No. 1	35 54 28	895	232	32–4	863	Henrietta.
19	Prairie Block Coal	F. G. Fowler, D.D.H	16 54 29	883	600	160	723	Cherokee.
20	Gabbert, Fowler, McCollouch	Fowler	16 54 29	868	311.5	.....	.....	
21	C. M., St. P. & Pac. R.R.	Fee No. 1	30 54 29	1062	604	251	811	Cherokee.

	Worth County.									
1	Grant City	Penny No. 2	1	65	31	915	880	233	682	Mississippian.
2	Grant City	Porter No. 1	12	65	31	909.8	1056	244	666	Mississippian.
3	Allendale Coal, Oil & Gas Co	W. A. Monday D.D.H. No. 2	23	66	30	928	950	416	512	Cherokee.
4	Allendale Coal, Oil & Gas Co	Chester Campbell, D.D.H. No. 1	27	66	30	992.5	1135	461	531	Cherokee.

Log of Rochester Coal Mining and Prospecting Co's., Webb Kirby Estate No. 1. Location: SE. cor. SW. 1/4 NW. 1/4 sec. 14, T. 59 N., R. 34 W., Andrew County, Mo. Elevation: 884 feet (P. T.). Completed May 15, 1890. Well No. 1 on Map, Pl. I.

	Thickness,		*Depth,*	
Pleistocene and recent series:	*Ft.*	*In.*	*Ft.*	*In.*
Black soil	6		6	
Yellow clay	6		12	
Sand	9		21	
Blue clay	7		28	
Pennsylvanian system:				
Pedee group:				
Limestone, gray, with clay seams	7		35	
Shale, blue, sandy, (Weston)	86		121	
Lansing group:				
Limestone	2		123	
Shale, light blue	10		133	
Limestone, gray	22		155	
Shale, light blue		7	155	7
Shale, black, and gray	2	9	158	4
Limestone	1	10	160	2
Shale, gray	1	2	161	4
Limestone		7	161 –	11
Clay, white		5	162	4
Limestone, impure	3	4	165	8
Shale, gray	1	6	167	2
Limestone, light gray	4	2	171	4
Shale, blue	4	7	175	11
Limestone		7	176	6
Shale, blue to gray	12	5	188	11
Limestone	1		189	11
Shale, blue	6		195	11
Limestone		6	196	5
Shale, gray	3	11	200	4
Limestone	5	10	206	2
Shale, dark	28	11	235	1
Kansas City group:				
Limestone	4		239	1
Shale, blue	9	5	249	6
Limestone	4	4	252	10
Shale, blue	1	8	254	6
Limestone	1	2	255	8
Shale, blue to dark	3	5	259	1
Limestone		8	259	9
Shale, blue	5	11	265	8
Limestone, white	8	3	273	11
Shale, blue to red	6	10	280	9
Limestone, impure	10	4	291	1
Shale, dark	2	4	293	5
Limestone	2	9	296	2
Shale, dark	3	1	299	3
Limestone		6	299	9
Shale, dark	6	3	306	
Limestone	2	1	308	1
Shale, blue	1	5	309	6
Limestone	6		315	6
Shale, dark	2	6	318	
Limestone	1	7	319	7
Shale, dark	3	3	322	10
Limestone, white	32	5	355	3
Shale, light blue to black	5	6	560	9
Limestone, impure	22	2	382	11
Shale, blue to black	11	5	394	4
Limestone, impure	10	2	404	6
Pleasanton group:				
Shale, light blue to dark with seam of coal	51	7	467	1
Limestone, dark brown, hard	2	8	469	9

Log of Rochester Coal Mining and Prospecting Cos.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Shale, light to dark with seam of coal	5	7	475	4
Limestone and shale	4	3	479	7
Shale, dark	10	10	499	5
Limestone, impure	23		522	5
Shale, blue	4		526	5
Limestone	5		531	5
Shale, dark	12	5	543	10
Limestone	1	2	545	
Shale, red, blue, and black	2	6	547	6
Shale, light blue	7	10	555	4
Henrietta group:				
Limestone, impure	16	1	571	5
Shale, blue to black	30		613 –	5
Coal		10	614	3
Shale, clayey	1	3	615	6
Limestone	5		620	6
Shale, blue	1	5	621	11
Limestone, impure	9	11	631	10
Shale, blue	9	7	641	5
Limestone and shale	11	10	653	3
Shale with some limestone	46	9	700	
Shale, light and dark	100		800	

Log of Home Oil Company No. 1, W. E. Patterson Farm. Location: SE. cor. SW. 1/4 NW. 1/4 NW. 1/4 sec. 8, T. 59 N., R. 35 W., Andrew County, Mo. Elevation: 1077 feet. Completed May 4, 1921. Well No. 2 on Map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Surface soil, yellow, soft	75	75
Sand and gravel, gray, hard (set 90 feet of 12½-inch casing)	15	90
Pennsylvanian system:		
Douglas group:		
Shale, blue	10	100
Lime, gray, hard (bed "A")	2	102
Slate or shale, light, soft	13	115
Lime, gray, hard	5	120
Slate and shale, blue	15	135
Shale and lime shells	77	212
Lime, gray (base of Amazonia?)	30	242
Clay, red	10	252
Shale, gray	83	335
Clay, red	5	340
Pedee, Lansing and Kansas City groups:		
Lime, gray, hard, sandy (Iatan)	8	348
Slate or shale, gray	52	400
Lime, gray, hard	10	410
Shale, hard	3	413
Lime, white, hard (base of Stanton)	17	430
Shale, dark	10	440
Lime, white (Plattsburg)	20	460
Shale, blue	15	475
Lime, white, hard	15	490
Shale, blue	30	520
Lime, white, hard	12	532
Shale, blue	28	560
Lime, white, hard	20	580
Slate or shale, blue	5	585
Lime, blue	20	605
Lime, gray, hard (base of Bethany Falls at 660)	55	660
Shale, blue	15	675
Lime, white, hard (Hertha)	15	690

Log of Home Oil Company No. 1, W. E. Patterson Farm—Continued.

	Thickness, feet	*Depth, feet*
Pleasanton, Henrietta and Cherokee groups:		
Shale, blue	36	726
Sand, white, hard, fine (hole full of salt water) (Knobtown)	29	755
Shale, blue	10	765
Lime, gray, hard	5	770
Shale, blue	5	775
Lime, gray, hard	5	780
Shale, drab	10	790
Shale, white	10	800
Shale, drab (set 812 feet of 10-inch casing)	15	815
Mud, red	3	818
Shale, gray	4	822
Lime, gray, hard	4	826
Shale, gray to white	20	846
Coal	1	847
Lime, gray, hard	8	855
Shale, gray, hard	10	865
Shale, white	13	878
Shale, gray	7	885
Shale, gray, sandy	25	910
Shale, gray	50	960
Shale, white, sandy	40	1000
Shale, gray	40	1040
Shale, white	30	1070
Lime, gray, hard	5	1075
Shale, gray	5	1080
Coal	3	1083
Shale, drab	30	1113
Sand, white, fine (hole full of salt water)	137	1250
Lime shells and sand, white	5	1255
Slate or shale, black, hard	35	1290
Sand gray, brown (more water)	12	1302
Shale, blue	10	1312
Lime, gray, sandy	13	1325
Sand, white, hard, fine	90	1415
Lime, black, hard	8	1423
Sand, white, hard	10	1433
Lime, gray, mixed with blue shale	7	1440
Shale, black	10	1450
Lime, black and gray	18	1468
Shale, black and blue	37	1505
Sand, white, hard, fine (hole full of sweet water) (Set 8¼-inch casing at 1605 feet.)	100	1605
Mississippian system:		
Lime, gray, hard ("Mississippian Lime")	45	1650
Shale, light blue	1	1651
Lime, light brown, hard	234	1885
Shale, blue, soft (Kinderhook)	25	1910
Devonian System:		
Lime, gray with brown spots, hard	80	1990
Sand, gray (water)	3	1993
Lime, gray (brown asphalt)	82	2075
Limestone, magnesian, and dolomite	135	2280
Silurian system:		
Dolomite, some magnesian limestone (asphalt reported)	40	2320
Ordovician (?) system:		
Shale (Maquoketa), some dolomite in upper portion, set 6 5/8-inch casing at 2425 feet	105	2425
Ordovician system:		
Dolomite (Galena), sulphur gas reported from 2425 to 2450 feet. (Strong show of salt water and asphalt reported)	91	2516

Log of Home Oil Company No. 1, W. E. Patterson Farm—Continued.

The following descriptions are from sample studies:

	Thickness, feet	*Depth, feet*
Devonian system:		
Limestone, finely crystalline	5	2075
Limestone, dense, lithographic	5	2080
Dolomite or limestone, light to dark brown, fine-grained to finely crystalline, earthy at 2105 feet, lithographic at 2115 feet	35	2115
Dolomite, very dark brown, finely and evenly crystalline, limestone at 2140-45 feet	34	2149
Limestone, light to dark gray and brown, dense, lithographic, more granular and slightly cherty at base, light show heavy oil at 2165-70. Good show heavy oil 2170-75	26	2175
Limestone, earthy, very cherty, show heavy oil	5	2180
Dolomite, light brown, finely granular, show of asphalt at 2180 and 2200	20	2200
Dolomite, coarsely crystalline, with quartz, calcite, and gray quartzose chert	32	2232
Limestone, dolomite, gray lithographic; gray-green shale	8	2240
Similar to 2200-2232	15	2255
Dolomite, fine-grained to finely crystalline and lithographic, some chert and rounded and frosted grains of sand	25	2280
Silurian system:		
Dolomite, brown, very finely crystalline, slight show of heavy oil	10	2290
Dolomite, grayish-blue, crystalline	15	2305
Dolomite, fine-grained, earthy, some pyrite, chert and sand	15	2320
Ordovician system:		
Maquoketa shale:		
Dolomite, light to dark, fine-grained, with much shale, hard, dark green, with black, lustrous, spores (?)	25	2345
Shale, dark green, hard, pyritic, spores	5	2350
Shale, gray, even textured	15	2365
No samples	60	2425
Kimmswick formation:		
Dolomite, light bluish gray, crystalline	10	2435
No samples	81	2516

Log of Charles Petroleum Company's Wm. C. Clark No. 1. Location: SE. 1/4 NW. 1/4 sec. 28, T. 60 N., R. 35 W., Andrew County, Mo. Elevation: 990 feet. Completed April 9, 1937. Well No. 4 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene or Recent series:		
Soil and clay	15	15
Mud and little gravel (some water at 25')	10	25
Pennsylvanian system:		
Douglas group:		
Lime (set 30' of 10")	5	30
Gray shale	4	34
Lime	4	38
Lime shells and shale	8	46
Lime	4	50
Red bed	20	70
Grayish-green shale	7	77
Tan lime (Amazonia)	7	84
Gray shale and lime shells	6	90
Dark gray shale	15	105
Gray sandy shale	20	125
Shaly sand (water, 3 GPM, probably more, F. C. G.)	25	150
Gray shale	24	174
Lime (Haskell)	3	177
Gray shale	3	180
Red bed	7	187
Gray shale	5	192

Log of Charles Petroleum Company's Wm. C. Clark No. 1—Continued.

	Thickness, feet	Depth, feet
Pedee group:		
Gray lime (Iatan)	5	197
Gray shale	61	258
Lansing group:		
Lime (U. Stanton)	6	264
Gray shale	6	270
Gray lime (M. Stanton)	14	284
Dark shale	3	287
Lime (L. Stanton)	1	288
Dark gray shale } Plattsburg Farley	9	297
Gray and tan lime } Plattsburg Farley	5	302
Gray shale	2	304
Gray lime	4	308
Dark shale	7	315
Gray shale and lime shells	4	319
Dark lime	6	325
Gray shale and lime shells	8	333
Lime	2	335
Green shale	2	337
Lime	8	345
Light shale and lime shells (SLM 350).	5	350
Dark gray shale	28	378
Kansas City group:		
Gray lime (Raytown)	7	385
Dark shale	18	403
Tan lime (Cement City)	5	408
Light shale	6	414
Lime (Westerville)	14	428
Gray shale-lime shells	2	430
Dark gray shale	7	437
Shaly lime	3	440
Gray shale	4	444
Lime (Block)	8	452
Gray shale	5	457
Gray lime (WS) (SWL 105' when drilling at 480. Varied from 105' to 120').	39	496
Dark shale	6	502
Gray lime (BF)	21	523
Black slate	2	525
Lime (Middle Creek)	2	527
Green shale	5	532
Gray shale and lime shells	3	535
Lime (Hertha)	12	547
Pleasanton and Henrietta groups: (SLM at 544. Red. to 8" at 549). Running 8¼ 3/20/37.		
Gray shale and lime shells	4	551
Black shale	2	553
Gray shale	5	558
Sandy lime	2	560
Gray shale	37	597
Shale and lime shells	2	599
Shale	2	601
Sandy lime	4	605
Gray shale	13	618
Green shale	7	625
Gray shale	5	630
Lime	2	632
Light gray shale	3	635
Lime	3	638
Light shale	7	645
Gray sandy shale	12	657
Lime	6	663
Red bed	2	665
Dark gray shale	9	674

Log of Charles Petroleum Company's Wm. C. Clark No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime	2	676
Gray sand broken	5	681
Dark gray shale	11	692
Lime and shale breaks (Lexington coal in cuttings)	6	698
Gray shale	5	703
Tan lime	2	705
Gray shale	10	715
Lime	1	716
Light shale	7	723
Lime	2	725
Light shale—lime shells	8	733
Sandy lime	2	735
Cherokee group:		
Light sandy shale	20	755
Gray shale	28	783
Dark shale, coal and slate	2	785
Dark gray shale	17	802
Lime	2	804
Gray shale	9	813
Lime (Ardmore)	4	817
Black shale	4	821
Lime	1	822
Light sandy shale	10	832
Gray shale	6	838
Lime	2	840
Light shale	5	845
Gray shale	15	860
Dark gray shale	8	868
Shaly lime	2	870
Light limy shale	11	881
Light shale	9	890
Dark shale	5	895
Gray shale	16	911
Lime	2	913
Gray shale	2	915
Black slate and coal	5	920
Dark gray shale	8	928
Gray sand broken	9	937
Light shale	5	942
Gray limy shale	5	947
Bkn sand and shale	14	961
Gray shale	4	965
Limy shale (SWL 175 or 200. Little water at 970-975)	5	970
Sand and shale	10	980
Sand (water strong at 985)	15	995
Gray sandy shale	5	1000
Water stands at 328.		
Sand, gray	49	1049
SLM 1049 Set 6¼ at 1002.		
Open (few cuttings)	1	1050
Limy sand (water as soon as drilling resumed after setting 6¼)		
Water level 245	8	1058
Dark blue shale	7	1065
Lime	2	1067
Sand, gray	63	1130
Limy sand	10	1140
Sand, gray	75	1215
Limy sand	25	1240
Hard light sand	30	1270
Water level 220.		
Medium hard sand	15	1285
Sand and thin shale breaks	10	1295
Light sand, soft	10	1305
Coarse sand	10	1315

Log of Charles Petroleum Company's Wm. C. Clark No. 1—Continued.

	Thickness, feet	*Depth, feet*
Firm sand	6	1321
Soft sand	14	1335
Coarse sand	5	1340
Sand and some flint	33	1373
Sand and some lime	7	1380
Hard sand	2	1382
Black slate and sand and some lime	8	1390
Thin layer of coal at 1383.		
Shale and lime, probably dark to black shale	39	1429
Mississippian system:		
Meramec group:		
St. Louis ? formation:		
Limestone, light tan, dense, sandy, residue 10 %, pyrite, and subrounded and frosted sand	5	1434 Total depth

Log of Schooler Bros. Fee No. 1. Location: SE. 1/4 SW. 1/4 SE. 1/4 sec. 23, T. 64 N., R. 40 W., Atchison County, Mo. Elevation: 949 feet (Bar.). Completed in November, 1937. Well No. 1 on Pl. I.

Pleistocene series: (Basal contact uncertain).	*Thickness, feet*	*Depth, feet*
Subsoil	0	2
Yellow clay	70	72
Blue clay	18	90
Sand	1	91
Brown clay	18	109
Sand	2	111
Pennsylvanian system:		
Part of Wabaunsee, all of Shawnee and part of Douglas groups:		
White slate	59	170
Brown slate	25	195
Shell, brown	2	197
Blue slate	78	275
Black slate	25	300
White slate	20	320
Brown slate	22	342
Lime, white	10	352
Slate, white	8	360
Lime shell, white	2	362
Slate, blue	1	363
Lime, white	2	365
Sand, water	5	370
Lime, white	11	381
Slate, black	5	386
Lime, shell	3	389
Slate, gray	11	400
Shale, white	5	405
Lime	4	409
Slate, brown	6	415
Slate, black	26	441
Shell, brown	2	443
Slate, white	2	445
Lime, white	10	455
Slate, dark	8	463
Lime, white	15	478
Slate, white	7	485
Shell, brown	1	486

NOTE: Cuttings from 486 to 518 T. D. were identified as Oread limestone. Well abandoned at 518 where salt water was encountered.

Log of W. F. Rankin No. 1 Fee. Location: SE. 1/4 SW 1/4 SE 1/4 sec. 14, T. 65 N., R. 40 W., Atchison County, Mo. Elevation: 911.3 feet. Completed August, 1914. Well No. 2 on map, Pl. I.

	Thickness, feet	*Depth, feet*	
Pleistocene series:			
Soil	25	25	
Sand, mixed with impurities	10	35	
Clay, blue, pebbly	95	130	
Sand, fine, water	45	175	
Pennsylvanian system:			
Shawnee and Douglas groups:			
Shale, gray	5	180	
Limestone, gray, fine-grained coarse cuttings	10	190	Deer Creek.
Shale, gray	20	210	
Limestone, no sample saved	4	214	
Shale, gray-blue	31	245	
Shale, gray	10	255	
Limestone, gray-blue, argillaceous	8	263	LeCompton.
Shale, blue-gray	15	278	
Limestone, gray	5	283	
Shale, gray-blue, effervesces	20	303	
Shale, lighter gray than above, effervesces freely	15	318	
Shale, black, bituminous, fossil	8	326	Oread Limestone.
Shale, gray, effervesces freely	19	345	
Limestone, light-gray	5	350	
Shale, gray, effervesces freely	5	355	
Shale, red, ferruginous, effervesces	25	380	
Shale, dark blue, effervesces	80	460	
Shale, gray (driller reports some lime shells)	5	465	Haskell
Shale, gray	5	470	
Shale, reddish-brown, soft	5	475	
Shale, bluish-gray	15	490	
Pedee, Lansing, and Kansas City groups:			
Limestone, dark-gray, fine-grained	5	495	Iatan.
Limestone, little lighter colored than above	5	500	
No sample, shale reported by driller	10	510	
Limestone, gray (Stanton limestone), vessicular	40	550	
Shale, dark blue	7	557	
Limestone, light gray, a small amount of dark shale (Plattsburg ls.)	15	572	
Shale, dark blue	20	592	
Limestone, gray-blue	28	620	
Shale, gray	15	635	
Limestone, gray-blue	10	645	
Shale, gray-blue	5	650	
Limestone, gray to blue	20	670	
Shale, grayish-blue	15	685	
Shale, dark blue with some limestone cuttings	5	690	
Shale, blue	5	695	
Limestone, gray	15	710	
Shale, no sample	15	725	
Limestone, gray	10	735	Winterset L. S.
Limestone, gray to blue, very hard fine cuttings	10	745	
Limestone, gray	12	757	
Shale, black fissle	3	760	
Limestone, light gray (Bethany Falls)	20	780	
Shale, very dark blue	4	784	
Shale, light gray	4	788	
Limestone, gray, shaley (Hertha)	6	794	

Log of W. F. Rankin No. 1 Fee—Continued.

	Thickness, feet	*Depth, feet*	
Pleasanton, Henrietta and Cherokee groups:			
Shale, dark gray to dark blue	126	920	
Shale, gray, calcareous, some limestone	5	925	
Shale, gray, very calcareous	5	930	
Limestone, gray, shaly	5	935	
Limestone, gray, shaly	20	955	
Shale, black, fissle	5	960	
Shale, dark blue	10	970	
Shale, blue	60	1030	Driller reports sandstone from 1030 to 1045.
Missing, probably shale	5	1035	
Sandstone, gray with dark blue shale	10	1045	
Open (driller reports shale)	15	1060	
Limestone, gray, some shale mixed in	10	1070	
Sandstone, dark gray	10	1080	
Sandstone, light gray, micaceous	15	1095	
Limestone, gray	25	1120	
Shale, dark blue	100	1220	
No samples from 1220 to 1330.			
Driller reports as follows (1220-1330):			
Red rock	5	1225	
Sandstone	5	1230	
Shale, dark	100	1330	
Shale, black	20	1350	
Shale, light gray	20	1370	
Shale, dark bluish-gray	10	1380	
Sandstone, gray, fine-grained, micaceous	5	1385	
Shale, gray	5	1390	
Sandstone, gray, fine-grained with dark shale cuttings mixed in	10	1400	
Same as above	10	1410	
Shale, gray	10	1420	
Shale, gray	40	1460	
Sandstone, white, mediumly coarse-grained	5	1465	
Sandstone, dark, fine-grained, micaceous	7	1472	
Shale, dark blue, bituminous	30	1502	
Shale, dark blue	49	1551* Total depth	

*Base of Cherokee not reached.

Log of W. F. Rankin No. 2 Fee. Location: SE. 1/4 SW. 1/4 SE. 1/4 sec. 11, T. 65 N., R. 40 W., Atchison County, Mo. Elevation: 913.6 feet. Completed December, 1915. Well No. 3 on map, Pl. I.—Driller's log to 496 feet, from 496 to 1,640 from sample descriptions by W. C. Hogoboom, from 1,640 to 2,340 from sample description by Miss Mary Hundhausen and H. S. McQueen.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Alluvium:		
Soil	28	28
Drift:		
Sand and water (fresh)	15	43
Mud or clay, blue	30	73
Sand and water (fresh)	40	113
Shale, very soft	40	153
Sand and water (fresh)	10	163
Pennsylvanian system:		
Shawnee and Douglas groups:		
Shale	7	170
Limestone	15	185
Shale, white	23	208
Limestone	4	212

Log of W. F. Rankin No. 2 Fee—Continued.

	Thickness, feet	*Depth, feet*
Shale, blue	38	250
Limestone	23	273
Shale, blue	4	277
Limestone	9	286
Shale, white	40	326
Limestone (Oread)	4	330
Shale, white (Oread)	5	335
Limestone (Oread)	4	339
Shale	11	350
Shale, very red, soft	20	370
Shale	70	440
Lime shells, shale, thin layers and limestone	11	451
Shale	7	458
Shale or red rock, soft	9	467
Shale	9	476
Pedee, Lansing and Kansas City, groups:		
Lime	10	486
Shale	10	496
Limestone, gray, bluish	29	525
Shale, dark gray, calcareous	20	545
Shale, reddish, slightly calcareous	15	560
Shale, gray, calcareous	5	565
Limestone, light gray	10	575
Shale, dark gray calcareous	10	585
Gray shale, calcareous	30	615
Shale, dark gray, calcareous	5	620
Shale, light gray, very calcareous with some limestone	10	630
Shale, dark gray to black, slightly calcareous	7	637
Light gray limestone, fine-grained	25	662
Shale, dark gray to black, slaty in places	10	672
Shale, soft, gray, calcareous	20	692
Limestone, gray	25	717
Shale, soft, gray, calcareous	10	727
Light gray limestone (Winterset)	38	765
Shale, light blue, somewhat calcareous	5	770
Limestone, light gray with Hustedia mormoni (fossil) (Bethany Falls)	10	780
Shale, slaty, dark gray to black	5	785
Limestone, light gray	15	800
Pleasanton, Henrietta and Cherokee groups:		
Shale, light to dark gray	10	810
Limestone, light gray	25	835
Shale, soft bluish-gray with fragments of crinoid stems, calcareous	8	843
Limestone, light gray with some shale	12	855
Shale, light bluish-gray, calcareous	20	875
Limestone, light gray	10	885
Shale, light bluish-gray, soft, calcareous	35	920
No sample (limestone)	17	937
Shale, gray, soft, calcareous	20	957
Shale, soft, light gray	73	1030
Sandstone, gray, calcareous	21	1051
Sandstone, hard, gray, calcareous, fine cuttings	7	1058
Shale, black, somewhat calcareous	7	1065
Sandstone, dark gray, with some carbonaceous material, limestone and mica	5	1070
Sandstone, gray, calcareous with pyrite and some dark gray shale	25	1095
Shale, light gray, soft	40	1135
Shale, soft black	10	1145
Shale, light gray, soft	30	1175
Shale, light gray and reddish	10	1185
Shale, soft, light gray	15	1200
Soft, light gray and reddish shale, somewhat calcareous	5	1205

Log of W. F. Rankin No. 2 Fee—Continued.

	Thickness, feet	*Depth, feet*
No sample	50	1255
Shale, gray to black	40	1295
Sandstone, dark gray, cuttings very fine	30	1325
Shale, soft, black	10	1335
Shale, soft, light bluish-gray	20	1355
Gray limestone, shale with pyrite	10	1365
Sandstone, gray, with shale and some limestone	10	1375
Sandstone, light gray, fine cuttings	45	1420
Sandstone, light yellowish-gray with fresh water, slightly calcareous, sample sent in for analysis	30	1450
Limestone, gray, with sandstone and black shale	20	1470
Shale, black, with gray limestone	5	1475
Shale, soft, black, with small amount of gray limestone	12	1487
Shale, light gray to black	15	1502
Calcareous sandstone, light gray, with gray shale, sandstone fine-grained	14	1516
Sandstone, light gray, fine-grained, calcareous, fine cuttings, "salt water"	22	1538
Sandstone, light gray, fine-grained, slightly calcareous, with much black shale	4	1542
Shale, dark blue, fissile	13	1555
Sandstone, fine-grained, gray with fissile shale from above	15	1570
Arenaceous shale, with black fissile shale	5	1575
Limestone, gray, crystalline and black fissile shale, all stained reddish with iron	5	1580
Sandstone, gray; and black, fissile shale	10	1590
Shale, black, fissile and sandstone	5	1595
Shale, light gray, some dark, a little sand	10	1605
Shale, very dark blue	10	1615
Shale, gray, blue to black, fissile	25	1640
Mississippian system:		
Meramec group:		
St. Louis formation?		
Limestone, 1 sample, tan, lithographic, slightly sandy. Insoluble residue: 10%; quartz aggregates, quartz crystals, quartzose chert; some faintly pink	15	1655
Warsaw formation:		
Limestone, light gray and tan, crystalline, with dolomitic lime, tan, some gray shale. Insoluble residue: 10% to 40%, chert, white, blue, gray, mottled, fossiliferous, some drusy chert, spores, green shale	70	1725
Osage group:		
Keokuk-Burlington formation:		
Limestone, white, coarsely crystalline, crinoidal, cherty, with dolomite, fine-grained, crystalline, light gray to white. Insoluble residue: 10% to 40%, chert, white to light gray sub-translucent, fossiliferous	115	1840
Kinderhook group:		
Gilmore City formation:		
Limestone, oolitic, light gray to white. Residue: 10%, light brown crinoids, quartzode, fine-grained silica. (Brown sugary crinoids)	10	1850
Limestone, dense, gray, cherty. Insoluble residue: 10% to 25%, chert, gray and white, dense to porous. Brown silicious crinoids in upper part	45	1895
Limestone, white, oolitic; oolites round, medium large. Insoluble residue: less than 10%, quartzose chert and fine-grained sand	25	1920
Kinderhook shale:		
Shale, greenish gray, some sand and pyrite	10	1930
Hematite, red, oolitic	5	1935
Hematite, red, oolitic, with red shale	20	1955
Shale, greenish-gray with some oolitic hematite (caved)	5	1960

Log of W. F. Rankin No. 2 Fee—Continued.

	Thickness, feet	*Depth, feet*
Limestone, gray, finely crystalline, slightly and finely sandy, with some green shale	5	1965
Chert, very calcareous, with large number of plant spores, and sponge spicules; gray chert is common	55	2020
Limestone, brown, very earthy with abundant Micro fauna consisting of Bryazoa, Ostracods, and crinoid segments; some brown chert and shale	4	2024
Shale, gray	4	2028
Similar in detail to 2020-2024	4	2032
Chert, very calcareous, gray, spores and spines being abundant, fine-grained sand is common	12	2044
Shale, gray with milky white quartz	16	2060
Shale, gray, calcareous, spore bearing	20	2080
Shale, gray, calcareous, spore bearing, with some spore and sponge spicule bearing chert	90	2170
Devonian system:		
Dolomite, dark brown, finely crystalline; some quartzose chert, apple-green shale and sand	170	2340 Total depth

Log of Missouri Independent Oil and Gas Company's W. O. Bishop No. 1. Location: NW. 1/4 SW. 1/4 NW. 1/4 sec. 20, T. 65 N., R. 41 W., Atchison County. Elevation: 1,121.95 feet. Completed December, 1928. Well No. 4 on map, Pl. I.

		Thickness, feet	*Depth, feet*	
Pleistocene series:				
Soil		90	90	
Sand, red		28	118	
Blue mud		3	121	
Clay, blue		32	153	
Pennsylvanian system:				
Wabaunsee and Shawnee groups:				
Lime (Jim Creek)		2	155	
Clay, blue		15	170	
Lime, gray (Dover)		1	171	
Shale, black		23	194	(Small amount of water.)
Lime, brown, sandy (Maple Hill)		2	196	
Shale, dark		4	200	
Lime, gray, very hard (Tarkio)		4	204	
Coal		1	205	
Shale, green to light gray	Elmont	19	224	
Lime	Elmont	7	231	
Shale, dark	Reading	3	234	
Lime and shale	Reading	3	247	
Shale, dark		2	249	
Red bed		7	256	
Shale, blue to dark		15	271	
Lime (Rulo)		3	274	
Shale, dark		56	330	
Shale, light green to white		21	351	Salt water.
Shale, dark pyrite		19	370	
Lime and shale		10	380	
Lime, gray, does not appear in outcrops either in Ks. or Mo		30	410	
Shale, sandy		13	423	
Lime (Howard)		7	430	
Sand (oil showing)		3	433	
Coal		1½	434½	
Shale, dark		17½	452	
Lime	(Topeka)	8	460	
Shale, dark	(Topeka)	3	463	
Lime, hard	(Topeka)	46	509	

Log of Missouri Independent Oil and Gas Company—Continued.

	Thickness, feet	Depth, feet	
Shale, white	10	519	
Shale, green	9	528	
Lime, Shale, dark, Lime varied, Shale, dark, Lime, hard — Deer Creek	2	530	
	3	533	Light water; salty.
	20	553	
	3	556	
	2	558	
Shale, green	15	573	
Shale, brown	2	575	
Shale, light	41	616	
Lime, white, Shale, light, Shale, dark, Lime — Lecompton	4	620	
	5	625	
	6	631	
	9	640	
Shale, light	4	644	
Lime, very hard	11	655	
Shale, light	11	666	
Douglas group:			
Lime and sand, Oread	34	700	
Shale, black	1	701	
Lime	2	703	
Shale, dark to blue	8	711	
Red bed	19	730	
Shale, Haskell (796-798)	68	798	
Shale, dark	3	801	
Sand	2	803	
Shale, dark	3	806	
Lime	1	807	
Red bed	7	814	
Shale, dark	6	820	
Pedee, Lansing and Kansas City groups:			
Lime, hard	16	836	
Shale, dark	2	838	
Lime	10	848	
Lime, sandy	3	851	
Lime, white	37	888	
Shale, dark	8	896	
Lime, coarse white chalky	14	910	
Shale, dark	3	913	
Lime	33	946	
Shale, blue	10	956	
Lime	11	967	
Shale, green	3	970	
Lime	16	986	
Shale, dark	9	995	
Lime	1	996	
Shale, blue	2	998	
Lime, black sandy	4	1002	
Shale, dark	5	1007	
Lime, gray	21	1028	(Winterset.)
Shale, dark black	3	1031	
Shale, light	7	1038	
Lime	34	1072	(Bethany Falls.)
Shale, dark	3	1075	
Lime	2	1077	
Slate, dark	3	1080	
Lime, gray	15	1095	(Hertha.)
Pleasanton, Henrietta, and Cherokee groups:			
Shale, dark	2	1097	
Lime	4	1101	
Shale, light blue	17	1118	
Shale, black	18	1136	
Lime	2	1138	
Shale, dark	12	1150	

Log of Missouri Independent Oil and Gas Company—Continued.

		Thickness, feet	*Depth, feet*	
Shale, light, blue, sandy		21	1171	
Shale, green		33	1204	
Shale, green		15	1221	
Shale, brown		20	1241	
Shale, gray		6	1247	
Shale, black		3	1250	
Shale, dark		15	1265	
Lime		1	1266	
Shale, light		10	1276	
Shale, black		6	1282	
Shale, light		38	1320	
Sand		10	1330	Water (top of Squirrel).
Shale, sandy and gray		10	1340	
Shale, dark		20	1360	
Shale, black and slaty		2	1362	
Shale, light and sandy		14	1376	(Bottom of Squirrel sand.)
Shale, black		2	1378	
Lime		2	1380	
Shale, dark	Ardmore	10	1390	
Lime		1	1391	
Shale		5	1396	
Lime		7	1403	
Shale, dark		3	1406	
Lime		2	1408	
Sandy shale, black		1	1409	
Shale, dark		39	1448	
Sandstone		2	1450	
Shale, blue to black, sandy streaks		17	1467	
Sand		6	1473	
Shale, brown		2	1475	
Shale, gray		37	1512	
Limestone		2	1514	
Sandstone		2	1516	
Shale		4	1520	
Sandstone		5	1525	
Shale, light, gray		5	1530	
Sandstone		5	1535	
Shale, light, gray		15	1550	
Sandstone		30	1580	Salt water showing.
Shale, white		10	1590	
Shale, white		20	1610	
Sandstone		25	1635	
Lime, soft		20	1655	
Lime, hard		5	1660	
Shale, brown		15	1675	
Lime		10	1685	
Lime, soft		5	1690	
Sandstone, bottom of hole		23	1713	

Log of Ray Glaspell's Peel No. 1. Location: NE. 1/4 SW. 1/4 NW. 1/4 sec. 32, T. 56 N., R. 35 W., Buchanan County, Mo. Elevation: 1,053.3 feet. Completed 1924 (?). Well No. 1 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil, clay soft	55	55
Pennsylvanian system:		
Douglas-Kansas City groups:		
Lime, red, hard (water)	3	58
Shale, gray, soft	4	62
Red bed, red, soft	6	68
Shale, red, soft	10	78

Log of Ray Glaspell's Peel No. 1—Continued.

	Thickness, feet	Depth, feet
Shale, blue, soft	67	145
Shale, dark, soft	45	190
Lime, gray and brown, hard (Iatan)	15	205
Shale, light, soft	90	295
Lime, white, hard	3	298
Shale, light, soft	7	305
Lime, white, hard	10	315
Shale, blue, soft	5	320
Lime, white, hard	5	325
Shale, blue, soft	5	330
Broken lime, hard	150	480
Shale, blue, hard	20	500
Lime, white, hard	5	505
Shale, black, soft	15	520
Lime and sand gray med. (Winterset)	25	545
Shale, light, soft	5	550
Lime, white, hard, (Bethany Falls)	20	570
Shale, white, soft (water)	5	575
Sandy lime, gray hard (Hertha)	15	590
Pleasanton, Henrietta and Cherokee groups:		
Shale, blue, soft	90	680
Lime, white, med	6	686
Shale, white, soft	54	740
Shale, blue, soft	30	770
Shale, dark, soft	15	785
Lime, gray, hard (Lexington horizon)	10	795
Shale, blue, soft	50	845
Shale, dark, soft	70	915
Lime, gray, hard (Ardmore)	5	920
Shale, blue, soft	20	940
Slate, dark, soft	10	950
Sand, dry, soft (gas)	10	960
Shale, blue, soft	40	1000
Slate, dark, soft	20	1020
Shale, dark, soft	30	1050
Shale, blue, soft	30	1080
Lime, white, hard	5	1085
Shale, blue, soft	15	1100
Shale, light, soft	5	1105
Coal, black	7	1112
Shale, dark, soft	50	1162
Lime, gray, hard	10	1172
Shale, blue, soft	20	1192
Slate, black, hard	8	1200
Sand, white, soft (water)	30	1230
Shale, blue, soft	5	1235
Lime, white hard	2	1237
Shale, blue, soft	40	1277
Shale, dark, soft	15	1292
Slate, black, soft	8	1300
Sand, white, soft (water)	30	1330
Shale, white, soft	30	1360
Shale, dark, soft	20	1380
Slate, black, hard	10	1390
Shale, blue, med	15	1405
Mississippian system:		
Meramec group:		
Warsaw formation:		
Lime, gray, hard	30	1435
Slate, little sand, dark, soft (light oil showing)	5	1440
Osage and Kinderhook group:		
Lime, gray, hard	95	1535
Sand, light, soft (water)	5	1540
Lime, gray, hard (casing set at about 1620) (8 1/4" hole)	125	1665

Log of Ray Glaspell's Peel No. 1—Continued.

	Thickness, feet	*Depth, feet*
Kinderhook group:		
Shale, blue, hard	55	1720
Shale, greenish gray, fine siliceous clay silt, somewhat calcareous, one sample	30	1750
Devonian system:		
Limestone, white and light gray, sandy, medium crystalline, pyrite	10	1760
Limestone, white and light gray, sandy, medium crystalline, pyrite	10	1770
Same, fine grained, sand grains but none observed in the limestone	10	1780
Same, light gray in color	10	1790
Limestone, white, fine grained, fewer sand grains and little pyrite	10	1800
Same and a little light green shale probably from above	10	1810
Same and light brown limestone; much light green shale, much lighter and softer than 1690 and possibly in place unless from above 1690 (hole cased about 1620)	10	1820
Same with light gray sandy limestone	10	1830
Same, very little pyrite	10	1840
Limestone, gray, fine grained; little light green shale as previously	5	1845
Limestone, white to light brown, fine grained, some sand grains, light green shale and pyrite	5	1850
Same (1750 to 1855 is apparently all in one formation)	5	1855
Limestone, white and light gray, many rounded sand grains	5	1860
Same	5	1865
Limestone, gray and brown, medium crystalline	5	1870
Limestone, light gray and light brown	5	1875
Same and a little greenish shale probably from above	5	1880
Dolomite, dark brown, crystalline	10	1890
Same	5	1895
Same	5	1900
Same and limestone light brown and white	5	1905
Limestone, light brown, very fine grained	7	1912
Limestone and dolomitic limestone, light brown and white and white cherty residue	8	1920
Same	5	1925
Dolomite, white and light brown, fine grained, a little pyrite	5	1930
Same, and a little gray chert, green-gray shale from above	5	1935
Dolomite, brown	5	1940
Dolomite, brown to gray	5	1945
Same	7	1952
Same	6	1958
Dolomite, light and dark brown (test for oil negative)	7	1965
Dolomite, white to light brown	5	1970
Same and many sand grains	15	1985
Same as above	10	1995
		Total depth

The following descriptions have been prepared from sample studies by Miss Mary Hundhausen and H. S. McQueen:

	Thickness, feet	*Depth, feet*
Mississippian system:		
Limestone, coarsely crystalline, highly crinoidal, brown, with dark shale partings; residue of shale, pyrite and silicified brochiopod fragments. One sample marked 1400 feet. Probably Warsaw		1400
Chert, light gray in color, rough and limestone; one sample marked 1540-1665. Probably Chouteau at least in part		1665

Log of Ray Glaspell's Peel No. 1—Continued.

	Thickness, feet	*Depth, feet*
Kinderhook group:		
Shale, gray, green, with black and brown spores. One sample marked 1690-1750		1750
Devonian system:		
Limestone, tan, crystalline, fine grained, with rounded and frosted sand grains and pyrite	10	1760
Dolomite, light tan, fine grained, crystalline, some sand as above	10	1770
Limestone, tan lithographic, sand as above and gray and green caved shale, some chert	20	1790
Limestone, white, lithographic sand and cherta as above, with some sand and bright green shale	30	1820
Limestone, tan and white, fine granular to dense, sub-lithographic; trace of white chert	25	1845
Dolomite, fine crystalline, light tan, some white chert	5	1850
Limestone, white, dense, sub-lithographic, with sand and green shale	15	1865
Dolomite, brown, fine grained, small amount tan to brown quartzose chert	5	1870
Limestone, finely crystalline tan and white, chert as above and aggregates of fine sand	10	1880
Dolomite, brown, fine grained, crystalline, some green shale and rounded and frosted sand, some quartzose chert	10	1890
Dolomite, brown, finely crystalline sucrose to lithographic and calcareous 1900-12, somewhat porous	10	1912
Dolomite, coarsely crystalline, white, with white to brown quartzose chert, quartz crystals, and some sand	28	1940
Dolomite, light brown, finely crystalline, sucrose, with white, dark gray and brown chert	25	1965
Dolomite, white, coarsely crystalline, with gray shale and gray chert	30	1995 Total depth

Condensed Log of Diamond Drill Hole near Saxton, Mo. Location: SW. cor. NW. 1/4 NW. 1/4 sec. 21, T. 57 N., R. 34 W., Buchanan County, Mo. Elevation: 837.5 feet. Commenced May 3, 1900. Completed June 26, 1900. Well No. 3 on map, Pl. I.

The descriptions of the cores below 620 feet are from a recent study by Miss Mary Hundhausen of the Missouri Geological Survey.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene series:				
Clay	23		23	
Sand	2		25	
Gravel	4		29	
Pennsylvanian system:				
Pedee group:				
Weston shale:				
Shale, blue	1		30	
Lansing group:				
Stanton limestone:				
Limestone	1		31	
Shale, blue	1		32	
Limestone	20		52	
Vilas shale:				
Shale, blue	4	6	56	6
Plattsburg limestone:				
Limestone	16	6	73	

Log of Diamond Drill Hole near Saxton, Mo.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Lane shale:				
Shale, blue	6		79	
Limestone	1		80	
Sandstone	17		97	
Shale, blue	1		98	
Limestone	2		100	
Shale, blue	9		109	
Limestone	4		113	
Shale, blue	4		117	
Limestone	1		118	
Shale, blue	38		156	
Kansas City group:				
Iola limestone and Chanute shale:				
Limestone	7	6	163	6
Limestone, fossiliferous	4		167	6
Shale	5		172	6
Limestone		6	173	
Shale	9		182	
Limestone	4		186	
Shale, blue	8		194	
Drum limestone:*				
Limestone	6		200	
Cherryvale shale:				
Shale, blue	1	6	201	6
Limestone	1		202	6
Shale, blue	3	6	206	
Limestone	5		211	
Shale, blue	13		224	
Limestone	2		226	
Shale, blue	7		233	
Limestone	5		238	
Shale, blue	6		244	
Winterset limestone:				
Limestone	8		252	
Shale, blue	1		253	
Limestone	20		273	
Galesburg shale:				
Shale	6		279	
Bethany Falls limestone:				
Limestone	21	6	300	6
Ladore shale:				
Shale, blue	2		302	6
Hertha limestone:				
Limestone	18	6	321	
Pleasanton group:				
Shale, black	1		322	
Coal (Ovid)		1	322	1
Shale	127	11	440	
Limestone	1		441	
Shale, blue	8		449	
Henrietta group:				
Limestone	3		452	
Shale, sandy	6		458	
Limestone	2		460	
Shale	23		483	
Limestone, conglomeratic	2		485	
Shale, black	3		488	
Limestone	1		489	
Sandstone	6		495	
Shale, black	11	6	506	6
Limestone, blue	1	6	508	
Shale	2	5	510	5

*May include some of the thin beds below.

Log of Diamond Drill Hole near Saxton, Mo.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Coal		7	511	
Shale, blue	8		519	
Limestone	7		526	
Shale, blue	9		535	
Limestone	3		538	
Shale, mixed with limestone	5		543	
Limestone	4	6	547	6
Cherokee group:				
Shale	5	6	553	
Sandstone	5		558	
Shale, clayey	4		562	
Sandstone	3		565	
Shale, blue	22		587	
Sandstone	3		590	
Shale, blue	6		596	
Sandstone	2		598	
Shale, blue	16		614	
"Cap rock"	1		615	
Coal (Bedford)	1	8	616	8
Sandstone	3	4	620	
Core missing	1	8	621	8
Shale, sandy, gray thin-bedded with much mica and plant remains	6	10	630	
Core missing	1	6		
Shale, gray, badly slacked, with several thin (¼") brown limestone beds	8	5	638	5
Limestone, argillaceous, somewhat fossiliferous, with gastropods		8	639	1
Shale, thin-bedded, platy, with sand and mica	5	6	644	7
Coal, badly slacked	1		645	7
Clay shale somewhat calcareous				
Limestone, very argillaceous, fossil shells	3		650	
(1′ core missing in above bed)				
Shale, light gray-green, with calcareous nodules in upper 10′. Calcareous fossils in shale at 659′. Much badly slacked shale	28	8	678	8
Shale, dark, carbonaceous, some siderite	5		683	8
Limestone, dark, brown, argillaceous	1	4	685	
Sandy shale, gray, badly slacked, with mica. Less sand, darker, more carbonaceous toward base	5	6	690	6
Coal		6	691	
Impure coal and black, carbonaceous shale, some fossil productids	4		695	
Sandstone, shaly micaceous	5		700	
Shale, thin-bedded, platey, dark gray to black	16		716	
Shale, black, slaty, some calcareous fossils	2		718	
Coal, impure	1	6	719	6
Shale, light gray, badly slacked, clay several thin lime streaks	4	6	725	
Shale, black, slaty, carbonaceous	1	2	726	2
Gray clay-shale, badly slacked	8	10	735	
Coal and black slaty shale	1	8	736	8
Shale, dark gray, badly slacked, 4" limestone at 742′	11	4	748	
Sand, micaceous, argillaceous, with plant remains	7		755	
Shale, gray, badly slacked, many plant fossils	7	4	762	4
Sandstone, irregular beds, cross-bedded, argillaceous	2	8	765	
Shale, gray, badly slacked	2	6	767	6
Shale, gray-green with psuedo-oolites of siderite	2	6	770	
Sandstone, fine-grained, argillaceous, with much mica, shale break (4") at 775′ 8"	6		776	
Siderite oolites in shale	2		778	
Shale, blue-gray, badly slacked	9		787	

Log of Diamond Drill Hole near Saxton, Mo.—Continued.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Shale, dark gray, thin bedded, with interbedded sand beds, brown mica, plant remains	14		801	
Shale, gray to black, with mica flakes	29		830	
Eight inches of sandy shale with plant remains at 857 feet	36		866	
Sandstone, fine-grained, argillaceous	3	9	869	9
Shale, gray and brown, thin-bedded, with some thin sandy beds carrying carbonized plant remains	3	3	873	
Sandstone, fine-grained, argillaceous, plant remains.	8	10	881	10
Core missing 1 foot 3 inches at 881 feet				
Coarse Arkosic grit, conglomerate? at base with coarse "clay ironstone" pebbles up to 2 inches in diameter	2	6	885	6
Shale, gray to black with thin beds and lentils of argillaceous sandstone. Contains woody fragments. 4 feet 8 inches black shale bed at base. Linguloid shells at 905 feet	22	2	907	8
Light gray clay shale, badly slacked		7	908	3
Shale, gray, arenaceous, with siderite psuedo-oolites, also some sand beds	2		910	3
Shale, gray, clayey, plant remains	2	9	913	
Sandstone, medium fine grained with much mica, also some irregular streaks of dark gray shale, and carbonized plant fragments	5	8	918	8
Shale, dark gray to black	1		919	8
Shale, gray, clayey, badly slacked	4		923	8
Sandstone as at 913 feet to 918 feet 8 inches	3		926	8
Shale, black, micaceous; contains some poorly preserved fossil imprints		4	930	8
Coal, impure, badly slacked		6	931	2
Gray clay shale, badly slacked	2		933	2
Shale, black, thin bedded, badly slacked with thin beds of brown iron carbonate	1	10	935	
As above	16	2	951	2
Gray clay shale, badly slacked, some carbonized plant remains in lower 10 inches	3	10	955	
Shale, dark gray to black, with thin sandy beds in lower 2 feet	5	4	960	4
Coal, badly slacked	1		961	4
Gray, clay shale some siderite psuedo-oolites	4		965	4
Dark gray to black shale with some mica	5	10	971	2
Coal, slacked, cannel, some shale		10	972	
Fire clay, light gray, compact, with some carbonaceous bands	3	4	975	4
Shale, dark gray to black, thin beds of iron carbonate	5		980	4
Light tan-gray argillaceous sandstone with leaf imprints	2	2	982	6
Shale, badly slacked dark gray and black 4 inches of brown iron carbonate "clay iron-stone" at 985 feet	4	2	986	8
Sandstone, gray, carbonaceous	1	2	987	10
Core missing	3	2	991	
As above	2	10	993	10
Gray clay-shale with plant fragments		8	994	6
Sandstone and shale, badly slacked, sandstone stained from oxidized pyrite, some plant remains	2	6	997	
Shale, gray, badly slacked, with plant remains and spores 4 inches sandy bed at 995 feet	15	4	1012	4
Sandstone, thin bedded, with much mica, shaly partings with carbonized plant remains	8	4	1020	8
Sandstone, fine-grained, white, heavy beds, mica	1	11	1022	7

Log of Diamond Drill Hole near Saxton, Mo.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Interbedded sand and shale, thin beds, much oxidized pyrite, plant remains, spores. Sand predominates	8	2	1030	9
Sandstone, thick bedded, micaceous, fine-grained	2	4	1033	1
Shale, gray, micaceous, plant remains	2		1035	1
Fire clay, gray, with leaf imprints	3	9	1038	10
Shale, black, badly slacked	2		1040	10
Core missing ?	13	2	1054	
Mississippian system:				
Meramec Group:				
Ste. Genevieve formation:				
Sandstone, dark, iron stained, with much organic material, sand is fine-grained, angular, regenerated. Shale, 4 inches at 1057-6 inches.	11		1065	
Sandstone, fine grained, regenerated quartz grains, little organic material, some chert fragments toward the base	10		1075	
St. Louis formation:				
Limestone, conglomeratic, with green shaley matrix	1	6	1076	6
Limestone, lithographic with stylolitic partings	4	4	1080	10
Limestone, with green shaly partings, 3 inches sandstone at base	2		1082	10
Limestone, fossiliferous, green shaly partings	2	2	1085	
Limestone, lithographic	3		1088	
Limestone, argillaceous, green clay matrix, fossiliferous	1	6	1089	6
Tan limestone, lithographic with some thin beds of oolitic limestone	5	6	1095	
Limestone, darker gray, lithographic alternating with shaly, fossiliferous beds, increasingly argillaceous toward the base	10		1105	

Remarks: The original record indicates this hole was drilled to a total depth of 1116 feet. This figure was not confirmed, however, by Miss Hundhausen's study.

Log of Turner Coal Co's. Jane Smith No. 1. Location: Cen. NE. 1/4 NW. 1/4 sec. 29, T. 57 N., R. 35 W., Buchanan County, Mo. Elevation: 844 feet. Completed 1884. Well No. 5 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Loess, dry and sandy	26	26
Pennsylvanian system:		
Vitrous shale	76	102
Limestone, reddish sandy	3	105
Limestone, white	9	114
Shale, soft	4	118
Shale, dark	2	120
Shale, black bituminous	2	122
Limestone, dark and shaly	3	125
Limestone, dark	6	131
Shale, sandy, gray	6	137
Shale, slaty, gray	33	170
Shale, soft, gray	5	175
Shale, dark	4	179
Shale, black slaty	5	184
Shale, dark, thin layers of L. S	34	218
Shale, hard	10	228
Shale, black, bituminous	1	229
Shale, dark	12	241
Shale, hard	5	246
Shale, soft	5	251

Log of Turner Coal Co's. Jane Smith No. 1.—Continued.

	Thickness, feet	*Depth, feet*
Limestone, hard and white	20	271
Shale, drab	28	299
Limestone, white	32	331
Shale, dark	7	338
Limestone	2	340
Shale, dark	20	360
Shale, black bituminous	1	361
Limestone, hard	22	383
Shale, limestone layers	8	391
Shale, contains pyrite	8	399
Shale	88	487
Shale	40	527
Shale, black, bituminous	2	529
Shale, black, bituminous	31	560
Limestone, gray	5	565
Shale, contains pyrites	126	691
Shale, contains coal	2	693
Shale, dark drab	4	697
Limestone, soft drab	5	702
Shale contains limestone layers	4	706
Limestone, light gray	4	710
Shale, limestone	14	724
Sandstone	63	787
"At the top of this sandstone issues a strong flow of salt water, containing sulphurrated hydrogen."		
Shale, dark drab	28	815
Shale	21	836
Shale	10	846
Shale, sandy	4	850
Shale, dark and white	53	903
Shale, contains S. S., L. S., and B. S	47	950
Shale, sandy, contains coal	1	951
Shale, sandy, sharp and dense	9	960
Sandstone	48	1008
Shale	5	1013
Shale	4	1017
Shale	8	1025
Shale	7	1032
Shale	10	1042
Shale	5	1047
Shale	36	1083
Coal		
Shale, dark	10	1093
Sandstone	107	1200
Mississippian system:		
Limestone	108	1308
		Total depth

NOTE: The above is a literal copy, including abbreviations, of the log made by the driller from incomplete notes and memory.

Log of F. O. McCain No. 1, Frank Bermond Farm. Location: SW. cor. SE. 1/4 SW. 1/4 sec. 26, T. 58 N., R. 34 W., Buchanan County, Mo. Elevation: 1,007 feet. Commenced about June 16, 1928, date of completion not known. Well No. 7 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Surface soil, yellow	5	5
Clay, yellow	10	15
Shale, soft light	22	37
Quicksand, light. ½ bailer water	6	43

Log of F. O. McCain No. 1, Frank Bermond Farm—Continued.

	Thickness, feet	*Depth, feet*
Sand, light	13	56
Shale, gray	4	60
Quicksand, gray	17	77
Sand, light. 3 bailers water	28	105
Sand, very fine, blue	5	110
Sand and gravel, gray, fresh water, unlimited supply, set 12½-inch casing	140	250
Pennsylvanian system:		
Lansing group:		
Shale, light	10	260
Shale and shells, light	15	275
Kansas City group:		
Shale, dark	20	295
Lime, white	15	310
Shale, dark	10	320
Shale, light	10	330
Shale and shells, light	10	340
Lime, light	5	345
Shale, blue	15	360
Lime, gray	20	380
Shale, light	5	385
Lime, gray	25	410
Shale, dark	5	415
Lime, light	45	460
Pleasanton group:		
Shale, light	15	475
Sand, hard gray. ¼ bailer water	15	490
Shale, light	35	525
Shale, dark	5	530
Shale, light	70	600
Henrietta group:		
Lime, gray	5	605
Lime and shells, light gray	25	630
Lime, gray	5	635
Shale, black	5	640
Lime, gray	15	655
Shale, light	10	665
Lime and shells, gray	10	675
Shale, black	5	680
Shale, light	5	685
Sand, gray. Light show gas	5	690
Shale, light	10	700
Shale, dark	5	705
Lime, dark	5	710
Top (?) of Cherokee group:		
Shale, dark	10	720
Shale, light	25	745
Shale, dark	20	765
Lime shells, gray	5	770
Shale, dark	5	775
Shale, light	10	785
Shale, dark	20	805
Shale, black	75	880
Sand, light	15	895
Shale, dark	10	905
Shale, dark, sandy	23	928
Shale, light	47	975
Shale, dark	25	1000
Shale, light	30	1030
Sand, brown and gray	145	1175
Shale, greenish-black	2	1177
Coal, black, question as to amount	3	1180
Sand, gray	7	1187
Shale, black	28	1215
Sand, brown and gray. Show gas and oil	20	1235

Log of F. O. McCain No. 1, Frank Bermond Farm—Continued.

	Thickness, feet	*Depth, feet*
Mississippian system:		
Warsaw formation:		
Lime, sharp and hard	16	1251
Shale, black	3	1254
Lime, light and hard	12	1266
Lime, gray and hard	14	1280
Shale, white	2	1282
Burlington-Keokuk limestone:		
Lime, gray	18	1300
Lime, gray	20	1320
Lime, gray and hard	30	1350
Lime, gray	15	1365
Lime, brown	10	1375
Lime, brown	55	1430
Lime, white	10	1440
Chouteau limestone:		
Lime, brown	10	1450
Lime, light	12	1462
Lime, brown and soft	38	1500
Lime, brownish and hard	20	1520
Kinderhook shale:		
Shale, green and red	10	1530
Shale, green	20	1550
Shale, mixed colors	20	1570
Shale, mixed colors	35	1605
Devonian system:		
Lime, brown	5	1610
Lime, brown and white, hard	5	1615
Lime, gray	95	1710
Lime, gray	185	1895
Lime, light brown	15	1910
Lime, light brown	25	1935
Lime, white	15	1950
Lime, light brown	8	1958
Lime, gray	7	1965
Lime, light brown	10	1975
Ordovician system:		
Maquoketa shale:		
Shale, light blue	30	2005
Kimmswick dolomite:		
Lime, soft light gray	15	2020
Lime, white	10	2030
Lime, dark brown	20	2050
Lime, gray	8	2058
Lime, brown	17	2075
Lime, white and brown	10	2085
Lime, hard, white. Show sulphur gas	20	2105
Lime, soft brown	25	2130
Lime, very hard, brown	30	2160
Lime, soft brown	35	2195
Decorah formation:		
Lime, hard, brown	35	2230
St. Peter sandstone:		
Sand	92	2322
Canadian system:		
Cotter dolomite:		
Dolomite	53	2375

Casing record: 250 ft. 12½".

Log of F. O. McCain No. 1, Frank Bermond Farm—Continued.

There follows a brief description of the samples from this well below the top of the Mississippian.

	Thickness, feet	*Depth, feet*
Mississippian system:		
Meramec group:		
Warsaw ? formation:		
Limestone, tan, dense, slightly sandy	19	1254
Limestone, tan, fossiliferous, with pink chalcedonic chert and soft apple green shale	36	1290
Warsaw formation:		
Limestone, gray, coarsely crystalline, with a large percentage (40 % to 50 %) of light gray to gray fossiliferous chert	60	1350
Osage group:		
Keokuk-Burlington formation:		
Limestone, white to light gray and tan, coarsely crystalline, cherty. Chert, white to gray, fossiliferous crinoidal, becoming more dense and sub-translucent toward the base	150	1500
Limestone, dolomitic, between 1390′ and 1415′.		
Kinderhook group:		
Chouteau ? (Gilmore City ?) formation:		
Limestone, fossiliferous with medium fine-grained sand aggregates, green shale and a small quantity of white chert	20	1520
Chattanooga ? formation:		
Grey shale with brown spores	10	1530
Shale, red, with pyrite and some hematite	20	1550
Shale, gray and green, spore bearing	55	1605
Devonian system:		
Limestone, gray, dense, with vugs 1635-80 feet, some green shale, some sand, light show dead oil ?	105	1710
Dolomite, brown, finely crystalline, with tan quartzose chert	30	1740
Chert, gray, speckled quartzose, with dolocasts, dolomite as above	25	1765
Dolomite, coarsely crystalline, mottled, chert as above	12	1777
Limestone, magnesian limestone and dolomite, gray, dense, lithographic, some pyrite and gray quartzose chert. Lithology is suggestive of Cooper	43	1820
Dolomite, finely crystalline, dark brown, becoming lighter near base, with white to tan quartzose chert, some sand and pyrite	100	1920
Dolomite, light, finely and evenly crystalline (glassy), some fine angular sand and white chert	15	1935
Dolomite, light brown, crystalline, sucrose, dead white, even-grained chert	15	1950
Sand, rounded and frosted, fine-grained, with some fine-grained dolomite and white chert	25	1975
Ordovician system:		
Maquoketa formation:		
Shale, gray, green, pyrite	30	2005
Kimmswick formation:		
Dolomite, white to bluish gray, very crystalline, with pyrite and white chert	25	2030
Dolomite, dark brown, crystalline, white to brown rough chert, cystid fragments. Slight show dead oil	20	2050
Chert, white, to dark gray, dense to dolocastic, with some gray crystalline dolomite	55	2105
Dolomite, gray, more finely crystalline, chert slate gray	10	2115
Dolomite, dark brown, finely crystalline, with white and brown chert, dark green shale	80	2295

Log of F. O. McCain No. 1, Frank Bermont Farm—Continued.

	Thickness, feet	*Depth, feet*
Decorah formation:		
Dolomite, very dark brown, with dark brown speckled chert, black spongy and green shale, fine, rounded and frosted sand increasing in amoung below 2212 feet...	35	2230
St. Peter sand:		
Sand, white, fine to medium-grained, rounded and frosted; some grains show secondary enlargement.....	92	2322
Canadian system:		
Cotter dolomite:		
Dolomite, brownish gray, finely crystalline and sucrose, with dead white chert, pyrite and quartzose chert...	53	2375

Log of Frank Hopkins No. 1. Location: SE. 1/4 SE. 1/4 SE. 1/4 sec. 31, T. 58 N., R. 35 W., Buchanan County, Mo. Elevation: 880 feet (H. L.). Completed 1896. Well No. 9 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene or Recent series:		
Soil	5	5
Clay	15	20
Pennsylvanian system:		
Douglas-Kansas City groups:		
Soapstone	30	50
Blue mud	20	70
Lime	15	85
Blue clay	70	155
Lime	25	180
Blue clay	50	230
Lime	5	235
Blue clay	20	255
Lime	15	270
Blue clay	50	320
Lime	50	370
Blue clay	5	375
Lime	25	400
Pleasanton-Cherokee groups:		
Blue clay	5	405
Lime	10	415
Blue clay	70	485
Lime	5	490
Blue clay	10	500
Red rock	5	505
Blue clay	10	515
Lime	50	565
Black shale	15	580
Black shale sand	15	595
Black shale	60	655
Black sand	23	678
Black shale	77	755
White sand	50	805
Black shale	5	810
White sand	25	835
Black shale	15	850
White sand	160	1010
Black shale	10	1020
White sand	15	1035
Black shale (water)	10	1045
Black sand	15	1060
Black shale	20	1080
Sand and lime	20	1100
Black shale	40	1140
Lime and shale	60	1200
Black sand	25	1225
Mississippian system:		
Lime and flint	33½	1258½

Struck water at about 1245 ft. Quit in limestone. Casing as follows: 10-in., 70 ft. 8¼-in., 540 ft. 6¼-in., 1075 ft.

Log of North Missouri Mining and Development Co's. M. F. Davis No. 1. Location: NW. 1/4 NE. 1/4 SW. 1/4 sec. 4, T. 55 N., R. 26 W., Caldwell County, Mo. Elevation: 858 feet (Bar.). Date of completion unknown. Well No. 1 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene or Recent series:		
Clay	14	14
Pennsylvanian system:		
Limestone	5	19
Soapstone	1	20
Limestone	4½	24½
Sandstone	9½	34
Oil shale	8	42
Soapstone	2	44
Shale	12	56
Limestone	6	62
Slate and sand	6	68
Oil sand	8	76
Sand and slate	5	81
Soapstone	6	87
Sand and slate	3	90
Soapstone	5	95
Oil sand	4	99
Soapstone	36	135
Kiel	8	143
Soapstone	12	155
Kiel	16	171
Limestone	8	179
Soapstone	11	190
Limestone, hard	3	193
Not recorded	5	198
Limestone	12	210
Sandstone	18	228
Sand	7	235
Limestone	2	237
Slate	5	242
Soapstone	1	243
Limestone	1	244
Kiel	2	246
Limestone	5	251
Soapstone	13	264
Kiel	2	266
Soapstone	4	270
Hard limestone	4	274
Soft limestone	27	301
Soapstone	10	311
Shale	14	325
Soapstone	5	330
Limestone	15	345
Soapstone	5	350
Hard flint	1	351
Slate	2	353
Hard flint	1	354
Limestone	21	375
Soapstone	2	377
Sandy shale	5	382
Limestone	1	383
Soapstone	11	394
Limestone	1	395
Coal	1	396
Soapstone	3	399
Dark clay	11	410
Soft limestone	10	420
Soapstone	11	431
Limestone	2	433
Coal	1	434

Log of North Missouri Mining and Development Co's. M. F. Davis No. 1—Continued.

	Thickness, feet	*Depth, feet*
Slate	3	437
Limestone	4	441
Shale	21	462
Clay	8	470
Limestone	3	473
Dark shale	28	501
Soft limestone	6	507
Dark shale	10	517
Flint	1	518
Slate	6	524
Iron shale	4	528
Limestone	6	534
Soapstone	9	543
Limestone	1	544
Soapstone	19	563
Limestone	6	569
Shale, dark	30	599
Saline sand	33	632
Soapstone	2	634
Sandstone	18	652
Tough dark clay	8	660
Clay	4	664
Hard sandstone	2	666
Hard sand	7	673
Mississippian system (undifferentiated:		
Limestone	94	767
Salt water	3	770
Limestone	27	797
Blue shale	1	798
Limestone	88	886
Kinderhook group:		
Chattanooga shale:		
Slate	30	916
Devonian and Ordovician:		
Limestone	25	941
Unrecorded	344	1285
Brown lime and grit	5	1290
Ordovician system:		
St. Peter sand:		
White sand	68	1358
Canadian system, undifferentiated:		
Black shale	5	1363
Flint and lime	12	1375
White shale	17	1392
Gray lime	18	1410

Log of Wilson et al. Glick No. 1. Location: NW. cor. NE. 1/4 SE. 1/4 NE. 1/4 sec. 10, T. 57 N., R. 26 W., Caldwell County, Mo. Elevation: 914.8 feet. Completed July 19, 1923. Well No. 7 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene or Recent series:		
Soil	4	4
Yellow clay	7	11
Gravel	4	15
Pennsylvanian system:		
Kansas City group:		
Lime, white	9	24
Dark shale	6	30
Lime, white	2	32
Dark shale, water	3	35
Lime, white (Bethany Falls)	13	48
Dark shale	14	62
Lime (Hertha)	8	70

Log of Wilson et al. Glick No. 1—Continued.

	Thickness, feet	*Depth, feet*
Pleasanton and Henrietta groups:		
Dark shale	4	74
Light shale	21	95
Lime, white	2	97
Dark shale	25	122
Sandy shale	73	195
Lime, white	5	200
Lime and shale	15	215
Light shale	5	220
Gray lime	10	230
Light shale (Lex. coal Hor.)	3	233
Lime	8	241
Sandy shale	17	258
Lime, white	5	263
Dark shale	5	268
Light shale	8	276
Cherokee group:		
Dark shale	29	305
Dark shale	6	311
Lime, white	9	320
Dark shale	36	356
Lime, brown	10	366
Dark shale	9	375
Lime	3	378
Broken shale	5	383
Lime, brown	7	390
Black shale	5	395
Lime (Ardmore ?)	5	400
Shale	17	417
Red shale	8	425
White shale	15	440
Red shale	10	450
Light shale	10	460
Dark shale	10	470
Black shale, oil show	5	475
Light shale	10	485
Lime	3	488
Light shale	7	495
Lime	3	498
White shale	4	502
Lime, white	3	505
Black shale	5	510
Lime, set 10" casing	3	513
Light shale	10	523
Black shale	24	547
Water sand, water	30	577
Lime	1	578
Sharp black shale	39	617
Hard lime	2	619
Shale	11	630
Sand, water	56	686
Mississippian system:		
Meramec, Osage and Kinderhook groups:		
Brown Mississippian limestone	41	727
Red shale	2	729
Col. shale	6	735
Lime	75	810
Mississippian limestone	215	1025
Kinderhook group:		
Black shale	1	1026
Lime	3	1029
Light shale	6	1035
Lime	2	1037
Light shale	12	1049

Log of Wilson et al. Glick No. 1—Continued.

	Thickness, feet	*Depth, feet*
Devonian system:		
Lime	36	1085
Blue shale	2	1087
Lime	87	1174
Light shale, set 8-in. pipe at 1176	3	1177
Sandy lime, oil	14	1191
Lime	80	1271
Sandy lime	15	1286
Lime	20	1306
Water sand	30	1336
Lime, gray	15	1351
Lime, black	86	1437
Lime, white	5	1442
Samples suggest base is at 1450.		
Ordovician system:		
Kimmswick formation:		
Lime, black	39	1481
Lime, black, sandy, set 6¼" casing at 1480, oil	10	1491
St. Peter sand:		
Sand, coarse	15	1506
Water sand	15	1521
Blue shale	5	1526
Sand, white	49	1575
Canadian system:		
Cotter or Jefferson City formation:		
Lime, brown	25	1600 Total depth

REMARKS: A few samples from this well are available for study. A sample from 1031 to 1037 feet contains bluish-gray to black, hard shale, carrying brown disc-like spores, Sporangites huronense. This shale is characteristic of the Chattanooga.

A few samples from the interval of the Devonian show that it ranges from dense, lithographic light colored limestone, to dark brown finely crystalline limestone or dolomite. A sample of sand from 1445-1450 is thought to be of basal Devonian age. It was not recorded as occurring, however, by the driller, although sand was reported from 1306 to 1336 feet. The driller's log reports a show of oil from 1177 to 1191 feet. Samples in this interval range from gray, dense to dark brown finely crystalline limestone.

The Kimmswick formation is represented by brown crystalline dolomite.

The usual characteristics of the St. Peter are expressed in the sample of it from this well.

Log of Breckenridge Oil and Gas Company's Glick No. 2. Location: SE. cor. NW. 1/4 SE. 1/4 NE. 1/4 sec. 10, T. 57 N., R. 26 W., Caldwell County, Mo. Elevation: 917.7 feet. Completed December 6, 1923. Well No. 8 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene or Recent series:		
Soil	5	5
Yellow clay	5	10
Pennsylvanian system:		
Kansas City group:		
Lime	4	14
Blue shale	6	20
Lime	4	24
Light shale	2	26
Lime	5	31
Black shale	9	40
Hard lime (Bethany Falls)	13	53
Broken shale	4	57
Lime	3	60
Dark shale	5	65
Green shale	3	68
Lime	9	77

Log of Breckenridge Oil and Gas Company's Glick No. 2—Continued.

	Thickness, feet	*Depth, feet*
Pleasanton and Henrietta groups:		
Shale, dark	5	82
Light shale	88	170
Lime	5	175
Light shale	3	178
Lime	10	188
Light shale	7	195
Lime and shale	15	210
Light shale	10	220
Gray lime	5	225
Light shale	6	231
Lime and shale	14	245
Dark shale	10	255
Green shale	15	270
Lime	2	272
Dark shale	8	280
Lime	6	286
Cherokee group:		
Light shale	72	358
Lime	4	362
Dark shale	5	367
Light shale	15	382
Black shale	10	392
Lime	3	395
Dark shale	25	420
Red rock	4	424
Blue shale	3	427
Red shale	6	433
Light shale	17	450
Red shale	5	455
Light shale	35	490
Blue shale	15	505
Dark shale	45	550
Dark sandy shale	13	563
Lime	2	565
Shale	2	567
Water sand	22	589
Black shale	41	630
Water sand	27	657
Black shale	5	662
Water sand	23	685
Mississippian system:		
Meramec, Osage and Kinderhook groups:		
Lime	3	688
Water sand (chert ?)	24	712
Lime	15	727
Brown shale	2	729
Green shale	3	732
Lime	3	735
Brown shale	4	739
Lime	7	746
Green shale	3	749
Lime	6	755
White shale	1	756
Lime	15	771
Shale	1	772
Lime	98	870
Gray ?	1	871
Lime	9	880
Miss. lime	125	1005
Kinderhook group:		
Chattanooga shale:		
Dark shale	26	1031

Log of Breckenridge Oil and Gas Company's Glick No. 2—Continued.

	Thickness, feet	*Depth, feet*
Devonian system:		
Broken oil sand	6	1037
Lime, white	112	1149
Lime, brown	53	1202
Light, shale	3	1205
Shale with lime partings	47	1252
		Total depth

Log of McDugal's Vrooman Acres No. 1. Location: SW. 1/4 NE. 1/4 NW. 1/4 sec. 14, T. 50 N., R. 32 W., Clay County, Missouri. Elevation: 735 feet. Completed about December, 1929. Well No. 6 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Recent series:		
Sandy clay	10	10
Blue mud	30	40
Quicksand (70 ft. 8¼" casing)	30	70
Pennsylvanian system:		
Pleasanton group:		
Gray shale	55	125
Henrietta group:		
Hard lime	18	143
Blue shale	3	146
Lime	2	148
Shale	4	152
Lime	8	160
Shale	5	165
Lime (Lexington "Caprock")	8	173
Black slate (some gas and water)	3	176
Dark shale	5	181
Green shale	9	190
Red bed	4	194
Green shale	4	198
Lime	2	200
Black shale	5	205
Gray shale	9	214
Lime	3	217
Cherokee group:		
Gray shale	16	233
Red bed	2	235
Gray shale	3	238
Lime	4	242
Black shale and sand	8	250
Gray shale	15	265
Black sticky shale	15	280
Gray shale and oil sand (Squirrel)	10	290
Blue shale	5	295
Gray shale	10	305
Black shale	9	314
Lime	2½	316½
Dark shale	8½	325
Gray shale	10	335
Dark shale	15	350
Gray shale	23	373
Light blue shale	5	378
Dark shale	8	386
Gray shale	9	395
Dark shale	3	398
Sand shale (L. B.)	2	400
White sand (Bartlesville) (lots of water)	36	436
Gray shale (6¼" casing set at 440)	4	440
Black shale	10	450

Log of McDugal's Vrooman Acres No. 1—Continued.

	Thickness, feet	*Depth, feet*
Dark shale	20	470
Gray shale	20	490
Dark gray shale	15	505
Dark shale	15	520
Light shale	10	530
Dark shale	10	540
Sand (Burgess sand) (water)	45	585
Sand and shale	5	590
Dark shale	3	593
Sand and gray shale	5	598
Mississippian system:		
Lime	32	630 Total depth

Log of North Kansas City Development Company's No. 7. Location: SE. 1/4 SW. 1/4 SW. 1/4 sec. 14, T. 50 N., R. 33 W., Clay County, Mo. Elevation: 742 feet. Date of completion not known, probably 1930 or 1931. Well No. 6A on map, Pl. I.

	Thickness, feet	*Depth, feet*
Recent series:		
Soil	4	4
Sand and shale	16	20
Sand and gravel	115	135
Pennsylvanian system:		
Pleasanton group:		
Shale	17	152
Henrietta group:		
Lime	2	154
Shale	17	171
Lime	1	172
Shale	6	178
Lime	5	183
Shale, light	12	195
Lime	1	196
Shale, light	6	202
Sand, oil and gas show, light	3	205
Shale, light	5	210
Shale, blue, gas light	9	219
Lime	6	225
White shale	2	227
Sand, gas and oil 125,000	12	239
Blue shale	9	248
Lime	3	251
Black shale-water	14	265
Lime	4	269
Shale, sandy	11	280
White shale	10	290
Sandy shale	8	298
Cherokee group:		
Black shale, more water, light	2	300
Sandy shale	15	315
Shale and lime shells	12	327
Broken sand, oil show good	13	340
White sand	14	354
Lime, hard	9	363
Shale, light	3	366
Sand and oil show	17	383
Sandy lime	20	403
Dark shale—water here too much	4	407
Lime and sand	11	418
Black shale—G and water	2	420

Log of North Kansas City Development Company's No. 7—Continued.

	Thickness, feet	Depth, feet
Lime	4	424
White shale	26	450
Sand—gas	4	454
Shale, sandy	4	458
Shale, black	4	462
Shale, gray	8	470
Shale, black	8	478
Shale, black	19	497
Lime	2	499
Shale, blue	8	507
Shale, white	18	525
Shale, black	3	528
Shale, blue	21	549
Lime	3	552
Brown shale	9	561
Sand—gas, 50,000	4	565
Shale, white	2	567
Lime	2	569
Shale, dark	36	605
Sand	8	613
Shale, light sandy	7	620
Shale, brown sandy	22	642
Lime	4	646
Shale, sandy	24	670
Sand—gas	39	709
Shale, blue	4	713
Mississippian system:		
Lime	11	724
Light sand and shale	9	733
Sand lime (gas at 737)	30	763
Shale, green	3	766
Lime, Miss	15	781
Shale, white	3	784
Lime	10	794
Shale, brown sandy	4	798
Lime and shale broken	40	838
Lime	25	863
Shale, brown	2	865
Lime	5	870

Log of General Utilities Company's D. B. Fields No. 1. Location: SW. cor. NE. 1/4 SE. 1/4 sec. 3, T. 51 N., R. 31 W., Clay County, Mo. Elevation: 950 feet. Completed August, 1933. Well No. 7 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Surface and clay	32	32
Pennsylvanian system:		
Kansas City group:		
Lime shell	2	34
Yellow mud and gravel	2	36
Lime	1	37
Blue shale	13	50
Light shale	2	52
Lime (Raytown)	6	58
Black shale	9	67
Lime (Cement City)	13	80
Blue shale	25	105
Gray lime (Westerville)	2	107
Gray shale	7	114
Gray lime	10	124
Dark shale — Winterset	2	126
Gray lime	16	142

Log of General Utilities Company's D. B. Fields No. 1—Continued.

	Thickness, feet	*Depth, feet*
Dark shale	3	145
Lime (Bethany Falls)	19	164
Shale	3	167
Lime (Middle Creek)	2	169
Dark shale	3	172
Lime (Hertha)	6	178
Pleasanton group:		
Gray shale	34	212
Broken sand and shale	18	230
Gray shale	55	285
Red rock	7	292
Gray shale	2	294
Gray sand	16	310
Green shale	9	319
Sandy shale	6	325
Blue shale	5	330
Blue sand	6	336
Gray shale	4	340
Henrietta and Cherokee groups:		
Gray lime	4	344
Gray shale	16	360
Gray lime	8	368
Gray shale	7	375
Gray lime (Lexington "Cap Rock")	8	383
Gray shale	22	405
Dark shale	7	412
Gray shale	18	430
Sandy shale	15	445
Light shale	10	455
Gray sandy shale	20	475
Gray shale	10	485
Black shale	2	487
Gray sand (Squirrel)	13	500
Gray shale	10	510
Dark shale	5	515
Gray shale	25	540
Limy shale	10	550
Gray shale	20	570
Dark shale	5	575
Gray shale	10	585
Gray sand	15	600
Gray shale	45	645
Gray sand	20	665* Total depth

NOTE: Large amount of water in gray sand at 645. At 665 the sand was turning to shale.

*Base of Cherokee not reached.

Log of City of Excelsior Springs Mineral Water System Sulpho-Saline well. Location: SE. 1/4 NE. 1/4 NW. 1/4 sec. 1, T. 52 N., R. 30 W., Clay County, Mo. Elevation: 821.85 feet (P. T.). Completed March 25, 1936. Well No. 17 on map, Pl. I,

	Thickness, feet	*Depth, feet*
Recent series:		
Soil and clay	8	8
Boulders	16	24
Pennsylvanian system:		
Pleasanton group:		
Shale (reduced at 55')	31	55
Shale	25	80

Log of City of Excelsior Springs Mineral Water System—Continued.

	Thickness, feet	*Depth, feet*
Lime	10	90
Shale, dark	24	114
Green shale	21	135
Henrietta group:		
Lime	3	138
Shale, dark, soft	23	161
Lime, hard	6	167
Shale, dark, soft	8	175
Lime and shale, dark, medium	5	180
Shale, dark	5	185
Lime	5	190
Shale, gray	15	205
Lime and shale, dark	10	215
Lime, hard	7	222
Shale, dark	4	226
Broken lime	14	240
Cherokee group:		
Shale	15	255
Broken sand and shale	8	263
Shale, dark	20	283
Shale, gray	27	310
Lime and shale, breaks	10	320
Lime, hard	8	328
Slate, black	3	331
Lime	8	339
Red rock, green shale	4	343
Lime	5	348
Shale, dark	5	353
Shale, light	22	375
Lime, hard	2	377
Shale, gray, muddy	13	390
Blue shale	15	405
Shale and sand, (water about 4 blrs.)	5	410
Sandy shale	5	415
Black slate, trace of coal	2	417
Shale, dark	3	420
Shale, light, sandy	30	450
Sand, light (1½ B. W. at 455)	15	465
Broken sand and shale	10	475
Sand, light	15	490
Sandy blue shale	10	500
Broken sand and shale, dark (about 7 B. W.)	5	505
Sandy shale, dark	23	528
Sand (water)	9	537
Shale	5	542
Sand	23	565
Broken sand and shale	3	568
Lime, hard	17	585
Shale, dark	10	595
Shale, gray	13	608
Chat (set 8" casing)	7	615
Mississippian system:		
St. Louis formation:		
Limestone, light tan to white, fine-grained to sub. lithographic, sparingly oolitic, some light green shale	30	645
Insoluble residue 10 % fine sand, quartzose oolites	30	645
Warsaw-Spergen formation:		
Limestone, gray, crystalline, highly fossiliferous, traces of glauconite. Much green shale and red chert at 670'-685'. Insoluble residue, 10 % to 30 % gray and green shale, red to white chalcedonic chert, highly fossiliferous	40	685

Log of City of Excelsior Springs Mineral Water System—Continued.

	Thickness, feet	*Depth, feet*
Warsaw (Lower ?) formation:		
Limestone, coarsely crystalline, crinoidal, with dark gray, mottled, fossiliferous chert, some glauconite. Dolomitic at 710'. Insoluble residue, 15 % to 40 % dark gray, highly fossiliferous chert. Trace of gray-green shale, and glauconite	25	710
Keokuk-Burlington formation:		
Limestone and dolomitic limestone, light tan to white, crystalline, highly crinoidal and cherty. Insoluble residue 10 % to 40 % chert, white, dense to porous, fossiliferous, crinoidal	95	805
Dolomitic limestone, dark gray, sandy. Insoluble residue 15 % to 50 %, white sand aggregates, medium coarse-grained with white, dense to porous, crinoidal, chert.	50	855
Sedalia formation:		
Dolomite, white, crinoidal, with much white dense to porous chert. Insoluble residue 20 % to 40 % chert, porous, white to gray, with some fine-grained gray sand aggregates	30	885
Chouteau formation:		
Dolomitic limestone, and limestone, gray, fine-grained to dense, argillaceous. Dolomite restricted to the upper part of the formation—cherty in upper portion. Insoluble residue 10 % to 50 % of gray, dense chert, with trace of porous brown shale, quartzose chert, sphalerite. Percentages decrease toward base of formation	65	950
Chattanooga?:		
Shale, black, platey, pyritiferous. Residue consists of shale, black, some sand grains and pyrite	5	955
Devonian system:		
Callaway formation:		
Dolomite and limestone, white to light gray, sandy. Insoluble residue, 10 % or less, white rounded sand, pyrite, and apple-green shale	50	1005
Cooper (and older) formation:		
Limestone, white, dense, fine-grained, with their beds of dolomite. Insoluble residue, 10 % or less, sand, gray shale, white to gray quartzose chert	145	1150
Ordovician system:		
Kimmswick formation (Galena):		
Limestone, gray, medium fine-grained, cherty. Insoluble residue 50 % to 80 % chert, dense gray, and white. Some porous chert with fossil prints. Coral fragments	65	1215
Decorah formation:		
Shale and limestone, light gray and tan. Shale bentonitic, limestone fossiliferous, medium coarse, granular. Insoluble residue 10 % to 30 % bentonitic clay, gray quartzose chert, fine sand	56	1271
St. Peter formation:		
Sand, white, rounded and frosted sand grains, medium coarse-grained. Insoluble residue 100 % sand, white, rounded and frosted with some caved bentonite	29	1300

NOTE: Drillers' log to 615 feet. Log from 615 to 1300 feet made from a study of well cuttings.

Log of Dr. Gordon McCleary No. 1 Fee. Location: NW. 1/4 SE. 1/4 NW. 1/4 sec. 10, T. 52 N., R. 30 W., Clay County, Mo. Elevation: 896 feet. Completed July 29, 1937. Well No. 18, on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil and clay	20	20
Clay and boulders	10	30
Pennsylvanian system:		
Kansas City group:		
Lime shells (Winterset)	5	35
Lime (Winterset)	22	57
Shale	9	66
Lime (Bethany Falls)	24	90
Shale, dark	1	91
Lime (Hertha)	9	100
Pleasanton group:		
Shale, sandy	105	205
Lime	5	210
Sand	4	214
Green shale	3	217
Red shale	12	229
Green shale	6	235
Gray shale	20	255
Sand	10	265
Henrietta group:		
Lime	4	269
Gray shale, sandy	5	274
Gray shale	8	282
Lime	3	285
Light gray shale	2	287
Brown lime	8	295
Light gray shale	7	302
Black shale	2	304
Lime (Lex. cap rock)	6	310
Black slate—gas bubbles (Lex. coal hor.)	2	312
Gray shale	2	314
Lime	5	319
Light shale	9	328
Dark gray shale	7	335
Lime	2	337
Black slate (Summit)	2	339
Dark shale	3	342
Gray sandy shale	3	345
Gray shale	4	349
Sandy lime (Base F. S.)	4	353
Cherokee group:		
Black slate	2	355
Dark shale	3	358
Gray shale	28	386
Gray sandy shale	5	391
Sand, shaly	4	395
Gray shale	20	415
Lime	1	416
Coal	1	417
Dark gray shale	33	450
Lime	2	452
Gray shale	3	455
Black slate	1	456
Dark gray shale	7	463
Gray shale	19	482
Dark shale and slate	4	486
Light gray shale	8	494
Dark shale	3	497
Coal	1	498
Gray shale	7	505
Lime	1	506

Log of Dr. Gordon McCleary No. 1 Fee—Continued.

	Thickness, feet	*Depth, feet*
Gray shale	6	512
Black slate	2	514
Dark shale	8	522
Light shale	8	530
Dark gray shale	5	535
Gray sandy shale	6	541
Light shale	3	544
Sand (little water)	6	550
Gray sandy shale	11	561
Dark shale	12	573
Gray sandy shale	5	578
Sand	9	587
Black slate	4	591
Gray shale	7	598
Gray sandy shale	34	632
(6¼" pipe set at 622, bottom joint perf. 30' blank then another perf. joint).		
Dark gray shale	5	637
Black shale	42	679
Sand—little water	4	683
Gray shale	15	698
Sand—water	33	731
Mississippian system:		
Warsaw or St. Louis formation?:		
Limestone, tan, fine-grained to dense, with some quartz aggregates. Residue consists chiefly of caved Pennsylvanian material	1	732

At 660' bailed 26 15-gal. bailers in 30 minutes. Lowered from 284' from top to 402' from top (sampled). Water in sand 698-731 rose 100' higher. (Sampled). Cuttings from 255-732 saved.

Log of Humphrey et al. Kilgore No. 1. Location: NE. 1/4 SE. 1/4 SE. 1/4 sec. 23, T. 52 N., R. 33 W., Clay County, Mo. Elevation: 1,034 feet. Completed June 30, 1930. Well No. 37 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	6	6
Clay	24	30
Sand (water)	21	51
Pennsylvanian system:		
Lansing group:		
Lime	2	53
Gray shale	19	72
Lime	16	88
Dark shale	5	93
Lime	2	95
Black slate	2	97
Dark shale	2	99
Lime (Plattsburg)	21	120
Gray shale	12	132
Lime (Upper Farley)	17	149
Dark shale	2	151
Lime (Lower Farley)	3	154
Gray shale	6	160
Sand	5	165
Gray sandy shale	19	184
Kansas City group:		
Lime	8	192
Gray shale	2	194
Brown lime	15	209
Gray shale	12	221

Log of Humphrey et al. Kilgore No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime (Raytown)	9	230
Dark shale	10	240
Sandy lime	17	257
Gray hard lime (Cement City)	15	272
Gray sandy shale	18	290
Lime, Drum (Westerville)	5	295
Gray shale	11	306
Lime (Winterset)	32	338
Black slate	2	340
Lime (Bethany Falls)	18	358
Light shale	10	368
Lime (Hertha)	16	384
Pleasanton group:		
Shale	16	400
Lime	4	404
Gray sandy shale	21	425
Gray shale	55	480
White sandy shale	12	492
Red bed	9	501
Shale	19	520
Light sandy shale	10	530
Henrietta group:		
Lime	4	534
Green shale	22	556
Lime	4	560
Light shale	13	573
Dark shale / Black slate } Lexington coal horizon	4 3	577 580
Lime	2	582
Gray sandy shale	13	595
Lime	2	597
Light shale	3	600
Lime	4	604
Light shale	13	617
Lime	3	620
Light shale	10	630
Light sandy shale	14	644
Cherokee group:		
Black slate	5	649
Light shale	1	650
Sand	8	658
Gray shale	8	666
Black slate (186,000 cu. ft. gas)	4	670
Sand	20	690
Dark shale	10	700
Gray shale	15	715
Lime	6	721
Gray shale	4	725
Lime	10	735
Gray sandy shale	25	760
Gray shale	20	780
Lime	6	786
Black shale	3	789
Gray shale	6	795
Light shale	19	814
Sand	10	824
Lime	2	826
Gray shale	5	831
Dark shale	10	841
Sand (water)	19	860
Gray shale	5	865
Dark shale	13	878
Sand	10	888
Gray sandy shale	7	905

Log of Humphrey et al. Kilgore No. 1—Continued.

	Thickness, feet	*Depth, feet*
Dark shale	5	910
Sand (water—salt)	18	928
Mississippian system:		
Lime	2	930 Total depth

Log of Gordon and Martin's Smithville Townsite No. 1. Location: SW. 1/4 NE. 1/4 SW. 1/4 sec. 23, T. 53 N., R. 33 W., Clay County, Mo. Elevation, 815 feet. Completed November 14, 1908. Well No. 52 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene and Recent series:		
Soil, gray	10	10
Sandy clay, brown	25	35
Gravel (water)	5	40
Kansas City group:		
Lime	10	50
Shale, blue, soft	30	80
Lime, brown, hard	20	100
Shale, dark, soft	10	110
Lime, soft, white	25	135
Slate	5	140
Lime, hard, brown	40	180
Slate, soft, black (water)	4	184
Lime, gray, hard (Hertha)	5	189
Pleasanton, Henrietta and Cherokee groups:		
Sand, gray, hard	6	195
Shale, dark, soft	55	250
Lime, hard, brown	5	255
Shale, dark, soft	35	290
Shale, white, soft	18	308
Lime, gray, hard	12	320
Slate, white, soft	10	330
Lime, brown, hard	5	335
Shale, white, soft	35	370
Lime, brown, hard	20	390
Shale, dark, soft	15	405
Lime, gray, hard	10	415
Shale, dark, soft	20	435
Sand, dark, hard (water)	3	438
Shale, light, soft	22	460
Black slate and coal	15	475
Shale, dark, soft	175	650
Sand, dark (water)	10	660
Sand, light	15	675
Shale, light	25	700
Shale, black	10	710
Sand, light	10	720
Shale, brown	10	730
Sand, light	74	804* Total depth

*Base of Cherokee not reached.

Log of O. K. Herndon et al. Thatcher No. 1. Location: NW. 1/4 NW. 1/4 SE. 1/4 sec. 34, T. 53 N., R. 33 W., Clay County, Mo. Elevation: 952 feet. Completed November 2, 1927. Well No. 56 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Recent series:		
Soil	12	12
Pennsylvanian system:		
Lansing group:		
Lime (2 B. W. at 45)	45	57
Shale	70	127
Kansas City group:		
Lime	38	165
Shale	10	175
Lime	10	185
Shale	35	220
Lime	15	235
Shale	10	245
Lime	5	250
Shale	5	255
Lime	15	270
Shale	6	276
Lime (Bethany Falls)	29	305
Shale	7	312
Lime (Hertha)	11	323
Pleasanton, Henrietta, and Cherokee groups:		
Shale	27	350
Lime	5	355
Shale	65	420
Red bed (soft and cavy)	7	427
Lime	3	430
Shale	74	504
Lime	8	512
Shale	3	515
Lime	3	518
Shale	17	535
Lime (8 B. W. at 540) (Lexington "Cap Rock")	8	543
Shale	7	550
Lime	2	552
Red bed (hard and sticky)	3	555
Dark shale (little gas at 565)	25	580
Light shale	50	630
Blue shale	27	657
Lime	2	659
Light shale (set 6¼" csg.)	141	800
Light shale	78	878
Dry sand (last 2 ft. of this sand was carrying lots of water, gummy and black)	67	945
Shale	33	978
Shale	19	997
Mississippian system:		
Lime	5	1002
Shale	7	1009
Lime	8	1017
		Total depth

Log of Ladow & Kunkel, Eliza Chenowith No. 1. Location: NW. 1/4 NW. 1/4 sec. 15, T. 55 N., R. 31 W., Clinton County. Elevation: 1,014 feet. Commenced November 10, 1931. Completed December, 1931. Well No. 19 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Surface and clay	15	15
Yellow sand (set 10-inch casing at 32 feet)	17	32

Log of Landow & Kunkel, Eliza Chenowith No. 1—Continued.

	Thickness, feet	*Depth, feet*
Pennsylvanian system:		
Lansing group:		
Lime shells	8	40
Lime	5	45
Dark shale	7	52
Lime (Plattsburg)	23	75
Shalebreak	2	77
Lime	5	82
Kansas City group:		
Grey shale	21	103
Lime (Farley)	3	106
Grey shale, sandy	15	121
Grey shale	31	152
Lime (Iola)	13	165
Dark shale	12	177
Lime	2	179
Blue shale	5	184
Lime	6	190
Lime and shale, broken	20	210
Gray shale	20	230
Lime	9	239
Gray shale	4	243
Lime	4	247
Gray shale	15	262
Lime (Winterset)	26	288
Black slate (4 blrs. of water)	3	291
Gray shale	3	294
Lime (Bethany Falls)	19	313
Black slate	3	316
*Lime (Hertha)	16	332
Pleasanton group:		
Dark shale	4	336
Lime	3	339
Green shale	5	344
Lime	3	347
Grey shale (set 8-inch at 384 feet)	76	423
Red bed	7	430
Green shale	7	437
Sand	10	447
Gray shale	20	467
Henrietta group:		
Lime	4	471
Grey shale	19	490
Green shale	2	492
Lime (S. L. M.)	8	500
Gray sand	6	506
Dark shale	6	512
Lime	4	516
Black slate, little gas, some water (Lexington coal horizon)	7	523
Gray shale	17	539
Blue shale	12	551
Lime	6	557
Light shale	11	568
Lime	2	570
Cherokee group:		
Gray shale	27	597
Sand ("Squirrel") (S. L. M. 605 feet)	47	644
Gray shale (set 6 5/8 at 672 feet)	31	675
Light shale	33	708
Gray lime (Ardmore)	2	710
Gray shale	18	728
Black slate	3	731
Gray shale	39	770
Black slate	3	773

Log of Landow & Kunkel, Eliza Chenowith No. 1—Continued.

	Thickness, feet	*Depth, feet*
Gray shale	17	790
Dark shale	28	818
Light shale, sandy (S. L. M. 819 feet)	15	833
Gray shale	12	845
Dark shale	10	855
Light shale	10	865
Gray shale, sandy	27	892
Gray sand (water, set 5 3/16 at 950 feet)	58	950
Dark shale (S. L. M. 962 feet)	32	982
Lime	2	984
Blue shale	64	1048
Mississippian system:		
Lime	64	1112
Black shale (sulphur water)	3	1115

Dry and abandoned.

Log of Charles Petroleum Company Moore Estate No. 1. Location: SW. 1/4 SE. 1/4 SW. 1/4 sec. 27, T. 56 N., R. 33 W., Clinton County, Mo. Elevation: 965.3 feet. Completed July 7, 1937. Well No. 22A on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	3	3
Yellow clay	12	15
Clay and boulders	5	20
Sandy mud and gravel	15	35
Pedee group:		
Gray shale	69	104
Lansing group:		
Lime (Upper Stanton)	2	106
Shale	6	112
Lime (Middle Stanton)	18	130
Brown shale	4	134
Lime (Lower Stanton)	3	137
Black slate	1	138
Lime (Plattsburg)	17	155
Shale	2	157
Lime	5	162
Dark shale	4	166
Lime	2	168
Gray shale	27	195
Lime	3	198
Lime and shale breaks } Farley	10	208
Lime	2	210
Gray shale	19	229
Kansas City group:		
Lime (Argentine)	4	233
Gray shale	7	240
Lime	7	247
Shale } Raytown	1	248
Lime	6	254
Brown and black shale	6	260
Lime	2	262
Gray shale	7	269
Lime (Cement City)	6	275
Red bed	5	280
Gray shale	8	288
Lime, gray (Westerville)	5	293
Gray shale	8	301
Lime, brown (Block)	7	308
Black slate and shale	10	318
Lime	2	320
D. gray shale	5	325
Lime	4	329

Log of Charles Petroleum Company Moore Estate No. 1—Continued.

	Thickness, feet	*Depth, feet*
Shale	13	342
Lime (Winterset)	25	367
Black shale	3	370
Gray shale	5	375
Lime (Bethany Falls)	19	394
D. shale and slate	3	397
Lime	2	399
Gray shale	2	401
Gray lime (Hertha)	17	418
Pleasanton group:		
Gray shale	9	427
Lime	2	429
Sandy shale	6	435
Gray shale	10	445
Gray, sandy shale	20	465
Gray shale	30	495
Shale, lime shells	5	500
Gray shale	5	505
Red bed	5	510
Green shale	2	512
Sand	10	522
Sandy shale	8	530
Gray shale	36	566
Henrietta group:		
Lime	5	571
Gray shale	4	575
Lime	4	579
Lime and gray shale seams	8	587
Blue shale	8	595
Brown shale	3	598
Black shale and coal (Lex. coal Hor.)	4	602
Sand, gray	4	606
Gray shale	6	612
Lime shell	2	614
Gray shale	14	628
Lime, sandy	5	633
Gray shale	5	638
Lime sandy, shale	3	641
Cherokee group:		
D. gray shale	4	645
Gray shale	25	670
D. gray shale	10	680
Gray shale	25	705
D. gray shale, coal	10	715
D. gray shale } Ardmore-Bevier coal {	5	720
Dark shale and coal and black slate, lime shells } Ardmore-Bevier coal {	15	735
Sand	10	745
Shale	5	750
Shale and red bed	5	755
Gray shale	7	762
Black slate and coal	4	766
Gray shale	8	774
Sand, gray	6	780
Sandy shale	10	790
Gray shale	10	800
Coal and black slate	5	805
Lime	$1\frac{1}{2}$	$806\frac{1}{2}$
Gray shale	$3\frac{1}{2}$	810
Sand	7	817
Gray shale, sandy	3	820
Lime shell and shale	5	825
Gray shale	14	839*
		Total depth

*Base of Cherokee not reached.

Log of Stewartsville Development Company's Robt. A. Pickett No. 1. Location: SE. 1/4 NE. 1/4 NW. 1/4 sec. 23, T. 57 N., R. 32 W., Clinton County, Mo. Elevation: 985 feet. Completed March, 1911. Well No. 27 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	50	50
Pennsylvanian system:		
Lansing and Kansas City groups:		
Clay and shale, soft	55	105
Shale, white, hard	45	150
Shale, white, hard (several shells of hard lime in this shale)	50	200
Lime, white, hard	15	215
Shale, brown, soft	45	260
Shale, white, medium	10	270
Shale, gray, soft	30	300
Lime, grayish, very hard	40	340
Lime, grayish, not so hard	30	370
Lime, grayish, hard	15	385
Lime, dead white, soft	15	400
Pleasanton, Henrietta and Cherokee groups:		
Shale, white	15	415
Shale, blue, soft	60	475
Rock, very soft	5	480
Shale, light, hard (close and tight)	60	540
Lime, white, hard	30	570
Shale, sandy, dark	30	600
Lime, white, hard	20	620
Shale, white, soft	45	665
Sand, brown	20	685
Lime, white, very hard	15	700
Shale, black, soft	10	710
Shale, white, soft	50	760
Sand, brown, close and hard (considerable water)	20	780
Shale, white, hard	20	800
Shale, white soft	65	865
Lime, grayish, dead and chalky	15	880
Sand, brown	15	895
Shale, black, soft	15	910
Sand, light, hard	5	915
Brown shale and sand	50	965
Sand, salt, white, hard	20	985
Lime and sand, dark, hard	5	990
Shale, black soft	95	1085
Sand, black, very hard (water)	10	1095
Sand and lime, white, lime hard	30	1125
Shale, brown, soft	35	1160
Mississippian system:		
Meramec group:		
St. Louis formation:		
Limestone, tan, lithographic, sandy. Insoluble residue, 10 % fine sand, quartzose chert	15	1175
Warsaw (?) formation:		
Limestone, tan, highly fossiliferous with green shale, with pink to red chert. Insoluble residue, 10 % to 30 % red chalcedonic chert, fossiliferous, quartzose fossil fragments, green shale. The zone of "red chert"	50	1225
Lower Warsaw:		
Dolomitic limestone, fine-grained, crystalline, with white white and gray fossiliferous chert. Insoluble residue, 10 % to 50 % chert, sub-translucent, waxy white to gray, mottled, fossiliferous Bryozoa and crinoid fossils	44	1269 Total depth

Log of second shaft of Winston Coal Company. Location: About center SE. 1/4 NW. 1/4 SE. 1/4 sec. 4, T. 58 N., R. 29 W., Daviess County, Mo. Elevation: 1,012 feet. Completed March 27, 1937. Shaft No. 1, on map, Pl. I.

		Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Pleistocene series:					
Clay, yellow, slightly sand, few boulders		75		75	
Pennsylvanian system:					
Lansing group:					
Shale, hard, gray, sandy		8		83	
Sandstone, fine-grained, gray, micaceous, ripple-marked, and gray sandy shale; coaly streak at 85		18		101	
Kansas City group:					
Described as "4 layers of bastard limestone 3"-9" thick, soapstone between" (2 beds hard gray, mic. calc. sandstone and 2 beds coarsely x-line limestone)		4		105	
Gray "soapstone"		4		109	
Gray mic. shale, foss. slightly limy.					
Blue "soapstone"		6		115	
Dark thinly lam. shale mic. and sandy, and carb. material.					
Limestone, fine-grained to coarse, crystalline (Raytown)		9		124	
Black slaty shale, reported as immediately under limestone (probably some gray shale intervening)		1	2	125	2
Gray shale		10±		135±	
Dark clay		7±		142±	
Lime rock, gray and green (Cement City)		8		150	
Shale		2		152	
Soapstone		4		156	
Limerock (Westerville)		4		160	
Soapstone		14		174	
Gray rock and soapstone		1		175	
Gray limestone		4		179	
Soapstone		8		187	
Lime rock		1	6	188	6
Soapstone		4		192	6
Limerock		3		195	6
Dark shale		1		196	6
Limerock	Winterset	2		198	6
Dark shale	Winterset	8	6	207	
Limestone, dense, fine-grained, brecciated appearance, with clay veins, alt. with calc. shale	Winterset	7		214	
Limestone, dense, cherty, dark shale, partings	Winterset	17		231	
Limestone, dense, cherty, dark shale partings	Winterset	6		237	
Dark gray shale	Winterset				
Black foss. shale	Winterset	3		240	
Dense black shale	Winterset				
Limestone, gray	Winterset	8		248	
Gray shale	Winterset				
Black slaty slate	Winterset	5		253	
Limestone, mottled light and dark gray (Bethany Falls)		14		267	
Gray "soapstone"		1	4	268	4
Black slaty shale		1	4	269	8
Gray limestone			8	270	4
Dark "soapstone"		4	8	275	
Limestone, top uneven and nodular		7		282	
Pleasanton group:					
Shale, gray, some purple shale		23		305	
Sandstone, gray		15		320	
Shale, little pockets of sand		10		330	
"Soapstone" (gray shale)		31		361	

Log of second shaft of Winston Coal Company—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Limestone, gray, nodular, dense		2	361	2
Shale, gray	8	7	369	9
Limestone, gray, nodular, dense		3	370	
Shale, gray	3		373	
Red bed, some green shale	4		377	
Sandstone, uneven, streaked	4		381	
Red bed	1		382	
Sandy "soapstone"	4	6	386	6
Soapstone	8		400	
Henrietta group:				
Limestone, hard pinkish ("granite")	1	3	401	3
"Jointed slaty soapstone" (shale) dark gray and purple	5	9	407	
"Turtle backs," limestone lenses and nodules, dense lithographic, in shale, and banded gray and yellow shale	4		411	
Shale, gray, green, and maroon	3		414	
Shale, gray, massive	16		430	
"Dirt" grayish-black (shale)	3		433	
"Turtle backs" (Nod. Ls.)	3		436	
Gray shale	5		441	
Limestone	1		442	
Dark shale	2		444	
Limestone		6	444	6
Shale		6	445	
Limestone 8" or 10"		6	445	6
Gray-banded shale, sandy, sharp contact	4		449	6
Black bat (black calc. foss. shale)		8	450	2
Limestone, shaly at top, grades into above		4	450	6
Limestone, brownish-gray, Chaetetes at top, has calcite lined cavities	4		454	6
Black bat (black calc. foss. shale)		6	455	
Hard black slaty shale, small rounded concretions at base		6	455	6
Black bat (black calc. foss. shale, local pocket on south side of shaft	..		...	
Coal (Lexington)	3		458	6
Fire clay with local "sulphur balls"	1		459	6
Green shale with many calc. concretions	1	6	461* Total depth	

*Base of Henrietta not reached.

Log of J. K. D. Shaffer's A. J. Tingley No. 1. Location: SW. 1/4 NW. 1/4 SW. 1/4 sec. 5, T. 59 N., R. 27 W., Daviess County, Mo. Elevation: 758.9 feet. Completed August 16, 1919. Well No. 3 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene or Recent series:		
Soil, black	4	4
Clay, yellow	34	38
Sand, brown	2	40
Sand, brown (H. F. W. at 42', set 15½" casing at 43'-7")	6	46
Pennsylvanian system:		
Pleasanton, Henrietta and Cherokee groups:		
Blue slate	34	80
Blue slate	20	100
Lime, white	4	104
Slate, white	20	124
Lime, white	6	130
Slate, blue	10	140
Slate, blue	20	160

Log of J. K. D. Shaffer's A. J. Tingley No. 1—Continued.

	Thickness, feet	Depth, feet
Lime, white	40	200
Coal	2	202
Slate, black	4	206
Slate, white	20	226
Lime, white (set 12½" casing at 238')	40	266
Slate, blue	10	276
Lime, white	30	306
Slate, blue	4	310
Slate, blue	6	316
Lime, white —water, 3 bailers per hour at 320'	15	331
Slate, white	8	339
Coal, black	3	342
Slate, white	12	354
Lime, white	4	358
Slate, black	6	364
Slate, white	10	374
Lime, white	5	379
Slate, black	15	394
Lime, white	14	408
Slate, brown	20	428
Slate, brown	10	438
Slate, black	30	468
Lime, white	15	483
Slate, black	25	508
Lime, white (3 bailers per hour at 528')	20	528
Slate, blue	30	558
Lime, white	10	568
Lime, white (2 bailers per hr. at 570' carrying 8 bailers)	20	588
Slate, brown	35	623
Slate, white	25	648
Mississippian system:		
Meramec, Osage and Kinderhook groups:		
Lime, white	2	650
Lime, white	3	653
Slate, white	10	663
Lime, white (H. F. W. at 670'—set 10" at 670')	7	670
Sand, white	16	686
Sand, white	15	701
Lime, white (H. F. W. at 750')	55	756
Lime, white	44	800
Lime, white	30	830
Miss. lime	30	860
Miss. lime	40	900
Miss. lime	50	950
Miss. lime	40	990
Miss. lime	30	1020
Kinderhook group:		
Slate, white (set 8" casing at 1015'-11")	5	1025
Slate, white	40	1065
Sand, white	5	1070
Slate, blue	15	1085
Devonian system:		
Lime, white	20	1105
Slate, white (hole, cave)	25	1130
Slate, white (U. R. 8" casing to 1162'-4")	70	1200
Slate, white	60	1260
Sand, white (15 bailers per hour at 1270'—hole caving)	10	1270
No log	10	1280
Slate	10	1290
Lime, brown (water at 1295')	10	1300
Lime, brown	10	1310
Lime, brown	20	1330
Lime, brown	10	1340
Broken lime	15	1355

Log of J. K. D. Shaffer's A. J. Tingley No. 1—Continued.

	Thickness, feet	Depth, feet
Miss. lime	5	1360
Lime	20	1380
Slate, white	5	1385
Hard lime	10	1395
Lime	5	1400
Broken lime	5	1405
Ordovician system:		
Kimmswick and Decorah formations:		
Sharp sandy lime	25	1430
Sharp sandy lime	30	1460
Sandy lime	10	1470
Lime	20	1490
Lime	10	1500
Lime	40	1540
Lime	10	1550
St. Peter formation:		
Brown sand	20	1570
Brown sand	5	1575
White water sand	30	1605
Water sand	45	1650
Water sand	25	1675
Canadian (and older) system ("Arbuckle lime"):		
Lime	65	1740
Sandy lime	25	1765
Sandy lime (10 days of drilling, July 8 to 17, 1919)	20	1785
No record given	285	2070
Sandy lime	30	2100
Sandy lime	90	2190
Sandy lime	10	2200
Sandy lime	30	2230
Sandy lime	102	2332 Total depth

NOTE: No samples are available from this well and the driller's log is a difficult one to correlate. The top of the Mississippian is at 649, 663 or 701 feet. The sand in the Kinderhook 1065-1070 feet has not been noted elsewhere in this part of the state. The shale section, 1105 to 1260 feet is too thick for the Kinderhook, and it is hardly likely that the Maquoketa is present although it might be. In the upper part of some Devonian sections shale is not uncommon, also the limestone has a tendency to drill into flakes. The section is here correlated with the Devonian. The sand 1260-1270 feet may be the basal sand of the Devonian, and on the other hand may be a zone of quartzose chert in the Devonian. The shale and limestone section from 1270 to 1405 feet is also correlated with the Devonian, although it might be older, and possibly the equivalent of the Maquoketa.

The sharp sandy lime logged from 1405-1470 feet may be the basal Devonian sand, but more likely is the cherty dolomite of the Kimmswick formation.

The sand 1550-1675 is no doubt the St. Peter.

It is not possible to subdivide the section below the St. Peter.

Log of R. B. Aniser's fee No. 1. Location: SE. 1/4 SW. 1/4 SW. 1/4 sec. 23, T. 60 N., R. 32 W., DeKalb County, Mo. Elevation: 1051 feet (Bar.). Date of completion unknown. Well No. 5 on map, Pl. I.

	Thickness, Ft.	In.	Depth, Ft.	In.
Pleistocene series:				
Drift	146		146	
Pennsylvanian system:				
Shale	14		160	
Limestone	6		166	
Clay	4		170	
Lime	14		184	
Clay	3		187	
Lime	4		191	

Log of R. B. Aniser's fee No. 1—Continued.

	Thickness, Ft.	In.	Depth, Ft.	In.
Slate	8		199	
Lime	16		215	
Shale	5		220	
Lime	8		228	
Shale	8		236	
Lime	4	6	240	6
Shale	19		259	6
Lime	4		263	6
Shale	4		267	6
Lime	4	6	272	
Shale	10		282	
Limestone	5		287	
Shale	9		296	
Lime	6		302	
Shale	26		328	
Lime	3		331	
Shale	18		349	
Clay	9		358	
Lime	1		359	
Clay	11		370	
Lime	11		381	
Shale	6		387	
Lime	4		391	
Shale	12		403	
Lime	4		407	
Slate		6	407	6
Clay		6	408	
Lime		5	408	5
Shale	10	6	418	11
				Total depth

Log of Berlin Coal, Oil and Gas Prospecting Company's L. C. Loest No. 1. Location: SE. 1/4 NE. 1/4 sec. 22, T. 61 N., R. 31 W., Gentry County, Mo. Elevation: 854.8 feet. Completed about October 25, 1913. Well No. 1 on map, Pl. I.

	Thickness, Ft.	In.	Depth, Ft.	In.
Recent series:				
Soil and gravel	14		14	
Pennsylvanian system:				
Lansing group:				
Limestone, hard / Shale, light blue / Limestone, soft (Plattsburg)	12		26	
	3		29	
	2		31	
Shale	3		34	
Limestone	3		37	
Shale	2		39	
Limestone	2		41	
Shale	4		45	
Limestone	2		47	
Shale, blue	31		78	
Kansas City group:				
Limestone and sand (Iola)	2	6	80	6
Shale	9	6	90	
Limestone, shelly	1		91	
Shale	1		92	
Sand	3		95	
Slate, black	4		99	
Shale, blue	10		109	
Shale, light	11		120	
Limestone, white	6		126	
Limestone, gray	12		138	

Log of Berlin Coal, Oil and Gas Prospecting Company's L. C. Loest No. 1—Continued.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Shale, light	15		153	
Shale, blue	4		157	
Limestone	3		160	
Shale	4		164	
Limestone (Winterset)	40		204	
Shale	6		210	
Limestone (Bethany Falls)	20		230	
Shale, dark	4		234	
Shale and shelly lime	6		240	
Limestone (Hertha)	10		250	
Pleasanton, Henrietta and Cherokee groups:				
Shale, blue	4		254	
Shale, light	75		329	
Shale, dark	4		333	
Shale, light	8		341	
Shale, light, sandy	13		354	
Shale, white	41		395	
Limestone	2		397	
Shale, white	8		405	
Shale, blue	12		417	
Shale, blue, and slate	15		432	
Shale, black, and coal	6		438	
Shale, sandy	5		443	
Limestone	6		449	
Shale, light	2		451	
Shale, dark	14		465	
Shale, blue	20		485	
Shale, sandy	25		510	
Shale, blue, sandy	60		570	
Sandstone, red	6		576	
Shale, blue, sandy	45		621	
Shale, blue	25		646	
Sandstone, white	24		670	
Shale, sandy	10		680	
Sandstone	16		696	
Sandstone	7		703	
Slate, black	2		705	
Slate, white	30		735	
Shale, dark	8		743	
Limestone	6		749	
Shale, sandy	16		765	
Limestone	2		767	
Shale, sandy	3		770	
Limestone	1		771	
Shale, sandy	9		780	
Shale, light	13		793	
Shale, dark	25		818	
Shale, white	10		828	
Slate	1		829	
Coal	2		831	
Slate	1		832	
Coal	2		834	
Sandstone	6		840	
Shale	25		865	
Limestone	2		867	
Shale	16		883	
Sandstone, white	56		939	
Shale, dark	12		951	
Sandstone	2		953	
Shale, black, sandy	4		957	
Shale, black	64		1021	
Shale, sandy	4		1025	
Shale, sandy	15		1040	
Shale, dark	30		1070	

Log of Berlin Coal, Oil and Gas Prospecting Company's L. C. Loest No. 1—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Shale	22		1092	
Sandstone	24		1116	
Sandstone	16		1132	
Mississippian system:				
Limestone	8		1140*	
				Total depth

*Total depth claimed to be 1,092 feet by steel line measure by some of the parties interested in this well.

Log of coal prospect hole drilled at Gentryville. Company and farm unknown. Location: SE. 1/4 NE. 1/4 SW. 1/4 sec. 36, T. 62 N., R. 31 W., Gentry County, Mo. Elevation: 827 feet. Completed in 1886. Well No. 3 on map, Pl. I.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Pleistocene series:				
Clay, dark yellow	18		18	
Sand	11	3	29	3
Pennsylvanian system:				
Kansas City group:				
Rock	2	3	31	6
Clay	2	2	33	8
Rock		6	34	2
Clay, blue	6	2	40	4
Rock	2	6	42	10
Clay, light	12	3	55	1
Rock, very hard	4		59	1
Clay		6	59	7
Rock	1	4	60	11
Clay	4	10	65	9
Shale, blue	11	6	77	3
Rock	1	3	78	6
Shale, light blue	6	8	85	2
Rock, light colored	14		99	2
Shale, dark	3	7	102	9
Rock		10	103	7
Shale, dark		8	104	3
Rock		8	104	11
Shale, dark		3	105	2
Rock		6	105	8
Shale, dark		8	106	4
Rock		3	106	7
Shale, dark		3	106	10
Rock		3	107	1
Shale, dark		3	107	4
Rock		5	107	9
Shale, dark		5	108	2
Rock		3	108	5
Shale, gray	1	5	109	10
Rock		7	110	5
Shale, light blue		7	111	2
Sandstone		10	112	
Shale, blue	2	8	114	8
Rock	2	3	116	11
Shale, light blue	2	7	119	6
Rock		10	120	4
Shale		6	120	10
Rock		11	121	9
Shale		4	122	1
Rock		5	122	6
Shale		3	122	9
Rock	1	8	124	5
Shale, blue	2	5	126	10

Log of coal prospect hole drilled at Gentryville—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Rock		6	127	4
Shale		6	127	10
Rock, very hard (Winterset)	34	4	162	2
Shale, dark	1	6	163	8
Shale, black	2	4	166	
Clay, light	3	2	169	2
Rock		9	169	11
Clay, light	1	2	171	1
Rock (Bethany Falls)	18		189	1
Clay, light	1	10	190	11
Shale, dark	1	7	192	6
Rock, white	3	4	195	10
Shale, light		7	196	5
Rock, white	2	7	199	
Shale, light blue		7	199	7
Rock (Hertha)	7		206	7
Pleasanton and Henrietta groups:				
Shale, light	2	1	208	8
Shale, dark		6	209	2
Shale, light	3	4	212	6
Sandstone, blue	2	7	215	1
Clay, light	1	8	216	9
Shale, blue and gray	19	5	236	2
Sandstone	1	3	237	5
Shale, dark	2	9	240	2
Sandstone	1		241	2
Shale, dark and purple	3	7	244	9
Shale, dark	32	8	277	5
Rock, dark	1	6	278	11
Clay, light	6	3	285	2
Clay, reddish		6	285	8
Shale, light		4	286	
Shale, brown		4	286	4
Shale, blue	2	9	289	1
Clay, red		7	289	8
Clay, light	1		290	8
Clay, red		4	291	
Shale, blue	3	1	294	1
Rock		7	294	8
Shale, light	5	8	300	4
Rock	1		301	4
Clay, light	1		302	4
Rock	2	5	304	9
Clay, red	2	7	307	4
Clay, light	2	3	309	7
Rock	17	9	327	4
Clay, light		9	328	1
Clay, red		4	328	5
Clay, light	2	4	330	9
Clay, red	2	6	333	3
Clay, light blue	1	4	334	7
Rock	8	2	342	9
Shale, light blue	7	9	350	6
Shale, dark	5	7	356	1
Shale, gray	6	9	362	10
Rock	2	4	365	2
Shale, light	5	2	370	4
Rock	1	1	371	5
Shale, light blue	2	9	374	2
Rock	4		378	2
Shale, gray		11	379	1
Shale, black		7	379	8
Shale, light blue	1	1	380	9
Rock	1	3	382	

Log of coal prospect hole drilled at Gentryville—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Shale, dark		6	382	6
Coal		7	383	1
Clay, light	3		386	1
Rock	7	4	393	5
Shale, light	1	11	395	4
Shale, dark		2	395	6
Rock		3	395	9
Shale, light		4	396	1
Rock	1	5	397	6
Shale, light blue	5	2	402	8
Rock	2		404	8
Shale, light blue	3	7	408	3
Rock	1	7	409	10
Shale, black		1	409	11
Rock		4	410	3
Cherokee group:				
Shale, light	1	7	411	10
Shale, dark	2	6	414	4
Shale, gray	26	1	440	5
Rock	31		471	5
Shale	3	6	474	11
Coal	2	2	477	1
Shale, light	1	1	478	2
Sandstone	6	8	484	10
Shale	8	3	493	1
Rock	2	5	495	6*
				Total depth

*Base of Cherokee not reached.

Log of James O'Neil Bruen's E. H. Frisbie No. 1. Location: SW. 1/4 NE. 1/4 NE. 1/4 sec. 10, T. 63 N., R. 28 W., Harrison County, Mo. Elevation: 857.75 feet (P. T.). Completed 1927(?). Well No. 5 on map, Pl. I.

	Thickness, feet	Depth, feet
Recent series:		
Soil, black	5	5
Sand, quick	14	19
Pennsylvanian system:		
Kansas City group:		
Lime, white	17	36
Shale, blue	10	46
Lime, white	29	75
Pleasanton, Henrietta and Cherokee groups:		
Shale, gray	10	85
Lime, white	5	90
Shale, light	60	150
Shale, pink	15	165
Shale, gray	8	173
Red rock	7	180
Shale, blue	44	224
Lime, dark	5	229
Shale, dark blue	31	260
Sandy shale, light	40	300
Shale, blue	100	400
Shale, dark	75	475
Shale, gray	35	510
Sand, water	50	560
Shale	70	630
Sand, white	45	675
Shale, dark	5	680
Shale, gray	10	690

Log of James O'Neil Bruen's E. H. Frisbie No. 1—Continued.

	Thickness, feet	*Depth, feet*
Shale, sandy	20	710
Shale, blue	12	722
Lime	3	725
Shale, light	62	787
Sand, gray	23	810
Shale, sandy	15	825
Shale, gray	10	835
Shale, blue	3	838
Sand	10	848
Mississippian system:		
(Contact uncertain)		
Lime, sandy	27	875
Shale, white	3	878
Sand, white, water	17	895
Shale, blue	3	898
Lime	7	905
		Total depth

Log of James O'Neil Bruen's Harrison County Farm No. 1. Location: NE. 1/4 NE. 1/4 SE. 1/4 sec. 9, T. 63 N., R. 28 W., Harrison County, Mo. Elevation: 851.15 feet. Completed in 1927. Well No. 4 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	4	4
Quicksand	13	17
Pennsylvanian system:		
Kansas City group:		
Limestone (Bethany Falls)	18	35
Blue shale	5	40
Limestone (Middle Creek)	2	42
Gray shale	18	60
Limestone (Hertha)	5	65
Pleasanton, Henrietta and Cherokee groups:		
Blue shale	5	70
Limestone	3	73
Gray shale	48	120
Sand	8	128
Shale	12	140
Limestone	20	160
Shale	5	165
Red bed	7	172
Gray shale	28	197
Limestone	7	202
Coal (Lexington)	2	204
Limestone	5	209
Shale	10	219
Limestone	4	223
Shale	86	309
Limestone (Ardmore)	12	321
Shale	24	345
Limestone	3	348
Gray shale	18	360
Limestone	3	363
Dark shale	17	380
White shale	15	395
Limestone	2	397
Dark shale	5	402
Limestone	6	408
Shale	20	428
Shelly lime	22	450

Log of James O'Neil Bruen's Harrison County Farm No. 1—Continued.

	Thickness, feet	*Depth, feet*
Sandy lime	55	505
Sandy shale, white	5	510
Gray sand	45	555
Gray shale	80	635
Blue shale	18	653
Limestone	7	660
Black shale	10	670
Sand	15	685
Blue shale	20	705
Sand	5	710
Shale	55	765
Sand	20	785
Shale	25	810
Mississippian system:		
Meramec group: ?		
Lime, brown	20	830
Shale, gray	2	832
Lime	8	840
Sand	5	845
Gray shale	15	860
Brown lime, water	10	870
Osage and Kinderhook groups:		
Lime sand, gray	222	1092
Kinderhook group:		
Green gray shale	14	1106
Devonian system: ?*		
Lime	90	1196
Shale, light	1	1197
Sand, blue	5	1202
Shale, light	2	1204
Lime	36	1240
No record	12	1252
		Total depth

*The section from 1092 to 1204 may be of Kinderhook age. Samples from this well are lacking, however, and the suggestion cannot be verified.

Log of New Hampton Coal and Mineral Company's Johnson Bros. No. 1. Location: NE. 1/4 SW. 1/4 sec. 17, T. 63 N., R. 29 W., Harrison County, Mo. Elevation: 919 feet. Completed in 1913. Well No. 8 on map, Pl. I.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene series:				
Surface and drift	60		60	
Coal (drift coal)	..	3	60	3
Light gray drift	39	9	100	
Pennsylvanian system:				
Kansas City group:				
Sandstone	3		103	
Light shale	1		104	
Limestone	2		106	
Light shale	8		114	
Limestone (Westerville)	12		126	
Dark shale	3		129	
Limestone	2		131	
Dark shale	1		132	
Limestone shale partings	28		160	
Light shale	3		163	
Limestone (Winterset)	31		194	
Hard dark shale	2		196	
Gray shale	4		200	
Limestone (Bethany Falls)	24		224	

Log of New Hampton Coal and Mineral Company's Johnson Bros. No. 1—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Dark shale, hard	1		225	
Gray shale	4		229	
Limestone (Middle Creek)	2		231	
Gray shale	5		236	
Limestone (Hertha)	12		248	
Pleasanton and Henrietta groups:				
Dark shale	3		251	
Coal (Ovid)	..	2	251	2
Fire clay	1	10	253	
Limestone	4		257	
Gray shale	52		309	
Limestone	2		311	
Gray shale	2		313	
Red shale	3		316	
Light shale	4		320	
Limestone	4		324	
Gray shale	5		329	
Limestone	2		331	
Gray shale	5		336	
Limestone	2		338	
Light gray shale	3		341	
Limestone	4		345	
Blue shale	4		349	
Red shale	5		354	
Blue shale	3		357	
Gray sand shale	14		371	
Gray shale	10		381	
Limestone	10		391	
Hard dark shale	1		392	
Gray shale	3		395	
Coal (Lexington)	1		396	
Fire clay	1		397	
Limestone	1		398	
Light shale	2		400	
Sandstone	6		406	
Light sand shale	2		408	
Limestone	4		412	
Dark shale	1		413	
Light shale	9		422	
Limestone	3		425	
Gray shale	2		427	
Limestone	4		431	
Cherokee group:				
Light shale	1		432	
Dark shale (Mulky Coal hor.)	5		437	
Light shale	3		440	
Light sandstone	2		442	
Light sand shale	13		455	
Sandstone	4		459	
Light sand shale	11		470	
Sandstone	10		480	
Gray sand shale	11		491	
Dark shale	3		494	
Coal (Bevier)	1		495	
Sandy fire clay	1		496	
Sandstone	23		519	
Gray shale	7		526	
Coal	1	4	527	4
Fire clay	1	8	529	
Light shale	3		532	
Gray shale	5		537	
Coal	..	6	537	6
Fire clay	1	6	530	
Sandstone	6		545	

Log of New Hampton Coal and Mineral Company's Johnson Bros. No. 1—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Light sand shale	11		556	
Gray shale	3		559	
Sandstone	3		562	
Gray shale	2		564	
Hard sandstone	3		567	
Dark gray shale	11		578	
Coal	..	6	578	6
False bottom	1		579	6
Fire clay	..	6	580	
Light sand shale	34		614	
Dark shale	11		625	
Hard black shale	2		627	
Coal	..	6	627	6
Fire clay	1	6	629	
Sandstone	5		634	
Light shale	4		638	
Sandstone	8		646	
Dark shale	14		660	
Coal	1		661	
Fire clay	..		...	
No record	..		778*	
			Total depth	

*Base of Cherokee not reached.

Log of Keystone Oil and Gas Company's Murphy School No. 1. Location: SE. 1/4 SW. 1/4 SW. 1/4 sec. 5, T. 64 N., R. 26 W., Harrison County, Mo. Elevation: 873.1 feet. Commenced November 25, 1908. Date of completion not known. Well No. 9 on map, Pl. I.

	Thickness, feet	Depth, feet
Recent series:		
Soil	15	15
Pennsylvanian system:		
Lime shell	4	19
Blue slate	31	50
Brown shale	20	70
Blue slate	25	95
Coal	4	99
Red rock (shale)	43	142
Brown slate	41	183
Brown shale	32	215
Sand, fresh water	28	243
Blue slate	27	270
White fire clay	25	295
Blue slate	32	327
Brown shale	28	355
Blue slate	18	373
White lime	37	410
Fresh water sand	45	455
Blue slate	25	480
Gray shale	60	540
Blue slate	39	579
Fresh water sand	21	600
Brown shale	37	637
Brown water sand	14	651
Blue slate	19	670
Brown shale	18	698
Sand, dry	12	710

Log of Keystone Oil and Gas Company's Murphy School No. 1—Continued.

	Thickness, feet	*Depth, feet*
Mississippian system:		
Meramec, Osage and Kinderhook groups:*		
White lime	70	780
Shale and lime shells	35	815
Lime	30	855
Sand	12	868
Lime	82	950
Blue slate	2	952
Fresh water sand	14	966
Lime	6	972
Sand	23	995
Lime	72	1067
Red rock shale	17	1084
Lime	46	1130
Kinderhook group:		
White shale	25	1155
Devonian system:*		
Lime	15	1170
Brown shale	6	1176
Lime	6	1182
Red shale	7	1189
Lime	184	1373
Brown lime	77	1450
White lime	15	1465
Brown lime	105	1570
Sandy lime	40	1610
		Total depth

*A limited number of samples from this well indicate that the St. Louis and Warsaw formations of the Meramec group were drilled. Samples also show the presence of the Burlington-Keokuk formations of the Osage group, and the Chouteau formation of the Kinderhook group may be represented in a sample from 1015 to 1025 feet. Samples through the Kinderhook shale section are not available and the limits of it cannot be defined. There is the suggestion that the red shales, 1067-1084 and 1182-1189 feet may be of Kinderhook age and equivalent to the red shales and oolitic hematite of Kinderhook age found in other wells in the western portion of the area.

A sample, 1180-1887 contains white crystalline, fossiliferous limestone, suggestive of the Upper Devonian Callaway limestone of Central Missouri. Other samples to 1578 feet attest to the Devonian age of this interval, and samples from 1570-1578 feet are highly suggestive of the lower Devonian as developed in wells in T. 65 N., R. 16 and 17 W., Putnam County, Mo. The interval, 1570-1610 feet as shown on the driller's log may represent in part the sand that is developed at the base of the Devonian in Putnam County and elsewhere in northern Missouri.

Log of Fred Morck and Company, Wm. Ross No. 1. Location: SE. 1/4 NW. 1/4 NW. 1/4 sec. 12, T. 64 N., R. 26 W., Harrison County, Mo. Elevation: 822.4 feet. Completed November 25, 1910. Well No. 10 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil and clay	35	35
Quicksand, brown	10	45
Blue, soft clay	5	50
Gray gravel	132	182
Pennsylvanian and older:		
Blue clay (1 ft. coal at 300)	118	300
Blue clay	70	370
Water and white sand	47	417
Clay	5	422
Black slate	8½	430½
Black coal (2½ ft. coal)	2½	433
Water and white sand	7	440

Log of Fred Morck and Company, Wm. Ross No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime	14	454
Black slate	11	465
Coal	1	466
White clay	7	473
Slate	7	480
Dark, soft lime	20	500
Water, sand, white	21	521
Gray lime	14	535
Gray lime	28	563
Blue, soft slate	15	578
Very hard, gray lime	3	581
Soft, black slate	14	595
Hard and soft water lime, white	139	734
Brown lime, medium	28	762
Brown lime, hard	20	782
Pale blue slate	36	818
Brown lime, medium	152	970
Gray lime, very hard	27	997
		Total depth

NOTE. This log is presented in view of the fact that a limited number of samples are available. They do not confirm the poor driller's log, and as a result furnish some additional evidence for this area.

Samples from 560 to 580 feet and from 590 to 595 feet show black shale. Sand and gray shale are present from 610 to 615 feet. All of the above are referred to the Cherokee formation.

Samples from 750 to 760 feet show dense to oolitic limestone of Upper Meramec age, and are suggestive of the Ste. Genevieve formation. As a result, the top of the Mississippian is probably at 734 feet and the "white lime" of the log, 595 to 734 feet, is probably the basal sand of the Cherokee formation.

Log of Town of Ridgeway Well No. 1. Location: SE. 1/4 NW. 1/4 NW. 1/4 sec. 3, T. 64 N., R. 27 W., Harrison County, Mo. Elevation: 1,057 feet. Completed in 1927. Well No. 11 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	4	4
Clay	136	140
Pennsylvanian system:		
Kansas City group:		
Lime	75	215
Pleasanton, Henrietta and Cherokee groups:		
Slate	15	230
Lime	10	240
Slate, W	60	300
Lime	10	310
Slate	45	355
Lime (Lexington Caprock)	5	360
Slate	30	390
Lime (Rhumboidalls ?)	5	395
Slate	20	415
Lime (Fort Scott ?)	5	420
Slate	80	500
Lime (Ardmore ?)	20	520
Slate	145	665
Sand	25	690
Shale, blue	4	694
Lime, gray	2	696
Sand rock	16	712
Shale, black	7	719

Log of Town of Ridgeway Well No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime, gray	6	725
Shale, black	15	740
Shale, and lime, streaky	8	748
Shale, blue-gray	8	756
Sand rock	29	785
Shale, black	13	798
Shale, blue	4	802
Lime, blue	5	807
Shale, blue	2	809
Lime, white	2	811
Shale, gray	29	840
Shale, black	10	850
Lime, gray	1	851
Shale, black	8	859
Lime, gray	1	860
Shale, blue	2	862
Lime, brown	2	864
Shale, lime, blue, streaked	14	878
Lime, gray	6	884
Sand rock	14	898
Shale, blue	15	913
White sand rock	9	922
Sand, hard, blue	18	940
Sand rock, white	19	959
Mississippian system:		
Lime, gray	55	1014
Shale, light gray	1	1015
Lime, gray	4	1019
Shale, green white	4	1023
Lime, gray	3	1026
Shale, green	3	1029
Lime, gray	1	1030
Sand rock, red	9	1039
Shale, white	11	1050
Sand rock, red	1	1051
Lime, white	24	1075
Lime, brown	3	1078
Lime, reddish brown	7	1085
Lime, gray	33	1118
Lime, white	16	1134
Lime, gray	10	1144
Lime, white	34	1178
		Total depth

Struck first water in 55-685.

Eight " casing set at 915' and perforated at all sands above that point up to the bottom of the 10" casing, which runs about 950 feet below the surface.

Log of Keystone Oil and Gas Company Rogers No. 1. Location: NW. 1/4 SE. 1/4 sec. 13, T. 65 N., R. 26 W., Harrison County, Mo. Elevation: 852.3 feet (P. T.). Completed 1908(?). (Log received October 31, 1910). Well No. 13 on map Pl. I. (Note. This is a drillers' incomplete log of a well which passed through the Cherokee into Mississippian (?) at 858 feet.)

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Coal		18	140	
Coal		24	180	
Coal		36	280	
Coal		48	380	
Coal		60	480	
Sandstone oil (water at 650 ft.)	50		650	

Log of Keystone Oil and Gas Company Rogers No. 1—Continued.

	Thickness, Ft.	In.	Depth, Ft.	In.
Shale, sand	50		700	
Shale	40		740	
Water sand	20		760	
Shale	20		780	
Sand showing oil	48		828	
Shale	27		855	
Sand	3		858	
Lime (water at 1020)	162		1020	
Lime	70		1090	
Sand shale	20		1110	
			Total depth	

Log of U. S. Civilian Conservation Corps' Eagleville Camp No. 1. Location: SE. 1/4 SE. 1/4 SW. 1/4 sec. 7, T. 66 N., R. 27 W., Harrison County, Mo. Elevation: 1,050 feet. Completed August, 1934. Well No. 17 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Soil, clay and boulders, soft	25	25
Clay and gravel, soft	10	35
Dark shale, soft	15	50
Sand (some water)	5	55
Sand and shale, soft	35	90
Sand and gravel (some water)	15	105
Pennsylvanian system:		
Kansas City group:		
Soft gray shale	20	125
Hard lime (Raytown)	4	129
Lime shells	11	140
Gray shale	8	148
Hard gray lime (Cement City)	4	152
Gray shale	9	161
Gray lime	7	168
Blue shale — Westerville	2	170
Hard gray lime	5	175
Gray shale	17	192
Dark hard lime	10	202
Gray shale	3	205
Gray lime shells — Winterset	5	210
Gray lime	2	212
Light sandy shale	5	217
Hard gray lime	9	226
Dark shale	10	236
Soft gray lime (Bethany Falls)	5	241
Hard lime (Bethany Falls)	19	260
Dark shale	5	265
Gray shale	15	280
Hard lime (Hertha)	8	288
Pleasanton group:		
Shale	27	315
Light shale	5	320
Soft sand and some water	5	325
Dark shale	25	350
Gray shale	5	355
Red shale	5	360
Gray shale	20	380
Henrietta group:		
Hard gray lime	4	384
Gray shale	19	403
Hard gray lime	6	409
Shale	20	429

Log of U. S. Civilian Conservation Corps' Eagleville Camp No. 1—Continued.

	Thickness, feet	*Depth, feet*
Hard gray lime	5	434
Coal (Lexington) (just a little water)	1	435
Dark shale	5	440
Soft gray lime	2	442
Light sandy shale	18	460
Dark shale	5	465
Lime shells	5	470
Cherokee group:		
Dark shale	8	478
Gray shale	7	485
Dark shale	3	488
Light sandy shale	37	525
Light shale	15	540
Dark shale	15	555
Gray shale	5	561
Gray shale	12	573
Gray lime (Ardmore ?)	2	575
Gray shale	13	588
Dark shale	2	590
Light shale	3	593
Sandy lime	7	600
Light shale	20	620
Dark shale	27	647
Light shale	3	650
Dark shale	10	660
Black shale	5	665
Gray shale	10	675
Dark shale	5	680
Gray shale	10	690
Light shale, a little water	10	700
Sandy shale	20	720
Fine sand, water	10	730
Dark shale	15	745
Light shale	5	750*
		Total depth

*Base of Cherokee not reached.
0'-161'—8" casing perforated.
86'-106'—bottom of 6" casing 561'.
Top of 6" casing 149'.
6" casing perforated 315' to 335'.
550' to 750'—4 7/8" casing perforated.
Bottom 60'.

Log of Blythedale Prospecting Company's Elwood White No. 1. Location: SE. 1/4 NE. 1/4 NE. 1/4 sec. 35, T. 66 N., R. 27 W., Harrison County, Mo. Elevation: 957 feet. Completed April 2, 1914. Well No. 20 on map, Pl. I.

	Thickness, Ft.	*In.*	*Depth, Ft.*	*In.*
Pleistocene series:				
Surface and drift	30		30	
Sand	4		34	
Gray drift	30		64	
Sand	7		71	
Pennsylvanian system:				
Kansas City group:				
Limestone (Bethany Falls)	14		85	
Dark shale (hard)	4		89	
Limestone (Middle Creek)	2		91	
Gray shale	4		95	
Limestone	2		97	

Log of Blythedale Prospecting Company's Elwood White No. 1—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Gray shale	5		102	
Red shale	2		104	
Gray shale	1		105	
Limestone (Hertha)	8		113	
Pleasanton, Henrietta and Cherokee groups:				
Gray shale	16		129	
Limestone	2		131	
Light shale	1		132	
Sandstone	10		142	
Gray shale (lime seams)	46		188	
Sandstone	4		192	
Light gray shale	3		195	
Sandstone	4		199	
Gray shale	16		215	
Yellow shale	5		220	
Limestone	6		226	
Gray shale	14		240	
Dark shale	3		243	
Limestone	4		247	
Dark shale	2		249	
Coal (Lexington)	1	6	250	6
Sandstone	6		256	6
Sandstone		6	257	
Light sand shale	15		272	
Dark shale	2		274	
Light shale	2		276	
Sandstone	4		280	
Light shale	2		282	
Sandstone	4		286	
Gray shale	3		289	
Light shale	2		291	
Red shale	1		292	
Light shale	2		294	
Sandstone	6		300	
Light sand shale	25		325	
Gray sand shale	15		340	
Dark shale	2		342	
Light sand shale	25		377	
Dark shale	2		379	
Coal	1	4	380	4
Fire clay		8	381	
Sandstone	3		384	
Light sand shale	3		387	
Gray shale	5		392	
Dark shale	1		393	
Coal		6	393	6
Fire clay	1	6	395	
Sandstone	6		401	
Light sand shale	7		408	
Sandstone	4		412	
Light shale	3		415	
Dark shale	2		417	
Coal	1		418	
Sandstone	2		420	
Light sand shale	3		423	
Dark shale	8		431	
Coal	1		432	
Fire clay	1		433	
Light gray sand shale	17		450	
Sandstone	3		453	
Light gray sand shale	12		465	
Sandstone	9		474	
Light gray sand shale	4		478	

Log of Blythedale Prospecting Company's Elwood White No. 1—Continued.

	Thickness, Ft.	In.	Depth, Ft.	In.
Light gray shale	6		484	
Dark shale	1		485	
Light sand shale	13		498	
Sandstone	4		502	
Light sand shale	6		508	
Sandstone	86		594	
Dark gray shale	11		605	
Sandstone	5		610	
Dark shale	2		612	
Sandstone (dark shale partings)	10		622	
Coal	3	10	625	10
Fire clay	3	3	629	1*
			Total depth	

"Plenty of water".

*Base of Cherokee not reached.

*Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo. Location: SE. cor. NW. 1/4 sec. 4, T. 59 N., R. 38 W. Elevation: 868 feet. Completed in 1901. Well No. 1 on map, Pl. I. Descriptions from 961 to 2,040 feet by Miss Mary Hundhausen; from 2,040 to 2,500 feet, by H. S. McQueen.

	Thickness, Ft.	In.	Depth, Ft.	In.
Pleistocene series:				
Sandy clay, no core (loess)	65		65	
Clay and boulders, no core (drift)	10		75	
Pennsylvanian system:				
Shawnee group:				
Tecumseh shale:				
Clay shale (no core)	15		90	
Lecompton limestone:				
Limestone, dark gray to green, argillaceous, very fossiliferous, especially Fusulina	6	8	96	8
Limestone, gray, fine-grained, much calcite, very fossiliferous, especially Fusulina	4	7	101	3
Shale, gray to black	3	5	104	8
Limestone, dark gray, Fusulina		9	105	5
Limestone, gray, fine-grained	10	4	115	9
Limestone and shale	3	10	119	7
Limestone	4	10	124	5
Kanwaka shale:				
Shale, greenish-gray fossiliferous	16	10	141	3
Limestone, dark gray	4	2	145	5
Shale, gray, with a thin one-half inch seam of coal	13	1	158	6
Douglas group:				
Oread limestone:				
Limestone, dark gray, granular to oolitic	9	9	168	3
Limestone, dark gray	21		189	3
Shale	3	10	193	1
Limestone, gray	2	6	195	7
Shale, gray and greenish	11	3	206	10
Limestone	6	8	213	6
Lawrence shale:				
Shale	19	1	232	7
Limestone, mottled gray and brown	4	11	237	6
Shale, dark gray, arenaceous	12	8	250	2
Sandstone and sandy shale interbedded	77	8	327	10
Shale	9		336	10
Limestone, soft, very fossiliferous	1		337	10
Shale	10		347	10

*Abridged from detailed log published in Mo. Bur. Geol. and Mines, vol. XIII, pp. 215-239, 1915.

Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Pedee group:				
Iatan limestone:				
Limestone, gray, nodular	9		356	10
Weston shale:				
Shale	61	3	418	1
Lansing group:				
Stanton limestone:				
Limestone, medium-grained, gray	8	5	426	6
Clay shale, greenish	2	1	428	7
Limestone	17	2	445	9
Shale	8	5	454	2
Limestone, buff	3	2	457	4
Vilas shale:				
Shale, dark	12	1	469	5
Plattsburg limestone:				
Limestone	4	9	474	2
Shale, black, calcareous		11	475	1
Limestone, gray	9	6	484	7
Shale, gray to dark gray	1	10	486	5
Limestone, dark gray, argillaceous	8	3	494	8
Shale, greenish		7	495	3
Limestone, light gray, fine-grained	1	8	496	11
Lane shale:				
Shale, dark blue, fossiliferous	2	3	499	2
Limestone	4	4	503	6
Shale	38	9	542	3
Kansas City group:				
Iola limestone:				
Limestone, light gray	11		553	3
Chanute shale:				
Limestone, very argillaceous	5	8	558	11
Shale	15	3	574	2
Limestone, gray, argillaceous	4	1	578	3
Shale, green, calcareous	4	2	582	5
Drum limestone:				
Limestone, gray, argillaceous	8	6	590	11
Cherryvale shale:				
Shale, gray, calcareous	1	11	592	10
Limestone, shaly	1	11	594	9
Shale, dark, bituminous, calcareous		10	595	7
Limestone, mottled light and dark gray	1	3	596	10
Shale, dark gray, calcareous, bituminous	6	8	603	6
Shale	17	1	620	7
Winterset limestone:				
Limestone, light gray, compact, crystalline	7		627	7
Shale	7	2	634	9
Limestone, light gray, medium-grained, fossiliferous	34	9	669	6
Galesburg shale:				
Shale, black to gray	5	8	675	2
Bethany Falls limestone:				
Limestone, gray, nodular at top	23		698	2
Ladore shale:				
Shale, dark, bituminous, calcareous	3	5	701	7
Limestone, very argillaceous		7	702	2
Shale, greenish, calcareous	5	4	707	6
Limestone, argillaceous, with shale beds	4	8	712	2
Hertha limestone:				
Limestone, gray, with shaly partings	12	11	725	1
Pleasanton and Henrietta groups:				
Shale, blue-gray, calcareous, sandy	1	6	726	7
Sandstone, dark and light bands, shaly	4	11	731	6
Clay, blue-gray, arenaceous	2	4	734	4
Sandstone, grayish, fine-grained, calcareous	17	10	752	2

Log of Diamond Drill Hole of W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Shale, grayish-blue	19	7	771	9
Limestone, dark gray, argillaceous	3	5	775	2
Shale	4	2	779	4
Limestone, light-colored, argillaceous	1	9	781	1
Shale, green, upper half calcareous	1	3	782	4
Clay and shale, blue, green, black	9	2	791	6
Limestone and shale, nodular	3	2	794	8
Shale, greenish	4	5	799	1
Limestone	1	5	800	6
Sandstone, light green, fine-grained (peru)	9	6	810	
Shale, gray, banded with red and green	5	2	815	2
Limestone, greenish, mottled, argillaceous	6	4	821	6
Shale	14	6	836	
Shale, black, with a thin layer of coal (Lexington) at bottom		10	836	10
Clay shale	6	7	843	5
Limestone, gray, argillaceous	5	7	849	
Clay, light gray, calcareous	2		851	
Shale	14	11	865	11
Limestone, dark gray, fine-grained	2		867	11
Sandstone, dark bluish-gray, fine-grained	5	5	873	4
Shale, black, slaty	15	8	889	
Coal, bony (Summit)		4	889	4
Sandstone	5	7	894	11
Shale, dark gray, arenaceous	4	4	899	3
Limestone	8	9	908	
Cherokee shale (top):				
Shale	11	10	919	10
Limestone, greenish, argillaceous	2	2	922	
Shale, green, calcareous; slightly arenaceous	4	2	926	2
Limestone, light gray, very argillaceous	2	3	928	5
Shale	8	2	936	7
Sandstone, fine-grained, argillaceous, calcareous in places; pyritiferous	7	5	944	
Shale, gray, contains pyrite nodules, small fragments of fossil shells. Plant remains	40		984	
Calcareous shale with Productus shells, 1′ Coquina at 985′	2		986	
Coal, shows woody structures. Shaly, poor quality		4	986	4
Shale, gray, somewhat micaceous with pyritized leaf imprints at 988′. Carbonized wood and leaf imprints at 992′	8		994	
Sandy shale, mica and plant remains, shows fine cross bedding	1	6	995	6
Coal	1		996	6
Shale, gray with much pyrite, and plant fragments—mica bearing and sandy. Poorly consolidated, with irregular inclusions of iron oxide and pyrite	7	6	1004	
Shale, gray, thin bedded, micaceous. Thin beds of red shale and black slaty shale. Black slaty shale predominates toward the base. Plant fossils. Linguloid shells and Ostracods	7	6	1011	6
Coal		5	1011	11
Shale, calcareous, green with calcareous nodules; some red mottled shale	4	7	1016	6
Shale, gray-green; brachiopod shells; Mesolobus?	14		1030	6
Shale, black, calcareous, thin-bedded with some small Ostracods	1		1031	6
Limestone, tan, fine-grained with dark mottling. Fossil brachiopods		6	1032	
Shale, gray, calcareous, some darker beds (badly slacked)	1	10	1033	10

Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Limestone, argillaceous, gray, many small Productus shells. Mottling in lower 6''.		11	1034	9
Shale, black; some small calcareous shells.	1	2	1035	11
Limestone, dark brown, very carbonaceous.		4	1036	3
Shale, black; some small calcareous shells.	1	9	1038	
Limestone, gray, argillaceous; some small Productus shells.		8	1038	8
Shale, black, slaty.	2		1040	
Coal.	1	2	1041	2
Shale, light gray-green (badly slacked); some plant remains and pyrite and limonite nodules. Contains mica.	4		1045	2
Sandstone, fine-grained, very argillaceous. Much mica—FeS^2—iron concretions.	3		1048	2
Shale, soft, gray-green, micaceous.	3	6	1051	8
Shale, gray-green (badly slacked); some iron concretions. Some red iron stains toward base.	4	10	1056	6
Shale, black, carbonaceous, contains carbonized plants and calcareous shells.	3	8	1060	2
Coal.		10	1061	
Shale, dark gray, slaty; much carbonized wood.		6	1061	6
Sandstone, shaly, micaceous, contains woody stems.	3	9	1065	3
Slate and shale, black, thin-bedded with some small lingulas and conodents. Much carbonized wood and impure coal.	4	10	1070	1
Coal with slate. Alternating slate and coal with 8'' of good coal at base.	1	5	1071	6
Shale, green, micaceous with calcareous, pyrite and limonite concretions.	9		1080	6
Shale, gray, slick with linguloid shells.	2	6	1083	
Coal, impure, pyritiferous.		2	1083	2
Shale, gray, badly slacked.	2	3	1085	3
Sandstone, argillaceous and micaceous, fine-grained. Shale beds at 1097 (8'') at 1098½' (18'').	16	7	1102	
Interbedded shale and sandstone. Plant remains and spores ? along bedding planes. Pyrite nodules. Shale content increases with depth. Much mica. Beds thin and irregular.	18		1120	
Shale, gray, micaceous with leaf and stem fragments. Some carbonate nodules.	7	6	1127	6
Red shale. Plant fossils.		1	1127	7
Shale, dark gray, micaceous. Plant fossils, brown spores.		11	1128	6
Shale, gray, thin bedded, very sparingly fossiliferous.	1	6	1130	
Shale, dark gray to black, fissile. Sparingly fossiliferous with pelecypods and plants noted at intervals. Becomes darker towards base. 3'' lime at 1137½.	10		1140	
Coal, pyritiferous, badly slacked.		7	1140	7
Shale, gray-green, badly slacked; fire clay in part; contains much pyrite.	9	2	1149	9
Coal, impure, pyritiferous, badly slacked.		5	1150	2
Shale, dark gray, micaceous. Plant fossils.	7	10	1158	
Coal.		1	1158	1
Clay, shale, light gray, sandy, with plant remains, badly slacked.	3	11	1162	
Grades into sandstone, micaceous, with clay cement, angular quartz grains. Becomes shaly, gray, with siderite psuedo-oolites toward base.	8	2	1170	2

Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Sandstone, fine-grained, micaceous, some shale; carbonized plants	1	10	1172	
Shale, gray, very carbonaceous with poorly defined bedding planes and many concretions of pyrite and siderite	10		1182	
Sandy shale, micaceous with plant fossils	1		1183	
Shale, sandy, irregularly bedded; somewhat calcareous at base; fish teeth at 1186'	3	4	1186	4
Wasted core	2	2	1188	6
Limestone, black, argillaceous and carbonaceous; fossils	2		1190	6
Shale, dark gray, carbonaceous, somewhat micaceous. Non-fossiliferous	16	6	1207	
Shale, light green with irregular nodules and small pseudo-oolites of siderite, some pyrite, no fossils. At 1214½', 1½' sandstone with white mica and clay cement. Good pseudo-oolites at 1217	12	6	1219	6
Shale, red and green, slick, thin beds; some show slicken-siding	2	10	1222	4
Shaly sandstone, mica; siderite nodules in last 18"	5	3	1227	7
Shale, gray		10	1228	5
Shale, black slaty, much carbonized wood at 1229' (sub-coal)		10	1229	3
Shaly sandstone, gray, irregularly bedded, badly slacked. Many plant remains. Mica flakes and siderite pseudo-oolites	6	5	1235	8
Shale, gray, plant remains, pyrite nodules. Small linguloid ? shells at 1248'	15	10	1251	6
Coal, badly slacked		5	1251	11
Sandstone, fine-grained, argillaceous, much mica, many carbonized wood fragments. Some small siderite nodules	6	1	1258	
Shale, black, slaty; several thin siderite beds	5		1263	
Coal, impure, badly slacked		8	1263	8
Sandstone, gray, argillaceous, micaceous; with numerous plant fossils	6	4	1270	
Shale, light gray, some mica	2		1272	
Shale, gray, mica bearing, with some plant remains and numerous nodules of siderite (clay ironstones)	8		1280	
Shale, dark gray, micaceous; some plant remains.		18	1281	6
Sandstone, much mica and plant remains		3	1281	9
Shale, badly slacked, light gray. Siderite concretions at 1285' 8"	4	4	1286	1
Coal, badly slacked, impure		1	1286	2
Shale, gray, sandy and micaceous		6	1286	8
Grades into sandstone, medium coarse-grained, very micaceous, with plant remains; spores.	5		1291	8
Black shale		2	1291	10
Sandy shale, thin beds, wavy bedding planes, much mica and plant remains. Increasingly sandy toward base. Some interbedded red shale layers	20	2	1312	
Sandstone, micaceous, irregularly bedded, medium coarse-grained; plant fossils	31	10	1343	10
Shale, gray, with pseudo-oolites of siderite	8	2	1352	
Shale, black, slick	4	6	1356	6
Sandstone, mica-bearing, with plant remains and iron concretions	1		1357	6
Shale, gray, with plant fossils. Contains some flakes of white mica	3	6	1361	

Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Sandstone, coarse, with large mica flakes and iron concretions. Also some plant fossils...	6	8	1367	8
Shale, light gray to white, with siderite pseudo-oolites....	2		1369	8
Sandstone, white, with inclusions of siderite.....	1		1370	8
Interbedded sand and shale. Thin, irregular beds, some pink and red shale beds. Plant remains; black spores.....	12		1382	8
Shale, gray to black, somewhat micaceous.....	1	4	1384	
Coal and black slate interbedded.....		8	1384	8
Shale, tan, with some carbonized plant remains..		8	1385	4
Clay shale, gray, badly slacked.....	1	6	1386	10
Shale, black, badly slacked, contains some pyrite.	3	2	1390	
Coal, impure, pyritiferous, badly slacked.....		6	1390	6
Clay shale, gray, badly slacked. (No core from 1392 to 1393).....	3	6	1394	
Shale, black, slaty, upper part slacked. Ironstone concretions near top; 1½" limestone at 1401'.....	9		1403	
Limestone, dark, argillaceous (calcareous shale to 1412'). Contains some shells.....	22	3	1425	3
Sandstone; contains much woody material and large brown spores.....	9	9	1435	
Shale, black.....	5		1440	
Shale, gray, badly slacked. Some pseudo-oolites of siderite. Some plant fossils.....	26		1466	
Shale, black, thin bedded, some shells; much carbonized wood. From 1467½ to 1474½ very shaly coal. Pyritiferous badly slacked. Some sandy shale, black toward base.....	22	8	1488	8
Sandstone, tan, medium coarse-grained, plant fragments carbonized.....	1	9	1490	5
Interbedded sandstone and darker gray shale. Sandstone is white, fine-grained, with glauconite, mica and clay particles. Shale is mica-bearing and fissile.....	3	1	1493	6
Shale, gray, badly slacked, with carbonized plant remains.....	1	10	1495	6
Sandstone with interbedded shale and clay filled cavities. Many plant remains, carbonized wood. Some siderite cement.....	11	2	1506	6
Shale, dark gray to black with fossil plants, some linguloid shells, condonents and spores.....	11	8	1518	2
Sandstone, fine-grained, with mica and plant remains; brown spores. Becomes shaly and more fine-grained with depth.....	6	10	1525	
Grades into shale, gray, micaceous with some sand, spores, woody fragments.....	5		1530	
Clay, soft, gray, with plant fossils, leaf imprints .	4	6	1534	6
Interbedded shale (micaceous), and sandstone, thin layers, with carbonized wood and plant remains, spores. Sandstone from 1441' 10"-1442' 6".....	21		1555	6
Sand, fine-grained, irregularly bedded with cross-bedded appearance. Many plant remains..	1	8	1557	2
Shale, black, carbonaceous; some linguloid shells.	2	10	1560	
Clay shale, with leaf imprints. Irregular beds...	5		1565	
Shale, black and dark gray, carbonaceous. Many plant remains. Sandy, conglomeratic at 1580'-1582'. Sandy at 1586½' to 1587½'. Large brown spores. Some thin sand beds in lower 10'.....	48		1613	

Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness,		Depth,	
	Ft.	In.	Ft.	In.
Mississippian system:				
Meramec group:				
Ste. Genevieve formation:				
Sand, fine-grained sub-angular quartz, with no mica. Some dark mineral grains (Magnetite ?)	5		1618	
Limestone, coarse-grains, oolitic ?		6	1618	6
Sand (as 1613'-1618') and limestone interbedded.	3	6	1622	
St. Louis formation:				
Limestone, light tan, fine-grained, somewhat oolitic and slightly sandy	8		1630	
Limestone, conglomeratic. Limestone pebbles in matrix of green shale and limestone	4		1634	
Limestone, light tan, lithographic, with green shale partings, pink and white quartzose chert. Fossiliferous in upper 6'	19		1653	
Limestone, conglomeratic. Lithographic limestone pebbles in matrix of limestone and green shale	2		1655	
Limestone, light tan, lithographic, with small stylolites	5		1660	
Warsaw ? formation:				
Limestone, dolomitic, light gray, finely crystalline, interbedded with green and gray shale and chert. Chert nodules and geodes consist of red and pink and white chert with chalcedony and quartz-lined cavities. Some spinose and fossiliferous chert. The core at 1694' consists of dark brown, dolomitic limestone, somewhat porous, showing slight oil stain.	48		1708	
Warsaw formation:				
Limestone, gray, medium coarse-grained, fossiliferous. Contains some blue and white chert	10		1718	
Shale, gray to green, interbedded with argillaceous and fossiliferous limestone. Beds average ½" in thickness	7		1725	
Limestone, coarse-grained, crinoidal, with black shale partings, interbedded with chert, gray fossiliferous, crinoidal mottled. Dolomitic limestone at 1738' and 1757'. Sparingly glauconitic	35		1760	
Shale, gray	1		1761	
Osage group:				
Keokuk-Burlington formation:				
Limestone, medium coarse-grained, crinoidal, with much chert. Chert, white and gray, fossiliferous. Some glauconite at 1804½'	46		1807	
Dolomite, fine-grained, light gray, with some darker, argillaceous streaks. Contains some gray and white nodules of chert	29		1836	
Limestone, tan to gray, medium coarse-grained, fossiliferous (crinoidal) and cherty. Glauconite at 1839½'	3	6	1839	6
Kinderhook group:				
Gilmore City ? formation:				
Limestone, light tan, oolitic and crinoidal. Green shale partings	4	6	1844	
Limestone, crystalline, medium fine-grained, with nodules of white porous chert	25		1869	
Limestone, medium fine-grained to lithographic with dark gray, fossiliferous chert	37		1906	
Limestone, white, oolitic; fossiliferous in lower portion	7		1913	
Limestone, dolomitic, brown to gray, argillaceous; contains disseminated pyrite	1		1914	

Log of Diamond Drill Hole on W. F. Davis Farm near Forest City, Mo.—Continued.

	Thickness,		Depth,	
	Ft.	In.	Ft.	In.
Kinderhook group, undifferentiated:				
Shale, gray to green, containing specks and streaks of carbonaceous material	5		1919	
Dolomite, gray, argillaceous	4		1923	
Shale, green and gray, with plant remains	24		1947	
Limonite, oolitic. Oolites are brown, flattened and oblong	4		1951	
Shale, gray and red	2	6	1953	6
Hematite, oolitic. Flattened, discoidal oolites cemented with calcium carbonates	3	6	1957	
Hematite, dark red, shaly		6	1957	6
Chattanooga ? formation:				
Shale, green, small mica flakes, black spores, conodonts	32	6	2000	
Shale, gray and green, spore-bearing	23		2023	
Shale, dark gray, calcareous	17	6	2040	6
Devonian system:				
Limestone, fine-grained, earthy, fossiliferous with fine-grained limestone conglomerate at base.	7	6	2048	
Limestone, fine-grained, earthy, dark colored, fossiliferous, finely conglomerate and green shale at base. Uneven lower contact. Lithology is suggestive of the Callaway	42		2090	
Limestone, gray, lithographic, with small disseminated, colorless, crystals of calcite, earthy and dolomitic from 2133-2136. The lithology is suggestive of the Cooper	46		2136	
Dolomite, gray to brown, fine-grained, porous, with dense gray speckled and quartzose chert	28		2164	
Limestone, dark grayish-blue, very dense, almost lithographic, slightly earthy	11		2175	
Dolomite, light to dark brown, very argillaceous.	5		2180	
Limestone, magnesian, bluish-gray mottled, dense to sub-lithographic. May be base of the Cooper	1		2181	
Dolomite, brown, finely crystalline at top grading to more coarsely crystalline and porous at base. Earthy at 2218 and 2226 feet; chert rough white and fine sand at 2234 feet. Vugs and small cavities common from 2251-2256 feet	75		2256	
Dolomite, gray, very argillaceous	36		2292	
Dolomite, dark brown, white, finely crystalline, with quartzose chert	26		2318	
Dolomite, light gray, argillaceous, distinct break with underlying dolomite	19		2337	
Dolomite, dark brown, finely crystalline with many vugs and small cavities, argillaceous at base. Free oil obtained with ether from finely crystalline dolomite at 2356 feet	24		2361	
Chert, white, bluish-gray, hard, glassy with abundance of rounded and frosted included sand grains. This is the wide-spread zone at the base of the Devonian	4		2365	
Silurian system:				
1. Dolomite, bluish gray, crystalline, very vuggy to cavernous with holes up to 1¾ inches in diameter. Calcite is common. Casts of fossils are abundant	52		2417	
2. Dolomite, bluish-gray, more finely crystalline and compactly-grained than above. Vugs much smaller, and less numerous	56		2473	
3. Dolomite, light grayish-brown, fine-grained, very argillaceous	27		2500	
			Total depth	

Log of Core Drill at Maryville. Location: Alice Beal Farm, SE. 1/4 SE. 1/4 SE. 1/4 sec. 17, T. 64 N., R. 35 W., Nodaway County, Mo. Completed 1888. Elevation: 1,047.3 feet. Well No. 5 on map, Pl. I.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene series:				
Clay and sand and a little gravel	50		50	
Clay	120		170	
Pennsylvanian system:				
Shawnee group:				
Dark argillaceous shale, calcareous at bottom (Tecumseh)	1		171	
Drab, highly calcareous shale, compact like limestone (Tecumseh)	5		176	
Limestone, argillaceous, somewhat granular (Lecompton)	10		186	
Limestone, coarse, hard, dark with shell fragments (Lecompton)	4		190	
Shale, black, slightly calcareous, grading into limestone at bottom	3		193	
Shale, calcareous, fine-grained, grading into dark shale toward bottom	4		197	
Limestone, coarse, somewhat granular, drab, dark, with fragments	2		199	
Limestone, compact, hard, clinking, white	4		203	
Shale, dark, somewhat sandy, micaceous, not calcareous, grading into next above	6		209	
Shale, dark, very fine and smooth-grained, argillaceous, growing calcareous toward bottom	7		216	
Douglas group:				
Limestone, earthy, dark and coarse with shell fragments (Oread)	2		218	
Shale, dark, smooth, non-calcareous (Oread)	5	6	223	6
Limestone, white, coarse, hard with dark streaks and shell fragments (Oread)	10	6	234	
Limestone, white, coarse, hard with dark streaks like above; semi-crystalline and fossiliferous (Oread)	11		245	
Shale, dark, argillaceous, noncalcareous (Oread)	4		249	
Shale, drab, slightly calcareous (Oread)	1		250	
Shale, dark, slightly calcareous (Oread)	2		252	
Limestone shells, grading into calcareous shale (Oread)	3		255	
Shale, soft, clayey, calcareous, drab	9		264	
Shale, red, concretionary, calcareous and argillaceous, with drab bands	12		276	
Shale, drab argillaceous and calcareous	1		277	
Limestone, with flint, drab and dark, very hard, with calcite crystals	1		278	
Clay, dark red, argillaceous and calcareous, solid red upper 4 ft., lower 2/3 streaked with drab clay shale, the latter predominating near bottom	12		290	
Shale, arenaceous, slightly calcareous with fine mica scales, pyritiferous	5		295	
Sandstone, coarse, rough micaceous and calcareous	2		297	
Shale, dark, drab, argillaceous, non-calcareous, bituminous near bottom	9		306	
Coal		3	306	3
Shale, drab argillaceous	4	9	311	
Shale, clayey red	4		315	
Shale, drab argillaceous	8		323	
Shale, argillaceous, drab, somewhat arenaceous, non-calcareous, slightly micaceous	27		350	
Sandstone, or sandy shale, drab, micaceous and non-calcareous with argillaceous portions	11		361	
Shale, arenaceous and argillaceous, drab, similar to above	22		383	
Shale, argillaceous, drab, non-calcareous	7		390	
Shale, calcareous, drab, pyritiferous, rough greenish near bottom (includes Haskell)	13		403	

Log of Core Drill at Maryville—Continued.

	Thickness, Ft.	In.	Depth, Ft.	In.
Shale, red, argillaceous	2		405	
Shale, drab, argillaceous, finely micaceous	7		412	
Pedee group:				
Limestone, hard, fossiliferous, gray, semi-crystalline (Iatan)	4		416	
Shale, drab, argillaceous, non-calcareous, black at bottom (Weston)	38		454	
Lansing group:				
Limestone, dark drab, compact, rough, earthy (U. Stanton)	4		458	
Shale, calcareous, and argillaceous	3		461	
Limestone, white, very hard (M. Stanton)	3		464	
Limestone, drab, compact, more earthy (M. Stanton)	9		473	
Limestone, drab, very hard fossiliferous (M. Stanton)	2		475	
Shale, drab, argillaceous and calcareous	4		479	
Shale, black, bituminous, calcareous	2		481	
Shale, gray, calcareous	1		482	
Limestone, dark, plenty hard (L. Stanton)	5		487	
Shale, sandy, calcareous, dark gray	1		488	
Limestone, gray, coarse, shaly	2		490	
Shale, dark gray				
Limestone, white and gray with white chert, compact hard	13		503	
Shale, light and dark drab, argillaceous	10		513	
Limestone, gray, compact, hard, shaly, passing into shale (U. Farley)	2		515	
Shale, dark drab, argillaceous and calcareous	10		525	
Limestone, nodular, with shale (L. Farley)	10		535	
Limestone, white compact, earthy (L. Farley)	7		542	
Shale, argillaceous, calcareous, light drab and dark gray, passing into shaly limestone in the last 2 feet	25		567	
Kansas City group:				
Limestone, hard, coarse-grained, drab, semi-crystalline (Raytown)	10		577	
Shale, drab, argillaceous and calcareous	5		582	
Shale, black, bituminous and calcareous	2		584	
Shale, drab, argillaceous, calcareous	9		593	
Shale, light gray, calcareous, seamy	5		598	
Limestone, compact, light gray or white	4		602	
Shale, light drab, calcareous, argillaceous	6		608	
Limestone, light drab, hard, compact	3		611	
Limestone and drab shale, more drab shale at bottom	3		614	
Shale, dark, bituminous, calcareous	2		616	
Limestone, dark, hard, semi-crystalline (Westerville)	4		620	
Shale, dark argillaceous, calcareous	10		630	
Shale, dark, argillaceous, calcareous	10		640	
Limestone, dark, granular	3		643	
Shale, dark, calcareous, argillaceous	8		651	
Limestone, white, compact, crystalline (Winterset)	8		659	
Limestone, drab, more compact, very hard (Winterset)	20		679	
Shale, black, bituminous, calcareous	4		683	
Shale, dark drab, non-calcareous	2		685	
Shale, light gray, slightly calcareous	8		693	
Limestone, gray, compact, very hard (Bethany Falls)	19		712	
Shale, black, bituminous, slightly calcareous	1		713	
Limestone, compact, shaly, drab, argillaceous in lower part (Middle Creek)	4		717	
Shale, clayey, slacks readily	5		722	
Limestone, white, gray, very hard, compact (Hertha)	6		728	
Pleasanton, Henrietta and Cherokee groups:				
Limestone, reddish, sandy	2		730	
Shale, dark, argillaceous, slightly calcareous	1		731	
Limestone, reddish, sandy and ferruginous like second above	6		737	

Log of Core Drill at Maryville—Continued.

	Thickness, Ft.	In.	Depth, Ft.	In.
Limestone, drab, compact, granular	3		740	
Shale, black, bituminous	2		742	
Limestone, nodular, some shale, slightly pyritiferous	11		753	
Shale, arenaceous, little mica, non-calcareous	14		767	
Limestone, drab, compact, smooth, somewhat earthy	7		774	
Shale, drab, slightly argillaceous, arenaceous, fine mica, non-calcareous	6		780	
Limestone, white, hard, semi-crystalline	4		784	
Shale, argillaceous, dark, slightly calcareous	2		786	
Shale, argillaceous, drab, and greenish calcareous in places and occasional limestone streaks	13		799	
Limestone, white, ferruginous from pyrites, hard	1		800	
Limestone, shaly, brecciated	3		803	
Shale, greenish argillaceous, non-calcareous	6		809	
Limestone, drab, hard, compact, granular	1		810	
Shale, greenish, drab, argillaceous, non-calcareous	10		820	
Shale, reddish, mottled, argillaceous	7	?	827	
Shale, drab, argillaceous, slightly calcareous and micaceous near bottom	9	?	836	
Shale, drab, argillaceous, somewhat arenaceous near top, non-calcareous, micaceous, lower portion drab, calcareous shale strongly effervescent	10		846	
Limestone, granular, somewhat argillaceous	5		851	
Shale, somewhat arenaceous, drab, micaceous	11		862	
Shale, argillaceous, growing dark towards bottom	13		875	
Limestone, coarse, granular towards bottom	4		879	
Shale, dark, argillaceous and very effervescent, granular, calcareous streaks in places	15		894	
Limestone, argillaceous, fine-grained, compact, drab	6		900	
Limestone, coarse-grained, not crystalline, drab	3		903	
Limestone, light gray, finer-grained than above	2		905	
Shale, drab, argillaceous, calcareous	26		931	
Shale, arenaceous, micaceous, calcareous, approaching sandstone in places, drab	12		943	
Shale, arenaceous, micaceous, non-calcareous, drab	15		958	
Shale, argillaceous, non-calcareous, drab	15		973	
Shale, slightly arenaceous and calcareous, drab	12		985	
Shale, argillaceous and slightly arenaceous, mostly non-calcareous, drab	18		1003*	

*Base of Cherokee not reached.

Log of Quitman Oil and Gas Company's Cardin No. 1 (serial number 2). Location: SE. 1/4 SE. 1/4 sec. 15, T. 64 N., R. 37 W., Nodaway County, Mo. Elevation: 940.2 feet. Completed June 6, 1927. Well No. 6 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Surface	10	10
Clay, yellow	15	25
Gravel (water)	10	35
Pennsylvania system:		
Shawnee group:		
Shale, blue	10	45
Lime (Deer Creek—Topeka)	3	48
Shale, light	4	52
Lime	1	53
Shale, light	2	55
Lime	5	60
Shale, light	2	62
Lime, white	12	74
Shale, light	8	82
Lime	7	89

Log of Quitman Oil and Gas Company's Cardin No. 1—Continued.

		Thickness, feet	Depth, feet
Shale		1	90
Lime		15	105
Shale, dark		3	108
Lime		4	112
Shale, dark		2	114
Lime		2	116
Shale, dark		10	126
Lime		2	128
Shale, light		1	129
Lime		3	132
Shale, light	Lecompton-Oread	45	177
Lime	Lecompton-Oread	13	190
Shale, dark	Lecompton-Oread	3	193
Lime	Lecompton-Oread	5	198
Shale, light	Lecompton-Oread	12	210
Douglas group:			
Lime	Lecompton-Oread	4	214
Broken shale	Lecompton-Oread	3	217
Lime	Lecompton-Oread	13	230
Shale, dark	Lecompton-Oread	3	233
Lime	Lecompton-Oread	15	248
Shale, dark		12	260
Shale, light		13	273
Red bed		12	285
Shale, light		139	424
Pedee and Lansing groups:			
Lime		5	429
Shale, broken		16	445
Lime		2	447
Shale, light		5	452
Lime		5	457
Shale, light		4	461
Lime		6	467
Shale, dark		8	475
Lime		10	485
Shale, light sandy		2	487
Lime, hard		1	488
Shale, light		12	500
Lime		15	515
Shale, light		3	518
Lime		4	522
Shale, light		2	524
Lime		2	526
Shale, sandy		4	530
Lime		5	535
Shale, dark		20	555
Shale, sandy		5	560
Kansas City group:			
Lime (Raytown Ls.)		10	570
Shale, dark		5	575
Shale, brown		10	585
Lime, brown		3	588
Red bed		5	593
Shale, sandy		7	600
Lime		4	604
Shale, dark		2	606
Lime, hard		26	632
Shale, dark		3	635
Lime		7	642
Shale, sandy		2	644
Lime (Winterset)		24	668
Shale, black		8	676
Lime, very hard (Bethany Falls)		20	696
Shale, black		4	700

Log of Quitman Oil and Gas Company's Cardin No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime (Middle Creek)	2	702
Shale, dark	5	707
Lime (Hertha)	11	718
Pleasanton, Henrietta and Cherokee groups:		
Shale, dark	2	720
Lime	12	732
Shale, broken	5	737
Lime	2	739
Shale, broken	7	746
Lime	2	748
Shale, dark	4	752
Lime	5	757
Shale, blue	5	762
Lime	8	770
Shale, blue	7	777
Lime	2	779
Shale, blue	5	784
Red bed	4	788
Shale, light	15	803
Lime	5	808
Shale, dark	29	837
Lime	7	844
Shale, light	4	848
Shale, dark	12	860
Lime	2	862
Shale	3	865
Lime	5	870
Shale, dark	3	873
Lime	3	876
Shale, dark	6	882
Lime	3	885
Shale, dark	4	889
Lime	8	897
Shale	5	902
Lime	1	903
Shale, black (Lexington coal horizon)	1	904
Lime	1	905
Shale, dark	5	910
Lime, gray	4	914
Shale, light	4	918
Lime, gray	4	922
Shale, dark	7	929
Shale, green	25	954
Shale, dark	62	1016
Lime (Ardmore)	4	1020
Shale, black	8	1028
Lime, hard	2	1030
Shale, black	7	1037
Shale, blue sandy	7	1044
Lime	1	1045
Shale, dark	2	1047
Lime	1	1048
Shale, dark	18	1066
Lime	4	1070
Shale, dark	10	1080
Lime	2	1082
Shale, dark	22	1104
Lime	1	1105
Shale, dark	11	1116
Lime	2	1118
Shale, dark	7	1125
Shale, yellow	7	1132
Shale, dark	19	1151
Lime	2	1153

Log of Quitman Oil and Gas Company's Cardin No. 1—Continued.

	Thickness, feet	*Depth, feet*
Shale, dark	7	1160
Shale, sandy	5	1165
Shale, dark	7	1172
Lime	1	1173
Shale	3	1176
Lime	2	1178
Shale, dark	17	1195
Shale, light sandy	16	1211
Lime, gray	2	1213
Shale, light sandy	5	1218
Shale, dark	82	1300
Sand-water (oil showing)	5	1305
Shale, dark	3	1308
Lime	3	1311
Shale, black	2	1313
Shale	1	1314
Lime	2	1316
Shale, black	16	1332
Water sand (oil showing)	5	1337
Shale, light	20	1357
Shale, dark	10	1367
Shale, black	3	1370
Shale, dark	10	1387
Shale, black	3	1390
Shell	1	1391
Shale	4	1395
Lime and pyrites of iron	5	1400
Shale, black	4	1404
Shale, gray	6	1410* Total depth

*Base of Cherokee not reached.

Log of Quitman Oil and Gas Company's Getta Karr No. 1. Location: SE. 1/4 SE. 1/4 SE. 1/4 sec. 22, T. 64 N., R. 37 W., Nodaway County, Mo. Elevation: 1,046.5 feet. Completed August 28, 1926. Well No. 7 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Surface	6	6
Clay, yellow	10	16
Gravel	15	31
Sand	15	46
Clay, yellow	10	56
Clay, blue	10	66
Pennsylvanian system:		
Shawnee group:		
Lime, hard (Howard, lower ledge)	3	69
Shale, broken	27	96
Lime, gray	2	98
Shale, blue	2	100
Lime	3	103
Shale, blue	27	130
Lime	25	155
Shale, broken	5	160
Lime	15	175
Shale and lime	10	185
Lime	15	200
Shale, blue	10	210
Lime, white (top Deer Creek)	6	216
Shale, brown	34	250

Log of Quitman Oil and Gas Company—Continued.

	Thickness, feet	*Depth, feet*
Lime, white	10	260
Shale, black	3	263
Lime	5	268
Shale, brown	7	275
Lime, gray	8	283
Shale, light	5	288
Shale, brown	4	292
Douglas group:		
Lime, white	6	298
Shale, dark	1	299
Lime	11	310
Shale, sandy	5	315
Lime, gray	5	320
Shale, dark	10	330
Lime, gray	5	335
Shale, sandy	21	356
Shale, brown	9	365
Shale, light	57	422
Shale, dark	75	497
Pedee and Lansing groups:		
Lime	1	498
Shale, light	3	501
Lime, hard	6	507
Shale, dark	11	518
Lime	4	522
Shale, dark	8	530
Lime, gray	5	535
Shale, light sandy	5	540
Lime, gray	5	545
Shale, dark	10	555
Lime, gray	2	557
Shale, light sandy	3	560
Lime	5	565
Slate, dark	8	573
Lime	7	580
Shale, sandy	6	586
Lime	3	589
Shale, sandy	12	601
Lime	2	603
Shale, sandy	20	623
Shale, dark	19	642
Kansas City group:		
Lime	1	643
Shale light	5	648
Lime, gray	4	652
Shale, dark	15	667
Lime	2	669
Shale	6	675
Lime	15	690
Shale, sandy	5	695
Shale, dark	6	701
Lime, gray	6	707
Shale, sandy	5	712
Lime	5	717
Lime, gray	11	728
Shale, light	5	733
Lime (Winterset)	3	736
Shale	5	741
Lime (Gas)	13	754
Shale	5	759
Lime, blue (Bethany Falls)	26	785
Shale, dark	11	796
Lime, black (Hertha)	17	813

Log of Quitman Oil and Gas Company—Continued.

	Thickness, feet	*Depth, feet*
Pleasanton, Henrietta and Cherokee groups:		
Shale, light	5	818
Shale, dark	5	823
Shale, light	10	833
Lime	7	840
Shale, light	3	843
Lime	7	850
Shale	13	863
Shale, red	4	867
Lime	5	872
Shale, broken	5	877
Lime	3	880
Shale, light	5	885
Shale, broken, sandy	35	920
Lime	3	923
Shale, sandy	20	943
Shale, dark	30	973
Lime, hard	4	977
Shale, blue	16	993
Lime	2	995
Shale, blue	5	1000
Lime	2	1002
Shale, dark	25	1027
Shale, blue	20	1047
Lime	2	1049
Shale, dark	25	1074
Lime	1	1075
Shale, dark	30	1105
Lime (Ardmore)	5	1110
Shale, black	10	1120
Shale, light	12	1132
Lime, hard	3	1135
Shale, light	23	1158
Lime	1	1159
Shale, light	16	1175
Shale, dark	20	1195
Lime	2	1197
Shale	3	1200
Shale, black	5	1205
Shale, light	11	1216
Lime	1	1217
Shale, light	9	1226
Shale, dark	6	1232
Lime	2	1234
Shale, dark	15	1249
Shale, light	11	1260
Lime	1	1261
Shale, dark	4	1265
Lime	10	1275
Shale, gray	1	1276
Lime	3	1279
Shale, gray	5	1284
Lime	4	1288
Shale, sandy	12	1300
Sand (Rainbow, good oil show)	9	1309
Shale, black	36	1345
Shale, blue	10	1355
Shale, light	5	1360
Shale, sandy	29	1389
Shale, black	15	1404
Lime	5	1409
Shale, black	26	1435
Lime	4	1439
Shale, dark	2	1441

Log of Quitman Oil and Gas Company—Continued.

	Thickness, feet	*Depth, feet*
Lime	2	1443
Shale, sandy	3	1446
Lime, gray	9	1455
Shale, sandy	10	1465
Shale, black	5	1470
Lime	3	1473
Shale, dark	13	1486
Lime, black	10	1496
Shale and lime, black	12	1508
Shale, broken, gray	9	1517
Lime	1	1518
Shale, light	3	1521
Lime	2	1523
Shale, dark	11	1534
Shale	9	1543
Shale, dark	19	1562
Shale, black	11	1573
Shale and lime	5	1578
Lime and shale	12	1590
Shale, broken	4	1594
Lime and shale	25	1619
Shale, dark	4	1623
Lime	1	1624
Shale, dark	20	1644
Sand (water)	55	1699
Mississippian system:		
Lime	1	1700

Casing Record: 66 feet of 12½ inch
725 feet of 10 inch
1215 feet of 8 inch
1485 feet of 6¼ inch

Log of Hopkins Gas and Development Company's D. A. Sargent No. 1. Location: NE. 1/4 SE. 1/4 SE. 1/4 sec. 2, T. 66 N., R. 35 W., Nodaway County, Mo. Elevation: 1,036.8 feet. Completed July, 1912. Well No. 9 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil and clay	22	22
Gravel (fresh water)	3	25
Pennsylvanian system:		
Shawnee-Kansas City groups:		
Lime, blue	10	35
Slate, black	10	45
Slate, white	303	348
Lime, gray (Stanton)	24	372
Shale	78	440
Lime	10	450
Shale	30	480
Lime	20	500
Shale	15	515
Lime	6	521
Shale	4	525
Lime	10	535
Shale	25	560
Lime	18	578
Slate, black	25	593
Lime (base of Hertha)	20	613
Pleasanton, Henrietta, and Cherokee groups:		
Shale	15	628
Sand (water)	24	652
Shale	130	782

Log of Hopkins Gas and Development Company's D. A. Sargent No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime	8	790
Slate, black	4	794
Coal (Lexington)	7	801
Shale	6	807
Sand	10	817
Shale	40	857
Sand	10	867
Shale	71	938
Sand (water)	10	948
Shale	10	958
Salt sand	42	1000* Total depth

*Base of Cherokee not reached.

Log of Hazlett, Decker and Wells' Park College No. 1. Location: NW. 1/4 NE. 1/4 NE. 1/4 sec. 1, T. 50 N., R. 34 W., Platte County, Missouri. Elevation: 751 feet. Completed February 17, 1931. Well No. 3 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Recent series:		
Soil and sand, dark	15	15
Sand, brown	37	52
Pennsylvanian system:		
Kansas City group:		
Lime, gray (Bethany Falls)	13	65
Slate, black (water)	1	66
Shale, gray	2	68
Lime, gray (Middle Creek)	3	71
Sandy shale, blue	3	74
Lime, gray (Hertha)	11	85
Pleasanton group:		
Shale, gray	10	95
Sandy shale, gray	13	108
Shale, blue	12	120
Shale, gray	61	181
Lime shell and shale, gray	9	190
Shale, gray	11	201
Red bed, pink	3	204
Lime, gray	8	212
Sand, gray	6	218
Shale, gray	12	230
Henrietta group:		
Lime, gray	2	232
Shale, gray	8	240
Lime, gray	3	243
Shale, gray	7	250
Sand, gray	10	260
Sandy shale, gray	10	270
Shale, gray, dark	6	276
Coal, black	1	277
Lime, gray	8	285
Sandy shale, gray	10	295
Shale, gray, dark	11	306
Lime, gray	2	308
Coal, black	2	310
Shale, gray	2	312
Lime, gray	1	313
Sand, gray (water)	8	321
Sandy, shale, gray	5	326
Shale, gray, light	14	340
Lime, gray	1	341

Log of Hazlett, Decker and Wells' Park College No. 1—Continued.

	Thickness, feet	*Depth, feet*
Shale, gray, dark	10	351
Lime, gray	2	352
Shale, gray, light	6	358
Lime, gray	3	361
Shale, gray	1	362
Lime shell and shale, gray	5	367
Cherokee group:		
Slate, black (Gas)	8	375
Shale, gray	5	380
Lime, gray	2	382
Shale, gray	7	389
Sand, brown (light green oil)	16	405
Sand, white (water)	10	415
Sandy shale, gray, dark	6	421
Sand (water), white	16	437
Shale, blue	8	445
Lime, gray	2	447
Slate, black	5	452
Sandy shale, gray	20	472
Shale, gray	8	480
Lime shell and shale, gray	5	485
Sandy lime, gray	5	490
Shale, gray	22	512
Slate, black	4	516
Lime, gray	2	518
Shale, gray	14	532
Lime, gray	2	534
Shale, gray	10	544
Shale, blue	9	553
Sandy shale, gray	17	570
Shale, gray	10	580
Lime, gray	1	581
Slate, black	4	585
Sandy shale, gray	15	600
Shale, gray	14	614
Sandy shale, gray	11	625
Shale, gray, dark	9	634
Sandy shale, gray, dark	11	645
Slate, black	9	654
Sand and shale-broken, blue	32	686
Sand, white (water at 700')	26	712
Shale, blue	6	718
Lime, gray	2	720
Shale, blue	30	750
Shale, gray	10	760
Shale, white	6	766
Mississippian system:		
Lime, gray	44	810
Green shale, green	1	811
Flinty lime, gray (Jack) (zinc)	5	816
Lime, gray	20	836
Lime, blue	6	842
Flinty lime, blue	18	860
Lime, brown	5	865
Lime, brown	27	892
		Total depth

Casing: 53 ft. of 8¼ in.
485 ft. of 6¼ in.
725 ft. of 4 7/8 in.

Log of Kelley, Newcomb, Lloyd and Empire Gas and Fuel Co's. Breen No. 1. Location: SW. 1/4 SW. 1/4 sec. 29, T. 51 N., R. 33 W., Platte County, Mo. Elevation: 961.5 (P. T.). Completed: Date unknown. Well No. 5 on map, Pl. I.

	Thickness, feet	*Depth, feet*	
Pleistocene or recent series:			
Soil	18	18	
Pennsylvanian system:			
Lansing group:			
Lime	5	23	Set 8¼ at 23
Clay, yellow	7	30	
Shale, black	24	54	
Lime	13	67	
Shale, black	19	96	
Kansas City group:			
Lime	19	115	
Shale, blue	25	140	
Lime	15	155	
Shale, blue	5	160	
Lime	13	173	
Shale, blue	2	175	
Lime	20	195	
Shale, blue	14	209	
Lime	2	211	
Shale, blue	2	213	
Lime	3	216	
Shale, blue	4	220	
Lime	11	231	
Shale	2	233	
Lime	17	250	
Shale	4	254	
Lime	25	279	
Shale, black	10	289	Water
Lime	6	295	
Pleasanton group:			
Shale, dark	55	350	
Shale	45	395	
Sand	15	410	Water
Shale	15	425	SIM
Shale, gray	25	450	Set 6¼ at 430
Henrietta group:			
Lime	10	460	
Sand	14	474	Oil show
Shale	13	487	SIM 476
Lime	4	491	
Shale, gray	14	505	
Shale, blue	10	515	
Lime	1	516	Water 515 to 520
Shale, blue	12	528	
Shale, gray	8	536	
Shale	4	540	
Shale, blue and sandy	16	556	Gas at 550 SIM
Lime	4	560	
Cherokee group:			
Shale, blue	10	570	
Shale	15	585	
Shale, gray	10	595	
Lime	1	596	Little gas
Shale, green	14	610	
Lime	6	616	
Shale, gray	9	625	
Sand	5	630	SLM
Sand	12	642	Show 630-35
Shale, blue	53	695	
Lime, sandy	10	705	
Shale, gray	20	725	
Slate, black	4	729	
Slate, gray	28	757	

Log of Kelley, Newcomb, Lloyd and Empire Gas and Fuel Co's.—Continued.

	Thickness, feet	Depth, feet	
Shale, black	8	765	
Shale, gray	15	780	
Shale, blue	30	810	
Shale, gray	10	820	
Shale, dark	59	879	
Lime, sandy	3	882	Set 4 7/8 at 894
Sand	37	919	Some water 886-90
Shale, dark	6	925	
Sand	10	944	
Mississippian system:			
Lime	14	958	Miss. Lime SIM TD

Log of Lasalle Oil Company's E. Hartsook No. 1. Location: NW. 1/4 NE. 1/4 SW. 1/4 sec. 29, T. 52 N., R. 34 W., Platte County, Mo. Elevation: 883 feet. Completed December 20, 1918. Well No. 14 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Soil	15	15
Sand	17	32
Pennsylvanian system:		
Lansing group:		
Blue shale, White lime, Blue shale, Lime } Stanton-Plattsburg		
Blue shale	3	35
White lime	37	72
Blue shale	3	75
Lime	5	80
Shale	10	90
Hard lime	20	110
Shale	40	140
Kansas City group:		
Lime, Blue shale, Lime } Argentine (Iola)		
Lime	15	155
Blue shale	4	159
Lime	3	162
Shale	8	170
White lime (Raytown)	15	185
Shale	15	200
Lime (Cement City)	10	210
White slate	15	225
Lime, Drum (Westerville)	10	235
Slate, Lime } (Winterset)		
Slate	9	244
Lime	6	250
Blue shale	20	270
Lime (Bethany Falls)	26	296
White slate	4	300
Lime (Hertha)	14	314
Pleasanton group:		
White slate	76	390
Lime	5	395
Blue slate	3	398
Lime	2	400
Blue slate	10	410
Lime (Warrensburg sand)	10	420
Dry sand	15	435
White slate	25	460
Henrietta and Cherokee groups:		
White lime	10	470
White slate	10	480
Lime	10	490
Water sand (Peru sand)	20	510
Slate	85	595
Lime	5	600
Slate	5	605
Lime	5	610
Slate	33	643

Log of Lasalle Oil Company's E. Hartsook No. 1—Continued.

	Thickness, feet	*Depth, feet*
Lime (Ardmore ?)	2	645
Slate	85	730
Lime	8	738
Slate	37	775
Lime	40	790
Slate	40	830
Lime	10	840
White slate	10	850
Lime	15	865
Black slate	55	920
Water sand	30	950
Black slate	5	955
Sandy lime	10	965
White slate	10	975
Sand	11	986
White slate	29	1015
Blue slate	20	1035
Sand	10	1045
Blue slate	15	1060
Mississippian system:		
Meramec, Osage and Kinderhook groups:		
Miss. lime	210	1270
Sand	20	1290
Sandy lime	60	1350
Water sand (water)	25	1375
Hard lime	41	1416
Sandy lime	8	1424
Hard lime	27	1451
Kinderhook group:		
Chattanooge shale:		
White slate	29	1480
Devonian system:		
Brown lime	60	1540
White lime	30	1570
Brown lime	20	1590
White lime	50	1640
White sand	20	1660
White lime	10	1670
Water sand	30	1700
White lime	50	1750
Ordovician system:		
Kimmswick-Decorah formations:		
White sand	15	1765
White lime	19	1784
Gray sand	43	1827
Blue slate	5	1832
St. Peter Sandstone:		
Hard lime	3	1835
Water sand	20	1855
Gray lime	15	1870
White sand	35	1905
Canadian-Ozarkian-Cambrian systems:		
White lime	10	1915
Sandy lime	35	1950
White sand	40	1990
Hard lime	15	2005
Sandy lime	40	2045
White sand	55	2100
Hard lime	50	2150
Water sand	10	2160
Sandy lime	140	2300
Hard lime	35	2335
White sand	35	2370
Pre-Cambrian system:		
Sandy lime	50	2420
		Total depth

Log of Goblin Dome Oil Company's Geo. W. McHenry No. 1. Location: SE. 1/4 SE. 1/4 NE. 1/4 sec. 19, T. 53 N., R. 33 W., Platte County, Mo. Elevation: 795 feet. Completed 1928. Well No. 17 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene or Recent series:		
Soil	44	44
Gravel	4	48
Sand rock	2	50
Clay (set 10" csg.)	26	76
Pennsylvanian system:		
Kansas City group:		
Lime	6	82
Shale, blue	32	112
Lime	5	117
Shale, blue	3	120
Lime	3	123
Shale, blue	9	132
Lime	25	184
Coal	3	187
Lime	13	200
Shale, blue	3	203
Lime	13	216
Pleasanton, Henrietta and Cherokee groups:		
Shale, blue	64	280
Lime	5	285
Shale, dark	30	315
Lime	2	317
Shale, light (3 BW)	28	345
Lime	6	351
Shale, blue	20	371
Lime	4	375
Shale, dark	26	406
Shale, light	79	425
Lime shale, light	55	480
Shale, dark	5	485
Shale, light	50	535
Lime	3	538
Shale, light (set 8" csg.)	12	550
Light red rock	5	555
Shale, blue	20	575
Lime	2	577
Shale, light	23	600
Shale, dark	4	604
Shale, light	31	635
Shale, dark	25	660
Sand, water (6 BW)	10	670
Shale, light	55	725
Sand, water (3 BW)	6	731
Shale, light	44	775
Sand, water	62	811
Dark shale	43	890
Oil sand	25	915
Shale, light	5	920
Mississippian system:		
Meramec ? group:		
Mississippi lime	4	924 Total depth

Log of Ed Mitchell's E. R. Miller No. 1.* Location: NE. 1/4 NW. 1/4 NE. 1/4 sec. 24, T. 53 N., R. 35 W., Platte County, Mo. Elevation: 792 feet. Completed January 24, 1931. Well No. 19 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene and Recent series:		
Surface	40	40
Quicksand	15	55
Water, sand and gravel	12	67
Pennsylvanian system:		
Lansing group:		
Shale	x 19	85
Kansas City group:		
Gray limestone (Argentine) (formerly Iola)	x 5	95
Shale	5	100
Gray lime (Raytown)	5	105
Coal and shale	5	110
Shale	10	120
Gray limestone (Cement City)	5	125
Shale	15	140
Gray lime (Westerville) formerly Drum)	7	147
Shale	25	172
Gray lime }	13	185
Shale } Winterset	12	197
Gray lime }	25	222
Shale	5	227
Gray lime (Bethany Falls)	21	248
Shale	2	250
Gray lime (Middle Creek)	3	253
Shale	2	255
Gray lime (Hertha)	13	268
Pleasanton group:		
Shale	12	280
Mixed lime	10	290
Shale	10	300
Sandy shale	20	320
Shale	40	360
"Water"	27	387
Shale	20	407
Henrietta and Cherokee groups:		
Lime	18	425
Shale	10	435
Limestone	15	450
Shale	10	460
Shale and coal	5	465
Sandstone	5	470
Shale	5	475
Lime	5	480
Shale	5	485
Shale and lime	5	490
Shale	90	570
Sand	15	585
Shale	20	605
Lime and shale	5	610
Shale	15	625
Lime	5	630
Shale	65	695
Light shale	15	710
Sandy shale	30	740
Mixed shale and sand	25	765
Sand (salt water)	20	785
Light shale (set first 6¼" casing at 790)	5	790

Hole down 845 feet when Snyder Bros. started to drill December 10, 1929. "From 790 to 890 just the different shales".

Light shale		890
Dark shale	25	915
Slate	5	920

Log of Ed Mitchell's E. R. Miller No. 1—Continued.

	Thickness, feet	*Depth, feet*
Blue shale	25	945
Sand	7	952
Dark shale	49	1001
Set 6¼" casing at 1002 ft.		
Mississippian system:		
Meramec group:		
Lime and flint	24	1025
Red shale	2	1027
Blue shale	4	1031
Gray lime	11	1042
Light shale	3	1045
Gray lime	6	1051
Light shale	x3	1053
Gray lime-pink flint	17	1070
Osage and Kinderhook groups:		
Blue lime	2	1072
Gray lime and flint	12	1084
Light lime	20	1104
Gray lime	18	1122
Brown lime	28	1150
Gray lime	30	1180
Lime	20	1200
George Conkright took over October 8, 1930.		
Mississippi lime		1210
Mississippi lime	162	1372
Kinderhook group:		
Chattanooga shale:		
Blue shale	3	1375
23 ft. break		
White shale	3	1378
Blue shale	12	1390
(Showing of iron at 1380)		
White shale	5	1395
Devonian system:		
Lime	405	1700
Ordovician system:		
Kimmswick formation:		
Brown lime or hard, white sand (two versions of log)	43	1743
Lime, brown	17	1760
Lime, white	9	1769
Decorah formation:		
Shale	2	1771
Lime, white	10	1781
St. Peter Sandstone:		
Sand (water)	39	1820 Total depth

Casing: 8¼"–375'; 6¼"–790'; then under reamed at Set at 1002'; 4 7–8"–1401'

*Drilled by Ed. Mitchell, deceased, to 765 feet and by Mrs. Gazelle Mitchell from 765 feet to 1,820 feet.

xAn x indicates error in original log.

Log of Danciger Bros. J. B. Doran No. 1. Location: cen. SW. 1/4 NE. 1/4 sec. 2, T. 53 N., R. 36 W., Platte County, Mo. Elevation: 871 feet. Completed Nov. 12, 1915. Well No. 20 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene and Recent series:		
Clay	12	12
Gravel	6	18

Log of Danciger Bros. J. B. Doran No. 1—Continued.

	Thickness, feet	*Depth, feet*
Pennsylvanian system:		
Pedee group:		
Rotten sandstone	2	20
Disintegrated lime, yellow, soft (Iatan)	5	25
Hard, gray lime (Iatan)	4	29
Blue shale, soft	76	105
Lansing group:		
Brown lime, hard (Stanton)	15	120
Blue shale, soft	2	122
Blue lime, hard (Lower Stanton)	3	125
Blue shale	17	142
Lime, gray, medium hard (Plattsburg)	20	162
Light shale, soft	20	182
Dark sandstone, soft	8	190
Light sandstone, soft	10	200
Fine gray water sand, soft	20	220
Blue shale, soft	20	240
Kansas City group:		
Dark lime, hard (Argentine and Raytown)	8	248
Blue shale, soft (Argentine and Raytown)	4	252
Lime (Argentine and Raytown)	2	254
Slate (Argentine and Raytown)	2	256
Lime (Argentine and Raytown)	4	260
Shale	10	270
Wet lime (Cement City and (Westerville))	15	285
Shelly lime (Cement City and (Westerville))	25	310
Lime, hard	10	320
Blue shale	16	336
Brown and white lime (Winterset)	6	342
Sand or lime (Winterset)	15	357
Lime, dark and coarse (Winterset)	8	365
Blue shale, soft	4	369
Lime, gray, medium (Bethany Falls)	27	396
Lime, gray	6	402
Dark blue shale	2	404
White lime (Hertha)	11	415
Pleasanton, Henrietta, and Cherokee groups:		
Blue shale, soft	6	421
Light sandy shale, soft	25	446
Sandy shale	54	500
Light shale	20	520
Sandy shale	8	528
Light shale	52	580
Fine fresh water sand	20	600
Shale	4	604
Coal	1	605
Sand and salt water	15	620
Shelly lime	20	640
Black shale, lime or sandstone	8	648
Lime, gray	5	653
Light shale	102	753
Lime	2	755
Slaty shale	75	830
Black shale	85	915
Light sand and salt water	6	921
Light shale	34	955
Water sand and water	10	965
Light shale	25	990
Dark sand and salt water	15	1005
Shale	10	1015
Water, sand, medium dark	14	1029
Fine water, sand light	4	1033* Total depth

*Base of Cherokee not reached.

Log of Dusenberry Brothers' Mrs. J. I. Burgess No. 1. Location: SE. cor. sec. 12, T. 54 N., R. 35 W., Platte County, Mo. Elevation: 1,034 feet. Completed August, 1922. Well No. 22 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	5	5
Yellow clay	10	15
Soapstone	30	45
Shale, yellow	20	65
Sand and gravel, little water	25	90
Pennsylvanian system:		
Douglas group:		
Shale, blue	20	110
Pedee group:		
Lime, white	10	120
Shale, light	95	215
Lansing group:		
Sand and lime	30	245
Shale, dark	5	250
Lime, brown	30	280
Shale, gray	30	310
Lime, some water	10	320
Shale, blue	30	350
Kansas City group:		
Lime	20	370
Shale, black	5	375
Lime	15	390
Shale, dark	10	400
Lime	20	420
Shale	5	425
Lime	15	440
Shale	5	445
Lime, white	30	475
Shale, dark	10	485
Lime	20	505
Pleasanton, Henrietta and Cherokee groups (Mississippian ? 1350-1370):		
Shale, dark	20	525
Shale, light	140	665
Lime, light	5	670
Shale, light	20	690
Shale, pink	10	700
Lime	5	705
Shale, red	10	715
Shale, blue	10	725
Into lime and sand at this depth above log by Chas. G. Mehrten, Supt. Drilling.		
Shale, gray or blue	5	830
Shale, carbonaceous black and coal, Bevier	2	832
Sandstone, very fine grained	8	840
Shale, black, (some coal) 2" coal hor	5	845
Quartz, very fine grained and mica sand	5	850
Shale, blue to gray (coal) Tebo Horizon 854 feet	15	865
Limestone, dense fine grained	7	872
Unknown. No sample of cuttings	28	900
Sandstone quartz and mica	7	907
Shale, blue or gray	15	922
Sandstone, very fine grained	8	930
Unknown. No sample of cuttings	20	950
Limestone probably	3	953
Shale, blue and gray and thin sandstone	7	960
Shale, dark blue carbonaceous	12	972
Sandstone, gray to white	18	990
Shale, black laminated hard	28	1018
Shale, gray and thin bedded sandstone	4	1022
Shale, thin hard black (coal)	8	1030
Unknown. No sample of cuttings	70	1100

Log of Dusenberry Brothers' Mrs. J. I. Burgess No. 1—Continued.

	Thickness, feet	Depth, feet
Shale, thin, black, hard	10	1110
Unknown	10	1120
Limestone, sandy, white	10	1130
Sandstone, fine-grained, calcareous	10	1140
Shale, gray and black (bituminous)	10	1150
Unknown, no samples of cuttings	25	1175
Shale, hard, black laminated	5	1180
Unknown. No sample of cuttings. Bottom of Cherokee about 1350	170	1350
Limestone overlain by thin black shales, probably Mississippian	20	1370

Log of Atchison Oil and Gas Syndicate's Kidwell No. 1. Location: NW. 1/4 NW. 1/4 sec. 12, T. 54 N., R. 37 W., Platte County, Mo. Elevation: 792.65 feet (P. T.). Well No. 23 on map, Pl. I. Commenced July 1, 1931.

	Thickness, feet	Depth, feet
Pleistocene and Recent Series: (Possibly including Weston shale):		
Clay, brown, very sandy, soft, with fragments of chert and quartz from alluvium	55	55
Shale, dark gray, calcareous, small amount of sandstone, pyrite, micaceous, few fragments of igneous rock, both probably of alluvial or glacial origin	5	60
Shale, similar to above, with few fragments of buff colored limestone, small amount of alluvial material	5	65
Limestone, buff, fine grained, in large fragments: shale as above; small amount of alluvial material	5	70
Shale, and alluvial material as in 55-60	5	75
Shale, as above	5	80
Limestone, buff, dense, with fine veinlets of calcite; with shale as above. Pyrite and soft tripolitic silica in residue	5	85
Similar to above	5	90
Pennsylvanian system:		
Lansing group:		
Shale, similar to above; limestone light gray, fine grained slightly oolitic; also considerable sandstone, as fine angular well cemented grains, with pyrite and mica, and blotches of organic matter	5	95
Limestone, white to light gray, dense, slightly oolitic; also sandstone as in 90-95	5	100
Limestone, brown, fine grained, with shale, gray; insoluble residue contains silicified and pyritized fossil fragments	5	105
Limestone, similar to 95-100 with sandstone and shale, as in 90-95	5	110
Limestone, white, drills up finer than limestones above; insoluble residue contains silicified and pyritized fossil fragments	5	115
Limestone, as in 110-115	5	120
Limestone, blue and brownish gray argillaceous, insoluble residue contains a few fossil fragments	5	125
Limestone, white, earthy, fine grained; insoluble residue contains a few silicified fossil fragments; some pyrite. 2 samples	10	135
Limestone, dark bluish gray, fine grained, fossiliferous; with 30 % black shale, also gray shale, one fragment showing a trace of sphalerite; insoluble residues contains pyritized and silicified fossil fragments	5	140
Shale, gray, calcareous with small amount of sandstone, gray, fine grained micaceous; some pyrite, 4 samples	20	160
Limestone, light gray, fine-grained; insoluble residue contains sandstone similar to that from 140 to 160; also chert, dark brown, mottled white, finely oolitic or speckled	5	165
Limestone, similar to above, with gray shale, sandstone and chert	5	170

Log of Atchison Oil and Gas Syndicate's Kidwell No. 1—Continued.

	Thickness, feet	*Depth, feet*
Shale, green and greenish gray, micaceous, platy with limestone like above only a small amount of sandstone	5	175
Shale, as above, but with less limestone, some sandstone. 5 samples	25	200
Limestone, brown, fine-grained, fossiliferous, with shale like above; sandstone as above; some pyrite. 2 samples	10	210
Shale, dark gray, calcareous with 40 % sandstone, fine grained, micaceous	5	215
Sandstone, white, fine-grained but coarser and not as firmly cemented as sandstone above, angular, micaceous; a few pieces of shale. Made salt water at 218 feet	5	220
Similar to 215-220 with addition small amount of limestone	5	225
Limestone, light gray to brown, the former being mottled blue, and occasionally being oolitic; insoluble residue contains sandstone as above, probably caved; pyrite, in part replacing fossil fragments a few silicified fossil fragments. 2 samples	7	232
Limestone, dark bluish gray, and brown, sandy; with 48 % sandstone, fine but irregularly sized, angular grains, micaceous	3	235
Sandstone, as above 55 %; limestone as above 45 %	5	240
Sandstone, as above 80 %; limestone 20 %	5	245
Kansas City group:		
Limestone, gray, fine grained; insoluble residue of 50 % contains chert, dark bluish gray, very waxy translucent and vitreous, slightly speckled; also light brown gray, porous, some pyrite; some sand as above	5	250
Chert, as above, with 20 % limestone	5	255
Limestone, white, slightly oolitic, somewhat fossiliferous; insoluble residue small, contains shale, gray, micaceous; small amount of pyrite and sand as above	5	260
Shale, micaceous gray, 60 %; black 40 % with coal	5	265
Shale, gray, micaceous, calcareous, limestone, gray; some black shale; insoluble residues contains silicified and pyritized fossils, chiefly sponge spicules	5	270
Limestone, light grayish brown, fine grained, fossiliferous; pyritized fossils as above	5	275
Limestone, light grayish brown, fine-grained; insoluble residue contains silicified fossil fragments and pyrite	5	280
Limestone, light gray; insoluble residue contains pale green, micaceous shale; pyritized and silicified fossil fragments	5	285
Limestone, as above, some shale	5	290
Shale, gray, buff, calcareous, micaceous; some limestone	5	295
No samples	5	300
Shale, dark gray, calcareous; residue yields shale, nearly black, spongy, and with pyrite	25	325
Shale, light gray, calcareous; residue yields fine grained gray shale and pyrite crystals	20	345
Limestone, light gray, crystalline; residue of 2 per cent yields dense, gray chert; quartz light green, greasy shale, pyrite sphalerite. Few fossil fragments	25	370
Shale, dark gray, calcareous, residue yields light gray shale and black shale, pyrite	10	380
Limestone, light gray, crystalline; residue of 1 per cent consists of translucent chert; crystalline quartz; pyrite; silicious networks; few fossil fragments	15	395
Shale, light gray, calcareous; residue consists of light gray and black shale; pyrite	15	410
Limestone, light gray, crystalline; residue of 1 per cent consists of white chert; silicious networks; pyrite; few chips of light gray shale; fossil fragments	10	420
Pleasanton group:		
Shale, light gray, calcareous; residue consists of soft gray shale and pyrite	83	503

Log of Atchison Oil and Gas Syndicate's Kidwell No. 1—Continued.

	Thickness, feet	*Depth, feet*
Sandstone, white to gray, fine grained and angular; residue consists of fine grained quartz sand and Muscocious material. Made salt water	2	505
Shale, gray, calcareous, pyritic, micaceous and gray sandstone	15	520
Shale, gray calcareous and micaceous, a fine grained gray sand is also present. A dark red sandy shale appears as small fragments in the cuttings	60	580
Henrietta and Cherokee groups:		
Limestone, gray, crystalline, argillaceous insoluble residue yields, gray shale, splinters, a fine grained red and gray sand, and pyrite, fossil fragment at 590	10	590
Shale, gray, highly calcareous, mica, pyritic, and sandy	10	600
Shale, gray, calcareous and sandy, carbonaceous from 610 to 615	20	620
Limestone, gray, crystalline. Insoluble residue consists of sandy black and gray shale, pyrite little silica	5	625
Shale, gray highly calcareous, carbonaceous material, pyrite	5	630
Limestone, gray, crystalline, insoluble residue consists of a sandy gray shale, fossil fragments, some of the shale is cave from above	5	635
Shale, gray, calcareous, sand grains, are angular to rounded, medium size sandstone is very micaceous	10	660
No samples from 660 to 695 (probably shale as below)	35	695
Shale, gray, calcareous	5	700
Sandstone, gray, calcareous, shaley micaceous, angular quartz medium grained	15	715
Shale, gray, calcareous some carbonaceous material at 765	50	765
Shale	5	770
Lime	7	777
Sand	2	779
Lime	6	785
Sand	15	800
Shale	5	805
Lime	6	811
		Total depth*

*Base of Cherokee not reached. This log is made from a nearly complete set of cuttings to 765 and the drillers' log from 765 to 811 feet.

Log of well on Baldwin (formerly Kugler) Ranch. Location: SW. 1/4 NW. 1/4 sec. 25, T. 52 N., R. 26 W., Ray County, Mo. Elevation: 688 feet (Bar.). Date of completion unknown. Well No. 1 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene and recent series:		
Surface (gravel 4-74)	74	74
Pennsylvanian system:		
Cherokee group:		
Fire clay	40	114
Shale and clay	150	264
Sand	20	284
Mississippian system:		
Lime	98	382
Lime and flint	85	467
Sand, white	50	517
Lime (salt water at 600)	83	600
Devonian system:		
Lime	84	684
Lime brown (oil sand)	20	704
Ordovician system:		
Lime cherty	40	744
St. Peter sand	40	784
		Total depth

Log of Pioneer Oil, Gas and Coal Company's Albert Adams No. 1. Location: SE. 1/4 SW. 1/4 NW. 1/4 sec. 29, T. 53 N., R. 28 W., Ray County, Mo. Elevation: 760 feet. Date of completion not known. Well No. 14 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Recent series:		
Top soil	17	17
Pennsylvanian system:		
Shale	25	42
Red sand	7	49
Lime	1	50
Black sand	2	52
Hard sand	4	56
Shale	40	96
Lime	8	104
Shale	232	336
Water sand	104	440
Coal	3	443
Shale	37	480
Mississippian system:		
Lime	9	489
Shale	2	491
Lime	9	500
Slate	16	516
Shale	109	625
Lime	1	626
Water sand	4	630
Sandy lime	50	680
White sand	32	712
Water sand	32	744
Lime	40	784
Blue shale	10	794
Devonian system:		
Hard lime	121	925
Blue shale	2	927
Lime	74	1011
Ordovician system:		
Kimmswick formation:		
Water sand	4*	1060
Hard lime	25	1085
St. Peter sand ?		
Water sand	4	1089
White sand	6	1095
Canadian system: ?		
Lime	155	1250
Shale	13	1263
		Total depth

*Error in original log.

Log of Interstate Production Company's T. C. Smith No. 1. Location: NW. 1/4 SE. 1/4 NE. 1/4 sec. 34, T. 53 N., R. 29 W., Ray County, Mo. Elevation: 1,045 feet. Commenced November 4, 1931. Date of completion not known. Well No. 15 on map, Pl. I.

	Thickness,		*Depth,*	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene series:				
Surface clay	40		40	
Sand clay	20		60	
Pennsylvanian system:				
Kansas City group:				
Shale, gray	26		86	
Lime, hard	2		88	
Shale, gray	2		90	
Lime (Raytown)	3		93	

Log of Interstate Production Company's T. C. Smith No. 1—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Shale	12		105	
Lime, hard (Cement City) (some water)	7		112	
Shale, gray	2		114	
Lime	2		116	
Shale, blue	3		119	
Lime, hard (Westerville)	6		125	
Shale, green	3		128	
Shale, gray	22		150	
Lime	2		152	
Shale, gray	2		154	
Lime } (Block)	1		155	
Shale } (Block)		6	155	6
Lime } (Block)	2	6	158	
Shale, gray	9		167	
Lime, hard } (Winterset)	17		184	
Shale } (Winterset)	1		185	
Lime, hard } (Winterset)	9		194	
Shale, brown	5		199	
Lime, hard (Bethany Falls)	18		217	
Shale, gray	3		220	
Lime, hard (Hertha)	8		228	
Pleasanton group:				
Shale, gray	1	6	229	6
Lime	1		230	6
Shale, gray	1	6	232	
Red bed	3		235	
Gray shale	32		267	
Sand	2		269	
Gray shale	1		270	
Sandy shale	40		310	
Sticky shale gray	22		332	
Sandy shale	14		346	
Red bed	3		349	
Shale, gray	20		369	
Lime	3		372	
Gray shale	2		374	
Red bed	3		377	
Shale	3		380	
Lime	1		381	
Gray shale	6		387	
Henrietta group:				
Lime	3		390	
Shale, gray	3		393	
Sandy lime	4		397	
Shale, gray	7		404	
Lime	1		405	
Shale, gray	14		419	
Lime, hard	7		426	
Shale, gray	4		430	
Lime, hard (Lexington cap rock)	5		435	
Shale, gray	4		439	
Coal (Lexington)	2		441	
Gray shale	3		444	
Lime	3		447	
Gray shale	17		464	
Black slate	2		466	
Gray shale	6	6	472	6
Lime, sandy	7		479	6
Shale	1		480	6
Lime	2	6	483	
Sand	2		485	
Gray shale	7		492	
Lime, soft	3		495	

Log of Interstate Production Company's T. C. Smith —Continued.

	Thickness, feet	Depth, feet
Cherokee group:		
Gray shale (little coal)	4	499
Lime shale (sand)	11	510
Sandy shale	53	563
Lime	2	565
Gray shale (some black slate 569)	4	569
Lime (Ardmore)	4	573
Black slate	3	576
Gray shale	4	580
Lime (set 592' 4 7/8")	2	582
Gray shale	6	588
Sandy shale (little oil?)	120	708
Sand (little water 635, water strong 708)	22	730* Total depth

*Base Cherokee not reached.

Log of Prairie Block Coal Co., T. G. Fowler farm. Location: SW. 1/4 NE. 1/4 sec. 16, T. 54 N., R. 29 W., Ray County, Mo. Elevation: 883 feet. Completed May 15, 1919. Well No. 19 on map, Pl. I.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Recent series:				
Clay	5		5	
Pennsylvanian system:				
Kansas City group:				
Shale, dark	5		10	
Lime, broken	3		13	
Limestone	5		18	
Soapstone	13		31	
Limestone	1		32	
Soapstone, rotten	5		37	
Limestone and shale	4		41	
Shale	2		43	
Lime shale	16		59	
Limestone	4		63	
Shale	3		66	
Limestone	2		68	
Shale	16		84	
Limestone	5		89	
Shale	2		91	
Limestone (Bethany Falls)	25		116	
Shale	6		122	
Limestone	2		124	
Shale	2		126	
Flinty limestone, very hard	13		139	
Pleasanton and Henrietta groups:				
Shale	5		144	
Flinty limestone	4		148	
Shale	2		150	
Limestone	10		160	
Shale	10		170	
Limestone, shale	15		185	
Shale	2		187	
Limestone	2		189	
Shale	4		193	
Sandstone, shaly, dense, hard	3		196	
Shale, blue	38		234	
Shale, dark	23		257	
Shale, blue	4		261	
Shale, light	14		275	
Shale, sandy	4	6	279	6

Log of Prairie Block Coal Co., T. G. Fowler farm—Continued.

	Thickness, Ft.	Thickness, In.	Depth, Ft.	Depth, In.
Limestone		1	279	7
Shale, black	4	9	284	4
Coal, good, fairly hard, no pyrite in core		8	285	
Fire clay	3		288	
Lime, shale	8		296	
Red shale	2		298	
Limestone	6		304	
Shale	3		307	
Limestone	7		314	
Soapstone	11		325	
Limestone, good cap rock not jointed appreciably	10		335	
Shale, dark	3	2	338	2
Coal (Lexington)		8	338	10
Clay band (Lexington)		2	339	
Coal, very good, is somewhat pyritic (Lexington)	2		341	
Fire clay	2		343	
Limestone	4		347	
Limestone shale	13		360	
Soapstone	9		369	
Shale, dark	3		372	
Coal, dirty		6	372	6
Fire clay	2	6	375	
Lime, shale	5		380	
Shale	3		383	
Limestone	3		386	
Shale	8		394	
Lime, shale	19		415	
Limestone	2	6	417	6
Cherokee group:				
Dark shale		2	417	8
Coal		4	418	
Sandstone	5		423	
Shale	2		425	
Sandstone	5		430	
Shale	19		449	
Sandstone	5		454	
Sandy shale	4		458	
Shale, blue	11		469	
Coal		7	469	7
Fire clay		5	470	
Lime shale	10		480	
Shale, light	2		482	
Shale, blue	2		484	
Shale	3		487	
Carbonaceous shale	6	6	493	6
Coal (Bedford ?)	1	6	495	
Shale	13		508	
Shale, dark	3		511	
Coal (Bevier ?)	2		513	
Sandy shale	5		518	
Lime, shale	7		525	
Coal	1		526	
Shale	9		535	
Shale, blue	3		538	
Shale, dark	3		541	
Coal	1		542	
Shale, light	3		545	
Lime, shale	5		550	
Shale, light	3		553	
Shale, dark, lime partings	7		560	
Sandy shale	40		600	
			Total depth*	

*Base of Cherokee not reached.

Log of unknown parties' Penny No. 1 (serial No. 2). Location: NW. 1/4 NE. 1/4 NE. 1/4 sec. 1, T. 65 N., R. 31 W., Worth County, Mo. Elevation: 915 feet. Completed August 4, 1922. Well No. 1 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	6	6
Yellow clay	15	21
Sand, red	13	34
Pennsylvanian system:		
Lansing group:		
Limestone	8	42
Shale, blue	13	55
Shale, red	2	57
Shale, green	2	59
Shale, red	3	62
Kansas City group (upper contact tentative):		
Limestone	8	70
Blue shale	3	73
Shale, black	12	85
Limestone (Raytown)	10	95
Shale, light	2	97
Limestone	5	102
Shale, light	4	106
Limestone, hard	5	117
Shale, light	15	126
Limestone	6	132
Shale, light	8	140
Limestone and shale mixed	5	145
Limestone, white	16	161
Shale, dark	9	170
Limestone and shale	15	185
Limestone, white (base of Winterset)	10	195
Shale, dark	5	200
Limestone, white	3	203
Shale, dark	3	206
Limestone, white (Bethany Falls)	19	225
Slate, black	2	227
Limestone (Hertha)	6	233
Pleasanton and Henrietta groups:		
Shale, dark	37	270
Limestone	3	273
Shale, light	10	283
Limestone	2	285
Shale, light	8	293
Limestone	4	297
Shale, light and sandy	8	305
Shale, green	6	311
Shale, brown	6	317
Shale, light and sandy	8	325
Shale, black (water)	20	345
Limestone, white	7	352
Shale, black	18	370
Limestone	5	375
Shale, light	8	383
Limestone (Lexington Cap)	4	387
Cherokee group:		
Shale, black	12	399
Shale, light	7	406
Shale, red	3	409
Shale, light	56	465
Shale, dark	12	477
Limestone, white	3	480
Shale, dark	4	484
Limestone, hard (Ardmore)	1	485
Shale, black	10	495
Shale, light	35	530

Log of unknown parties' Penny No. 1—Continued.

	Thickness, feet	*Depth, feet*
Shale, black	5	535
Shale, sandy	15	550
Shale, dark	20	570
Shale, black	14	584
Shale, red	5	589
Shale, sandy (water)	12	601
Shale, light and sticky	17	618
Shale, sandy	12	630
Oil sand	6	636
Shale, light and sandy	10	646
Shale, dark	13	659
Slate, black (water)	10	669
Shale, light	10	679
Shale, dark	46	725
Shale, sandy	5	730
Water sand (water)	10	740
Shale, dark	2	742
Water sand (water)	8	750
Mississippian system:		
Lime, white	5	755
Shale, dark	2	757
Limestone	4	761
Shale, light	4	765
Shale, dark	12	777
Limestone, light	12	789
Shale, dark	20	809
Mississippian limestone	71	880
		Total depth

Casing Record: 34 feet of 12½-inch. 226 feet of 10-inch.
618 feet of 8¼-inch. 725 feet of 6¼-inch.

NOTE: Samples from this well are not available. Assuming that the driller's interpretation of the lithology below 750 feet is correct, then these rocks are of Mississippian age. Studies of samples from the city well at Lenox, Taylor County, Iowa (sec. 8, T. 70 N., R. 32 W.) show that the upper part of the Mississippian section consists of fine-grained sandstone, limestone, marl and shale, all of which have been assigned to the St. Louis-Ste. Genevieve formations of the Meramec group. There is the suggestion that the two sections have much in common. The presence of Mississippian at this depth, 750 feet, calls for a considerable thinning of the overlying Cherokee formation. This could reasonably be possible in view of the structural feature present in this area, and may be evidence of earlier uplift.

Log of unknown parties' Porter No. 1. Location: SE. 1/4 SW. 1/4 SW. 1/4 sec. 12, T. 65 N., R. 31 W., Worth County, Mo. Elevation: 909.8 feet. Completed May 19, 1922. Well No. 2 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Soil	6	6
Yellow clay	10	16
Black clay	15	31
Pennsylvanian system:		
Lansing group:		
Sandy shale	21	52
Lime	2	54
Dark shale	4	58
Lime	1	59
Blue shale	6	65
Lime	2	67
Blue shale	3	70
Red shale	5	75

Log of unknown parties' Porter No. 1—Continued.

	Thickness, feet	*Depth, feet*
Kansas City group (upper contact tentative):		
Lime	4	79
Blue shale	22	101
Lime (water) (Raytown)	14	115
Dark shale	5	120
Lime	4	124
Light shale	5	129
Dark shale	6	135
Lime and shale mixed	5	140
Lime	4	144
Shale	6	150
Lime	7	157
Dark shale	15	172
Shale	8	180
Lime	5	185
Gray lime (Winterset)	22	207
Dark shale	12	219
White lime (Bethany Falls)	17	236
Dark shale	6	242
Lime (Hertha)	2	244
Pleasanton and Henrietta groups:		
Light shale	32	276
Lime (cased 10")	7	283
Lime and shale	23	306
Gray lime	10	316
Shale	14	330
Red shale	4	334
Lime	3	337
Light shale	13	350
Blue shale	12	362
White lime (Lexington "Caprock")	5	367
Blue shale	13	380
Gray lime and shale	23	403
Cherokee group:		
Coal	2	405
Green shale	10	415
Red shale (water)	5	420
Dark shale	75	495
Lime (Ardmore)	2	497
Dark shale	18	515
Light shale	35	550
Dark shale	33	583
Light shale	19	602
Sandy shale (water)	6	608
Sandy shale (cased 8")	44	652
Sandy shale	3	655
Water sand (water)	38	693
Blue shale	6	699
Sand and shale	2	701
Black shale	6	707
Light shale	5	712
Dark shale	15	727
Lime	2	729
Dark shale	15	744
Light shale	4	748
Lime	3	751
Dark shale	39	790
Light shale (cased 6¼)	13	803
Light shale	4	807
Lime	2	809
L. sandy shale	36	845
Water sand	40	885
Dark blue shale	12	897

Log of unknown parties' Porter No. 1—Continued.

	Thickness, feet	Depth, feet
Mississippian system:		
Miss. lime	14	911
Water sand	5	916
Broken sand (traces of zinc)	6	922
Lime	2	924
Water sand	9	933
Black shale	8	941
Lime	4	945
Light shale	3	948
Lime	108	1056 Total depth

NOTE: Samples are not available from this well. The section from 897 to 948 feet is suggestive of the section from 750 to 809 feet in the Penny well, sec. 1, T. 65 N., R. 31 W., and the remarks following the log of that well are applicable to this record.

Log of Allendale Coal, Oil and Gas Company's W. A. Monday Diamond Drill Hole No. 1 (serial No. 2). Location: Center SE. 1/4 sec. 23, T. 66 N., R. 30 W., Worth County, Mo. Elevation: 928 feet. Completed in 1912. Well No. 3 on map, Pl. I.

	Thickness, feet	Depth, feet
Pleistocene series:		
Mellow clay	12	12
Sand	13	25
Blue clay, gravel	10	35
Sand and gravel	6	41
Pennsylvanian system:		
Douglas and Pedee groups:		
Limestone	2	43
Soft, light, shale	1	44
Limestone	2	46
Soft light shale	6	52
Dark soft shale	22	74
Soft shale	6	80
Blue shale limestone bands (Iatan)	10	90
Sandy shale, soft partings	45	135
Lansing group:		
Limestone and shale	25	160
Limestone	7	167
Dark gray shale	5	172
Limestone, shale bands (Stanton-Plattsburg)	4	176
Soft gray shale	8	184
Limestone	6	190
Gray shale, limestone bands	7	197
Blue shale, limestone bands	29	226
Soft dark gray shale	16	242
Fossiliferous shale	6	248
Red shale	3	251
Gray shale	2	253
Kansas City group (upper contact tentative):		
Limestone	4	257
Fossiliferous limestone (Raytown)	3	260
Blue shale	2	262
Black shale	2	264
Blue shale, limestone bands	9	273
Limestone (Cement City)	6	279
Light shale	2	281
Blue shale with limestone	6	287
Limestone (Westerville) (Drum)	7	294
Blue shale	3	297
Limestone	5	302

Log of Allendale Coal, Oil and Gas Company's—Continued.

	Thickness, feet	*Depth, feet*
Dark gray shale	8	310
Dark shale, limestone bands	7.5	317.5
Limestone (Block)	3	320.5
Dark shale, limestone bands	6.5	327
Blue shale	5	332
Limestone (Winterset)	24	356
Dark blue shale, limestone bands	4	360
Shale and limestone	15	375
Limestone (Bethany Falls)	15	390
Dark shale	6	396
Soft blue shale	7	403
Limestone (Hertha)	13	416
Pleasanton and Henrietta groups:		
Blue shale	7	423
Dark shale	2	425
Blue shale, limestone bands	6	431
Blue sandy shale	10	441
Dark shale	10	451
Blue shale	12	463
Blue shale and limestone	7	470
Soft red shale with limestone	3	473
Mixed shale	6	479
Blue shale, limestone bands	4	483
Mixed shale	3	486
Soft mixed shale	4	490
Limestone	2	492
Soft mixed shale	4	496
Limestone	2	498
Light blue shale	2	500
Blue shale	8	508
Mixed shale	6	514
Limestone	4	518
Mixed shale	2	520
Blue shale	5	525
Sandy shale	10	535
Dark shale	2	537
Light shale, shaly hard bands	7	544
Limestone	5	549
Streaky dark shale	8.8	557.8
Coal (Lexington)	.7	558.5
Dark shale	1.5	560
Limestone	2	562
Limestone and soft shale	10	572
Blue shale, limestone bands	6	578
Soft gray shale	2	580
Limestone	3	583
Blue shale, limestone bands	7	590
Cherokee group:		
Dark shale	4	594
Light sandy shale	2	596
Sandy shale	9	605
Blue shale	2	607
Red shale	5	612
Blue sandy shale	5	617
Sandy shale	2	619
Blue shale	3.5	622.5
Sandstone	.5	623
Gray sandy shale	9	632
Gray shale	13.7	645.7
Dark blue shale	1	646.7
Sandstone and coal	.3	647
Light shale	1	648
Sandstone	3	651
Gray sandy shale	6	657

Log of Allendale Coal, Oil and Gas Company's—Continued.

	Thickness, feet	*Depth, feet*
Blue shale	9	666
Dark shale	4	670
Slaty coal	.3	670.3
Soft gray shale	2.7	673
Blue shale, limestone bands	6	679
Limestone (Ardmore)	2	681
Dark blue shale	9	690
Black shale	.3	690.3
Coal	.5	690.8
Soft fine clay	4.7	695.5
Sandstone	.5	696
Soft sandstone	3	699
Sandy shale	2	701
Blue shale	2	703
Blue shale	5	708
Dark shale	4	712
Light shale	4	716
Limestone	3.5	719.5
Dark shale	5.5	725
Black shale	2.7	727.7
Coal	1.3	729
Fire clay	5	734
Fire clay	1.5	735.5
Light sandy shale	12.5	748
Gray sandy shale	11	759
Dark shale	3	762
Sandy shale	9	771
Dark shale	21	792
Sandstone	5	797
Dark shale	9	806
Sandstone	5.5	811.5
Sandy shale	15.5	827
Shale and sandstone	15	842
Light shale	10	852
Sandy shale	8	860
Dark shale	6	866
Sandstone	5	871
Dark shale	2	873
Black shale	7.7	880.7
Coal	1.2	881
Black shale	5.6	887.5
Coal	.5	888
Light shale	2	890
Black shale	6	896
Dark shale	10	906
Dark shale	1	907
Shaly sandstone	9	916
Sandy shale	3.25	919.25
Born coal	.75	920
Sandy shale	8	928
Dark shale	16	944
Coal	.5	944.5
Soft gray shale	2.5	947
Light sandy shale	3	950*
		Total depth

*Base of Cherokee not reached.

Log of Allendale Coal, Oil and Gas Company's Chester Campbell Diamond Drill Hole No. 1. Location: SE. 1/4 SW. 1/4 SE. 1/4 sec. 27, T. 66 N., R. 30 W., Worth County, Mo. Elevation: 992.5 feet. Completed in 1912. Well No. 4 on map, Pl. I.

	Thickness, feet	*Depth, feet*
Pleistocene series:		
Clay	10	10
Fine sand	10	20
Blue clay	50	70
Hard pan	32	102
Pennsylvanian system:		
Douglas and Pedee (?) groups:		
Soft clay shale	20	122
Fossiliferous shale	11	133
Sandstone and shale	40	173
Sandy shale	5	178
Tough shale	6	184
Lansing group:		
Decomposed limestone	6	190
Shale with hard bands	15	205
Limestone	14	219
Dark shale	6	225
Limestone (Stanton-Plattsburg)	2.5	227.5
Gray shale	6	233.5
Limestone	7	240.5
Gray shale	2.5	243
Limestone	1.5	244.5
Shale with limestone bands	25.5	270
Dark shale	21	291
Fossiliferous shale	5	296
Red shale	2	298
Dark shale	3	301
Kansas City group (upper contact tentative):		
Decomposed shale	6	307
Fossiliferous shale	3	310
Dark shale	3	313
Shale	8	321
Red shale	2	323
Limestone and shale (Cement City)	10	333
Shale	3	336
Blue shale	1	337
Limestone	6	343
Dark shale (Westerville-Drum)	2	345
Limestone	5	350
Dark shale	8	358
Dark shale, limestone bands	8	366
Limestone (Block)	2	368
Dark shale with limestone bands	5	373
Shale	2	375
Limestone with shale partings (Winterset)	26	401
Limestone	3.5	404.5
Dark shale	4.5	409
Gray shale	5	414
Limestone (Bethany Falls)	21	435
Fossiliferous shale	1	436
Dark shale	3	439
Shale with limestone bands	11	450
Limestone with shale partings	5	455
Limestone (Hertha)	6	461
Pleasanton and Henrietta groups:		
Dark shale	4	465
Sandy shale	35	500
Soft sandstone	7	507
Sandy shale	13.5	520.5
Lime shale	1.5	522
Dark gray shale	9	531

Log of Allendale Coal, Oil and Gas Company's—Continued.

	Thickness, feet	*Depth, feet*
Limestone with shale bands	7	538
Dark gray shale	5	543
Limestone	3	546
Dark gray shale	4	550
Lime and shale mixed	1	551
Limestone	2	553
Lime and shale mixed	2.5	555.5
Soft blue shale	4.5	560
Red shale	2.5	562.5
Shale and limestone	3	565.5
Limestone	3.5	569
Sandy shale	13	582
Dark shale	5	587
Fossiliferous shale	3	590
Sandy shale	4	594
Limestone	6	600
Red shale	7.5	607.5
Coal (Lexington)	1	608.5
Fossiliferous shale	1	609.5
Light shale	2.5	612
Limestone	1	613
Limestone with shale bands	8	621
Shale with limestone bands	3	624
Dark shale	1	625
Soft gray shale	13	638
Cherokee group:		
Dark shale	3	641
Dark shale sandstone partings	.5	641.5
Light sandy shale	15	656.5
Red shale	3.5	660
Soft sandstone	10	670
Dark shale	5	675
Gray sandy shale	4	679
Light sandy shale	9	688
Gray shale hard bands	4	692
Dark shale, hard bands	6	698
Black shale	1	699
Fire clay	1	700
Sandy shale	8	708
Sandy shale	4	712
Blue shale	4.5	716.5
Dark shale	5.5	722
Coal	.25	722.25
Fire clay	3.75	726
Fire clay, limestone bands	3.5	729.5
Limestone (Ardmore)	2	731.5
Dark shale	7.5	739
Blue limestone	.8	739.8
Black shale	.8	740.6
Coal	* .7	741.5
Fire clay	2	743.5
Sandstone	3.5	747
Soft sandstone	6.5	753.5
Sandy shale	3	756.5
Light shale	5.5	762
Blue shale	3	765
Mixed shale	7	772
Sandy shale	2	774
Dark gray shale	4	778
Black shale	3	781
Slaty coal	.7	781.7
Dark shale	1.3	783
Fire clay	4	787
Sandy shale	13	800

Log of Allendale Coal, Oil and Gas Company's—Continued.

	Thickness, feet	*Depth, feet*
Gray sandy shale	4	804
Dark shale, hard bands	6	810
Sticky dark shale	7	817
Black shale	1.5	818.5
Coal	1.5	820
Fire clay	2.5	822.5
Limestone	1	823.5
Soft shale	3.5	827
Soft light shale	5	832
Dark shale	4	836
Limestone	2	838
Black shale	2	840
Soft light shale	4	844
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*Error in original log.

**Base of Cherokee not reached.

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