

STATE OF MISSOURI
GEOLOGICAL SURVEY AND
WATER RESOURCES



BIENNIAL REPORT *of the*
STATE GEOLOGIST

Transmitted to the
SIXTIETH GENERAL ASSEMBLY



1939

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REPORT OF INVESTIGATIONS

Appendix I, The Subsurface Geology of Northeastern Missouri, by John G. Grohskopf, Norman S. Hinchey and Frank C. Greene.

LETTER OF TRANSMITTAL

To His Excellency, Lloyd C. Stark, Governor of Missouri:

Dear Sir:—I have the honor to submit herewith a brief report covering the work of the Missouri Geological Survey and Water Resources for the biennial period of 1937-1938.

The report also contains a very brief summary of the mineral production of the state up to 1937. These figures are compiled in cooperation with the United States Bureau of Mines.

Appendix I of 160 pages is devoted to the Subsurface Geology of Northeastern Missouri. This and a companion volume on Northwestern Missouri have been prepared and published in order that the data and records in the office of the State Geologist might be made available promptly to the many oil operators now investigating the possibilities of oil and gas in the northern part of the state.

Respectfully submitted,

H. A. BUEHLER,
State Geologist.

CHAPTER I.

WORK OF THE GEOLOGICAL SURVEY AND WATER RESOURCES DURING 1937 AND 1938.

The work of the Geological Survey and Water Resources during the past biennial period is briefly outlined in the following report. This department is charged with (1) making a geological survey of the state and describing its mineral resources; (2) studying the surface water resources; and (3) completing an accurate topographic map of the state.

In order to carry out the above duties the activities of the department are grouped under three distinct engineering branches as follows:

(1) **GEOLOGY AND MINING BRANCH**, which has for its object a geological study of the state and the development of its mineral resources. The expenditures under this branch include the salaries and traveling expenses of the permanent geological staff and office assistants, the engraving and printing of all maps and reports and the cost of office maintenance.

(2) **WATER RESOURCES BRANCH**, which is devoted primarily to a study of the surface water resources throughout the state, the principal object being to determine the stream flow of the various major streams in Missouri. This work is carried on in cooperation with the United States Geological Survey which matches state funds dollar for dollar.

(3) **TOPOGRAPHICAL MAPPING BRANCH**, which has for its object the making of an accurate surface or topographic map of the state. The Federal Geological Survey also matches state funds dollar for dollar in this work. The engineers and technical staff are supplied by the Federal Government, which also engraves the final edition of the map without cost to the state.

In general the work of the department during the last biennial period has proceeded along lines very similar to those in the preceding period, except that in the latter part of 1938 a widespread important leasing campaign for oil and gas in North

Missouri threw an unexpectedly heavy load on the limited technical personnel of the department. From approximately the first of September to the end of the year, geologists representing the major and larger independent oil companies have visited the Geological Survey office at Rolla for the purpose of obtaining drill records, maps, reports, and other information with regard to the geology of North Missouri. The demand for information has practically depleted the supply of several of the reports published by this bureau, and the entire edition of the state geological map was exhausted. In order that the information of the department might be universally available, two reports were hastily prepared covering the geology of the northern portion of the state, and both bulletins were published before the end of the year. Volume XXV, entitled "The Geology of Northwestern Missouri", is a volume of some 220 pages and contains all of the important deep well records in that part of the state; also a base map showing the location of all deep wells in the area; a magnetic map of that portion of the state which shows possible structural trends; a general description of the formations that will be encountered in deep drilling; and cross-sections of the area. This report indicates that there are possibilities down to the "Arbuckle" limestone, which occurs at maximum depths of approximately 3500 to 4000 feet in certain of the northwest Missouri counties.

The second report, dealing with the Subsurface Geology of Northeastern Missouri, is printed as an appendix to this Biennial Report. It contains 160 pages of drill records and a general description of the surface geology. The volume carries two cross-sections showing general structural conditions and outlines the information that has been collected by this department through field work in the area in past years.

Both of these reports were published on the 15th of December and the demand has been greater than for any report ever published by this bureau.

In addition to these reports, a number of reports describing the results of field work by the Geological Survey, and unpublished because of the lack of funds for printing during the past few years, have been made available to those visiting the office. These reports have been of material assistance to those intending to make independent geological surveys. It is unfortunate that these reports could not be issued also at this time.

There are at the present time several hundred geologists and leaseholders active in the northern part of this state and it is es-

estimated that over 2,000,000 acres have already been leased. Without a doubt this activity will continue throughout the coming biennial period and will result in deep drilling eventually, throughout the entire region. In order to obtain the geological data that will result from such drilling, the Geological Survey should have additional members added to its staff to follow the developments in that part of the state. Such work will consist of correlating and analyzing the information obtained as the result of drilling.

The activity described was not expected in the early part of the biennial period, nor was it evident at the time the budget was prepared in July, 1938. In order to serve the people of North Missouri during this important exploratory campaign, the Geological Survey should devote a large portion of its activities to this particular investigation.

As this report goes to press, scattered leasing has started in the lowland area of Southeast Missouri, which has undetermined oil and gas possibilities. Deep tests have been drilled in northeastern Arkansas and one deep hole is now being drilled about two and one-half miles south of the Missouri-Arkansas line. The Missouri Survey has made a magnetic survey of this region. This map should be published immediately, together with a short resume of the geology of that region. In order to be of the greatest service the Survey should have assistants in that area at an early date.

PERSONNEL.

The department lost the service of a valuable, well-trained assistant in Mr. Willard Farrar who resigned early in 1937 to become associated with one of the major oil companies; also in the resignation of Miss Roma Doris Preuss the services of a valuable office assistant were lost. Two assistant geologists have been appointed during the past biennium, namely Kenneth Aid and Miss Mary Hundhausen. Other than the above mentioned changes the permanent staff has remained the same as in the former biennial period.

Through the employment of summer assistants considerably more field work was completed than during the former two years. Four geologists were employed during the three months of each summer, and a part time chemist was employed both years.

GEOLOGY AND MINING BRANCH.

Full-time Employees, Geologic Branch.

<i>Name.</i>	<i>Position.</i>
H. A. Buehler	State Geologist
H. S. McQueen	Ass't State Geologist
F. C. Greene	Principal Geologist
Norman Hinchey	Geologist
John Grohskopf	Geologist
Mary Hundhausen	Ass't Geologist
Kenneth Aid	Ass't Geologist
C. O. Reinoehl	Engineer-Draftsman
Jean McCaw	Chief Clerk
E. E. Hawkins	Janitor-Laboratory Ass't.

Part-time Employees, Geologic Branch.

G. A. Muilenburg	Geologist, 1937-1938
O. R. Grawe	Geologist, 1937-1938
E. L. Clark	Geologist, 1937-1938
C. M. Dodd	Ceramist, 1937-1938
R. P. Alger	Field Ass't, 1937
R. T. Rolufs	Chemist, 1937-1938
Leroy E. Allen	Lab. Ass't, 1938

WATER RESOURCES BRANCH.

The personnel of this branch is provided by the United States Geological Survey, with the exception of one junior engineer. The work is done in cooperation with the expenses being borne equally. The Federal bureau maintains the District Engineer's headquarters at the Survey building. The following is a list of the members of the staff working out of Rolla headquarters:

H. C. Beckman, District Engineer	(Federal)
C. J. Eyberg, Associate Engineer	(Federal)
W. M. Littlefield, Assistant Engineer	(Federal)
C. H. Jennings, Junior Engineer	(State)
D. S. Wilder, Junior Engineer	(State)
E. R. Leeson, Junior Engineer	(Federal)
J. W. Odell, Junior Engineer	(Federal)
K. J. Craig, Junior Engineer	(Federal)
W. L. Doll, Junior Engineer	(Federal)
J. H. Meyer, Junior Engineer	(Federal)
J. A. Short, Junior Engineer	(Federal)
Marie T. Ramsey, Secretary	(Federal)
E. S. Miller, Jr., Part-time Computer	(State)

TOPOGRAPHIC MAPPING BRANCH.

The United States Geological Survey cooperates in making topographic maps on a dollar for dollar basis. The Federal bureau furnishes the technical staff and maintains a section office at the Missouri Survey headquarters. The list of employees is not given as they are subject to change from year to year.

COOPERATION.

The value of the work of this department to other state and government agencies, cities, corporations and citizens, is reflected in the number of these organizations that cooperate in furnishing both personnel and funds. In a number of cases, cooperation is carried on in order that the cooperating department may obtain information for its use that would not be available if the Survey was only able to operate under its own funds. Cooperation with other agencies is carried on in all three branches of Survey activities and during the present biennium the extent and value of cooperation has exceeded that of any other biennial period. The character of cooperation with each agency is briefly described in the following paragraphs.

Federal Works Progress Administration.—The Geological Survey has sponsored a state-wide engineers project which is financed in part by the Works Progress Administration of Missouri. This has been the most extensive cooperation maintained during the biennial period. The project employs 100 or more persons who have been unable to obtain other employment. The results achieved through this project have been of far reaching importance to each branch of the Survey's activities. Field geologists, chemists, engineers, computers, magnetometer operators, topographers, levelmen, transitmen, ceramic engineers, draftsmen, stenographers, clerks and laborers have been employed on the project.

The work done and investigations undertaken by this project could not have been accomplished by regular Survey activities. The results are being published in many instances.

United States Geological Survey.—Each biennial period, cooperation in topographic mapping and surface water investigations is carried on with the United States Geological Survey. The Federal Survey matches Missouri funds dollar for dollar and largely supplies the trained personnel for both branches. By such cooperation in the Topographic Mapping Branch the Missouri work is coordinated with similar work done in the other states. The maps are produced on the same scale and the accuracy of the work is kept up to the same standard as other states, and the photolithographs and engraved maps are all reproduced in the same detail as in other states. In the Water Resources Division the records also coordinate with records taken in all

other streams in the United States. This uniformity is of great value in the use of these maps and gaging records, as their accuracy is well known to all engineers.

The U. S. Geological Survey maintains district engineers at the Survey office in Rolla. In topography the district includes in addition to Missouri the states of Arkansas, Kansas, Nebraska and North and South Dakota. This branch of the work is under the supervision of Captain C. L. Sadler.

The stream gaging work is under the supervision of Mr. H. C. Beckman, who is also in charge of all the gaging stations on the Missouri and Mississippi rivers as far south as Cairo and north through Kansas, Nebraska and the Dakotas.

State Highway Department.—The State Geologist is ex-officio member of the State Highway Commission. Many problems in highway location and construction are problems of geology, topography and the flow of surface streams, and the two bureaus cooperate closely.

In topographic mapping the Geological Survey recognizes the great value of topographic maps in highway location and a large part of the areas chosen for mapping during the present biennial period have been so chosen because of their value in highway work. The State Highway Commission cooperates financially in areas where such accurate maps are desired.

The size of culverts and bridges is based upon the maximum amount of water that can be expected in any drainage area. For this reason a knowledge of actual maximum flow is of the greatest value in bridge design. The Highway Department cooperates in the maintenance of 17 gaging stations on small streams which the Survey could not maintain alone.

The Geological Survey keeps in close touch with many problems of the Geology Branch through the Testing Division of the Highway Department.

State Board of Health.—A pure, healthful water supply is an important factor in the general health of the people of the state. A contaminated city water supply is a continual menace to the residents of any community. Deep well supplies, unless properly cased, may easily be contaminated. This is especially true in the southern part of the state where, over large areas, the rocks have been dissolved and large open caves, sink-holes and fracture systems exist. All of these features are potent factors in allowing

contaminated surface waters to enter improperly cased drilled wells. The underground conditions as they pertain to water supplies are distinctly within the province of the Geological Survey, and a number of years ago a close cooperative agreement covering the drilling and casing of deep water wells was entered into with the State Board of Health. At the present time the matter of casing wells from which a supply of water is obtained for public or semi-public use, is supervised by the State Geological Survey. Approval of such supplies by the State Board of Health is subject to supervision of construction by the Geological Survey. The service rendered by the Geological Survey in this connection to the people of the state is one of the most important functions of the department.

United States Bureau of Mines.—The publication of accurate statistics covering mineral production is of importance to the entire mineral industry. The Missouri Geological Survey and the U. S. Bureau of Mines cooperate in assembling the statistics covering the production of all mineral resources except coal. The statistics of the coal industry are compiled by the Federal Bituminous Coal Commission. This cooperation also avoids needless duplication that would be in effect if each bureau endeavored to collect these statistics independently. The state bureau endeavors to visit all delinquents who fail to answer the usual correspondence inquiry.

Securities Department.—The State Geologist or some member of the staff passes upon the geologic and economic features of all mining and oil applications to the Securities Commission for the sale of stock in this state. This cooperation has resulted in refusing the application in many cases where no possibility of success is evident.

State Planning Board.—Any future plan for Missouri must include a plan covering the various uses of the surface and ground waters of the state. As this bureau is the only department collecting information covering the water resources, the State Geologist was made chairman of the Planning Board Committee covering surface water supply. A report by the State Planning Board is now being published. It embodies the findings of this committee.

Cities and Towns—Many cities and towns cooperate with the Survey in the matter of getting adequate deep well water sup-

plies. This service is important for with proper supervision and advice surface contamination is eliminated. In addition to the matter of properly casing the wells, the Geological Survey has made in many instances extensive geological surveys in order to locate properly deep well sites for municipal supplies.

Missouri State Fair.—Many citizens attending the State Fair are interested in the mineral industries and water resources of the state. In order that there may be opportunity for consultation with the Geological Survey and an opportunity afforded to know more of the mineral resources of the state, the Geological Survey maintains an exhibit at Sedalia in cooperation with the State Fair officials. Two members of the staff are in constant attendance at the exhibit.

State Conservation Commission.—The flow of the large springs located in the various State Parks is of great interest to the citizens of the state. The Survey in cooperation with the Conservation Commission makes daily readings of the flow of a number of these springs.

Unites States Forestry Service.—The Survey cooperates with the U. S. Forestry Service in examining dam sites in the various forest units and in the matter of obtaining adequate sanitary ground water supplies from drilled wells.

United States Weather Bureau.—Close cooperation is maintained with the Federal bureau in the reporting of flood conditions in Missouri and in the maintenance of stream gaging stations.

Drainage Districts.—The flow of many streams is of vital importance to various drainage districts, a number of which cooperate in maintaining gaging stations.

Federal Public Works Administration.—Many P. W. A. projects involve obtaining an adequate sanitary water supply from deep wells. Whenever an application is presented involving water resources the problem is presented to the State Geological Survey and its report is a vital factor in granting such applications.

State Eleemosynary Board.—Geological Surveys have been made for this board in order that information might be available relative to obtaining an independent water supply for the State Hospitals at Farmington and at Marshall.

INVESTIGATIONS OF THE GEOLOGICAL SURVEY.

The following is a brief summary of the more important lines of work undertaken by the Survey during the past biennium. The extent of the work which has included practically every county in the State has been made possible by the wide-spread cooperation received from other State and Federal agencies.

GEOLOGIC BRANCH.

Ground Water Studies.—During the biennial period, more than 60,000 samples of well-cuttings from more than 1,100 drilled wells were examined in the laboratories of the Geological Survey. The steadily increasing demand for the services of the Survey in connection with the development of underground water-supplies by deep drilling in the State is indicated by the increasingly greater number of well-samples forwarded to this office for examination in the course of the construction of drilled wells. During 1935 and 1936 cuttings were received from 873 wells, there being 36,131 individual samples. During 1937 and 1938 the number of wells increased to 1173 and the number of samples to 60,954.

The Geological Survey has continued to co-operate with the State Board of Health in the supervision of the proper construction of deep wells for municipal water supplies. These wells are drilled according to specifications which both departments have evolved and considered practical. The Geological Survey determines the point at which the well casing is to be set. This point is determined from an examination of the samples of the well cuttings and from other information that the driller may supply. The proper setting of casing is an important detail in the matter of protecting the well from being contaminated by surface water and shallow seepage.

In addition to the above mentioned service this department has been called upon by the Public Works Administration and Works Progress Administration for information concerning proposed deep well supplies which required financial grants from these federal agencies. The Survey furnished estimates of the depth necessary to drill to obtain the desired yield, made preliminary estimates of the amount of casing required, and gave an opinion regarding the quality of the water that could be expected.

Much of the information desired was available in the ground-water files of this department. However, in special cases a member of the staff was detailed to make a field study of local geological conditions which might have affected the specifications for the proper construction of a well. Wells which were constructed under the supervision of the Geological Survey are enumerated below.

<i>Town</i>	<i>County</i>
Belle.....	Maries
Cabool.....	Texas
East Prairie.....	Mississippi
Farmington.....	St. Francois
Fornfelt.....	Scott
Freeburg.....	Osage
Gasconade.....	Gasconade
Gerald.....	Franklin
Golden City.....	Barton
Linn.....	Osage
Mount Vernon.....	Lawrence
Mountain View.....	Howell
Neosho.....	Newton
Parma.....	New Madrid
Warrenton.....	Warren
Washington.....	Franklin

In addition to city wells, many school wells were drilled during the biennium. Those drilled under this department's supervision are:

<i>School</i>	<i>County</i>
Cross Timbers.....	Hickory
Farber.....	Audrain
Fremont High.....	Carter
Hermitage.....	Hickory
Kelso.....	Scott
Licking.....	Texas
New Bloomfield.....	Callaway
Vienna.....	Maries
Weaubleau.....	Hickory

The various State Institutions have availed themselves of the services of the department. Wells drilled for such institutions and supervised by the Survey are:

<i>Institution</i>	<i>County</i>
Missouri School of Mines.....	Phelps
Missouri School for the Deaf.....	Callaway
Missouri State Penitentiary.....	Cole
Missouri Auxiliary Prison.....	Cole
University of Missouri.....	Boone
Missouri State Fruit Farm.....	Wright

Various Federal agencies which have wells that were drilled under the supervision of the Survey, include the National Park Service, the Forest Service and the Resettlement Administration. The Resettlement Administration carried on a project in Pettis County which involved the drilling of 18 wells. This project required the presence of a member of the staff of the Survey at the sites of the drilling for several weeks.

Many industrial, semi-private, and private wells were constructed under the supervision of the Geological Survey. The owners of these wells desired a type of construction which would meet with the approval of the State Board of Health. This service enables the Survey to aid many concerns and individuals. Supervision thru the determination of the proper casing point was provided for wells drilled at ice plants, creameries, railways, dairies, hatcheries, hotels, taverns, theatres, stores, country clubs, recreational parks, churches, farms, and residences.

The State Board of Health employs a chemist who analyzes the municipal waters once a year for their mineral content. This work is done in the laboratory of the Geological Survey. In addition to the regular chemical analysis of each municipal supply, the Survey has analyzed a number of water samples from wells which were drilled in critical areas where the information derived from a chemical analysis was needed to augment the knowledge of different qualities of water. This is especially important in areas where drilling below a certain depth will encounter salt or "sulfur" water. Study of the results of such analyses has proved to be of great practical benefit in making recommendations for proposed drilling in certain areas.

It is believed by many investigators that a certain concentration of fluorides in water is detrimental to the proper development of the teeth of growing children. The Survey has continued to analyze waters for their fluoride content. This has involved the analysis of new well waters, and the checking of water-supplies previously analyzed to determine variations in their fluoride content. This important work should be continued and additional data assembled and analyzed, as it may ultimately prove to be of great value to the betterment of the public health.

Barite Deposits.—An investigation of the barite deposits of the state has been underway during the biennium, and a comprehensive report is in preparation. The area centering around

Potosi in Washington County has been mapped as have also the outlying areas in adjoining counties. The producing area has been considerably expanded in the last decade, and barite mining was reported from Crawford, Franklin, Gasconade, Jefferson, Perry, St. Francois, and Washington counties. With the geographical extension of producing areas in the southeast district evidence of greater geologic distribution has been found. The Potosi and Eminence formations continue to be the chief producers, but commercial deposits are known to occur in every geologic formation beginning with the Bonnetterre and extending up through the Roubidoux. Of special interest are newly developed deposits in the Davis formation near Wescos in Crawford County and in the Bonnetterre formation, on the east side of the St. Francois River near Bonnetterre in St. Francois County.

In the central district the renewed activity has resulted in the reworking of many previously abandoned properties and the exploitation of new ones. In this area commercial deposits are found in the Eminence, Gasconade, and Jefferson City formations, and also in the Mississippian and Pennsylvanian.

The deposits in the older Paleozoic formations are chiefly "circle" or "filled sink" deposits in which barite was deposited in the open spaces between the rock fragments filling the sink and in fractures in the walls. Subsequent solution has removed much of the limestone and in many deposits the barite now lies in a mass of residual clay and chert boulders. Those in the Mississippian, at Lupus, appear to be in part, replacements of limestone along the walls of a solution channel and in part the filling of open spaces around chert boulders and surface debris which filled the channel or opening.

Another interesting deposit is found northwest of Prairie Home in Cooper County. Here, barite occurs in a fractured zone in a small outlier of Pennsylvanian shale and sandstone. Some of it shows evidence of deposition in open fractures, but much of it is distinctly layered and suggests replacement of calcareous members of the formation. This deposit is the highest in the geologic column of any so far observed, and indicates that at least some of the mineralization occurred in post-Pennsylvanian time.

Pyrites and Marcasite.—With the steady production of and a stable market for pyrite or marcasite, a sulphide of iron, there have been many requests in the last few years covering the occurrence and nature of these minerals.

The Survey has never had a report on the sulphide resources of this State and in answer to these requests a detailed investigation of the occurrence of this ore in the Ozark region has been undertaken during the past two field seasons.

These minerals occur in association with iron ore in the south central Ozark region. The production in this state at present comes from these deposits. Every known deposit of pyrite and marcasite has been visited and examined, also many iron ore deposits that are not known to carry pyrite. The field work has been completed and the report is practically ready for publication.

Damsite Investigations.—A state-wide major project of the Works Progress Administration is the construction of dams for the purpose of conserving surface water supplies. Much of the time of one geologist has been required to make a geological examination and a topographic map of each proposed site. Similar examinations and maps have been prepared for the Federal Forest Service operating in the eight units in this state.

Geologic investigations and topographic maps of over 315 dam sites have been completed.

Water Analyses.—The Geological Survey, in cooperation with the State Health Department, analyzes some 200 city water supplies every year, the Health Department employing the chemist and paying for the work done in the Survey laboratory. This work has continued through the biennial period and has involved a complete analysis of over 400 samples of water.

Oil and Gas Studies.—Activities of the Survey have kept pace with the increased oil and gas development that has taken place during the last two years. Logs have been obtained of nearly all wells drilled, and cuttings and water samples have been obtained from many of them. A report on the oil and gas pools of Jackson County has been completed by J. R. Clair. A plane table party has been engaged in running elevations of all wells drilled in Cass, Bates and Vernon counties and in addition, has obtained elevations of all the currently drilled wells in the active areas.

In the older pools in the counties north of Missouri River, where the Survey had formerly obtained well elevations with an altimeter, a re-survey was made with a plane table. The elevations of all important wells in northwest Missouri were ob-

tained by a plane table party or by carefully checked altimeter readings. A magnetometer survey of all the counties in northwestern Missouri has been completed.

Much of the work mentioned above was in anticipation of a general report on the geology of northwestern Missouri which has been published as Volume XXV. While this report was in preparation, oil and gas leasing on a large scale began in the north-central and northeastern counties, as well as the northwestern counties, necessitating a companion report which is published in this report. (See Appendix I).

The importance of the leasing activities in the northern part of the state can not be over emphasized. It is estimated that acreage under lease as of Jan. 1, 1939, is at least 2,000,000 acres. As many of the major oil companies are interested, it appears probable that the area will be thoroughly tested during the coming summer. In addition to the preparation of the two reports mentioned, the geological staff and office files of the Survey have been available for consultation by the geologists of the companies evincing real interest in northern Missouri. It appears probable that many tests for oil and gas will be made on locations selected with the best scientific advice obtainable in a sincere effort to ascertain the merits of Missouri as an oil and gas area. The Survey has been and will continue to be of real service in these efforts.

Work of Federal Works Progress Administration, Official Project 465-55-3-24.—During the past two years, the Geological Survey has sponsored and supervised a state-wide, geological, engineering, and mineral research project of the Works Progress Administration of Missouri, Matthew S. Murray, Director. This project was designed to give employment to technically trained, skilled, and other workers in the fields of basic sciences, and to obtain results related to the development of the mineral resources of the State. Some of the studies and the results of the project may be described as follows:

Groundwater Studies.—In connection with the studies of ground water resources, geologists have delimited and correlated those formations of the Canadian, Ozarkian, and Cambrian systems occurring in the State. A statewide structure map, contoured on the elevation of the base of the Roubidoux formation as revealed by these studies, is now rapidly nearing completion. The preparation of well cuttings for study has also been an important undertaking.

Oil and Gas Surveys.—Locations and elevations have been determined on many old wells and prospect holes drilled in the northwestern part of the State. This information serves to complete old records in the files of the survey and assists materially in the studies of oil and gas resources. A new State base map, scale $\frac{1}{4}$ inch to 1 mile, has been completed; prints of which are now being used extensively by oil geologists, who are interested in the possible oil and gas resources of northern Missouri. The employees of the project contributed in many ways in the preparation of the two recently published reports describing the geology and oil and gas possibilities of northern Missouri.

Clay, Water, Mineral, and Geological Prospecting.—In the extreme southeastern (embayment) portion of the State, only a few rock outcrops are present and, since fault patterns of a highly complicated nature exist, it is impossible to accurately determine the general geology of this area by surface observations alone. Due to the fact that the formations immediately beneath the surface consist of comparatively soft clays and sands, prospecting by means of earth augers has been resorted to, in order to obtain geological information and samples of clays and other minerals of possible commercial value. Two geologists have supervised and directed the work of thirty-three laborers engaged in drilling shallow prospect holes in Scott County; 639 holes have been drilled representing a total footage of 24,920 feet.

As a result of this work several clays have been found by testing to be satisfactory for making pottery and art ware. Much information, pertaining to the general geology of the embayment region, has been obtained also.

Geophysical Surveys.—During the past biennium magnetometer surveys have been completed of the entire embayment region of southeastern Missouri, including Mississippi, New Madrid, Pemiscot and Dunklin counties, and portions of Stoddard, Bollinger, Wayne, Butler, and Ripley counties. Similar surveys have also been completed during this period in central and north central Missouri the counties surveyed entirely being Caldwell, Cooper, Daviess, Grundy, Harrison, Howard, Livingston, Mercer, Moniteau, Ray and Saline. In addition several counties were partially surveyed. They were Boone, Carroll, Chariton and Pettis counties. The total mileage surveyed in this period was approximately 11,000 square miles.

It has become apparent that certain definite relationships exist between magnetic anomalies and regional geologic structure. Such information is of importance and valuable, particularly in those areas where geologic data, in the form of outcrops and well records, are lacking. Three such areas are North Central, Northwestern, and Southeastern Missouri, maps for which have been or will soon be published. Due to the oil and gas interest in these areas, these maps will be of great interest and value.

In addition to the magnetic survey, electrical resistivity and self potential surveys have been employed during the first part of the biennium. Surveys have been conducted on iron ore and pyrite deposits occurring in Crawford, Dent, Franklin, Maries and Phelps counties.

Ceramics.—During the latter part of the biennium, ceramic work was again undertaken in cooperation with the Department of Ceramics of the Missouri School of Mines. The physical properties and drying and firing behavior have been determined on seventy different samples of clay collected from shallow prospect holes drilled in southeast Missouri, and in some instances indicate a commercial value for some clay deposits discovered in that work.

Areal Geology.—Reconnaissance field studies have been made of certain areas in northeastern, central, and southwestern Missouri, in order to obtain additional information regarding structural features and sequence of rock formations. More detailed work pertaining to structural geology has been done in the counties of Barry, Crawford, Franklin, Greene, Lawrence, and McDonald. This work is of importance in connection with studies of ground water and other mineral resources. The resulting geologic maps also have been used in the compilation of a new state geologic map.

Other Investigations.—In connection with routine chemical analyses of various waters used in municipal supplies, chemists employed on the project have made quantitative determinations of other constituents found to be present, such as bromine, fluorine, iodine, manganese, and strontium.

Engineers have been engaged in establishing horizontal and vertical control surveys and in the preparation of topographic maps. This work serves to expedite the mapping program conducted by the sponsor in cooperation with the U. S. Geological Survey.

Engineers also assist in the preparation of daily discharge records of the principal streams and larger springs of the State. This work serves to expand the regular stream-flow measurement program conducted by the Missouri Geological Survey in co-operation with the U. S. Geological Survey.

The work of the project has been directed to furnish additional information for the development of the natural resources of the State and the results obtained are of a useful and permanent nature. It is believed that the reemployment of professional, skilled and intermediate workers has, through the training and supervision given these employees, better fitted them for positions in private work, and work with other governmental agencies. Records of turnover in the above mentioned classes of personnel reveal that fifty-seven percent of those assigned since the inception of this work have received other employment.

PUBLICATIONS.

In addition to the Biennial Report, two volumes have been prepared and published, describing in general the geology of the northern part of the state. One is entitled, "The Geology of Northwestern Missouri". It is a volume of some 220 pages, containing the records of deep wells and prospect holes drilled in that part of Missouri, a base map showing the location of all holes drilled, a magnetic map showing the anomalies of the entire area, a structural contour map of the base of the Hertha limestone, and maps of a number of local structures mapped in the past by this Survey. Geologic cross-sections show the stratigraphy and character of the subsurface formations.

The second volume is devoted to the Subsurface Geology of Northeast Missouri. In addition to two geological cross-sections there is a base map showing the location of the holes drilled in that part of the state and the records are all printed in the body of the report. There is a brief stratigraphic description comprising the first part of the volume.

Both volumes are intended to convey the basic data upon which investigations in the north part of the state might be based. Both reports are exceedingly timely in that the investigations in North Missouri will no doubt continue throughout the next year. It is expected that during the coming season the area will be given a thorough test by many of the more important oil companies.

The level net of the state was completed the early part of the present biennial period. In cooperation with W. P. A. and the United States Geological Survey both the level and traverse notes have been prepared for publication. For convenience the state has been divided into 8 districts and the first 4 parts of the level bulletins have been published by the U. S. Geological Survey in cooperation with the State Survey. Copies of these reports are available at the headquarters of the State Geological Survey. The remaining 4 level books and the 3 parts of the traverse survey are now in the hands of the Federal printer and should be issued during the coming year. The reports will be of great value in presenting the engineering basic data covering points of elevation in the state.

The entire edition of the state geological map has been exhausted, but at the present time a new map with many revisions is being prepared. It should be available for distribution during 1939.

TOPOGRAPHIC MAPPING.

In the work of this branch, which is done in cooperation with the United States Geological Survey, the State Highway Department and W. P. A., a total of 3,775 square miles of topography has been mapped, to which can be added 210 square miles which has been mapped under a federal P. W. A. mapping program. The total square miles mapped is 3,985. In addition to actual mapping, 492 miles of third order traverse and 1,350 miles of third order levels were completed.

Photolithographic editions of 19 sheets on a scale of 1=48,000 amounting to a total of 3,105 square miles have been issued by the government printing office; also 10 sheets on a scale of 1/24000 have been received, and one map of the Babler State Park area on a scale of 1/12000. There are 8 sheets inked and ready for editing and photolithographing in Washington and 13 sheets in process of preparation at Survey headquarters in Rolla.

In cooperation with W. P. A. 8 level bulletins, which cover the entire state, have been compiled, edited and forwarded to Washington. Four parts have been printed.

Three traverse bulletins, which cover about a third of the state, have been edited and forwarded to Washington for printing.

A base map of Pettis County compiled on a scale of 1 inch to 1 mile from airplane photographs has been published. A similar map of Bates County is now ready for publication.

SURFACE WATER RESOURCES INVESTIGATIONS.

The work of the Missouri Geological Survey and Water Resources during the biennial period relating to the surface water resources of the State has consisted principally of a continuation of the stream-flow investigations for use in flood-control, drainage, water-power, and water-supply developments. These investigations have been carried on, as in the past, in co-operation with the Water Resources Branch of the United States Geological Survey, which organization furnished trained personnel to carry on the work, and during the biennial period contributed \$29,500 to its cost. The Federal Public Works Administration also contributed \$10,000 for the improvement of gaging stations, which was used largely to install automatic recording gages to replace staff or wire gages. Two new gaging stations were established; none were discontinued. At this time 92 gaging stations are being maintained on the principal streams of the State. At 53 stations a local resident reads a gage once or twice a day to determine the height of the water. At 39 stations a continuous height record is obtained by means of recording gages. The engineers make measurements of the flow, or discharge, of the stream in terms of cubic feet per second, prepare rating curves and tables showing the flow for any gage height, and then compute from the daily gage heights the flow for each day of the year.

During the biennial period, the Geological Survey received many requests for stream flow records for use in planning flood-control, drainage, water-power, water-supply, and sewage disposal developments, and new bridges for the State Highway system. The stream flow records constitute important basic information necessary for the design of such works.

The water-power plants on the Osage River near Bagnell and Osceola and the one on the Niangua River near Lebanon were completed during the past few years at a cost of about \$36,000,000. Their design and construction were based upon the stream flow records collected by the Geological Survey and

Water Resources. Without such records, these plants could not have been built and the beautiful Lake of the Ozarks, with a length of 129 miles and an area of 61,000 acres (resulting from the construction of the Bagnell dam), could not have been created.

The United States Army Engineers are now constructing a dam on the St. Francis River at Wappapello, Mo., and will later improve the levee system, in order to protect many thousands of acres of fertile farm land in Southeastern Missouri and Northeastern Arkansas from the devastating floods which have visited this region so frequently in the past. The estimated cost of the entire project is about \$20,000,000. The stream flow records collected by the Geological Survey and Water Resources were used in planning this important project.

Many important flood-control and water-power projects are now under consideration in Missouri. Several of these are included in the \$375,000,000 plan authorized by Congress in the "omnibus" flood-control bill of 1938. This bill makes it mandatory to install penstocks for the development of power in flood-control dams when so recommended by the Chief of Engineers, U. S. Army, and the Federal Power Commission. In all flood-control reservoirs it is also planned to maintain a minimum pool level, below which the water will not be drawn, in order to provide a permanent conservation lake, which may be used for recreation.

Other sites are also being studied by the Federal Government and private agencies for the development of power. Some of these sites may be used for multiple-purpose dams, such as for combinations of flood control, power, and water conservation.

The following table shows the more important reservoir projects for flood control, power development, and water conservation, which are now under consideration for construction within the State of Missouri:

River.	Location.	Height of dam in feet.	Area of lake in acres.	Purpose.
Grand.....	Chillicothe*.....	80		Flood control
Osage.....	Osceola*.....	65	218,000	Multiple-purpose
South Grand.....	Warsaw*.....	70		Multiple-purpose
Pomme de terre.....	Hermitage*.....	80		Multiple-purpose
Gasconade.....	Richland.....	100	12,500	Multiple-purpose
Gasconade.....	Arlington*.....	106	15,800	Multiple-purpose
Gasconade.....	Rich Fountain.....	95	17,300	Multiple-purpose
Meramec.....	Moselle*.....	95		Multiple-purpose
Big.....	Eureka*.....	92		Multiple-purpose
Black.....	Leeper*.....	130	14,400	Multiple-purpose
Current.....	Eminence.....	94	5,720	Power
Current.....	Van Buren.....	84	4,630	Power
Current.....	Doniphan.....	84	8,750	Power
White.....	Branson-Table Rock.....	190	50,000	Power

*Included in authorized projects under "omnibus" flood-control bill passed by Congress in 1938.

Besides these proposed reservoir projects, several agencies of the Federal Government have or are now making preliminary investigations for channel improvements, levees, and water retardation and soil conservation measures, at many other places, including the Grand, Chariton, Fox, Wyaconda, Fabius, Salt, and Cuivre, and St. Francis River Basins.

The estimated total cost of these reservoir and other projects is more than \$150,000,000. Their construction would confer very substantial benefits upon the State of Missouri. The stream-flow records being collected by the Missouri Geological Survey and Water Resources constitute the basic information upon which all these projects are being planned.

The stream flow records so collected have also been used during the biennial period by consulting engineers, city officials, and the State Board of Health in studies relating to public water supplies, sewage disposal, and stream pollution. The Geological Survey and Water Resources is cooperating with the cities of Springfield, Joplin, and Shelbina in collecting records of flow of nearby streams for these purposes.

The State Highway Department has made frequent use of the stream flow records in designing new bridges for the State highway system. In order to obtain more complete information, the Highway Department cooperated with the Geological

Survey in maintaining 14 gaging stations by furnishing the services of maintenance men or nearby residents to read the gages and the services of engineers to help make flow measurements during periods of high water.

A wide public interest is being shown in the large springs of the State, and many requests are received for information regarding their flow. In order to be able to supply this information, the Geological Survey and Water Resources makes occasional measurements of the flow of all the larger springs. The Survey also cooperates with the State Park Department in determining the daily flow of four large springs in State parks—namely, Big, Alley, Round, and Bennett Springs.

The United States Army Engineers are making extensive improvements on the Mississippi and Missouri Rivers within the State of Missouri to provide navigation and to stabilize the river banks, and they are also making many studies for flood control and the development of water power in the State. In planning this work, they make frequent and thorough use of the stream flow records. They furnished funds to the United States Geological Survey (with whom the State Survey cooperates) to pay the cost of maintaining eleven gaging stations on the Mississippi, Missouri, and other rivers in the State. During the biennial period they contributed \$5,600 for this purpose.

During the spring of 1936, the President of the United States requested the National Resources Committee (an independent Federal agency) to prepare a report upon the water resources of the country and to submit a comprehensive plan for their utilization and development. The Federal Works Progress Administration allotted funds to the various State Planning Boards of the country to enable the latter to prepare State reports under the guidance of special consultants appointed by the National Resources Committee. This Committee used the several State reports to prepare its own nation-wide report to the President. The Missouri State Planning Board prepared its report upon the water resources of Missouri in ten sections, which outlined the scope, characteristics, and value of these resources, and recommended plans for their future use, control, and development. Later these sections were condensed into one volume and published by the State Planning Board. The Missouri Geological Survey and Water Resources furnished a large amount of basic information upon these subjects to the State Planning Board and cooperated fully with the Board in the prepa-

ration of the reports. The State Geologist also served as Chairman of the Water Planning Committee of the State Planning Board.

The widespread interest throughout the State in the stream-gaging work of the Geological Survey and Water Resources is evidenced by the large number of requests for the records, and also by the amount of cooperation furnished by private and public agencies interested in developing the streams for flood control, drainage, water power, water supply, bridge design, soil conservation, and other purposes. These agencies contributed \$4,300 during the biennial period in order to assist in the expansion of the work—this being exclusive of the funds contributed by the United States Geological Survey and the United States Army Engineers, and of the services furnished by the State Highway Department and the State Park Department, as noted above. The following list gives the names of those who cooperated in the work and the number of gaging stations each helped to maintain during a part, or the whole, of the biennial period:

Missouri Highway Department.....	14
Missouri Park Department.....	4
United States Army Engineers.....	11
United States Weather Bureau.....	9
United States Soil Conservation Service.....	2
Little River Drainage District.....	7
Empire District Electric Company.....	4
Union Electric Company of Missouri.....	6
Missouri Electric Power Company.....	1
City of Joplin.....	1
City of Springfield.....	1
City of Shelby.....	1
Total.....	61

APPROPRIATION FOR 1937-1938.

The 59th General Assembly made the following appropriation for the Geological Survey covering 1937-1938:

Personal service.....	\$80,000.00
Additions.....	1,800.00
Repairs and replacements.....	3,500.00
Operation.....	29,000.00
	\$114,300.00

The activities and investigations described on the preceding pages were carried on under this appropriation, supplemented by cooperative funds obtained from other state and government bureaus. The amount contributed by these outside organizations was more than double the amount of appropriation to this department. Much of the work done during the past biennium could not have been accomplished if such funds had not been available.

APPROPRIATION REQUEST FOR 1939-1940.

The Geological Survey occupies a building on the campus of the Missouri School of mines, the upkeep of which is maintained by the School. The Survey therefore has no budget items covering buildings or grounds. The activities of the Geological Survey are chiefly centered around field investigations and office work, and our budget request falls under the following designations: (a) Personal Service, (b) Additions, (c) Repairs and Replacements, and (d) Operation. The chief expenditures are under Personal Service and Operation, with relatively small amounts for Additions or Repairs and Replacements. The following tabulation gives the individual items comprising the total request:

The actual operations of the Bureau are divided into three branches, namely, (1) Geology and Mining, (2) Water Resources, and (3) Topographic Mapping. The appropriation request is tentatively allocated to these three branches as follows:

Geology and Mining (including printing and office expenditures)	\$110,540.00
Water Resources	20,000.00
Topographic Mapping	20,000.00
	\$150,540.00

The above request is divided into the following items as required by the budget:

Personal Service	\$84,440.00
Additions	1,950.00
Repairs and Replacements	5,050.00
Operation	59,100.00
	\$150,540.00

<i>Personal Service:</i>		
Geology and Mining.....	\$60,440.00	
Water Resources.....	12,000.00	
Topographic Mapping.....	12,000.00	
		\$84,440.00
<i>Additions:</i>		
Laboratory Cases.....	\$500.00	
Microscope.....	350.00	
Office Furniture and Equipment.....	300.00	
1 Ford Car.....	600.00	
Small Equipment.....	200.00	
		1,950.00
<i>Repairs and Replacements:</i>		
Office Equipment.....	\$150.00	
Laboratory Supplies.....	2,000.00	
Transportation and Conveying Equipment.....	2,200.00	
Miscellaneous Repairs.....	700.00	
		5,050.00
<i>Operation:</i>		
Telephone and Telegraph.....	\$600.00	
Postage.....	800.00	
Operation of State Cars.....	7,000.00	
Railroad and Bus Fare.....	400.00	
<i>Subsistence:</i>		
Geology and Mining Branch.....	7,000.00	
Water Resources Branch.....	3,000.00	
Topographic Mapping Branch.....	8,000.00	
Freight, Express and Drayage.....	800.00	
Laboratory and Field Supplies.....	2,000.00	
Laundry and Cleaning.....	100.00	
Stationery and Office Supplies.....	400.00	
Printing Reports and Maps.....	5,000.00	
		35,100.00
<i>W. P. A.:</i>		
Field Expenses.....	\$24,000.00	24,000.00
Total.....		\$150,540.00

The total request is but slightly greater than the amount requested two years ago.

The investigations of the three branches are tentatively planned to continue most of the present activities. The recent oil and gas leasing campaign in North Missouri has made it imperative that the Survey largely increase its activities in that region. Additional field work should be undertaken. The cuttings from all drilling should be obtained and studied. Samples of water should be taken at various depths and analyzed, and much additional study of the surface and subsurface geology should be made. This oil play makes it possible for the Geologi-

cal Survey to serve North Missouri as never before. It would be unfortunate if the Survey through lack of field work should miss the opportunity of gathering the important geological data that will be made available through the present commercial activities in that part of the state.

While not so acute at present, there is every indication that an extensive leasing and drilling campaign will be under way in the lowland area of southeast Missouri in the near future. Leasing has already started. During the past biennial period the survey prepared a magnetic map of the entire area and has studied the geology of the northern part of the area. In order to be of the greatest assistance to those interested in the possibilities of this part of the state, the geological and magnetic data now in the files of the Survey should be published and additional field investigations should be undertaken. Here again is a rare opportunity for the Survey to be of material assistance in the development of this part of the state.

During the past two biennial periods the work necessary to supervise deep drilling for ground water supplies has continually increased and at present requires the services of three members of the permanent staff. During the last two years more than 60,000 samples from approximately 1100 wells were received and studied. From all indications there will be no diminution in this work during the coming biennium.

There is no activity that is of greater value than this investigation covering the drilling and construction of deep wells.

It is planned to complete the barytes investigation which has been under way the past two field seasons. The burning and testing of clays will be continued. Samples of seventy clays from southeast Missouri have recently been tested, some of which are apparently of excellent quality.

The plan is to continue the topographic mapping in cooperation with the U. S. Geological Survey and the tentative plan is to spend \$20,000.00 of the proposed budget for this purpose. Approximately 45% of the state has been covered with accurate maps.

There are now 92 gaging stations on the major streams of the state. The data collected is of importance in any state or local plan of utilizing our surface waters. The program of operation involves the use of \$20,000.00 of state funds, which is matched dollar for dollar by Federal funds. This is the same amount as requested in former biennial periods for this work.

Since the inception of the relief program the Geological Survey has sponsored a very extensive state-wide project for the employment of engineers, chemists, geologists, computers and laborers. According to present plans the project will continue through the coming biennial period. Under present regulations the sponsor must pay all field and traveling expenses amounting to more than \$5.00 per man per month. The cost to the Survey is approximately \$1,000.00 per month, or \$24,000.00 for the biennial period, and this is the largest single item in the budget request. It is estimated that the Works Progress Administration will spend \$180,000.00, or \$7.00 of Federal funds to each \$1.00 of State funds.

The results of this project are extremely valuable and cover work accomplished in all three branches of the Survey which could not have been done without this cooperation. Results already obtained have been mentioned on preceding pages.

VALUE OF MINERAL PRODUCTION OF MISSOURI, 1928-1936.

Commodity	1928	1929	1930	1931	1932	1933	1934	1935	1936
Lead concentrates..	\$19,223,836	\$21,130,453	\$16,640,768	\$9,898,703	\$4,932,306	\$4,135,573	\$4,548,519	\$5,667,955	\$7,403,159
Zinc concentrates..	924,577	845,356	573,607	127,131	30,728	264,951	363,362	392,541	1,098,233
Coal.....	9,637,000	9,778,000	8,967,033	7,248,000	6,654,000	6,175,000	6,278,000	6,923,917	7,559,000
Clay products.....	16,073,334	15,319,000	13,212,081	7,010,925	3,897,558	5,572,752	6,323,896	7,443,931	10,795,047
Cement.....	12,367,018	11,557,905	11,470,751	5,052,840	3,666,220	4,722,441	5,449,606	4,940,713	7,134,240
Limestone.....	4,476,135	5,704,241	4,819,475	3,962,469	3,223,507	3,194,792	2,660,428	2,452,036	3,732,753
Marble.....	1,425,060	932,471	851,337	553,761	402,939	248,822	170,419	179,812	380,825
Sand and gravel...	3,248,813	4,170,593	4,776,078	2,646,756	2,114,400	1,668,048	1,462,740	1,889,787	2,402,304
Lime.....	1,398,843	1,401,090	1,861,605	835,914	526,488	597,180	907,338	1,046,243	1,283,175
Lime, hydrated....	853,577	918,796	805,090	645,326	508,362	524,115	631,562	713,675	764,014
Clay.....	1,442,644	1,797,448	1,275,787	738,607	504,403	713,127	961,854	1,006,862	1,336,382
Chats.....	475,888	646,292	355,821	335,865	260,000	493,597	479,283	296,125	682,530
Barytes.....	810,203	880,319	938,812	539,152	463,347	510,551	581,889	727,888	1,008,528
Copper.....	9,360	394	22,958	(b)	(b)	(b)	(a)	5,616	35,144
Mineral waters ...	(a)	(a)	20,025	(b)	(b)	(b)	(b)	(b)	(b)
Iron ore.....	(a)	661,055	508,354	337,144	72,144	(a)	13,271	8,764	16,566
Granite.....	69,707	54,642	48,599	38,591	6,544	12,480	33,905	40,303	29,372
Silver.....	103,451	96,813	65,531	11,600	318	(b)	40,770	79,459	126,801
Sandstone.....	(a)	322,508	288,120	158,485	112,337	21,477	48,663	(a)	(b)
Natural gas.....	(b)	25,920	85,120	122,720	82,016	59,224	47,000	282,000	196,000
Pyrites.....					(a)	50,161	51,640	77,263	77,660
Miscellaneous (a)..	579,190	141,170	239,663	192,243	131,159	221,357	180,429	266,889	278,870
Totals.....	\$72,539,446	\$76,384,466	\$67,826,615	\$40,456,232	\$27,588,816	\$29,135,487	\$31,234,574	\$34,441,779	\$46,340,603

(a) Miscellaneous includes, in addition to items noted: Tripoli, silica, miscellaneous stone, and asphaltic sandstone.

(b) No production reported.

CHAPTER II.

MINERAL PRODUCTION OF MISSOURI.

By Norman S. Hinchey.

Missouri continues to maintain her prominent national position as a producer of a wide range of mineral products. Statistical summaries for 1936 show that Missouri ranked first among the States in the nation's production of lead, barite, chats, and tripoli and second in the quantity of raw clay produced. In that year, Missouri's mineral products were valued at \$46,340,-603 which represented a value \$11,898,825 greater than the corresponding figure for 1935. Complete data are not available for 1937, but figures which are at hand indicate that the 1937 total will probably be appreciably higher than that for 1936. The table on the preceding page presents annual summaries of the value of mineral production in the State for the years 1928 to 1936 inclusive.

In order of value of mineral products in the State for 1936, clay products was first with a total value of \$10,795,047. Raw clay mined had a value of \$1,336,382. Coal ranked second and production for that year was valued at \$7,559,000. Lead concentrates and cement were next in order with total values of \$7,403,159 and \$7,134,240 respectively. It is interesting to note a much higher figure for lead in 1937, when \$14,736,662 was reported as the total value of concentrates. This figure represents an increase of approximately 100 percent over the corresponding value for 1936 and indicates that, when final figures for 1937 are available, lead will probably be in or near first place among Missouri's mineral products. The value of barite production in 1937 showed an increase of more than 25 percent over the 1936 value.

The following pages contain a brief summary of conditions in the principal mineral industries of the State, together with data concerning the production, and value of production, for each of these industries. Statistical data are collected in cooperation with the United States Bureau of Mines, and that Federal agency compiles final, annual tabulations of these data. The Federal

Bureau of Mines publishes annually a statistical review of developments in the mineral industries of the nation, the "Minerals Yearbook".

ASPHALTIC SANDSTONE.

Certain sandstone strata in the Cherokee group of formations are impregnated with bituminous material at places where they outcrop in Barton, Cedar and Vernon Counties. The bitumen content of the beds varies greatly from place to place within the same deposit and is known to range from a mere trace to as much as 14 per cent. An average content of approximately 6 per cent has been reported from asphaltic sandstone deposits which have been worked in western Missouri. These bituminous rocks have been described in several of the reports of the Geological Survey which are available for distribution.

In 1937, sales of bituminous rock in the United States decreased in comparison with 1936 sales, and a decline in Missouri production and sales was also reported for 1937. As there are fewer than three producers of asphaltic rock in Missouri, the figures for quantity and value of production are concealed and are included under "Miscellaneous" in the accompanying table which shows the value of mineral production in Missouri.

BARITE.

By G. A. Muilenburg.

The barite industry in Missouri showed considerable activity during the first half of the biennium. Stimulated by favorable prices and steady demand, the output of crude barite increased from a low of 85,417 tons in 1932 to an all-time high of 198,101 tons in 1937. At the same time, the average price per ton rose from \$4.54 in 1933 to \$7.24 in 1937. In 1936 the total value of the ore reached the million-dollar mark for the first time since 1920, although the price per ton was only \$6.27 compared with \$10.17 in 1920. Production in 1937 exceeded that in 1936 by more than 37,000 tons, and the market value was nearly \$422,000 greater than in 1936. In 1937 Missouri produced 56% of the total output for the United States, an amount which is more than two and one-half times greater than that of the next largest producing state, Georgia. Late in the fall of 1937 there was a decline in production because of the slump in general business conditions. This continued into 1938, and forced many producers to curtail

their operations or close their mines entirely. The full extent of this curtailment will not be known until production figures for 1938 have been completely reported.

The present trend in the industry is toward mechanization. The change will not be abrupt, but there has been a gradual decrease in the amount of hand mining and somewhat more than a corresponding increase in mechanical mining during the last few years. In the mechanization process, use is made of power shovels for loading, and logwashers, crushers and jigs for cleaning and concentrating, thus making it possible to handle a larger tonnage and make a better product. Furthermore, by these methods, ground that has already been worked by hand may be reworked and much finely broken barite, lost in hand mining, can be recovered. The larger scale operations resulting from mechanization also permit the working of low grade deposits which the hand miner cannot handle. The full significance of the change to mechanical mining and washing will be appreciated when it is recalled that under average conditions of hand mining, less than 35% of the total ore is recovered. There is at present a great need for a small portable type of washer and concentrator that may be moved from place to place and used to wash dumps and refuse from abandoned hand mines and other small deposits.

There has been some expansion of the boundaries of producing areas, but the bulk of the production still comes from Washington County and adjacent portions of Franklin, Jefferson, and Crawford Counties. Two outlying areas are worthy of mention. One is near Wesco in Crawford County producing from the Davis formation, and another is in St. Francois County, east of East Bonnetterre, where the ore occurs in the Bonnetterre dolomite. In the central district production has continued to come from established areas. The Lupus district was active during 1937, but because of the slump in market conditions, operations were suspended during 1938.

Barite is used principally in the manufacture of lithopone, as ground barite, and in the manufacture of barium chemicals. Lithopone is an intimate mixture of zinc sulphide and barium sulphate used chiefly as a white pigment. Ground barite is used as a filler in paper, rubber, oilcloth, linoleum, plastics, and resins, but its chief use is in the preparation of heavy mud for oil-well drilling where high gas pressure is encountered. Small amounts are used in the ceramic and glass industries. Barium chemicals have numerous uses in the arts and trades.

No standard tests or specifications for barite are in use. Much of it is sold on contract, and it is customary to specify the minimum barium sulphate and maximum iron content. A common specification is 95% BaSO_4 and not over 1% Fe_2O_3 . Some users allow a premium for BaSO_4 in excess of 95% and low iron, but exact a penalty for iron over 1%.

In 1935, Missouri produced 131,921 short tons of barite with a value of \$727,888. Corresponding figures for 1936 were 160,866 tons, valued at \$1,008,528; and in 1937 production was reported to be 198,101 tons with a value of \$1,430,397.

CEMENT.

The output of large cement plants at five places in Missouri make the State an important producer of this structural material, and the value of cement produced adds an important figure to the total value of mineral production. The active plants in Missouri are those of the Universal Atlas Cement Company at Ilasco, Ralls County; the Marquette Cement Mfg. Company at Cape Girardeau, Cape Girardeau County; the Alpha Portland Cement Company at Alpha and the Missouri Portland Cement Company (2 plants) at Prospect Hill, St. Louis County; and the Missouri Portland Cement Company at Sugar Creek, Jackson County.

The general recession in industrial activity late in 1937 was reflected in this industry, and Missouri production of cement in that year was approximately 4 percent less than that in 1936.

The mixtures of limestone and clays which are burned and ground for cement in Missouri are obtained from various geological formations at different localities. The plant at Ilasco, Ralls County, utilizes Burlington limestone and Grassy Creek shale, both of Mississippian age. The plant near Kansas City at Sugar Creek, Jackson County, uses mixtures of limestone and shale from the Kansas City group of formations of Pennsylvanian age. The Missouri Portland Cement Company's plant at Prospect Hill, in northern St. Louis County, is the oldest Portland cement plant in the State. Its quarries are operated in deposits of Pleistocene loess, Cherokee shales, and limestone beds of the Ste. Genevieve formation. The Alpha Portland Cement Company has a large plant at Alpha in the southeastern part of St. Louis County, where Mississippian limestones are quarried. At Cape Girardeau, Cape Girardeau County, the Marquette Cement Manufacturing Company quarries Plattin limestone of Ordovi-

cian age which is mixed with clay taken from the alluvial deposits of Mississippi River.

Sulphate-resisting cements and cements which have a low heat of hydration are being produced, and Missouri diaspore clay and "iron-band" diaspore are being used as raw materials in the manufacture of these special types of cement.

The Geological Survey has published reports on the lime and cement resources of the State as well as a report on the quarrying industry. These bulletins describe the nature and occurrence of the raw materials for cement manufacture which are available and accessible in many parts of the State.

For 1936, it was reported that 4,632,191 barrels of Portland cement were sold for \$7,134,240. In 1937, sales of 4,565,448 barrels brought \$7,041,016. The average price of \$1.54 per barrel remained unchanged during that two-year period.

CLAY AND CLAY PRODUCTS.

Since 1933, the total annual value of clay and clay products produced in Missouri has exceeded that of any other mineral product in each year. During 1935 and 1936, the production of raw clay and clay products in the State showed an appreciable increase over production in previous years since 1930. The total value of the output in 1936 is above the corresponding annual values since 1930 and raw clay production in 1937 was greater than in 1936. Statistics indicating the value of clay products for 1937 are not available.

The clay deposits of Missouri include many types of clay of varied chemical composition and varied physical properties. The deposits range from shale, loess, and clay suitable for ordinary brick manufacture to diaspore or high-alumina clay which is used in the manufacture of high-grade refractories; and they include plastic clay, flint clay, kaolin, ball clay, and pottery and chinaware clay. A large portion of Missouri's clay deposits occur in the strata of the Pennsylvanian System of rocks which outcrop at the surface over a large part of the State. Shales and clays which are found in many parts of the State are used in the manufacture of common brick, face-brick, hollow-tile, drain-tiles, sewer-pipe, and terra cotta.

The diaspore clay deposits which are mined in the northern portion of the Ozark region of southern Missouri are the only known diaspore deposits which have been developed commercially in North America. The high-alumina diaspore clay

production has increased steadily in recent years as is shown by the production figures in the accompanying table.

In recent years iron-bearing diaspore clay has been mined in the northern Ozark region. This type of diaspore contains oxides and hydrous oxides of iron as impurities associated with the high-alumina clay. Iron-bearing diaspore which is mined in Gasconade County has been shipped by barge from Hermann, down Missouri and Mississippi Rivers to Cape Girardeau, where it is used in a cement plant located at that city. Use of this material in the preparation of certain types of cement imparts special properties to the finished product. There is reported to be a demand for cement with special properties which are imparted to it by the use of diaspore in its manufacture. Iron in cement reduces its heat of hydration and makes for a sulfate-resisting product.

Flint fire clays are also produced in the northern Ozark region which yields the diaspore clay. Flint clay is utilized in the manufacture of fire-brick, and the value of the annual production of this type of clay makes an appreciable contribution to the total value of clays produced in the State. In 1936, some 64,048 tons of flint clay, with a value of \$100,392 was produced, and in 1937, a value of \$100,769 was placed on the 68,541 tons mined.

The non-plastic flint, burley and diaspore clays of the northern Ozark region are mined in Phelps, Osage, Gasconade, Franklin and adjoining counties. Deposits of plastic fire-clay are worked in parts of St. Louis, Audrain, Callaway, and Montgomery Counties, where the Cheltenham clay of Cherokee age is mined. These plastic fire-clay deposits are the basis for the important refractory industries which make the major contribution to the total value of clay and clay products in the State. Special reports, on the nature and occurrence of the Cheltenham clay and the flint and diaspore clays have been published by the Survey, in addition to other reports on Missouri clays. Copies of these reports are available for distribution from the office of the State Geologist.

The Geological Survey has continued its studies of clay deposits in Southeast Missouri where pottery and chinaware clays and bleaching earth have been found. Descriptive reports concerning the clays of this portion of the State are also available for distribution in printed form.

In the production of raw clay in the United States, Missouri ranked second among the states in 1936 in the order of quantity produced and third in the order of value of raw clay.

CLAY MINED AND SOLD, 1932-1937.

Year.	Fire Clay.						Miscellaneous.		Total.	
	Plastic.		Flint.		Diaspore.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1932	87,845	\$390,549	30,772	\$56,655	6,789	\$51,798	1,084	\$5,401	126,490	\$504,403
1933.....	116,759	527,769	47,701	127,037	11,809	53,485	900	4,836	177,169	713,127
1934.....	139,456	694,379	62,653	158,278	20,294	104,692	619	4,505	223,022	961,854
1935.....	175,320	712,139	68,955	183,498	23,248	104,316	835	6,909	268,358	1,006,862
1936.....	373,914	1,080,585	64,048	100,392	33,584	150,455	700	4,960	472,246	1,336,382
1937.....	401,059	1,179,355	68,541	100,769	49,769	245,395	192	3,720	519,561	1,529,239

Miscellaneous includes: Ball clay and kaolin clay in 1930 to 1937, inclusive; stoneware clay in 1930 to 1933, inclusive.

COAL.

Almost four million tons of coal were produced in Missouri in 1936 which is near the maximum annual production for the ten year period, 1926 to 1936, and total production in 1936 showed a slight increase over the corresponding figure for 1935.

Coal beds in Missouri are persistent over rather large areas in the northern and western portions of the State, where strata of Pennsylvanian age lie at and comparatively near the surface. Coal was mined in 28 counties of the State in 1936, and six of these counties produced approximately 80 percent of the coal which was mined. These six leading counties, ranked in the order of tonnage produced, were: Barton, Bates, Henry, Randolph, Lafayette, and Ray.

Open-pit or strip mining operations account for much of the tonnage mined in Barton, Bates, Henry, Randolph, and Vernon Counties. During recent years, stripping or surface operations have been extended, and it is probable that this tendency will continue to affect mining methods in areas where shallow coal seams are accessible to this type of development. Shaft mining is employed in certain parts of the State, particularly in areas where coal beds lie deeper and cannot be economically worked by stripping.

In 1934, Mr. J. O. Elliot and associates began the sinking of a coal shaft about one mile south of Winston, Daviess County. The shaft was completed at a depth of 460 feet, with 36 to 38 inches of coal which bears a remarkable resemblance in its details to the Lexington coal mined in the Mendota-Unionville area in Putnam and Schuyler Counties. The mine is now operated by the Winston Coal Co., and in April, 1936, this company sank a new and larger shaft on the property, retaining the original shaft as an air-shaft. A complete log of the second shaft was obtained by the Geological Survey and is published in volume XXV, "The Geology of Northwestern Missouri", by H. S. McQueen and F. C. Greene (1938, pp. 150-1).

The Cameron Mining Company was organized in 1937 and began sinking a shaft on the J. B. Russell land, about three miles east of Cameron on U. S. Highway 36, in Caldwell County. The coal bed was reached at a depth of 350 feet in the shaft in the fall of 1938 and the mine will soon be in production. The files of the Geological Survey contain the log of a diamond drill prospect hole put down only a short distance from this shaft.

The coal here, as at Winston, bears a close resemblance to the northeastern districts mentioned above, about 100 miles distant. The Lexington coal is being mined at Melbourne, Harrison County and has been produced on a small scale at other places in the intervening area, of which Kingston, Brimson, Spickard and Galt may be mentioned. South of the Winston-Cameron district, the Lexington coal has been produced on a large scale at Elmira and Knoxville and in the Lexington-Richmond district, which is one of the State's most important coal mining areas. It should not be inferred from the foregoing that the Lexington coal bed is continuous as a mineable seam in all of the intervening area.

Missouri ranked twelfth among the coal producing states in 1936. Preliminary statistics available for 1937 indicate a probable small increase over 1936 figures. The constant volume of total annual production in the State for more than ten years indicates that the market for Missouri coal is a comparatively stable one.

In 1935 coal production in Missouri was reported as 3,645,996 tons, with a value of \$6,923,917 and an average price of \$1.90 per ton. The same price was reported for 1936 when the 3,984,999 tons mined had a value of \$7,559,000.

COPPER, COBALT AND NICKEL.

In the process of smelting the lead-ore concentrates in the southeastern Missouri lead district, small amounts of copper are recovered as a by-product. In 1936, the recovery amounted to 464,418 pounds and in 1937, when the smelters took a greater tonnage of concentrates, 695,569 pounds of copper were produced. So far as is known, the copper minerals which are accessory minerals associated with ores of other metals, constitute the only important source for the copper production which has been reported from the State in recent years.

Deposits of copper minerals have been worked in Shannon and Ste. Genevieve Counties. The occurrences of these deposits have been described in the following publications of the Geological Survey:

"The Geology of Ste. Genevieve County", Volume XXII, second series, 1928.

"Geology of the Eminence and Cardareva Quadrangles", Volume XXIV, second series, 1930.

During the past biennial period additional prospecting for copper has been carried on in Shannon County.

Cobalt and nickel minerals are known to occur in a complex ore deposit just east of Fredericktown in Madison County, where a considerable tonnage of ore has been mined in the past. In recent years, however, there have been no attempts to further develop this deposit and it has not been worked during the past biennial period.

GOLD AND SILVER.

No commercially workable deposits of gold are known to occur in Missouri. Very small amounts are known to occur at places in the unconsolidated sands, gravel and clays of the glacial drift deposits which lie beneath the soil and above the hard bed-rock over most of the area north of Missouri River. However, this glacial material is known to have been transported into the State from the far north during the ice age of the Pleistocene. The minute amounts of metallic gold which have been reported from the drift are apparently widely scattered in occurrence and are not known to have been concentrated in any area.

As an indication of the negligibly small amounts of gold which might be expected to occur in the glacial drift, it is of interest to note the results of washing many tons of sand and gravel from the glacial drift at Sampsel, Livingston County. At a gravel plant at this place, several thousand tons of sand and gravel were washed over riffles in a three day period. In the course of this run, it is reported that less than one ounce of gold was recovered from the washing.

The Geological Survey examines many samples described as containing gold and sent in by citizens from all parts of the State. Such material often is the rather commonly occurring "fool's-gold" (iron sulphide, or pyrite), or fine flakes of clear or yellowish mica, or various oxides or hydrous oxides of iron. At first glance, some of this material may have the appearance of gold and may deceive the eye of the inexperienced observer.

Some silver is recovered from the smelting of the lead concentrates in the Southeastern Missouri lead district. The recovery of this silver is incidental to the smelting for lead, and the ores cannot be worked for their silver-content alone. In 1936, the recovery of silver from this process netted 163,720 fine ounces of the metal which were valued at \$126,801. In 1937, silver in the amount of 179,700 ounces, valued at \$138,999 was

reported from this source in Missouri. The increase followed a corresponding increase in the amount of lead concentrates smelted in the district.

In the Silver Mine Area, approximately nine miles west of Fredericktown in Madison County, argentiferous lead ores were worked at one time for their silver content. Values of approximately 30 ounces of silver to the ton of concentrates were reported. It is probable that the ores were worked out and no additional, economically workable bodies have been found. A detailed report describing the geology of this area was published by the Survey in 1933, and copies are available for distribution.

IRON ORES.

By O. R. Grawe.

Comparatively small amounts of iron ore have been produced in Missouri during the past biennial period. The iron ores of Missouri are hematite and limonite, which are commonly called red ore and brown ore, respectively. Dense, fine-grained, grayish hematite is commonly called blue ore or specularite.

Many of the old iron banks in the State have been mined out and there has been little incentive to develop new ores. There is no blast furnace in operation in Missouri, and the furnace in East St. Louis, Illinois, to which much of the Missouri ore has been shipped, has been out of blast since 1932. Hard blue ore is purchased by a producer of open hearth steel in Granite City, Illinois, and a small quantity of red ore is used in the manufacture of paint, drilling fluid, and ferruginous Portland cement. Recently a purchaser of Missouri ore has been found in Ohio. Ore which is low in its content of phosphorous is in demand at Birmingham, Alabama, and most of the brown ore produced in southern Missouri is shipped there to dilute the high phosphorous ore mined in that region.

During 1936, the Ozark Ore Company shipped ore from its stock pile at Iron Mountain, St. Francois County and a considerable amount of iron ore was mined by Julian Pickles at his Silver Hollow mine in Franklin County. The Salem Iron Co., Inc., produced both iron ore and paint ore at the Wiggins Bank in Dent County, and Thomas and Williams shipped some iron ore from their pyrite mine, Moselle No. 10 in Phelps County. The four producers mined 3,272 long tons of ore, and sold 2,933

tons, containing from 53 to 66.65% iron, for \$16,566. In addition, some paint ore was sold. Total for 1936 show a slight increase over the 1935 all time low of 2,069 long tons which were sold for \$8,764.

In 1937, production was again reported from the stock pile at Iron Mountain, from the Wiggins Bank and Mont Rouge (Mt. Rusch) in Dent County and from Moselle No. 10, Phelps County. Demand for and production of brown ore increased in 1937. Most of the brown ore came from Butler, Carter, Howell, Shannon and Wayne Counties and was handled by Chapman and Doane. The R. C. Mining Company produced a small amount of brown ore in Oregon County. Of the State's total production of 19,955 tons, 1,550 tons of ore were mined underground and 18,405 were obtained from open pits. During the year 19,897 long tons of ore were sold for \$57,687. Some limonite was sold for cement manufacture, and some hematite and limonite went into the manufacture of paint.

In 1937, M. E. Richards, local manager for Siems-Helmers, Inc., of St. Paul, Minnesota, started drilling and development of the Christy mine, 12 miles southeast of Leasburg, in Crawford County. This mine had been favorably reported by the Survey in 1912 and had been operated in 1931 and 1932. Richards reopened the property and began shipping ore to Ohio in April, 1938. The Christy deposit is an interesting and somewhat unusual type of deposit.

In addition to obtaining ore from the Christy bank, Richards purchased ore from several other small producers in 1938. Mr. Moutra of Sullivan leased the Silver Hollow mine from Julian Pickles and cleaned out some of the pit, from which some ore has been shipped. J. F. Moore has intermittently operated the Coleman property, 7 miles southeast of Leasburg, and some limonite is being produced at the Collier property, 1½ miles west of Davisville, Crawford County. H. B. Kerruish leased Iron Ridge No. 1, three miles northwest of Fanning, Crawford County. This is an interesting deposit, for the ore filled a long underground channel as well as the usual sink structure. The hematite production in Missouri for 1938 will greatly exceed that of 1937.

LEAD.

The southeastern Missouri lead district continues to be the most important lead producing area in the United States. In 1937, the Missouri lead belt contributed 33 percent of the total production of the nation. From southeastern Missouri, an output of 153,205 tons of recoverable lead was reported for 1937, as against 108,422 tons for 1936, or an increase of 41 percent in spite of the general recession in industrial activity in the latter part of 1937.

The galena (lead sulphide), which is the ore mineral in the southeast Missouri district, occurs in, and is disseminated through dolomite beds of the Bonnetterre formation in that region. The ores mined are extremely low grade and averaged \$2.50 per ton in 1936. However, extensive deposits of these low-grade ores permit large-scale, highly mechanized operations, and production costs compare favorably with those in smaller mines which work higher grade lead ores. The use of mechanical shovels and the extensive electrification of underground workings at Flat River, St. Francois County, indicate the nature of attempts to reduce mining costs by increasing the efficiency of mining methods.

During the biennium, there was a development of activity near Mine LaMotte and Fredericktown in Madison County, and near Annapolis, Iron County.

Comparative total values of lead concentrates produced in 1936 and 1937 shows the effect of higher prices in the latter year. Production of concentrates rose from 148,209 tons in 1936 to 215,697 tons in 1937, whereas the total value of concentrates produced in 1937 was almost twice the corresponding figure for 1936. Total value of concentrates mined in Missouri rose from \$7,403,159 in 1936 to \$14,736,662 in 1937.

Lead production in the southwestern Missouri district showed a rather sharp increase in 1936 and 1937. However, the Joplin area has not contributed greatly to the total of Missouri's lead ore production for a number of years. Southwestern Missouri concentrates were valued at \$376,391 in 1937, when the southeastern district production was reported to have a total value of \$14,360,271. The southwestern Missouri concentrates were given a value of \$124,409 for 1936 and \$29,950 for 1935. The southeastern district concentrates in 1936 were valued at \$7,278,750 and the corresponding value for 1935 was reported to have been \$5,638,005.

While the average quantity of lead in the crude ore and concentrates of the southeastern Missouri district fluctuated but little between 1935 and 1937, the value per ton of concentrates rose with advancing prices. The value per ton of concentrates was \$42.91 in 1935, rose to \$50.00 in 1936, and was reported as \$68.42 in 1937.

LIME.

The limestones of Mississippian and Ordovician age which outcrop in Missouri contain beds which are satisfactory for the production of lime at a number of places in the State.

Mississippian limestones are quarried for lime burning in Greene, Lawrence, Marion, Newton, and Ste. Genevieve Counties. The Ordovician Kimmswick formation is used in Jefferson and St. Louis Counties, where quarries and kilns are located at Glen Park and Glencoe. Mississippian limestones are worked for plants at Ash Grove, Galloway, Hannibal, and Pierce City.

At and near Ste. Genevieve, Ste. Genevieve County, the Spargen limestone of Mississippian age is quarried extensively and burned to produce lime which has a national reputation as high-grade chemical lime and which finds uses in a wide variety of industrial processes.

Missouri ranked third in total lime production among the states of the nation in both 1936 and 1937. Ten plants operating in the State produced 426,514 tons of lime and hydrated lime in 1937, and this total production had a value of \$2,326,928.

The character and composition of the limestone formations which are suitable for use in the lime industry have been described in a report published by the Geological Survey.

In recent years, much of Missouri's lime production has been used in the chemical industries, in building and construction work, in tanneries, for water-treatment, in metallurgical processes, and for a variety of other purposes.

Lime and hydrated lime produced had a total value of \$1,759,918 in 1935 when 312,462 tons were produced. In 1936, the production of 379,354 tons was valued at \$2,047,189; and in 1937 an output of 426,514 tons was valued at \$2,326,928.

MINERAL WATERS.

No statistics are available to indicate the production and value of mineral waters in Missouri. Mineralized water flows from springs at certain places in the State, and deep drilling in

parts of western, northern and extreme eastern Missouri encounters mineralized waters. Much water is taken from such springs and flowing wells without compensation to owners, or is sold locally.

Excelsior Springs, in Clay County, is the State's most important watering place. Mineralized waters are obtained from drilled wells in the vicinity of that town, and it enjoys a considerable reputation as a health resort as do such resorts as Eldorado Springs in Cedar County,

In recent years there has been an increased use, in certain metropolitan areas, of mineralized waters as a supply for swimming pools. Wells have been drilled or deepened in the vicinity of St. Louis to obtain sulpho-saline water for this purpose, and several bathing resorts have been developed where water of this quality is available from deep wells.

OIL AND GAS.

The last two years have witnessed an increase of about 60 percent in drilling activity and one of the best periods in gas production on record. Over 100 gas wells were completed with an initial open flow capacity of over 100,000,000 cubic feet. There was no marked change in new oil wells from the previous period. The outstanding gas discovery was a shoe-string pool in a sand believed to be the Burbank, extending with two interruptions from sec. 15, T. 49 N., R. 32 W., southeast to sec. 8, T. 48 N., R. 31 W., Jackson County, and a horse-shoe shaped pool in the same sand in secs. 16 and 21, T. 49 N., R. 32 W., Jackson County.

Other discoveries were a Squirrel sand gas pool in the southwest part of T. 49 N., R. 32 W., and a Squirrel sand oil pool in sec. 5, T. 47 N., R. 32 W., both in Jackson County. The Richards-Stotesbury area of Vernon County has received some attention, particularly in the latter part of 1938 and one well is reported to have produced 30 barrels, but to have settled rapidly to about a barrel per day.

Wildcatting also increased considerably over the previous biennial period, with wells in Andrew, Bates, Clay, Clinton, Hickory, Marion, Platte and St. Clair Counties, none of which was successful in finding new production.

The Burbank sand gas pool, generally termed the Sni-a-bar, is of the true shoestring type, over seven miles long and about 600 or 700 feet wide. The sand is at least 35 feet thick in the center of the belt and thins rapidly to the edges. Wells ranged from

500,000 to 4,500,000 cubic feet per day initial open flow capacity. The depth of the wells ranged from 350 feet to 650 feet depending on the surface topography. The original pressure ranged from 149½ to 169½ pounds but dropped rapidly when the wells were put on the line. The gas is sold to the Missouri Valley Gas and Oil Company and the Panhandle Eastern Pipe Line Company, the standard price being 8 cents per 1,000 cubic feet.

In connection with the recent increasingly active interest in the oil and gas possibilities of northern Missouri, the Geological Survey has published two reports concerning the surface and subsurface geology of that portion of the State. Volume XXV, "The Geology of Northwestern Missouri", by H. S. McQueen and F. C. Greene was published late in 1938. A preliminary report on "The Subsurface Geology of Northeastern Missouri", by J. G. Grohskopf, N. S. Hinchey, and F. C. Greene is published as Appendix I to this report.

A brief summary of the results of drilling for oil and gas in Missouri during 1935 and 1936 indicates that in that two-year period 35 oil wells, 46 gas wells, and 78 dry holes were drilled. This drilling was reported from Cass, Clinton, Jackson and Platte Counties. As a result of this drilling, the total initial production from the oil wells was reported to have been 211 barrels. Total open-flow of the gas wells was given as 15,387,968 cubic feet.

A similar summary of incomplete figures for 1937-1938 shows that drilling resulted in the addition of 23 new oil wells, 109 gas wells, and 132 dry holes. Total initial production from these oil wells was 242 barrels, and the gas wells had a total initial open flow of 101,413,643 cubic feet. The new producing wells reported were located in Cass, Jackson, and Vernon Counties. Dry holes were drilled in Andrew, Bates, Cass, Clay, Clinton, Hickory, Jackson, Marion, Platte, St. Clair, and Vernon Counties during the past biennial period.

PYRITES.

By O. R. Grawe.

The term pyrites generally is used to include the various kinds of iron sulphide, but when applied to Missouri ore it includes only the two forms of iron disulphide (Fe S_2), marcasite and pyrite ("fool's gold"). This material is used primarily as a source of sulphur in the manufacture of sulphuric acid and is often referred to as "sulphur ore".

Pyrites has been produced in three districts in Missouri. One is the coal region comprising the western two tiers of counties and those north of the Missouri River. Here pyrite occurs in lenses, concretions and thin plates in the coal and in the clays and shales associated with the coal. The coal miners refer to this material simply as "sulphur" or as "coal brass". Another district is in Madison County between Marquand and Fredericktown. In this region both marcasite and pyrite occur in the lower part of the Bonneterre dolomite where it overlaps upon the underlying Pre-Cambrian felsite porphyry. The third district is an area approximately 30 miles wide and 80 miles long which extends from northeast to southwest through Franklin, Crawford and Phelps Counties. Here marcasite and pyrite are associated with sink structures and usually occur beneath oxidized zones of hematite and limonite, which were formerly worked for iron ore. These deposits are the most important in the State at the present time. They occur in bowl-like depressions in dolomite, principally near the contact of the Roubidoux and Gasconade formations, although strata varying from Pennsylvanian to Potosi in age are known to be associated with them.

In 1932, the present period of activity in the pyrites industry of the State was born. The Evans-Wallower Zinc Company of East St. Louis sought a new cheap source of sulphur in order to fulfill a contract for sulphur dioxide. In September, 1932, Evans-Wallower leased the Ruepple Mine, in Franklin County, from which some pyrites had been shipped and which was known to contain much more. In addition to using Ruepple ore, Evans-Wallower offered to buy ore. This led to the opening of other properties in 1933. During 1934, Evans-Wallower ceased buying ore but the Titanium Pigments Division of the National Lead Company already had entered the market. This company, by purchasing all the pyrites produced, encouraged prospecting of abandoned iron pits. The most notable new development was the discovery of a large body of pyrites in the bottom of Moselle No. 10. This mine is in Phelps County about 9 miles south of Rolla and 2 miles west of U. S. Highway 63. The ore was so close to the surface and of such high grade that mining paid for itself almost from the very start. During 1934 five mines produced 14,557 tons of ore valued at \$51,640.

All the pyrites produced during 1934 was obtained underground. This method of mining iron sulphides in old iron pits is not satisfactory and is not very profitable, moreover, only a

portion of the ore can be recovered. A number of the usual difficulties were encountered at Moselle No. 10, and stripping was started on April 2, 1935. By this time some idea of the size of the ore body had been obtained and the small amount of overburden, especially in the eastern part of the pit, made open pit mining feasible. The success of Moselle No. 10 and the steady market for pyrites encouraged considerable prospecting, and attempts were made to reopen other properties. At Cherry Valley No. 2, five miles east of Steelville, Crawford County, Lark stopped hoisting ore from his shaft and removed it through an inclined adit which was opened in the bottom of the pit and connected with the old workings. The four mines which operated during 1935 produced 24,883 tons of pyrites valued at \$77,263.

In 1936, the Williams Fire Clay Company leased the Leslie mine, $2\frac{1}{2}$ miles south of Leslie in Franklin County. After shipping a number of cars of ore the mine was abandoned and has not been worked since. The company also gave up its lease on the St. Clair mine which was then taken over by the Cisco Mining and Manufacturing Company of St. Louis. Ore continued to be mined underground from a shaft on the rim. Adjoining the St. Clair mine is property now known as the Duckworth mine, owned by Dr. W. H. Duckworth. This property has been prospected years ago. In 1936 a number of holes were drilled, and, as a result of the drilling, a shaft was sunk. The production of this mine has not been reported, and it is now closed.

During 1936, production at Cherry Valley increased slightly. At Moselle No. 10, Thomas and Williams continued deepening the eastern portion of the pit, and the ore continued to be high grade, car loads averaging 49% to 51% sulphur.

Five mines produced pyrites during 1936 but only three reported their production. This amounted to 27,293 tons which were sold for \$77,660. The actual production was about 3000 tons greater.

During 1937 prospecting for pyrites became very intensive. Companies as well as individuals were now searching for "sulphur ore". The Missouri Geological Survey assigned a geologist to make a field study of the pyrite deposits, collect data and to assist those engaged in prospecting. During the summer, 97 properties were visited in 11 counties. Fifty of these properties had been prospected since 1932. Within the year, development work was conducted at two properties. The Starkey mine in

Madison County, 3 miles north of Marquand, was reopened by Elmer A. Whitener and Dan Johnson and several car loads of pyrites were shipped from shallow pits sunk along the contact of the Bonneterre dolomite with the underlying felsite porphyry. In July, 1937, Julian Pickles started a new shaft on the Kelsey property, $1\frac{1}{2}$ miles northeast of Stanton, Franklin County. A steady supply of ore continued from Moselle No. 10, but, as the pit continued to be deepened, the necessity of a change in mining method became obvious. At Cherry Valley No. 2 the usual difficulties of underground mining were encountered, and the property was shut down in March.

Moselle No. 10 continued to be the only important producer of pyrites in Missouri in 1938. At least 50 feet of ore is known to exist below the present working level and the bottom of the deposit has not been determined. The ore known to exist in Moselle No. 10 is sufficient to permit the mine to maintain its present rate of output for several years. In addition to Moselle No. 10, one other mine, the Kelsey, is known to have produced sulphur ore in 1938. The shaft started by Julian Pickles in 1937 attained a depth of 165 feet and drifts were started on the 152 foot level. Pickles' production at the Kelsey has been intermittent. The drift has been driven about 125 feet from the shaft but as yet no provision has been made for extensive mining. During the summer of 1938 an extensive drilling campaign was carried on at Cherry Valley No. 2 and in September, Herman Lark purchased the property which he had been operating under lease. According to the new plan of mining as much ore as possible will be removed by stripping the central part of the pit and the deeper ore in the ends will be removed by underground methods.

It is likely that more sulphur ore will be produced in Missouri in 1938 than was produced in 1937. If economic methods are developed for mining the ore revealed by recent prospecting at Cherry Valley No. 2 and at the Kelsey Mine, the potential pyrites production in Missouri should rise materially in 1939. Actual change will depend on other factors such as property control and markets.

At present all the pyrites produced in Missouri is purchased by the Titanium Pigment Division of the National Lead Company. If the pyrite reserve in the State could be built up sufficiently to insure a constant ore supply over a period of years there is no doubt but that other companies would consider re-

modeling their plants to utilize this ore. Only two new pyrites properties, the Duckworth and Moselle No. 10 have been opened in the last 20 years.

The price of pyrites delivered in St. Louis has been maintained at \$3.70 a long ton for ore containing 45% sulphur. An additional 12 cents per ton is paid for each unit of sulphur above this basic amount. Pure pyrites contains 53.4% sulphur.

Although the pyrites industry in Missouri is not large it has aroused considerable interest. The total production for the State by the end of 1938 is likely to be about 185,000 long tons valued at \$535,000.

The Geological Survey is engaged in field and laboratory studies of the pyrites deposits of the State, and a report on the results of these investigations is being prepared.

SAND AND GRAVEL.

Extensive deposits of sand and gravel are of common occurrence in the stream valleys of Missouri. These important resources are the basis for a large industry because of the steady demand for them as construction materials and in road building and road surfacing. A report on, "The Sand and Gravel Resources of Missouri" has been published by the Geological Survey and is available for distribution.

The value of production of sand and gravel reached a total of \$1,889,787 in 1935, of \$2,402,304 in 1936, and \$2,481,464 in 1937. Production is given as 3,109,104 short tons in 1935 and 4,074,565 in 1936; and in 1937 the State output rose to 4,409,708 tons.

STONE.

A great variety of commercial stone is produced in Missouri, as the various geological formations exposed at the surface in different areas make available a wide range of rock types. Almost every portion of the State contains some resources of this kind. Among the commercially developed quarry products are limestone, marble, granite, porphyry, dolomite (magnesian limestone), sandstone, and tripoli. The character of Missouri rocks quarried or available for quarrying is described in a report published by the Geological Survey and entitled, "The Quarrying Industry of Missouri".

The output of stone from Missouri quarries was valued at \$4,160,847 in 1936 and at \$4,752,700 in 1937. These figures in-

clude appreciable quantities of non-commercial stone which were quarried by various Federal, State, County, and Municipal agencies during the biennial period.

Limestone.—Fifth in rank among Missouri's mineral industries is the production of limestone. In 1936, the value of its production was \$3,732,753 and in the following year, this figure had risen to \$4,209,079. Its uses are widely diversified and much of Missouri's limestone is used for agricultural purposes, road metal, concrete aggregate, riprap, building stone, fluxing, railroad ballast, glass manufacture, rubble, and flagging and curbing. These uses are in addition to the use of this material in lime manufacture. Certain types of dolomitic limestone are used in the manufacture of rock-wool, an insulating material. The Geological Survey has recently published a report describing the nature and occurrence of the dolomitic limestone beds of the Sedalia formation in Boone, Cooper, and Moniteau Counties, where these beds have the characteristics of high-grade wool-rock. This stone has been sampled and analyzed, and a fine, white wool has been prepared from it. As a result of the Survey's attempts to develop this potential mineral resource within the State, the construction of a rock-wool plant in Boone County is proposed.

Marble.—Production of Missouri marble increased steadily during 1935, 1936 and 1937. In 1936, the total value of marble sold by producers in the State was \$380,825. For 1937, the corresponding figure reported was \$461,152. Very attractive, fossiliferous, colored marble is quarried from the Little Saline and Grand Tower formations, both of Devonian age, near Ozora in Ste. Genevieve County. As the product of these quarries can be given a high polish, it is much in demand as an interior and ornamental stone. In southwestern Missouri, Mississippian limestone formations are quarried for marble at Carthage and Joplin, in Jasper County, and at Phenix in Greene County.

The Kimmswick formation of Ordovician age has been quarried recently for the production of marble in Ste. Genevieve County.

Granite.—Pre-Cambrian granite and porphyry outcrop in the southeastern portion of the State in the St. Francois mountain area. In the vicinity of Graniteville, Iron County, the porphyry and granite exposures have been quarried for many years as a source for ornamental stone, rough and dressed monuments,

rough construction and architectural stone, paving blocks, riprap, road metal, and in concrete aggregate. The granite has an attractive deep red color, and monoliths of large size can be quarried. The value of granite produced was \$29,372 in 1936 and \$38,965 in 1937.

Sandstone.—Sandstone from the Roubidoux formation of Ordovician (Canadian) age is quarried in parts of the Ozark region to provide stone facing for small buildings and flagstones for local construction. This stone is rather easily worked, and its colors and markings are varied and interesting. Most of the sandstones in the State are too friable for use as building stones and do not resist the attacks of the weather. Sandstone is used for riprap along the banks of Missouri River where it is quarried locally from beds of Pennsylvanian age. The white, soft sandstone of the Ordovician St. Peter formation is quarried at several places in St. Charles, St. Louis and Jefferson Counties. This sandstone is easily crushed to sand and is put to many uses, chief among which are its use as a glass sand, as molding sand, and making refractory brick. The nature and occurrence of the St. Peter sandstone in Missouri has been described in reports of the Geological Survey.

Chats.—Enormous quantities of waste rock, known as chats, accumulate as a result of the milling of lead and zinc ores. In the Southeast Missouri lead district the waste material is the dolomite of the Bonneterre formation, but in the southwest zinc and lead district it is principally chert or flint of Mississippian age. Chats are used as railroad ballast, in highway construction, and in concrete making. In the accompanying table, the value of the chats sold in Missouri is a wholly arbitrary figure based on a price of twenty-five cents per ton. In 1936 this assumed value was \$682,530 and in 1937 it amounted to \$496,100.

Tripoli.—In western Newton County, Missouri, and a contiguous area in Oklahoma, tripoli has been mined for many years. This white or cream-colored, siliceous material is used chiefly as an abrasive, in filters, as a washing powder, and as a filler in rubber manufacture. The Newton County deposits occur in beds near the surface where the over-burden of waste material is usually less than ten feet thick. It is, therefore, accessible to strip-mining methods and stripping is employed in the recovery of the tripoli. Among the states of the United States, Missouri ranked first in order of the quantity and value of tripoli produced in 1936.

SULPHUR.

Free, elemental or native sulphur is not known to occur in Missouri in commercial quantity. The so-called "sulphur ore" produced in the State is pyrites, which is discussed under that heading in this report.

ZINC.

During 1936 and 1937, the southwestern Missouri zinc mining district continued to show an increase in ore shipments to the large central mill near Cardin, Oklahoma. The revival of activity in Missouri is indicated by the fact that, while 1937 production from the entire Tri-State district of Oklahoma, Kansas and Missouri showed an increase of 4 percent over 1936 production, Missouri mining showed a corresponding increase of 10 percent. Much of this increased production is taken from the area around Oronogo and Webb City in Jasper County, where underground workings have been de-watered by extensive pumping operations in the recent past, after these mines had been flooded for many years. During 1937 and the early part of 1938, ore was hauled from this part of the district to the central mill, and the mines in this area are being kept dry so that they may be workable at any times when market conditions justify operations. Stripping operations in this area have been continued during the biennial period and a concentrating mill located just north of Oronogo was put in operation late in 1938. Early in this year, a small concentrating mill was operating on the La Tosca property in the Oronogo district.

In the vicinity of Stark City and Wentworth in Newton County, drilling operations were carried on in 1937 and 1938, and ore is being shipped to the central mill from the Stark City area. Ore bodies have also been developed in the Wentworth vicinity.

During the early part of the biennium, development was most active in the Oronogo, Webb City, Waco, Joplin, Neck City, Spring City and Spurgeon areas. The U. S. Bureau of Mines reported that about 65 mines were working in southwestern Missouri in 1937. Sixteen mills were operated and the greater part of the ore mined was treated in Oklahoma. Tailings which were treated in that year came from near Webb City and Joplin. Minor amounts of sphalerite (zinc sulphide) are recovered from

the concentrates which are produced by milling operations in the southeastern Missouri lead district, where small quantities of zinc sulphide are associated with the lead sulphide for which the ore is mined.

Statistics compiled by the United States Bureau of Mines indicate a steady increase in the total value of zinc produced in Missouri since 1934. In 1935, a total of 14,420 short tons of zinc concentrates were produced, and a total value of \$392,541 was assigned to this production. In 1936, production rose to 34,801 tons, valued at \$1,098,233. In 1937, 39,429 tons of concentrates were produced and had a total value of \$1,655,289.

FINANCIAL STATEMENT FOR 1937-38—GEOLOGY

1937

H. A. Buehler.....	\$5,566.14
H. S. McQueen.....	4,335.39
F. C. Greene.....	3,328.88
John Grohskopf.....	2,367.64
Norman Hinchey.....	2,308.07
Willard Farrar.....	508.79
Kenneth Aid.....	2,018.70
C. O. Reinohl.....	2,036.58
Mary Hundhausen.....	810.00
Roma D. Preuss.....	559.35
S. R. B. Cooke.....	100.00
W. L. Haseltine.....	68.75
R. T. Rolufs.....	720.36
Kenneth D. Cox.....	95.76
Lyle McManamy.....	1,384.06
Edward L. Clark.....	785.32
G. A. Muilenberg.....	368.66
O. R. Grawe.....	706.77
Robert Alger.....	457.94
E. E. Hawkins.....	1,357.76
Jean I. McCaw.....	1,500.00
Student labor.....	993.32
Monsanto Chemical Co.....	117.88
Helen Baysinger, Postmaster.....	286.46
Fuller Brush Company.....	12.25
Midland Printing Company.....	648.26
Triangle Blue Print & Supply Co.....	12.96
Heil Corporation.....	114.52
American Star Cork Co.....	130.41
Kansas City Paper House.....	36.24
American Paulin System.....	23.75
Continental Electric Co.....	24.12
American Askania Corporation.....	137.67
Kimble Glass Co.....	255.00
Chase Bag Company.....	250.92
Rolla Motor Company.....	465.86
Taylor Instrument Co.....	11.20
Martin Hardware Co.....	50.00
Standard Electric Stove Co.....	22.00
Keuffel & Esser Co.....	48.93
Woodstock Typewriter Co.....	80.00
Pure Oil Company.....	150.00
Buck Lee Tire Co.....	59.12
General Tire & Rubber Co.....	20.50
Oswald Griner.....	19.30
Firestone Tire & Rubber Co.....	39.82
Goodyear Tire & Rubber Co.....	210.01
W. & L. E. Gurley.....	9.00
Chas. Bruning Company, Inc.....	50.81
Kee-Lox Mfg. Co.....	17.20

FINANCIAL STATEMENT FOR 1937-38—GEOLOGY—Continued.

Western Union Telegraph Co.....	\$ 25.87
Railway Express Agency.....	274.22
United Telephone Co.....	154.58
Walsh-Record, Inc.....	66.46
Laboratory & Field, miscellaneous supplies.....	364.29
	\$36,567.85

1938

H. A. Buehler.....	\$5,464.91
H. S. McQueen.....	4,406.23
F. C. Greene.....	3,297.85
Norman Hinchey.....	2,772.25
John Grohskopf.....	2,430.90
Kenneth Aid.....	2,590.58
C. O. Reinoehl.....	2,033.90
Mary Hundhausen.....	950.00
R. T. Rolufs.....	741.67
Kenneth D. Cox.....	375.45
Lyle McManamy.....	2,575.36
Edward L. Clark.....	888.68
G. A. Muilenberg.....	655.13
O. R. Grawe.....	536.53
E. E. Hawkins.....	1,320.00
Jean I. McCaw.....	1,518.83
Student labor.....	946.97
Midland Printing Co.....	84.41
Monsanto Chemical Co.....	159.47
Goodyear Tire & Rubber Co.....	172.02
Firestone T. & R. Co.....	58.20
Chas. Bruning Company, Inc.....	71.29
Superior Chevrolet Co.....	604.25
Glasco Electrical Supply Co.....	13.40
J. J. Rieth Co.....	7.35
F. B. Powell Lumber Co.....	51.20
L. L. Lewis Auto Sales Co.....	47.03
Williams & Heintz Co.....	46.00
Helen Baysinger, Postmaster.....	268.00
Keuffel & Esser Co.....	36.81
Heil Corporation.....	35.73
American Star Cork Co.....	108.68
Kimble Glass Co.....	382.50
M. O. Martin Hdwe. Co.....	50.00
C. D. Via.....	16.20
The McCaw Company.....	12.25
Iwan Bros.....	3.78
C. M. Dodd.....	300.00
Leroy Allen.....	210.00
E. E. Branson.....	178.66

FINANCIAL STATEMENT FOR 1937-38—GEOLOGY—Continued.

Carl Branson.....	\$ 88.61
Wm. C. Smith.....	91.11
S. P. Ellison.....	93.15
Craig Tire & Sales Co.....	24.06
Commonwealth Chevrolet Co.....	695.00
Earl Chevrolet Co.....	75.00
Cenco Microscope Illuminating Co.....	7.01
Walter Post Co.....	20.51
Chase Bag Co.....	243.13
Line's Garage.....	15.32
Erker Bros.....	10.50
Spencer Lens Co.....	7.50
R. L. Griggs.....	65.25
J. S. Swift Co.....	139.20
A. B. C. Fireproof Warehouse Co.....	141.00
Montgomery Ward Co.....	10.07
Western Union Telegraph Co.....	28.71
Railway Express Agency.....	177.30
United Telephone Co.....	174.63
Rolla Ice & Wood Co.....	5.32
Griner Co.....	15.00
U. S. Government Printing Office.....	75.00
Henderson Auto Supply Co.....	68.12
Rolla Oil Co.....	70.87
Valley Bag Co.....	99.15
Triangle Blue Print & Supply Co.....	41.50
Miscellaneous Laboratory and field supplies.....	385.03
	\$39,289.52

Note

The following items have been contracted, to be paid from the 1937-38 appropriation:

U. S. Government Printing Office (400 level books).....	\$ 75.00
Midland Printing Co. (Vol. XXV and Biennial Report).....	4,436.88*
A. Hoen & Co. (New edition State Geol. map).....	3,620.00**
	\$8,131.88

*Estimated total cost submitted by Midland Printing Co.

**Bid price made by A. Hoen & Co.

FINANCIAL STATEMENT FOR 1937-38—TOPOGRAPHIC MAPPING

1937

C. L. Sadler.....	\$258.33
W. R. Broadbuss.....	324.99
C. C. Juhre.....	192.21
T. V. Cummins.....	476.65
Daniel Kennedy.....	560.83
J. B. Leachman.....	175.00
S. B. O'Hara.....	75.00
J. A. Shumate.....	135.00
F. L. Whaley.....	87.50
	\$2,285.51

1938

Irwin Klein.....	\$772.91
C. C. Juhre.....	308.33
E. P. Hodge.....	693.74
L. B. Walker.....	725.00
H. S. Barger.....	323.44
C. L. Sadler.....	416.66
W. R. Broadbuss.....	216.66
C. E. Goss.....	281.02
C. A. Killian.....	733.14
J. A. Shumate.....	1,396.64
F. L. Whaley.....	291.66
T. A. Magee.....	204.10
Herman Kolb, Jr.....	32.50
Jos. F. W. Smith.....	101.50
F. C. Lentz.....	195.27
J. T. Powell.....	95.15
W. V. Kennedy.....	251.28
W. P. Metcalfe.....	107.37
J. B. Leachman.....	970.00
A. C. McCutchen.....	172.50
T. V. Cummins.....	175.00
Daniel Kennedy.....	361.00
S. B. O'Hara.....	1,489.98
C. L. Salley.....	98.15
Frank Vincent.....	189.58
O. G. Johnson.....	29.92
Opal R. Kolb.....	54.00
S. E. Mitchell.....	101.01
W. D. Phillips.....	104.05
W. B. Brewer.....	974.14
	\$11,865.70

FINANCIAL STATEMENT FOR 1937-38—WATER RESOURCES

1937

H. C. Beckman.....	\$2,047.18
G. N. Mesnier.....	50.48
C. H. Jennings.....	2,220.00
E. S. Miller, Jr.....	90.65
Robert Elgin.....	99.40
J. W. Odell.....	525.00
Kenneth J. Stedelin.....	229.07
J. J. Crane.....	71.90
C. D. Craig.....	34.90
F. Y. Brown.....	19.00
Warwick L. Doll.....	83.33
C. J. Eyberg.....	112.50
Gage Readers.....	606.76
Smith Service Station.....	30.07
Superior Chevrolet Co.....	33.38
Rolla Motor Co.....	404.21
	\$6,657.83

1938

H. C. Beckman.....	\$2,076.88
C. H. Jennings.....	2,264.41
Edgar S. Miller, Jr.....	230.65
J. W. Odell.....	987.15
J. J. Crane.....	121.31
Fred Singleton.....	35.50
Gage Readers.....	594.00
C. J. Eyberg.....	409.84
Warwick L. Doll.....	333.16
Wallace B. Roach.....	131.92
David S. Wilder.....	904.46
E. R. Leeson.....	190.13
Smith Service Station.....	25.24
Superior Chevrolet Co.....	35.97
W. M. Littlefield.....	225.00
	\$8,565.62

Subsurface Geology

of

Northeastern Missouri

A Preliminary Report

By

J. G. GROHSKOPF, N. S. HINCHEY AND F. C. GREENE



Appendix I, 60th Biennial Report

1939

MISSOURI

GEOLOGICAL SURVEY AND WATER RESOURCES

H. A. BUEHLER, *Director and State Geologist*

ROLLA, MISSOURI

MIDLAND PRINTING COMPANY
JEFFERSON CITY, MO.



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SUBSURFACE GEOLOGY OF NORTHEASTERN MISSOURI.

A PRELIMINARY REPORT

By

J. G. Grohskopf, N. S. Hinchey, and F. C. Greene

INTRODUCTION.

The files of the Missouri Geological Survey contain many unpublished records pertaining to the geology and mineral resources of the State. In accordance with the policy of this organization, it is thought to be desirable to publish certain records of the results of well drilling in North Central and Northeastern Missouri because of the recent active interest in, and demand for, such data.

Several of the published reports of this Survey contain well data and subsurface geologic information which pertain to this area. Among these reports, those which are particularly pertinent include:

“Structural Reconnaissance of the Mississippi Valley Area from Old Monroe, Missouri, to Nauvoo, Illinois,” by Frank Krey. Missouri Bur. Geology and Mines, 2nd series, vol. 18, 86 pp., XVIII pls. (including map), 1924.

“The Occurrence of Oil and Gas in Missouri,” by M. E. Wilson, Missouri Bur. Geology and Mines, 2nd series, vol. 16, 285 pp., XI pls. (including maps), 1922.

A few of the original logs of wells given below have been taken from the U. S. Geological Survey's Water-Supply Paper No. 195, entitled “Underground Waters of Missouri, Their Geology and Utilization”, by E. M. Shepard (1907); and from “Artesian Water in Missouri”, by A. W. McCoy, Missouri University Bulletin, Engineering Experiment Station, series 4, number 3 (1913). Attempts have been made to revise the correlation of some of these older logs with the aid of more recently acquired data.

Other publications which describe subsurface and surface geological conditions in Missouri are listed in "Publications of the Missouri Geological Survey and Water Resources", reprinted from the 58th Biennial Report of the State Geologist in 1935.

In addition to its published reports, the Geological Survey's files contain several unpublished reports in manuscript, and unpublished maps which describe parts of the area. These include: a report on the Geology of Mercer and Grundy Counties with areal geologic maps of those counties, by F. C. Greene; a report on, and maps of, the Green City and Queen City Quadrangles in parts of Putnam, Schuyler, Sullivan, and Adair Counties, by F. C. Greene; an outcrop map of the Gallatin and Chillicothe Quadrangles, by R. B. Rutledge; and unpublished field notes of Bucklin Area, Linn County, by J. M. Thiel. These reports and maps are available for examination at the offices of the Missouri Geological Survey at Rolla, Missouri.

During the past few years the Missouri Geological Survey has cooperated with the United States Geological Survey, the Federal Emergency Relief Administration, and the Works Progress Administration, in completing the third-order level network of the State. Benchmarks have been established in the area and are described in notes which may be consulted in the office of the Geological Survey at Rolla.

Since the publication of the reports of Wilson and Krey, additional information has been obtained in the form of well logs and samples of well-cuttings from wells drilled in northern Missouri. With the aid of this additional information, it has been possible to revise and re-interpret some of the correlations of well data given in earlier reports. Because of the demand for such information, the logs of important north central and northeastern Missouri wells of record in the files of the Geological Survey are assembled and published herein, together with a brief summary of the stratigraphy of the area.

ACKNOWLEDGMENTS.

The work incorporated in this report was undertaken under the direction of Dr. H. A. Buehler, State Geologist, to whom the writers are indebted for sound advice and helpful criticism. Mr. H. S. McQueen, Assistant State Geologist, has shown an active interest in the work and has aided in its prosecution.

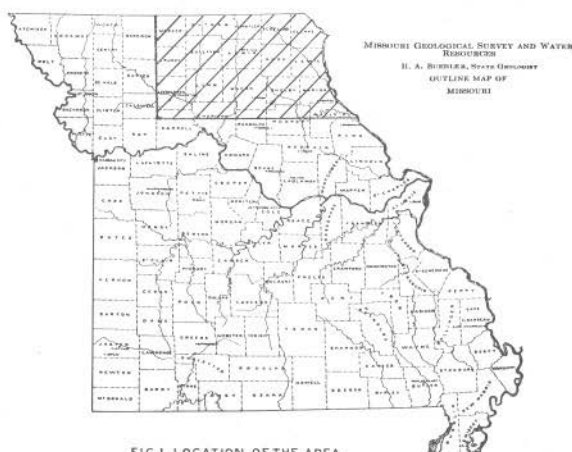


FIG. 1 LOCATION OF THE AREA

The associates of the writers on the staff of the Missouri Geological Survey have assisted materially in the preparation of data used in the report. Miss Mary Hundhausen and Mr. Earl McCracken have furnished valuable subsurface details in their studies of well-samples. Mr. Kenneth Aid has assisted in field and office work.

Credit is due to Mr. Leo Lambiel for the careful preparation of the accompanying illustrations, and to Miss Mary Houston for her valuable services in completing the necessary stenographic work.

STRATIGRAPHY OF THE AREA.

Pre-Cambrian Rocks.

No pre-Cambrian rocks are known to outcrop within the area considered in this report. Available records indicate that at least two wells have penetrated these rocks. The driller's log of well No. (4) in Macon County suggests that the top of the pre-Cambrian was reached at a depth of 2,611 feet. An excellent set of samples are available for study from well No. (15), Ralls County, in which well the top of the pre-Cambrian was reached at depth 2,185 feet. It consists of red granite containing some magnetite.

Cambrian System.

The Cambrian rocks do not outcrop in the area, but drill records indicate their occurrence in the subsurface. The Cambrian system has a thickness of 1,230 feet in the eastern part

of the area. The following formations, which have been recognized and are described, are all of upper Cambrian age:

Eminence formation	}	(Ozarkian system of E. O. Ulrich)
Potosi formation		
Doe Run formation		
Derby formation		
Davis formation		
Bonne Terre formation		
Lamotte formation		

Lamotte Formation: The Lamotte is a sandstone, the grains of which are usually coarse, well-rounded and white in the upper 100 feet. In the lower portion of the formation the sand grains are smaller in size, darker in color and grade from shades of yellow to pink. The thickness, as determined from well No. (15) in Ralls County, is 330 feet.

Bonne Terre Formation: The Bonne Terre is a dolomite, usually dark gray in color, which contains some fine silt or sand in its upper portion. The lower portion becomes increasingly sandy and glauconitic and seems to be transitional with the Lamotte. Its thickness, as determined from well No. (15) in Ralls County, is 225 feet.

Davis Formation: The Davis is a silty to sandy dolomite, which becomes shaly near the base. The sand is glauconitic and medium-grained, and the shale is green and splintery. A thin bed of white, rounded and frosted sand is found at the base. The thickness of the Davis, as determined from well No. (15) Ralls County, is 300 feet.

Derby and Doe Run Formations: These formations are not separated in this area because of their similarity and because so few samples are available for study. They consist of very pure dolomites with slight traces of pyrite, a little silt and some glauconite. Near the base some silicified sponge spines have been noted. Their combined thickness, as determined from well No. (15) Ralls County, is 235 feet.

Potosi and Eminence Formations: (Ozarkian system of E. O. Ulrich). These formations have not been separated in this report. However, in well No. (15) Ralls County, the Potosi may be present. In general the Eminence is a gray crystalline dolomite, somewhat cherty and contains some quartz near its base. The Potosi is a brown siliceous dolomite which is charac-

terized by the presence of banded quartz druse. Their combined thickness, as determined from well No. (15) Ralls County, is 120 feet.

Ordovician System.

The Ordovician formations which have been identified in this area, are as follows:

Cincinnatian Series:

Maquoketa formation

Mohawkian Series:

Kimmswick formation

Decorah formation

Plattin formation

Big Buffalo Series:

Joachim formation

Everton-St. Peter formations

Canadian System of E. O. Ulrich:

Cotter formation

Jefferson City formation

Roubidoux formation

Ozarkian System of E. O. Ulrich:

Gasconade formation

Van Buren formation (with basal Gunter sand)

No formations older than Joachim are known to outcrop within the region. In the area east of Range 7 West, in Townships 55 and 56 North, Ordovician formations younger than the Joachim are known to outcrop, as shown on the State geological map.

Gasconade-Van Buren Formations: These formations are not separated in this report. They consist of gray cherty dolomites, at the base of which is found a sandy dolomite that has been identified as the Gunter member. As determined from a few wells within the area these formations are from 250 to 300 feet thick including the Gunter member, which averages about 40 feet in thickness.

Roubidoux Formation: The thickness of the Roubidoux within this area averages about 125 feet. It consists of dolomite, oolitic chert and sand. The sand beds do not always occur at the same horizon and are therefore not reliable markers in the subsurface.

Jefferson City Formation: The Jefferson City formation is composed of brown and gray, finely crystalline and cherty to argillaceous dolomites. Some thin green shale beds are present, especially in the upper portion. Thin sandstone beds are common throughout the formation. The average thickness of the Jefferson City is from 225 to 250 feet.

Cotter Formation: The lithology of the Cotter formation is very similar to that of the Jefferson City. It usually contains more shale than does the Jefferson City. It has been differentiated from the underlying formation on the basis of faunal and regional stratigraphic studies. No average figure can be given for its thickness because of the great unconformity at the top. The Cotter represents the upper portion of the "Siliceous Lime" of Kansas and the "Arbuckle" of Oklahoma.

St. Peter and Everton Formations: These two formations are considered as a unit in this report because of their similarity in lithology and their intimate association. The upper portion usually consists of a pure non-calcareous sand, the grains of which are medium to coarse in size, well-rounded and frosted. In some instances this coarse sand grades into a finer sand below or there may be present either a shale or dolomite break between the two sand bodies. In other instances, the white sand rests directly upon a gray finely crystalline dolomite containing some green shale. The thickness of these two formations varies from 30 to 150 feet within the area, with 100 feet being more nearly the average. These formations are considered by some geologists as correlative with the "Simpson" of the Mid-Continent region.

Joachim Formation: This formation is a yellow, non-cherty, argillaceous dolomite and dolomitic limestone which is sandy near the base. It is thickest in Ralls County where 40 feet of it has been noted in well cuttings. It thins to the north and west and has not been noted in wells west of Shelby, Knox and Scotland Counties. According to Krey⁵ it outcrops as far north as sec. 25, T. 56 N., R. 6 W., Ralls County.

Plattin Formation: The Plattin formation is a gray to blue limestone, the texture of which varies from granular to lithographic. It may become dolomitic at places and contains a small amount of chert. The thickness and distribution are similar to that of the Joachim. It outcrops in Pike and Ralls Counties.

Decorah Formation: In the area covered by this report the Decorah is one of the most widespread and easily recognized of the post-St. Peter Ordovician formations. The Decorah consists of fossiliferous gray to tan limestone, which is shaly and bentonitic in many places. The thickness varies from 0 to 55 feet, with 25 feet being more nearly the average. Some of the shale is very organic and pieces of it taken from well samples contain enough organic matter so that it burns upon ignition. It outcrops in Pike and Ralls Counties.

Kimmswick Formation: In the eastern portion of the area the Kimmswick or "Trenton" is composed of gray to white, coarsely granular limestone. Near the middle of the formation a prominent chert bed has been noted on the outcrop and in well cuttings. The lower half of the formation is dolomitic at places and has a brown appearance. This portion of the section is often described as sand by well drillers.

The Kimmswick thickens to the north where it is a dolomite. It increases in thickness from 125 to 175 feet in that direction. The formation outcrops in Pike and Ralls Counties. It is a part of the "Viola" of the Mid-Continent region.

Maquoketa Formation: The Maquoketa ("Sylvan" of the Mid-Continent region) is in the main, a shale. The formation may be divided for convenience into three parts, the upper black shales, the middle gray shales, and the lower gray, flaggy and calcareous shales. The black shales usually contain graptolites which serve as an easy means for distinguishing it from the Mississippian Grassy Creek shale formation which overlaps it at places. In the extreme southeastern portion of the area along Mississippi River the Maquoketa attains a thickness of 150 feet. It thins rapidly to the northwest and west, and in well No. (18) Marion County it is only 18 feet thick. Farther west it is absent in wells as shown on cross-section A-A'.

Silurian System.

Alexandrian Series

Edgewood Formation: The Noix oolite member of the Edgewood formation has been recognized on the outcrop at a few isolated localities in northeastern Ralls County, where its distribution is known to be patchy. No beds which can be definitely referred to the Silurian are known elsewhere in the

region either on the surface or in the subsurface. An excellent discussion of the Silurian immediately south and east of the area is given by Rowley⁹ and Krey⁵.

Devonian System.

The Devonian formations which have been identified within the area are classified as follows:

Upper Devonian series:

Callaway formation

Middle Devonian series:

Cooper formation (with basal sandstone)

These formations have been described in detail by Branson¹, and are also discussed by Wilson¹¹ and Krey⁵. The Devonian is known to outcrop in Marion and Ralls Counties. In the subsurface the Devonian varies from 100 to 300 feet in thickness, with the latter thickness being almost constant in the western part of the State. This uniform thickness is shown on cross-section A-A', and is reported to obtain in northwestern Missouri⁷.

Cooper Formation: The Cooper formation, as known from well cuttings, consists of a lithographic gray to tan limestone with disseminated calcite crystals. It is slightly sandy in the eastern portion of the area, the sand occurring in the limestone matrix. The sand grains are well-rounded, of medium size and are white to light tan in color. The grains resemble those of the St. Peter, from which they probably were derived. In wells in the eastern portion of the area, the Cooper limestone rests on the Maquoketa or Kimmswick. The thickness of the Cooper limestone varies from 25 feet in well No. (18) in Marion County to 95 feet in well No. (3) in Knox County in which well the base of the formation was not reached.

To the north and west of Marion and Knox Counties the Cooper thickens and in Putnam and Livingston Counties a dolomite and basal sandstone wedge into the section as shown on the cross-sections A-A' and B-B'. The dolomite is 19 feet thick in well No. (2) Putnam County and is underlain by 34 feet of white sand, the grains of which are well-rounded and frosted. The sand is very similar to that of the St. Peter from which it probably was derived. Whether the sand and dolomite are basal Devonian or upper Silurian can not be definitely proven

at this time. In this report they are considered as basal Devonian.

Callaway Formation: The Callaway formation as identified from well cuttings lends itself to a two-fold division. The lower division is tan, sucrose dolomite and dolomitic limestone containing sand. The upper division consists in the main, of fine-grained to dense, gray limestone which is slightly sandy, cherty and argillaceous. In well No. (3) in Knox County and well No. (18) in Marion County, both of these divisions are clearly shown.

The base of the upper zone is characterized by the presence of a very fossiliferous layer, containing *Tentaculites*, ostracodes, and brachiopods. Cuttings from wells in the Colmar oil pool in McDonough County, Illinois, were made available to the Missouri Geological Survey through the courtesy of Mr. L. E. Workman of the Illinois Geological Survey. A comparison of these samples with those of Marion and Knox Counties, Missouri, has shown that the fossiliferous zone at the base of the Callaway limestone and the sandy dolomite immediately below it are present in both areas. The sandy and dolomitic division contains the Hoing sandstone according to Workman¹².

Mississippian System.

General Statement

Rocks of Mississippian age outcrop in the eastern portion of the area in parts of Clark, Lewis, Marion, Pike, Ralls, Monroe, Shelby, Knox, and Scotland Counties. A comparatively thick mantle of glacial drift covers the indurated rocks of the Mississippian, and outcrops are found only in those valleys in which the major streams have cut through the veneer of glacial deposits. In areal geologic mapping, the cover of drift makes difficult the drawing of accurate boundary lines in a large part of the region, and geologic maps should be examined with this factor in mind.

Somewhat detailed descriptions of the pre-Pennsylvanian rocks which outcrop in the eastern part of the region have been published by Krey⁵. Krey's report includes a discussion of the stratigraphy and geologic structure of the easternmost tier of counties in northeastern Missouri and adjacent counties in Illinois. Detailed faunal and stratigraphic studies of the Mississippian strata below the top of the Warsaw formation in Missouri have been made by R. C. Moore⁸, whose bulletin on the

early Mississippian formations contains descriptive and interpretative material concerning the exposures of these Mississippian rocks in the northeastern part of the State.

The following Mississippian units are discussed in this report:

Mississippian system:

Meramec group:

- Ste. Genevieve (?) formation.
- St. Louis formation.
- Spergen (Salem) (?) formation.
- Warsaw formation.

Osage group:

- Keokuk formation.
- Burlington formation.
- Sedalia formation.

Kinderhook group:

- Chouteau formation.
- Hannibal formation.
- Louisiana formation.
- Grassy Creek formation.

No beds which can be assigned with reasonable assurance to the Chester series are known to be present in the area.

Kinderhook Group.

Grassy Creek Formation: The term Grassy Creek formation as used in this report includes beds of black, fissile or thinly laminated shale and the greenish-gray or bluish-gray shales which have been termed "Saverton" by certain authors. These beds outcrop in the southeastern part of the area in Pike, Marion, and Ralls Counties. At places, the Grassy Creek shale is somewhat sandy near its base, and these sandy beds often contain fragmental fish remains and coprolites. The light colored beds usually lack the finely laminated bedding which is more or less characteristic of the black portions of the formation. Organic remains which have been called spores are present locally in the Grassy Creek and are often recognized in samples of well-cuttings. The thickness of the formation is variable, and at places it is entirely absent. In the Mississippi River bluff at Louisiana, Pike County, six feet of black and light colored Grassy Creek shale lies on Silurian dolomite and is overlain by the Louisiana limestone. The formation apparently thickens

to the north along Mississippi River and 85 feet of beds are assigned to it in the Fabius River Development Company's No. 1 Tate well in sec. 22, T. 59 N., R. 6 W., in Marion County. In well Number (5) in Lewis County, 150 feet of shale is reported to occur at the horizon of the Grassy Creek. To the west, the shale thins appreciably and less than 25 feet is present in wells of record in the western part of the area.

Louisiana Formation: The Louisiana formation is made up of rather thin beds of light gray to buff-colored, dense limestone which is essentially "lithographic" in texture. At places, parts of the limestone are somewhat dolomitic, and geodes filled with crystalline calcite are present in many of the limestone beds. The occurrence of the formation is restricted to the eastern part of the area of this report and it is apparently absent in the subsurface in the central and western parts of the region. In outcrops at Hannibal, Marion County, the Louisiana is approximately 60 feet thick⁵, and in southwestern Marion County exposures, its thickness is approximately 30 feet. It is present in wells in eastern Knox and Shelby Counties, but has not been recognized in wells farther west. The Louisiana is apparently missing from well-sections in northwestern Knox County and in the extreme eastern part of Putnam County.

Hannibal Formation: The Hannibal formation consists of beds of buff and light-green or bluish shales and sandy shales which outcrop in the southeastern part of the area. The upper portion is more sandy than the bulk of the formation and has been called the "Vermicular Sandstone" because of the presence of small tubular holes filled with soft, earthy material which ramify through the soft sandstone. The sandy upper beds include very fine-grained sandstone, and some shale containing rather evenly disseminated grains of fine sand. The upper portion has an average thickness of from 20 to 30 feet where this sandy facies is developed, and the entire formation has a total thickness which is near 100 feet in the eastern counties of the region. In the Mississippi River bluffs at Hannibal, 67 feet of the formation rests on Louisiana limestone⁸. In a well in sec. 34, T. 55 N., R. 5 W., Ralls County, 125 feet of Hannibal was drilled, and the formation is 117 feet thick in the No. 1 Tate well in sec. 22, T. 59 N., R. 6 W., in Marion County. In general the distribution of the Hannibal is similar to that of the Louisiana limestone in the area included in this report. It has not been

recognized in the few deep wells of record in the area west of eastern Shelby and Knox Counties.

Chouteau Formation: The Chouteau formation is exposed at the surface in the southeastern part of the area and outcrops are known as far northwest as southeastern Knox County. The Chouteau is made up of limestone beds of somewhat variable color and texture. It is usually drab to dark-gray, dense or earthy limestone, though locally it is more crystalline and lighter in color. At places the limestone is somewhat argillaceous or slightly shaly and some beds are dolomitic. Samples of the Chouteau from wells in the central and western parts of the area show it to be a rather dark-gray, dense limestone with some slate-gray chert. In the area of its outcrop, the Chouteau is usually fossiliferous and at places the beds are crowded with organic remains. The Chouteau is reported by Moore⁸ to be "mostly absent" along Mississippi River in Marion, Ralls and Pike Counties and subsurface data at hand seem to substantiate this generalization. Moore has measured a section in Knox County in sec. 26, T. 60 N., R. 10 W., in which 35 feet of Chouteau are described. To the west, the formation apparently thickens, and its average thickness in the central and western parts of the area is probably nearer 80 to 100 feet.

Osage Group.

Sedalia Formation: The Sedalia formation is described as a massive, brownish-gray, siliceous, dolomitic limestone which is typically developed in west central Missouri. Moore⁸ refers 18½ feet of limestone to this formation in describing a measured section in sec. 26, T. 60 N., R. 10 W., in Knox County. Comparatively little information is available concerning the thickness, lithologic character, or distribution of the Sedalia formation in the area considered in this report.

Burlington-Keokuk Formations: In subsurface studies in the region, the Burlington and Keokuk cherty limestones have been grouped together as a single unit. They are made up of white, gray, and brown, coarsely crystalline and crinoidal limestones which are usually very fossiliferous. The limestones contain an appreciable amount of white, tan, and gray, dense or fossiliferous chert. These formations are well exposed in the eastern part of the area along Mississippi River and its principal tributaries. Most of the beds of the Burlington and Keokuk are

composed of pure limestone, though they include some magnesian strata and a few layers of dolomite at places. Except where they have been removed at the surface by recent erosion in the southeastern portion of the area, the Keokuk and Burlington are present at or beneath the surface in the entire region. The two formations have an aggregate total thickness of from 150 to 200 feet over most of the area.

Meramec Group.

Warsaw-Spergen (Salem) (?) Formations: In north central and northeastern Missouri it has not always been possible to accurately delimit the Spergen (Salem) formation, though certain local exposures of this part of the Mississippian section include beds which are lithologically similar to the Spergen (Salem) of St. Louis and Jefferson Counties, southeast of the area. Limestones which resemble the Spergen (Salem) are included in the upper part of the Warsaw formation in this discussion. The Warsaw outcrops in the extreme northeastern part of the area are made up of beds of shale with minor amounts of limestone. To the south and west, there is less shale in the formation, and the subsurface Warsaw in most of the region is made up of limestone and cherty limestone beds with minor amounts of shale. The shale apparently occurs as thin beds or as partings between the limestone strata. The limestone beds are cherty, especially in the lower part. The upper Warsaw contains a rather distinctive pink or red, chalcedonic chert at most places in the central and western parts of the area. The lower portion of the Warsaw consists of white, gray, and buff colored limestones and cherty limestones. In texture, the limestones are both fine-grained and coarsely granular. The cherts are light to dark-gray, dense or mottled and fossiliferous. Only a few wells have penetrated the Warsaw in the central and western parts of the region, where its total thickness is approximately 75 feet.

St. Louis-St. Genevieve (?) Formations: The term St. Louis formation as used in this report may include some beds of Ste. Genevieve age at its top. The Ste. Genevieve has been recognized in the subsurface in northwestern Missouri⁷. In Lewis and Clark Counties the uppermost Mississippian contains sandy, fossiliferous, oolitic limestone beds and beds of sandstone which may belong in the Ste. Genevieve formation, but which cannot be readily separated from the underlying beds. In the

area of its outcrop in the northeastern portion of the region, the St. Louis is usually a brecciated or conglomeratic limestone with phenoclasts of limestone in a matrix of limestone and sandy or argillaceous limestone. Locally, dolomitic limestone and sandstone beds are found just above the brecciated beds. Much of the St. Louis limestone is dense or sub-lithographic in texture, and this texture is typical of most of the boulders in the clastic limestone beds. In general, the lithologic character of these phenoclasts resembles that of the limestones above the clastic beds rather than that of the subjacent strata. Thin, greenish-gray shale beds or partings occur between some of the St. Louis beds, and there are small amounts of shale in the matrix of the brecciated beds, at some places. Krey⁵ reports from 40 to 60 feet of St. Louis at places in Lewis and Clark Counties where "the upper portion contains oolitic layers interbedded with the dense, and at several localities a sandstone layer up to 6 feet thick is present". Where the St. Louis is present in wells of record in the central and western parts of the area, it has a maximum known thickness of approximately 40 to 50 feet.

Pennsylvanian System.

Introduction.

Rocks of Pennsylvanian age outcrop or occur below the glacial drift in the northern and western parts of the district. The mantle of drift precludes drawing of definite boundary lines except for short distances in relatively small areas and areal geology maps of the district should be used with this understanding.

The Pennsylvanian beds in the district are included in the Cherokee, Henrietta, Pleasanton and Kansas City groups, the relative size of the outcrop area of each decreasing from Cherokee upward to Kansas City.

The principal rock types are shale, sandstone, clay, coal, limestone and conglomerate. With the exception of the Ardmore, the limestones are confined chiefly to the Henrietta and Kansas City, greatly limiting the area in which reliable beds are available for surface structure mapping. Some coal beds and black slaty shales are rather persistent and constitute reliable key beds for log correlation or prospect drilling.

The following is a generalized section for the eastern part of the area:

Generalized Section of Pennsylvanian System in Northeastern Missouri.

	Feet.	Inches.
Kansas City group:		
1. Limestone in nodules.....	3	
2. Limestone, gray; heavy bedded above, thin bedded below; has a few shale partings. (Bethany Falls.).....	12	4
3. Shale, blue.....	1	10
4. Shale, black, slaty.....	1	6
5. Limestone, gray (Middle Creek).....		4
6. Shale, drab.....	5	
7. Sandstone, yellow; even and thick bedded.....	4	9
8. Shale, light drab; sandy.....	10	4
9. Limestone, gray; in two beds at Milan, but to the east contains several shale partings. (Hertha.).....	5	
Pleasanton group:		
10. Shale, variable; lower part is commonly black and slaty and bears large spherical concretions.....	15	
11. Coal (Ovid), very irregular, ranges from a mere film to 2 feet in thickness.....		3
12. Clay and shale.....	5	
13. Sandstone, blue when fresh, yellow or brown when weathered; in places calcareous; cross-bedded at top and locally contains 1 to 20 feet of conglomerate and coarse sandstone at base; unconformable on underlying beds; thickness of sandstone irregular, 15 to 88 feet, averaging about.....	50	
14. Shale, drab; thickness 5 to 55 feet where present; replaced by the preceding sandstone in some areas; average probably.....	20	
15. Limestone, dark and shaly to blue and siliceous; interbedded with fossiliferous shale.....	2	
16. Shale, generally red at base; blue drab and red above; argillaceous or in places sandy, and locally containing one or two thin coal beds accompanied by black slaty shale; average.....	20	
Henrietta group:		
17. Limestone, gray, massive to nodular; apparently lacking in places but generally present; (possibly equivalent of Altamont or Worland); average thickness about.....	3	
18. Shale, red and green near top; about 10 feet thick in southern part of area; contains a layer of sandstone in upper part and is 22 feet thick in northern part; average.....	15	
19. Limestone in several layers with shale partings; locally called the "water rock" (probably Pawnee).....	2	
20. Shale, variable, drab to dark; argillaceous, calcareous, or bituminous.....	10	
21. Limestone, gray; even bedded ("10-inch cap rock").....	1	
22. Shale, gray, blue, or green.....	2	
23. Limestone, blue, argillaceous; weathers to buff earthy material; the "cap rock".....	2	
24. Shale, black, slaty.....	1	2
25. Coal (Lexington) with two or three clay partings; absent in many places; coal and overlying black shale not known to be present in Livingston, Linn or Macon counties.....	3	3
26. Clay, 2 to 7 feet, average.....	3	
27. Limestone, blue to drab; upper surface uneven; in places conglomeratic; (upper bed of upper member of Fort Scott), 2 to 6 feet, average.....	3	
28. Shale and sandstone, whitish at top.....	23	
29. Limestone, dark, impure; (lower part of upper member of Fort Scott ?); 2 to 12 inches.....		3
30. Shale, dark and soft at top, black and slaty below ("slate vein").....	5	6
31. Shale, dark; calcareous, with abundant shells.....		6
32. Coal (Summit), 1 to 6 inches.....		1
33. Clay, shaly at base; 5 to 10 feet, average.....	7	
34. Limestone, blue, weathers buff; nodular on top.....	2	
35. Shale, clayey.....	3	

Generalized Section of Pennsylvanian System of Northeastern Missouri—Continued.

	Feet.	Inches.
36. Limestone, blue, even bedded, weathers to buff colored blocks; absent in much of area. (No. 34 is the lower member of the Fort Scott and No. 36, when present, is so closely associated with it that it should also be considered a part of the lower member of the Fort Scott.).....	1	
Cherokee group:		
37. Shale, light at top, black and slaty at base; generally absent in northern counties, but in places 6 feet thick; much more general in Macon and Linn counties; average.....	2	
38. Coal (Mulky); generally absent in northern counties, but 21 inches in one place; wide spread in Macon and adjoining counties.....	2	
39. Shale, sandstone, and clay, 36 to 55 feet; clay at top and shale or sandstone at base, ("Squirrel sand" of drillers), average about.....	47	
40. Coal (Bevier); replaced by sandstone at a few places near Kirksville; north and west of Connellsville and Novinger the thickness is irregular as the lower clay parting thickens to 20 feet and locally contains sandstone; in Bevier and Novinger districts has been found up to 6 feet thick but average probably not over.....	2	
41. Clay, locally containing calcareous nodules at base; 1 to 7 feet; average.....	3	6
42. Limestone, generally in two beds separated by shale (Ardmore).....	4	
43. Shale, clayey and sandy; containing locally a 12-inch coal bed near middle; a wide spread bed of red clay is present in upper part; 40 to 60 feet thick; average.....	50	
44. Coal (Lower Ardmore), persistent and fairly uniform.....	2	
45. Shale, sandstone, and several irregular coal beds (including Eureka in Bevier district); lower beds absent in southern part of area.....	160	
46. Coal (Cainesville ?) upper and lower benches thin where parting thickens; absent in southern part of area; average.....	6	
47. Shale, sandstone, and clay, absent in southern part of area.....	40	
Unconformity.		
Mississippian system.		

Cherokee Group.

Glacial drift and younger formations cover most of the Cherokee in northeastern Missouri and information concerning it is based almost entirely on the results of drilling. The outcropping beds include, in descending order, the Lagonda shale and sandstone (Squirrel sand of drillers), Bevier coal, Ardmore limestone, and a few feet of the underlying shale. There is a regional thickening from southeast to northwest, chiefly by the addition of older beds at the base.

Except for the upper 100 feet, it is hard to generalize the description of the Cherokee and the reader should refer to the appended well logs for information in local areas.

The lowest persistent bed in the Cherokee is the Lower Ardmore coal. From mining operations and coal test holes, it appears to be one of the best markers in the entire section when considered in connection with the overlying Ardmore limestone

and Bevier coal. The average thickness is about 24 inches, although in some mining districts it may be over or under this figure.

The Ardmore limestone is one of the most wide spread beds in the Pennsylvanian. It is known as the Rich Hill limestone in southwestern Missouri and the Verdigris limestone in Oklahoma. It is variable in thickness, but in much of northeastern Missouri consists of two thin beds. It will prove to be an excellent marker in drilling structure test holes.

The Bevier coal bed is also present in a wide area but presents some features which are not clearly understood. Observations from outcrops and information from drilling, suggest that the influx of clastic material into the Pennsylvanian sea was variable during the deposition of the Bevier coal. In the Bevier and Novinger mining districts, where the overall thickness of the Bevier coal is 3 to 6 feet, there is at least one thin clay parting, and locally two partings are present. In many places there are two coal beds, each a few to 24 inches thick, separated by shale with some sandy shale or sandstone, the interval attaining a thickness of 20 to 25 feet. The possibility is suggested that a quarter inch clay parting in one locality thickens to 20 or 25 feet in others. This has led to a confusion in names, the upper bed being termed locally the Bedford coal (from Bedford, Livingston County) and the lower, the Bevier. The Lagonda shale and sandstone above the Bevier Coal (Squirrel sand of drillers) is similar to other Pennsylvanian clastic zones. The sandy part is irregularly distributed horizontally, and locally channels downward at the base to replace the underlying Bevier coal and Ardmore limestone.

The top of the Cherokee is marked by the horizon of the Mulky coal (synonyms: Macon City, Lower Fort Scott and "Red"). This coal has been found at widely scattered points, both on outcrop and by drilling, but is not persistent. It has been mined at many places in Macon County, but rarely has been found to the north. In general the overlying black, slaty shale and limestone are absent where the coal is missing.

Henrietta Group.

The description of the Henrietta given in the generalized section leaves little to be added in the matter of description. The nomenclature presents some problems. The limestone (No. 34) below the Summit coal resembles the lower member of

the Fort Scott at the type locality in Kansas with the exception that it is only half as thick. Whether the next limestone (No. 36) below, where present, is the stratigraphic equivalent of the lower part of the lower member of the Fort Scott at the type locality is not known at present. The Summit coal is considered to be the exact equivalent of the coal between the upper and lower members at Fort Scott, Kansas.

The limestone (No. 29) above the Summit coal has no geographic name in Missouri, but was known to all the early workers as the "Rhomboidal" limestone. It thickens from 2 inches or less in the northern counties to $2\frac{1}{2}$ feet in Howard County and again thins southward, where its stratigraphic position is in or just below the base of the upper member of the Fort Scott limestone at Fort Scott, Kansas.

The limestone (No. 27) below the Lexington coal is the equivalent of some part of the upper member of the Fort Scott limestone at the type locality.

The limestone beds in the upper part of the Henrietta need more study before definite correlations can be made. Suggested correlations are given in the generalized section.

Both the Lexington and Summit coal horizons and the associated limestones are dependable markers for both surface mapping and subsurface correlations.

Pleasanton Group.

The Pleasanton in northeastern Missouri is mostly sandstone, which is unconformable, and locally conglomeratic, at the base. The relations of the different beds of the Pleasanton to each other and to the underlying Henrietta are not well understood, but a few tentative suggestions can be made. The sandstone which forms the bulk of the Pleasanton in northeastern Missouri, probably has no relation to the Warrensburg, but is more likely associated with the Knobtown member of the Kansas City area. One of the best exposures of this sandstone is along State Highway No. 6, on Grand River just west of Trenton.

The shaly fossiliferous limestone (No. 15) placed in the generalized section at about 20 feet above the base of the Pleasanton is believed to be the limestone above the "Wayside" sand of the Kansas City area. If such is the case, the horizon of the Warrensburg sandstone occurs in the interval between this limestone and the top of the Henrietta, possibly explaining some of the irregularities found in the interval.

The above mentioned limestone, (No. 15), is the only known horizon marker in the lower part of the Pleasanton. The best outcrops are found in the deep valleys northeast of Green City, Sullivan County. In many places it has been replaced by the overlying sandstone and its extent beneath higher beds to the west is, of course, unknown, but the distinctive fossil content should make it a valuable marker in structure drilling. It is characterized by a varied molluscan fauna and on a weathered outcrop many finely preserved fossils can be found.

Kansas City Group.

With a few small exceptions, the Kansas City is confined to the western edge of the district under discussion. The principal outcrop is along the western edge of Livingston, Grundy and Mercer counties. The largest outlier is that near Milan. A few other small outcrops have been found and it is to be expected that others, not now known, will be found.

The lower part of the Kansas City consists of three fairly thick limestones, which, with included shales and thinner limestones, aggregate about 75 feet in thickness. The three limestones, Hertha, Bethany Falls and Winterset, have been resistant to erosion, and as a rule, all three are found in one outcrop and usually extend much farther east than the less resistant higher beds of the group.

The following is a generalized section of the Kansas City group as found in Mercer and Grundy Counties:

Generalized Section of the Kansas City Group in Mercer and Grundy Counties.

	Thickness.	
	Ft.	In.
1. Limestone, gray and thin bedded, below, massive, oolitic, sandy, and weathering deep-brown above (Raytown).....	11-12	
2. Shale, drab to dark-blue, grades into No. 3.....	2	9
3. Shale, black, slaty.....	1	
4. Limestone, gray, large knobs on upper surface. (Paola).....	2	3
5. Shale, drab, argillaceous, 11 feet exposed, thickness probably about.	15	
6. Limestone, gray, surface rough, (Cement City), 3 feet exposed, thickness probably about.....	5-6	
7. Shale, drab, green, red and purplish, argillaceous.....	15-20	
8. Limestone, gray, crystalline, composed almost entirely of large and small fragments of fossils; in places composed of fusulinid shells: maximum noted.....	2	6
9. Limestone, yellowish, earthy, variable, in 3 or 4 layers (8 and 9 Westerville).....	2	3

Generalized Section of the Kansas City Group in Mercer and Grundy Cos.—Continued.

	Thickness.	
	Ft.	In.
10. Shale, color variable, but usually yellowish, somewhat sandy and calcareous.....	1-2	
11. Shale, blue, argillaceous, with thin, rather evenly spaced layers of blue argillaceous limestone, which are studded with large fossils, grades at top into No. 10.....	20	
12. Shale, blue, with thin lenses of blue limestone, variable.....	6-7	
13. Limestone, blue, much jointed, uneven on upper and lower surface, usually in 3 layers of 6, 12, and 4-6 inches with shale partings that contain calcareous nodules, average about.....	2	6
14. Shale, blue and argillaceous above, composed of limestone nodules (in places appearing as a cellular limestone) in lower part; in places with a thin lense of blue limestone near middle.....	15	
15. Limestone, gray to blue, thin bedded and cherty in lower portion, more massive above; in upper part the stone is composed almost exclusively of fusulinid shells; a number of blue shale partings, 1 inch to 2 feet occur..... (13, 14, and 15—Winterset)	25	
16. Shale, light to dark blue, 6 inches to 2½ feet, usually.....	2	
17. Shale, black, slaty, 1 to 2½ feet, usually.....	2	
18. Shale, light, in places with a thin lense of limestone (Canville) at top, grades into No. 19.....	4-6	
19. Limestone, a mass of unconsolidated nodules, or a buff cellular limestone, 0 to 4 feet.....	2	
20. Limestone, gray to nearly white, upper part "brecciated" or oolitic, lower part thin bedded; in places the entire bed is oolitic; usually not cherty, but in places there are small chert concretions; thickness 10 to 20 feet, usually about (19 and 20—Bethany Falls).....	15	
21. Shale, light, argillaceous, grades into No.	2	
22. Shale, black, slaty.....	1	6
23. Limestone, dark, usually in two layers (Middle Creek).....	1	
24. Shale, light, with 1 or 2 thin layers of nodular, buff-weathering limestone.....	15	
25. Limestone, gray with curved crystalline cross-sections of shells; usually in two layers of about 18 and 30 inches, latter at top (Hertha).....	4	

In comparing the lower part of the foregoing section with that given for the Pennsylvanian in the eastern part of the area, it will be noted that the sandstone (No. 7) of that section is absent from the shale above the Hertha in Mercer and Grundy counties.

Beds above the Winterset are exposed in very few places in Mercer and Grundy counties. The Raytown limestone and associated beds may be seen in the SW. ¼ sec. 18, T. 64 N., R. 24 W., and the beds above the Winterset are well exposed in the railroad cut in sec. 29, T. 60 N., R. 25 W.

Pleistocene Series.

Distribution:

With very few exceptions the entire upland area of the district covered by this report is mantled by glacial drift and in much of the area even the larger streams have not cut down through it. Where pre-glacial uplands existed, present erosion has removed much of the drift.

The thickness ranges from a few feet to more than 300 feet. The original upper surface of the till sheet probably had a low and fairly uniform slope to the southeast. The thickness of glacial material now existing in any particular area depends on the relation of the depth of present erosion to the topography of the pre-glacial bed rock surface. Where a present upland exists over a pre-glacial lowland, the drift is thick. Where a pre-glacial upland existed, only a small amount of present cycle erosion has been needed to expose the bed rock surface.

Character:

The greater part of the till is boulder clay, originally dark bluish-gray but weathered to a yellowish color, to a depth of 30 or 40 feet over most of the area. It is covered with an ashy gray soil on the uplands. Locally yellow clay has been found in drilling below bluish-gray clay, but this is exceptional. Sand beds are scattered through the boulder clay and both sand and gravel are found at many places where the drift rests on the underlying bed rock surface. In the deeper pre-glacial valleys, sand, gravel and boulder beds are usually present.

The boulders are of many types of igneous, metamorphic and sedimentary rock and range in size up to many cubic feet. In some instances these boulders have been of sufficient size and hardness to interfere with drilling or driving casing.

Regional Structure.

Any interpretation of the regional structure is of necessity vague and indeterminable because of the lack of geologic control. Most of the area contains a mantle of drift which obscures outcrops of the underlying rocks. Reliable records of only a few widely scattered, deep wells are available and there is a paucity of data at hand upon which an accurate structure-contour map can be based. A highly generalized, regional structure map of a portion of the area is shown as Figure 3. As control in the

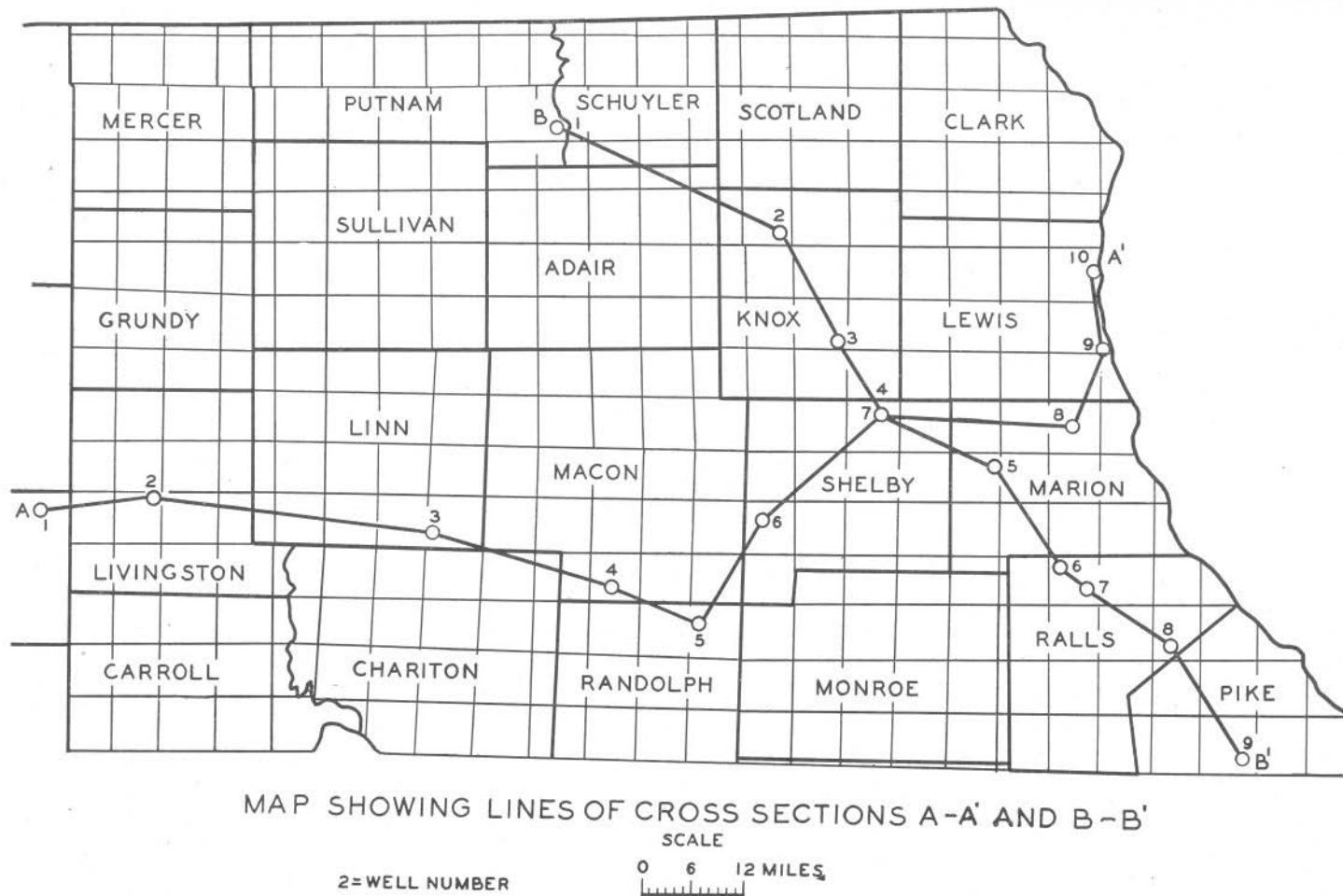
western portion is inadequate, only the eastern portion of the area has been contoured. In this western portion, control points are shown where available well-logs make possible a reasonable estimate of the elevation of the datum. Contours have been drawn on the base of the Burlington formation. At places in the area, this datum represents the top of the Sedalia limestone, the top of the Chouteau limestone, or the top of the Hannibal shale, as the Burlington rests on each of these formations locally.

The most prominent structural feature is the Lincoln fold in the eastern portion of the area. The Lincoln fold has been described by Krey⁵, who prepared a structure map of the area bordering Mississippi River in northeastern Missouri. This structural feature is named for Lincoln County, Missouri, where it is prominently developed. The Lincoln fold has also been termed the "Cap au Gres fold" and "Nemo Uplift". It is the "Trenton back-bone" of Rowley's report on the geology of Pike County⁹.

This fold enters the area in the northeastern portion of Ralls County and has a trend of about north 45 degrees west toward Putnam County. This is shown by the structure map, Figure 3. The cross-section A-A' is presented to show the structure across the fold in a NE.-SW. line. The cross-section B-B' is taken in a NW.-SE. direction and is at or near the crest of the fold with the exception of the well at Bowling Green which apparently is east of the crest. As shown on the structure map the fold plunges to the northwest. This is also shown by cross-section B-B' which shows younger beds occurring in the upper portion of the section to the northwest. The oldest formation brought to the surface in this area by the Lincoln fold is the Joachim.

The State geological map indicates several anticlinal and synclinal features to the south of the area. These features seem to parallel the general trend of the Lincoln fold. However, with the data at hand their extension into the area can only be surmised.

The Brown Station anticline, located in Townships 51 and 52 North, Ranges 12 and 13 West, may extend to the northwest into the area of the Cherokee inlier in Townships 59 and 60 North, Ranges 22 and 23 West.



The Davis Creek anticline located in Townships 50 and 51 North, Ranges 10 and 11 West, and the Howard County syncline located in Townships 51 and 52 North, Ranges 16 and 17 West, probably extend into the area.

An examination of the State geological map shows that, in Townships 62 to 64 North and Ranges 18 to 21 West outliers of Kansas City beds are present at places. These beds are surrounded by Pleasanton and are 15 miles southeast of the nearest Pleasanton-Kansas City line of contact. These outliers probably indicate a structurally low area.

Attention should be called to an error on the State geological maps of 1922 and 1926. The small patch shown as Mississippian, on the creek in sec. 33, T. 54 N., R. 20 W., Chariton County, should be Pennsylvanian and is Warrensburg-Moberly sandstone.

Recent field work has shown the presence of Devonian and Ordovician rocks in Saline County. In the SE. $\frac{1}{4}$, sec. 36, T. 51 N., R. 19 W., the Callaway limestone lies on the Kimmswick limestone. According to local report, a sandstone, which is probably the St. Peter, was exposed at this locality before Missouri River changed its course some years ago. This reported sandstone outcrop is now covered by alluvium.

Minor Structural Features.

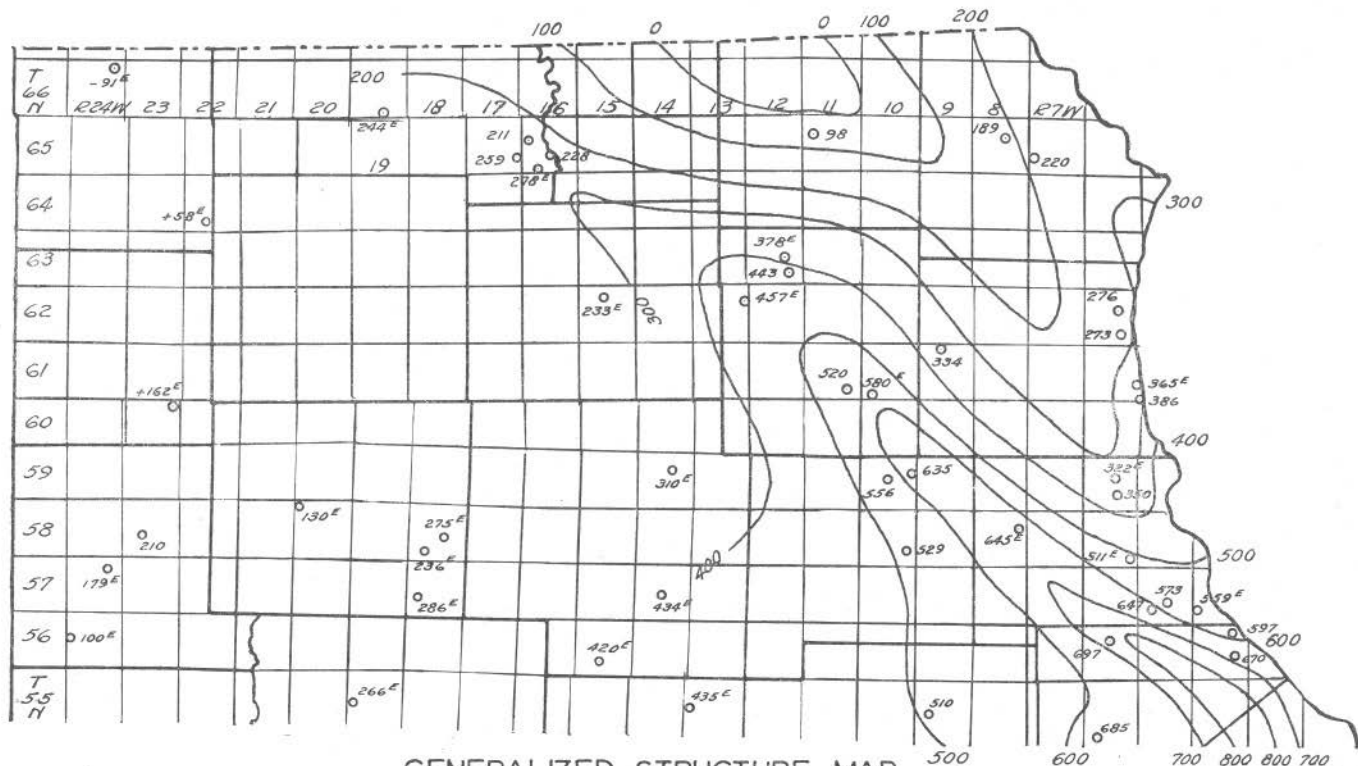
In the part of northeastern Missouri covered by Pennsylvanian beds, small areas of relatively steep dips and possible faults have been found in several places. Their distribution is such as to suggest that others will be found. In some cases the steep dips appear to be connected with synclinal structure and care should be exercised in considering these features in connection with locating tests for oil and gas.

Brief descriptions of the known areas follow:

Area Northeast of Bosworth, Carroll County.

Location. Northeast part of sec. 8, T. 54 N., R. 21 W.

Beds involved: Cherokee and Henrietta outcrop in a relation which suggests a fault. On the west bluff of Grand River, the Bedford coal has been mined. Along a small branch to the west, limestones of the Henrietta may be seen dipping steeply to the east. It is believed the east dip is terminated by a fault.



GENERALIZED STRUCTURE MAP
 DATUM=BASE OF BURLINGTON FORMATION
 CONTOUR INTERVAL 100 FEET
 SCALE

6 0 6 MILES

○ 236 ELEVATION OF DATUM

○ 270 E. ELEVATION OF DATUM ESTIMATED

Brunswick Area, Chariton County.

Location: On the east bank of Salt Creek, where it crosses the line between sections 20 and 29, T. 54 N., R. 20 W., an outcrop shows beds dipping very steeply to the south and partly crumpled, while nearby beds to the north and south are essentially flat.

Beds involved: At the north end of the outcrop, flat-lying shale is exposed. The shale is grayish-green, gritty and non-laminated. Above the south end of the outcrop there is sandstone which appears to be above the steeply dipping beds. A section of the steeply dipping beds is given below. Due to poor outcrops and crumpling of the beds, it is not possible to make exact measurements in places.

Section on East Bank of Salt Creek, near Brunswick.

	Thickness.	
	Ft.	In.
Sandstone, thin bedded to massive.....	20 +	
Shale, sandy.....	1	
Shale, dark, and covered.....	5	
Limestone, gray, nodular, fossiliferous.....	1	10
Limestone, in thin beds with shale partings.....	1	10
Shale, irregularly bedded, lithified.....	1	9
Shale, light-drab.....	10	
Layer of large concretions, 1 foot in diameter, embedded in shale.....	1	
Shale, light.....	3	
Shale, dark.....	3	
Shale and sandstone.....	10	
Fibrous gypsum.....		1
Shale and covered.....	15 ±	
Limestone, gray, in loose nodules.....	2	
Shale, dark, slaty, with thin beds of sandstone.....	17	
Coal.....		7
Shale, drab.....	9	
Shale, black and impure bony coal.....		3
Siderite, sandy, in 2 or 3 beds, concretionary.....	5	
Shale, dark, slaty.....	12	
Shale, light; becomes slaty, but not dark, at base.....	13	
Coal (squeezed).....		10
Shale.....	7	
Sandstone, irregularly bedded.....	1	6
Shale, drab, sandy.....	2	
Shale, dark.....	4	
Shale and sandstone.....	16 ±	
Total about.....	164	

These beds are referred to the Cherokee, and judging from the thickness, the base of the section is probably close to the base of the Cherokee.

Jamesport Area, Grundy County.

Location: A synclinal trough with a northwest-southeast axis is well exposed in a cut on the Rock Island Railroad east of Jamesport in section 29, T. 60 N., R. 25 W., Grundy County.

Beds involved: The top of the Bethany Falls limestone, all of the Winterset, the Block and Westerville and intervening shales are completely uncovered in the cut.

A section of the rocks exposed is as follows:

Section on the Rock Island Railroad, Sec. 29, T. 60 N., R. 25 W.

	Thickness.	
	Ft.	In.
1. Limestone, gray, massive, composed of fossil fragments.	1	6
2. Limestone, yellowish; in 3 or 4 layers; very nodular and impure.	2	3
3. Shale, yellowish; calcareous; with thin lens of limestone.		9
4. Shale, blue, clayey; with thin even layers of limestone; at top yellow and slightly arenaceous.	19	6
5. Limestone; six thin layers with shale partings.	4	
6. Shale, blue.	2	2
7. Limestone, very fossiliferous.		3-6
8. Shale.		6
9. Limestone.		6
10. Shale.		1-2
11. Limestone, blue, wavy-bedded.	1	
12. Limestone, nodular in 1 or 2 layers.		8
13. Shale.		4
14. Limestone.		7
15. Shale, blue; contains finely preserved fossils.	6	
16. Limestone, thin-bedded, lenticular.	¼-1	
17. Shale; upper 2 feet argillaceous; grades into loose calcareous nodules at bottom.	8	
18. Limestone, fine-grained; in 4 layers.	3	8
19. Limestone, shaly or shale.	1	3
20. Limestone; composed largely of fusulinids.	1	
21. Limestone, argillaceous.	2	9
22. Shale, blue; with two nodular layers of limestone.	2	
23. Limestone, thin-bedded, cherty; buff shaly partings.	3	
24. Shale parting.		8
25. Limestone, like No. 23.	4	6
26. Shale parting.		6-8
27. Limestone, like No. 25.	4	10
28. Shale, dark.		6
29. Shale, black, slaty, bituminous.	2	6
30. Shale, blue, clayey.	6	
31. Limestone; upper shaly nodular portion of Bethany Falls, to track. .	1	6

Area west of Browning and Purdin, Linn County.

Location: Near the coal bank formerly worked by Stultz, in the SW. ¼ sec. 10, T. 59 N., R. 21 W.

Beds involved: Henrietta and possibly Pleasanton. The relations of the beds suggest faulting on a small scale.

Woodland Mills, Linn County.

Location: A few miles southeast of Laclede, near the center of sec. 14, T. 57 N., R. 21 W.

Beds involved: Near the old mill beds of the Henrietta dip steeply to the southeast and are overlain, probably unconformably, by sandstone either of Knobtown or Warrensburg age. A few hundred yards southeast limestones which are believed to be of Kansas City age may be seen dipping at an angle of 80°. The area is believed to be the most complicated in structural relationships in northern Missouri.

Area northeast of Chillicothe, Livingston County.

Location: This area is west of Medicine Creek, in secs. 22 and 23, T. 58 N., 23 W., with the best outcrops along a tributary flowing east into Medicine Creek.

Beds involved: At the west edge of the area is sandstone of Pleasanton age. East of this and dipping successively down stream to the east are the Hertha, Bethany Falls and Winterset limestones and the intervening shales. There were several quarries in the area in July 1911. On Medicine Creek, beds of the Henrietta and Pleasanton outcrop.

Area near Milan, Sullivan County.

Location: At the southwest edge of Milan, between Missouri State Highway No. 6 and railroad.

Beds involved: In the cut on the highway, in the quarry and in the railroad cut is an excellent and almost completely uncovered section of the beds from the upper part of the Pleasanton to the Galesburg shale above the Bethany Falls limestone. They are in a syncline with the axis probably in a northwest-southeast direction.

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WELL-LOGS

ADAIR COUNTY.

Log of H. L. Miller's Fee (?) No. 1. Location: NE. 1/4 SW. 1/4 sec. 20, T. 61 N., R. 18 W., Adair County, Mo. (drilled with core drill). Well No. (1), Pl. I.

	Thickness.		Depth	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Dirt, black.....	2		2	
Clay, yellow.....	20		22	
Sand.....	2		24	
Pennsylvanian system:				
Shale, soft, light.....	43		67	
Shale, sand.....	5		72	
Shale, light.....	10		82	
Sandstone.....	11		93	
Shale, sand.....	9		102	
Rock, conglomerate.....	2		104	
Shale, sand.....	4		108	
Shale, sand.....	19	6	127	6
Coal (Bevier).....	3		130	6
Fire clay.....	1		131	6
Shale, sand.....	20	6	152	
Shale, dark.....	2		154	
Shale, sand.....	38	6	192	6
Coal.....	1	8	194	2
Fire clay.....	1	10	196	
Sand shale, light.....	12		208	
Shale, various colored.....	2		210	
Lime shale.....	9		219	
Sandstone, soft.....	3		222	
Lime shale, blue.....	6		228	
Limestone, soft.....	2		230	
			Total	depth

ADAIR COUNTY—Continued.

Log of coal test on Webster No. 1. Location: NE. 1/4 NW. 1/4 or NW. 1/4 NE. 1/4 sec. 5, T. 62 N., R. 15 W., Adair County, Mo. Well No. (2), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Soil and drift.....	190		190	
Pennsylvanian system:				
Slate, black (Summit).....	2	6	192	6
Shale, blue (Summit).....	1	6	194	
Shale, light.....	8		202	
Sandstone.....	49	8	251	8
Coal (Bevier).....	2	2	253	10
Fire clay.....	3		256	10
Shale, light.....	10		266	10
Shale, sandy.....	35	2	302	
Coal (Lower Ardmore).....	1	8	303	8
Fire clay.....	1	4	305	
			Total	depth

Log of well drilled by City of Kirksville. Location: NW. 1/4 NE. 1/4 SE. 1/4 SW. 1/4 sec. 4, T. 62 N., R. 15 W., Adair County, Mo. Elevation: 972 feet (plane-table.) Well No. (2A), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Clay.....	170		170	
Pennsylvanian system:				
Limestone.....	8		178	
Coal.....		1	178	1
Clay shale.....	30		208	1
Sandstone.....	22		230	1
Shale.....	15		245	1
Hard limestone.....	2		247	1
Shale, about.....	20		267	1
Coal.....	1	6	268	7
Shale.....	30		298	7
Shelly broken limestone.....	20		318	7
Soft, mushy, blue clay.....	20		338	7
Limestone.....	15		353	7
Coal.....	2		355	7
Shale.....	50		405	7
Fine white sandstone.....	45		450	7
Mississippian and older:				
Solid limestone.....	700		1,150	7
Flint, very hard limestone and sandstone.....	140		1,290	7
			Total	depth

ADAIR COUNTY—Continued.

Log of coal test on Payne Bros. No. 2. Location: sec. 6 (?), T. 62 N., R. 15 W., Adair County, Mo. Well No. (6), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	90		90	
Pennsylvanian system:				
Henriette group:				
Limestone (Lexington sump-rock).....	3		93	
Shale, light.....	12		105	
Shale, sandy.....	16		121	
Shale, light.....	3		124	
Slate, black (Summit).....	5		129	
Light shale with limestone bands.....	16		145	
Cherokee group:				
Slate, black.....	3		148	
Shale, sandy.....	19		167	
Slate, black.....	5	3	172	3
Coal (Bevier).....	3	5	175	8
Fire clay.....	1	4	177	
			Total	depth

Note: Base of Cherokee not reached.

Log of coal test on Campbell and Ross. Location: N. 1/2 NE. 1/4 sec. 7, T. 62 N., R. 15 W., Adair County, Mo. Well No. (8), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Recent series:				
Sand and soil.....	7		7	
Pennsylvanian system:				
Limestone.....	7		14	
Soapstone.....	5		19	
Hard rock.....	1	6	20	6
Shale rock.....	3		23	6
Hard rock.....	4		27	6
Soapstone.....	7		34	6
Shale rock.....	8		42	6
Soapstone.....	2		44	6
Hard rock.....	3		47	6
Soapstone.....	6	8	54	2
Hard shale.....	7	6	61	8
Black soapstone.....	3		64	8
Rock.....	1	3	65	11
Poor coal.....	1	6	67	5
Fire clay.....		6	67	11
Soapstone.....	1	5	69	4
Soapstone.....	4	8	74	
Shale.....	3		77	
Shale.....	4		81	
Hard rock.....	2		83	
Soapstone.....	6	8	89	8
Rock.....	1	6	91	2

ADAIR COUNTY—Log of coal test on Campbell and Ross—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Shale.....	2	6	93	8
Soapstone.....	3		96	8
Rock.....	1		97	8
Shale.....	3		100	8
Rock.....	1	8	102	4
Hard shale.....	12		114	4
Rock.....	2		116	4
Shale.....	2		118	4
Hard shale rock.....	3	9	122	1
Coal (Bevier).....	3	10	125	11
Fire clay.....	1		126	11
Soapstone.....	3		129	11
Hard rock.....	1		130	11
Shale.....	1		131	11
Rock.....		6	132	5
Hard shale.....	12	8	145	1
Soapstone.....	3	3	148	4
Shale.....	4		152	4
Soapstone.....	3	7	155	11
Hard soapstone.....	16	8	172	7
Coal (Lower Ardmore).....	2	6	175	1
Fire clay.....	6		181	1
Soapstone.....	2		183	1
Hard rock.....	1		184	1
Rock.....	7	8	191	9
Shale.....	5		196	9
			Total	depth

Log of Star Coal Company's No. 1 at air shaft. Location: sec. 8, T. 62 N., R. 15 W., Adair County, Mo. Elevation: 865 (?) feet. Well No. (13), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Black dirt.....	1		1	
Yellow clay.....	10		11	
Sand.....	8		19	
Black clay mixed with sand.....	51		70	
Pennsylvanian system:				
Henrietta group:				
Broken L. S.....	2		72	
Sandshale.....	30		102	
Black slate.....	5		107	
Limeshale.....	6		113	
Limestone.....	2		115	
Cherokee group:				
Dark shale.....	2	6	117	6
Light shale.....	7	6	125	
Sandstone.....	37	10	162	10
Coal.....	1	3	164	1
Shale.....		1	164	2
Coal.....	1		165	2
Fire clay.....	3	4	168	6

ADAIR COUNTY—Log of Star Coal Company's No. 1 at air shaft—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Light shale.....	2		170	6
Limestone.....		9	171	3
Blue shale.....	1	2	172	5
Limestone.....		7	173	
Sandshale.....	32		205	
Light shale.....	9	10	214	10
Coal.....	2		216	10
Fire clay.....	2		218	10
Limeshale.....	25	2	244	
Sandstone (water bearing).....	8		252	
Limeshale.....	10		262	
Limestone.....	2		264	
Limeshale.....	10		274	
Limestone.....	2		276	
			Total	depth

Base of Cherokee probably not reached.

Note: This is the deepest of ten holes, Nos. (3), (4), (5), (7), (9), (10), (11), (12) and (15). Pl. 1, drilled in this vicinity with a core drill.

Log of coal test on Allison. Location: sec. 18 (?), T. 62 N., R. 15 W., Adair County, Mo. Well No. (14), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Soil and drift.....	25		25	
Pennsylvanian system:				
Henrietta group:				
Shale, sandy.....	3	6	28	6
Shale, variegated.....	21	6	50	
Limestone.....	3	6	53	6
Lime shale.....	3	6	57	
Dark shale with limestone bands (Lexington horizon).....	3		60	
Shale, variegated.....	23		83	
Sandstone.....	7		90	
Shale, light, sandy.....	19		109	
Shale, black (Summit).....	7		116	
Limestone.....	1	6	117	6
Cherokee group:				
Shale, dark, soft.....	3	6	121	
Shale, hard, sandy.....	9		130	
Sandstone.....	42	6	172	6
Dark shale with limestone bands and 5 in. Coal (Bevier).....	8	6	181	
Limestone.....	2	6	183	6
Sandstone.....	13	6	197	
Shale, dark.....	37		234	
Coal (Lower Ardmore).....	2	6	236	6
Fire clay.....		6	237	
			Total	depth

Base of Cherokee not reached.

ADAIR COUNTY—Continued.

Log of D. D. Novinger's Fee No. 1. Location: NE. 1/4 NE. 1/4 sec. 10, T. 62 N., R. 17 W., Adair County, Mo. Completed May 23, 1914 with core drill. Well No. (16), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene and Recent series:				
Surface.....	24		24	
Pennsylvanian system:				
Sand shale.....	10		34	
Limestone.....	2		36	
Sandstone.....	9		45	
Sand shale.....	5		50	
Various colored shale.....	6		56	
Limestone.....	1		57	
Black shale.....	2		59	
Limestone.....	1		60	
Sandstone.....	11		71	
Sandstone.....	7		78	
Blue shale.....	14		92	
Black slate.....	5		97	
Lime shale.....	3		100	
Limestone.....	5		105	
Sand shale.....	9		114	
Red shale.....	4		118	
Soft sandstone.....	18		136	
Blue shale.....	8		144	
Coal.....	3	11	147	11
Blue shale.....	5	1	153	
Coal.....		6	153	6
Fire clay.....	4		157	6
Hard black rock.....		8	158	2
Sand shale.....	37	10	196	
Blue shale.....	2		198	
Coal.....	3		201	
Fire clay.....	1		202	
Sandstone.....	5		207	
Red shale.....	6		213	
Sand shale.....	6		219	
Hard black rock.....	1		220	
Various colored shale.....	45		265	
Black shale.....	30		295	
Hard black rock.....	6		301	
Black shale.....	11		312	
Black sandstone.....	26		338	
Mississippian system:				
Limestone.....	25		363	
			Total	depth

ADAIR COUNTY—Continued.

Log of coal test on Payne Bros. No. 1. Location: W. 1/2 sec. 31 (?), T. 63 N., R. 15 W., Adair County, Mo. Well No. (17), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	75		75	
Pennsylvanian system:				
Henrietta group:				
Limestone—(Lexington sump rock).....	2		77	
Shale, sandy.....	2		79	
Sandstone.....	8		87	
Shale, sandy.....	12		99	
Shale, blue.....	6		105	
Conglomerate rock.....		6	105	6
Shale, black (Summit).....	8	6	114	
Shale, light.....	5	10	119	10
Rock, hard.....	3		122	10
Cherokee group:				
Dark shale with limestone partings.....	2		124	10
Shale, light.....	7	2	132	
Shale, sandy.....	12		144	
Sandstone.....	2		146	
Clay, black.....	4	4	150	4
Coal (Bevier).....	2	4	152	8
Fire clay.....	1	8	154	4
Shale, sandy.....	46	1	200	5
Coal (Lower Ardmore).....	1	2	201	7
Fire clay.....	1	5	203	
			Total	depth

Note: Base of Cherokee not reached.

Log of coal test near Connelsville. Location: sec. 9, T. 63 N., R. 16 W., Adair County, Mo. Well No. (18), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Black dirt.....	4		4	
Yellow clay.....	16		20	
Blue clay.....	57		77	
Blue clay mixed with sand.....	33		110	
Pennsylvanian system:				
Cherokee group:				
Soft light shale.....	7		117	
Limestone.....	2		119	
Light shale.....	7		126	
Coal.....		2	126	2
Fire clay.....	1	1	127	3
Shales of various color.....	34	9	162	
Sandstone.....	2		164	
Green shale.....	14		178	
Sandstone.....	4		182	
Light shale.....	12		194	

ADAIR COUNTY—Log of coal test near Connelssville—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Sandstone.....	1		195	
Dark sand shale.....	28		223	
Soft sandstone.....	7		230	
Soft sand.....	28		258	
Mississippian system:				
Limestone.....	42		300	
			Total	depth

Log of coal test at Danforth. Location: NE. 1/4 SW. 1/4 sec. 30, T. 63 N., R. 16 W., Adair County, Mo. Well No. (19), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Recent series:				
Surface material.....	5		5	
Pennsylvanian system:				
Henrietta group:				
Limestone.....	2		7	
Clay.....		6	7	6
Limestone.....	2	6	10	
"Slaty" shale, Coal (Lexington), and clay.....	7		17	
Limestone.....	2	8	19	8
Clay.....		6	20	2
Limestone.....		2	20	4
Shale.....		2	20	6
Sandstone.....	3	1	23	7
Shale.....	21	4	44	11
Limestone.....		8	45	7
Shale, black, slaty with "bat." at base.....	2		47	7
Coal (Summit).....		6	48	1
Clay and shale.....	11	2	59	3
Limestone.....	2	6	61	9
Cherokee group:				
Shale, gray, "slaty".....	5	7	67	4
Limestone.....	4	7	71	11
Shale, gray, "slaty".....	35	8	107	7
"Bat".....	4		111	7
Coal (Bevier), 1 1/2-inch clay seam 1 ft. from base..	3	7	115	2
Clay.....	1	5	116	7
			Total	depth

Note: Base of Cherokee not reached.

CARROLL COUNTY.

Log of Wm. Forsyth Fee No. 1, 3 miles northeast of Tina in approx. sec. 22, T. 55 N., R. 23 W., Carroll County, Mo. Completed 1913. Well No. (1), Pl. I.

The driller reports 8 feet of drift; shale and limestone to 420 feet; and "Mississippi lime" to 520 feet, T.D. Water at 300 feet and 470 feet.

Log of Winterrood No. 1. Location: SW. 1/4 SE. 1/4 sec. 20, T. 55 N., R. 25 W., Carroll County, Mo. Elevation: 876 feet. Well No. (2), Pl. I.

This hole was drilled as an oil and gas test. It is reported to have gone into the Mississippian at 600 feet, had 20 feet of hard sandstone at 700 to 720 feet, 10 feet of shale below at some unknown depth, below which was limestone to the total depth of 1,100 feet.

Log of Mandeville Petroleum Company's No. 1. Location: sec. 32, T. 55 N., R. 24 W., Carroll County, Mo. Completed March, 1924. Well No. (3), Pl. I.

No log available; samples submitted at 752, 1050, 1052 and 1082 feet. Sample at 752 feet suggests Warsaw? Mississippian. Samples at 1052 and 1082 feet suggest Devonian. Sample at 1050 is a blue green non-calcareous shale which has large specks of black organic matter along the bedding planes.

CHARITON COUNTY.

Log of W. M. Brunk Fee No. 1. Location: SW. 1/4 SW. 1/4 sec. 19, T. 55 N., R. 19 W., Chariton County, Mo. Elevation: 741 feet. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene and Recent Series:		
Soil and clay.....	30	30
Pennsylvanian and Mississippian Systems:		
Limestone.....	10	40
Sandy shale.....	8	48
Limestone.....	50	98
Shale (Some fresh water at 145').....	50	148
Dry sand.....	20	168
Sandy shale.....	40	208
Limestone.....	20	228
Sandy shale.....	60	288
Lime with shale breaks.....	24	312
Solid limestone.....	90	402
White sandstone*.....	1	403**

*Sample from this depth shows 50 % limestone and 50 % flint-is from Burlington formation.

**T.D. Water.

CLARK COUNTY.

Log of R. M. Boulware well. Location: sec. 26 (?), T. 64 N., R. 6 W., Clark County, Mo. Completed 1915. Well No. (1), Pl. I.

No log available, total depth 679 feet.

Log of George Brown well. Location: sec. 5, T. 65 N., R. 6 W., Clark County, Mo. Completed May, 1915. Well No. (2), Pl. I.

No log available, total depth 575 feet.

Log of C. P. Fore well. Location: SW. 1/4 sec. 7, T. 65 N., R. 6 W., Clark County, Mo. Completed August 4, 1915. Well No. (3), Pl. I.

No record available; total depth reported to be 768 feet.

CLARK COUNTY—Continued.

Log of Henry Johnson well. Location: SE. 1/4 sec. 17, T. 65 N., R. 7 W., Clark County, Mo. Completed August 24, 1915. Well No. (4), Pl. I.

No record available; total depth reported to be 776 feet.

Log of Missouri Condensed Milk Company's well at Kahoka. Location: SW. 1/4 NW. 1/4 sec. 19, T. 65 N., R. 7 W., Clark County, Mo. Elevation: 692 feet (aneroid). Completed 1908. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil and yellow clay.....	15	15
Yellow clay.....	20	35
Drab clay.....	25	60
Blue clay.....	90	150
Sand and gravel.....	11	161
Gray limestone.....	9	170
Sandstone, soft, water.....	9	179
Limestone, very fine grained.....	51	230
Soapstone.....	60	290
Blue "granite"—(limestone).....	110	400
Fire clay.....	6	406
Limestone with chert.....	20	426
Limestone, hard, white.....	20	446
Limestone, soft, white.....	26	472
Soapstone, blue.....	30	502
Sandstone, bluish.....	9	511
Soapstone, blue.....	115	626
Shale, blue-gray.....	11	637
Soapstone, ash color.....	20	657
Shale, brown.....	25	682
Shale.....	85	767
Limestone.....	293	1060
Sandstone.....	131	1191
Limestone.....	12	1203
		Total depth

(The shale from 230 to 290 feet probably is Warsaw shale. The base of the "Mississippi lime" is at 472 feet, and the sandstone from 1060 to 1191 feet probably is St. Peter sandstone.)

Log of Keokuk Canning Company's well at Kahoka. Location: SW. 1/4 NW. 1/4 sec. 19, T. 65 N., R. 7 W., Clark County, Mo. Elevation: 696 feet (aneroid). Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
Bumbo.....	20	20
Yellow clay.....	20	40
Sand.....	10	50
Blue clay.....	20	70
Gray clay.....	30	100
Yellow clay.....	40	140
Blue clay.....	10	150
Sand.....	7	157
Rock, shelly.....	2	159
Rock, solid.....	31	190
Limestone.....	10	200
Limestone, gray.....	10	210

CLARK COUNTY—Log of Keokuk Canning Company's well at Kahoka—Continued.

	Thickness, Ft.	Depth, Ft.
Soapstone.....	13	223
Water bearing rock.....	11	234
Shale.....	6	240
Sandstone.....	16	256
Shale.....	2	258
Rock.....	12	270
Soft rock.....	18	288
Limestone.....	22	310
Shale.....	5	315
Limestone.....	45	360
		Total depth

(The section below 159 feet is "Mississippi lime.")

Log of A. S. Harkness well. Location: SE. 1/4 SW. 1/4 SE. 1/4 sec. 10, T. 65 N., R. 8 W., Clark County, Mo. Elevation: 714 feet (aneroid). Completed March, 1923. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil, yellow clay, and blue clays.....	196	196
White limestone, "first lime".....	50	246
Blue shale.....	40	286
Limestone, "second lime".....	239	525
Blue and gray sand shales.....	100	625
Limestone, blue with some iron.....	10	635
Brown shale, looks like Maquoketa.....	165	800
Trenton limestone, samples sent in.....	159	959
		Total depth

Note: A few samples from 795 to 959 indicate: Kimmswick (800 ft. to 905 ft.), Decora-Plattin (905 ft. to 959 ft.). Driller reports this well runs about the same as Producers Cold Storage Company well at Medill, from surface to 400 ft.

Log of Producers Cold Storage Company's well at Medill. Location: NW. 1/4 SW. 1/4 NW. 1/4 sec. 15, T. 65 N., R. 8 W., Clark County, Mo. Elevation: 702 feet (aneroid). Completed May, 1923. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil, yellow clay and blue clays.....	196	196
Limestone, white "First lime".....	50	246
Shale, blue.....	40	286
Limestone "second lime".....	114	400
		Total depth

(Water at 395 feet. Shale from 246 to 286, probably is Warsaw shale.)

CLARK COUNTY—Continued.

Log of Dr. W. C. McReynold's well. Location: SE. 1/4 sec. 31, T. 65 N., R. 9 W., Clark County, Mo. Elevation: 756 feet (aneroid). Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	225	225
Limestone, fine grained.....	75	300
Shale.....	61	361
		Total depth

Section below 225 feet in "Mississippi Lime."

Log of Atchison, Topeka and Santa Fe Railway Company's well at Wyaconda. Location: SW. 1/4 sec. 32, T. 65 N., R. 9 W., Clark County, Mo. Elevation: 750 feet (estimated). Completed July, 1911. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	3	3
Yellow clay.....	62	65
Blue clay.....	40	105
Yellow clay.....	35	140
Blue clay.....	69	209
Sand, a little water.....	9	218
Blue clay.....	17	235
Limestone.....	25	260
Blue clay.....	4	264
Limestone.....	26	290
Blue clay.....	5	295
Limestone.....	46	341
Blue clay.....	49	390
Shale, a little water between 460 and 484.....	94	484
Sand rock.....	18	502
Water bearing sand, 16 gallons per minute.....	16	518
Limestone.....	80	598
Slate.....	5	603
Shale.....	5	608
Limestone.....	20	628
Blue clay.....	5	633
		Total depth

(Plugged and abandoned.)

Log of McKee Brothers well No. 3. Location: NW. 1/4 sec. 25, T. 66 N., R. 7 W., Clark County, Mo. Elevation: 720 feet (estimated). Completed July, 1913. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	52	52
Limestone, fine-grained, hard.....	15	67
Limestone, shaly.....	15	82
Soapstone.....	10	92

CLARK COUNTY—Log of McKee Brothers well No. 3—Continued.

	Thickness, Ft.	Depth, Ft.
Dark blue limestone.....	52	144
Flint rock.....	6	150
Black flint rock.....	10	160
White limestone.....	110	270
		Total depth

Log of McKee Brothers well No. 1. Location: Near C. sec. 26, T. 66 N., R. 7 W., Clark County, Mo. Elevation: 740 feet (estimated). Completed 1907. Well No. (12), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	712	712 Total depth

(Report sandstone reached between 600 and 700 feet.)

Log of McKee Brothers well No. 2. Location: NE. 1/4 sec. 27, T. 66 N., R. 7 W., Clark County, Mo. Elevation: 735 feet (estimated). Completed June, 1913. Well No. (13), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	77	77
Sandstone.....	10	87
Limestone, hard.....	20	107
Shaly limestone.....	50	157
Dark limestone.....	9	166
Soapstone.....	6	172
Limestone and flint.....	25	197
Flint.....	5	202
White sandstone.....	2	204
Limestone.....	53	257
		Total depth

Log of J. N. Lewis well. Location: (?) sec. 25, T. 66 N., R. 8 W., Clark County, Mo. Completed 1909. Well No. (14), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clays.....	100	100
Limestone.....	94	194
Shale.....	55	249
Limestone, shale, flint.....	158	407
		Total depth

(Well probably bottomed in Osage group. Location described as "3 1/4 miles north of Kahoka, Mo".)

CLARK COUNTY—Continued.

Log of Andrea O'Day well. Location: SW. 1/4 sec. 28, T. 66 N., R. 8 W., Clark County, Mo. Completed November, 1908. Well No. (15), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	30	30
Shell rock.....	3	33
Limestone.....	90	123
Shale.....	55	178
Limestone.....	114	292
Limestone.....	41	335
		Total depth

GRUNDY COUNTY.

Log of Chicago, Milwaukee, St. Paul and Pacific Railway Company's No. 1 well at Laredo, Mo. Location: NE. 1/4 SW. 1/4 SW. 1/4 sec. 12, T. 60 N., R. 23 W., Grundy County, Mo. Elevation: 762 feet (estimated). Completed April 4, 1937. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pennsylvanian system:		
Henrietta group:		
Tan sandy silt.....	5	5
Red marl.....	5	10
Shale, gray, calcareous.....	5	15
Limestone, shaley (Lexington Cap rock).....	5	20
Shale, dark gray to black (Lexington Horizon).....	5	25
No samples.....	10	35
Limestone, tan, sandy fossiliferous.....	15	50
Shale, calcareous, dark gray to black, coal (Summit).....	5	55
Shale, gray, calcareous.....	5	60
No samples.....	10	70
Limestone, gray to tan, fossiliferous.....	10	80
Cherokee group:		
Shale, red, calcareous.....	10	90
Limestone, sandy.....	15	105
Shale, calcareous, gray.....	10	115
Sandstone, slightly calcareous, with thin coal seam between 120' and 125'.....	15	130
Shale, gray.....	5	135
Coal, and limestone (Bevier).....	5	140
Limestone, sandy, sandstone 252' to 254'.....	20	160
Shale, black, carbonaceous.....	5	165
Coal and gray to black shale.....	5	170
Limestone, tan, gray, argillaceous.....	2	172
Shale, grey, with brown, clay ironstone (siderite) beds.....	8	180
Shale, red, with plant fossils.....	5	185
Coal, with gray shale.....	5	190
Shale, gray, calcareous.....	5	195
Shale, gray, sandy, with siderite beds.....	5	200
Shale gray.....	8	208
Shale, green.....	2	210
Shale, red.....	8	218
Shale, grey to green.....	5	223
Shale, grey, sandy, contains siderite beds.....	5	228
Shale, grey to tan, with some siderite.....	7	235

GRUNDY CO.—Log of C., M., St. P. and P. Ry. Co.'s No. 1 well at Laredo, Mo.—Cont.

	Thickness, Ft.	Depth, Ft.
Sandstone, fine grained argillaceous, some mica.....	21	256
Shale, grey, micaceous, with siderite oolites.....	8	264
Coal, with grey shale.....	1	265
Shale, light grey, with abundant siderite oolites.....	5	270
Shale, grey.....	5	275
Sandstone, medium fine grained, micaceous, siderite oolites.....	5	280
Sandstone, as above with coal.....	5	285
Shale, grey, with siderite oolites.....	5	290
Shale, black.....	5	295
Shale, light grey (fire clay).....	5	300
Coal and grey shale.....	2	302
Shale, black.....	3	305
Shale, grey.....	5	310
Sandstone, shaly, arkosic, somewhat calcareous with thin impure coal bed.....	10	320
Shale, sandy, micaceous.....	10	330
Shale, black, with some mica and sand.....	5	335
Sandstone, somewhat arkosic, with mica.....	5	340
Shale, dark grey.....	18	358
Sandstone, white, sub-angular grains.....	17	375
Shale, black with sand aggregates (probably caved).....	10	385
Sand, coarse, with pyritized plant fossil and siderite beds...	17	402
Shale, grey to black.....	13	415
Sand, coarse, iron stained, with pyrite and chert fragments.	1	416
Mississippian system:		
St. Louis formation:		
Limestone, white, fine grained to sub-lithographic, sandy...	16	432
Limestone, white to light tan, oolitic, sandy.....	12	444
Warsaw? formation:		
Limestone, tan, coarsly crystalline, fossiliferous, with green shale, contains red chalcedonic to quartzose chert.		
Very shaly from 458' to 466'.....	35	479
		Total depth

Correlation and Descriptions based on study of samples.

Log of Grundy County Coal Company's coal test in bottom of old shaft. Location: SW. 1/4 SW. 1/4 sec. 16, T. 61 N., R. 24 W., Grundy County, Mo. Completed June, 1888, with core drill. Well No. (5), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Old shaft.....	234	5	234	5
Pennsylvanian system:				
Cherokee group:				
Sandy fire clay.....	1	5	235	10
Black shale.....	6	6	242	4
Clay shale and sandstone irregular stratified thick and thin layers.....	10	2	252	6
Yellow sandstone.....	2	6	255	
Yellow sandstone, shale.....	2	7	257	7
Blue sand shale.....	12		269	7
Black bituminous shale.....	7	9	277	4
Brown shale.....	15	4	292	8

GRUNDY CO.—Log of Grundy Co. Coal Co.'s coal test in bottom of old shaft—Cont.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Black shale.....	3		295	8
Soapstone.....	3		298	8
Brown sand shale.....	1	6	300	2
Brown shale.....	15	9	315	11
Brown sand shale.....	4		319	11
Black shale.....	6		325	11
Brown sand shale.....	8		333	11
Black shale.....	11	4	345	3
Coal, mixed.....		2	345	5
Sand shale and fine clay.....	8	6	353	11
Black shale.....	16	6	370	5
Hydraulic limestone with thin layers micaceous sand shale.....	9	9	380	2
Black shale.....	5		385	2
Brown sand shale.....	18	11	404	1
Micaceous sandstone.....	28		432	1
Bituminous sand shale.....	4		436	1
Micaceous sandstone.....	2		438	1
Bituminous sand shale.....	14	3	452	4
Black shale.....	8		460	4
Sandstone.....	1		461	4
Micaceous S.S. alter. with thin layers of black sand Sh. 1/8 to 1 inch thick.....	43	11	505	3
Coarse friable S.S.....	50		555	3
Mississippian system:				
Cherty limestone.....	41	5	596	8
Crystalline limestone.....	9	2	605	10
(left off in this)			Total	depth

Log of Trenton Coal Company's coal test No. 1. Location: SW. 1/4 NE. 1/4 NW. 1/4 sec. 17, T. 61 N., R. 24 W., Grundy County, Mo. Elevation: 807 feet. Well No. (8), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Soil and drift.....	38		38	
Pennsylvanian system:				
Soapstone.....	1		39	
Sand stone, soft.....	6		45	
Soapstone, white.....	25		70	
Gray shale.....	6		76	
Sandstone.....	5		81	
Shale gray.....	10		91	
Soapstone.....	4		95	
Gray shale.....	6	10	101	10
Coal.....	1	1	102	11
Clay and coal.....		2	103	1
Soapstone.....	5	3	108	4
Shale gray.....	15	4	123	8
Coal, (Bevier).....	1	3	124	11
Shale, dark gray.....	2	8	127	7
Sandstone, gray.....	8	1	135	8

GRUNDY COUNTY—Log of Trenton Coal Company's coal test No. 1—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Soapstone.....	1		136	8
Sandstone, hard.....		6	137	2
Black slate, soft.....	6		143	2
Shale, sandy, gray.....	1		144	2
Limestone hard.....		6	144	8
Slate.....		11	145	7
Black slate.....		5	146	
Gray shale.....	1	6	147	6
Limestone (Lower Ardmore?).....		2	147	8
Shale, gray.....	3	3	150	11
Soapstone.....	8	6	159	5
Shale, gray.....	5		164	5
Slate, dark.....	2	6	166	11
Coal.....		8	167	7
Soapstone.....	9		176	7
Hard sandstone.....		8	177	3
Soapstone.....	6	2	183	5
Slate, black.....	2		185	5
Coal.....		1	185	6
Soapstone.....	1		186	6
Coal.....		2	186	8
Soapstone.....	5	5	192	1
Gray slate.....	2		194	1
Soapstone.....	15	6	209	7
Sandstone.....		6	210	1
Soapstone.....	10	9	220	10
Limestone.....		6	221	4
Shale, gray.....	21		242	4
Slate, black.....	3		245	4
Soapstone.....	10		255	4
Limestone.....		8	256	
Sandstone.....	1	6	257	6
Soapstone.....	5	6	263	
Black slate.....	1		264	
Coal.....		2	264	2
Fire clay.....	1		265	2
Sandstone, soft.....	15		280	2
Black slate.....	10	7	290	9
Coal.....	1	6	292	3
Fire clay.....	1	7	293	10
Sandstone.....	3	2	297	
Slate, black.....	2	4	299	4
Coal.....		6	299	10
Rock.....		1	299	11
Coal.....		11	300	10
Soapstone.....	4	4	305	2
Sandstone.....		8	305	10
Slate, black.....	2		307	10
Sandstone.....		6	308	4
			Total	depth

(Note: This is the deepest of seven coal tests (wells No. (2) to No. (10) Pl. I) drilled in this vicinity. This does not include well No. 5 and well 9, logs of which are published.)

GRUNDY COUNTY—Continued.

Log of Trenton Oil & Gas Company's Collier Estate No. 1. Location: SW. 1/4 SW. 1/4 sec. 18, T. 61 N., R. 24 W., Grundy County, Mo. Elevation: Uncertain (745 to 760 feet). Completed 1911. Well No. (9). Pl. I.

The driller's log of this well has not been obtained. Incomplete samples are as follows:

- 500—Sand, fine to coarse grained. Grains angular.
- 500?—Limestone, buff to gray and mottled gray—white chert.
- 800—Limestone—buff, crystalline.
- 840—Limestone—dark gray, fine grained, some chert and gray, crys. Ls. in sample.
- 940—Limestone—gray, finely crys.
- 1030—Limestone—dense, and some crys. Ls.
- 1080—Limestone—gray, crystalline.
- 1090—Limestone—buff, crystalline.
- 1130—Limestone—brown, crystalline, some gray Ls.
- 1152—Limestone—dark gray, dense.

Pennsylvanian System. 0 to 500

Mississippian System:

- Warsaw Limestone in sample at. 500
- Keokuk-Burlington limestone in sample at. 800
- Chouteau limestone in sample at. 840

Devonian System:

- Callaway and Cooper limestones, 5 samples at 940, 1030, 1080, 1090, 1130.

Total depth reported 1198.

Log of R. H. Wood and Company's Citizens State Bank (Robinson) No. 1. Location: NE. 1/4 SE. 1/4 sec. 14, T. 61 N., R. 25 W., Grundy County, Mo. Elevation: 980 feet (aneroid). Completed Sept. 30, 1931. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pennsylvanian system:		
Kansas City group:		
No samples.	20	20
Limestone, tan crystalline, somewhat fossiliferous. (Bethany Falls).	5	25
Limestone as above, with black platy shale.	5	30
Shale, sandy, slightly calcareous.	15	45
Limestone, gray, dense, sparingly fossiliferous (Hertha).	5	50
Pleasanton group:		
No samples.	30	80
Shale, sandy, micaceous, calcareous, with some siderite (clay ironstone) in the top of five feet.	15	95
Sandstone, shaly, calcareous, medium coarse grained.	20	115
Limestone, tan, fossiliferous, with black shale.	5	120
Sandstone, arkosic, with much mica, calcareous in part—some calcareous fossils.	40	160
Limestone, tan, shaly, with green shale.	5	165
Shale, gray, slightly calcareous.	5	170
Shale, gray, sandy. Sand very fine-grained, micaceous.	30	200
Henrietta group:		
Limestone, shaly, with gray green shale, pyrite.	5	205
Limestone, gray, fossiliferous.	5	210
Limestone, shaly with black shale (Lexington horizon).	5	215
Limestone, light tan and gray, medium coarse grained, argillaceous and sandy.	10	225
Limestone and shale, somewhat sandy.	5	230
Shale, gray, with thin beds of siderite.	10	240
Limestone, shaly, with same glauconite.	5	245
Limestone, as above, with black carbonaceous shale.	5	250
Limestone, brown, fossiliferous.	5	255

GRUNDY CO.—Log of R. H. Wood & Co.'s Citizens State Bk. (Robinson) No. 1—Cont.

	Thickness, Ft.	Depth, Ft.
Cherokee group:		
Sandstone, medium coarse grained angular, slightly calcareous.....	20	275
No sample.....	15	290
Sandstone, much mica.....	5	295
No samples.....	10	305
Sandstone, very angular grains, mica.....	5	310
No samples.....	15	325
Sandstone, angular grains, mica, slightly calcareous.....	10	335
No samples.....	25	360
Limestone, shaly, glauconitic, (Ardmore horizon).....	3	363
Shale, black, somewhat calcareous.....	2	365
Shale, gray, calcareous.....	10	375
Shale, black, calcareous, some coal.....	5	380
Shale, gray, somewhat calcareous.....	10	390
Shale, gray.....	5	395
Shale, gray and red.....	5	400
Shale, gray, calcareous in upper part.....	10	410
Shale, gray, calcareous.....	5	415
Shale, gray, with siderite oolites.....	10	425
Sandstone, very shaly, with siderite concretions.....	5	430
Shale, gray, calcareous.....	5	435
Sandstone, shale, siderite.....	5	440
No samples.....	35	475
Shale, gray, with siderite.....	5	480
Sandstone, medium fine grained Argillaceous, with siderite.....	10	490
Shale, gray, with siderite oolites.....	5	495
Sandstone, medium coarse, with some feldspars altering to kaolin.....	5	500
Shale and sandstone, thin bedded, micaceous, with siderite.....	20	520
No samples.....	15	535
Shale, sandy, with mica, plant remains, and siderite (concretions?).....	15	550
Sandstone, mica, plant remains.....	5	555
Shale, gray, with mica.....	5	560
Sandstone, with mica and plant remains.....	15	575
Sandstone, with black carbonaceous shale.....	8	583
No samples.....	7	590
Sandstone, angular, medium coarse with some feldspar and mica.....	40	630
No samples.....	20	650
Sandstone, fine grained, gray, with siderite beds.....	5	655
No samples.....	45	700
Sand, very coarse grained.....	6	706
		Total depth

Descriptions and correlation based on a study of samples of cuttings.

GRUNDY COUNTY—Continued.

Log of Medicine Valley Coal Company's shaft. Location: SE. 1/4 NW. 1/4 sec. 32, T. 62 N., R. 22 W., Grundy County, Mo. Completed 1894-5. Shaft No. (12), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Soil.....	1		1	
Subsoil.....	1	6	2	6
Gumbo.....	10		12	6
Mixed sand clay and water clay.....	9		21	6
Pennsylvanian system:				
Shale, hard.....	20		41	6
Rock, hard, blue.....	4		45	6
Shale, light, hard.....	16		61	6
Limestone, gray.....	130		191	6
Shale, blue, hard.....	16		207	6
Fossil rock.....	4		211	6
Shale, light-gray.....	5		216	6
Limestone.....	2		218	6
Slate.....	14		232	6
Coal.....	1	8	234	2
Drilled below coal.....				
Sandstone.....	15		249	2
Shale, hard, blue.....	10		259	2
Granite stone.....	4		263	2
			Total	depth

Log of John Tolle Fee No. 1. Location: E. 1/2 NE. 1/4 sec. 27, T. 62 N., R. 23 W., Grundy County, Mo. Completed July, 1913. Well No. (13), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	140	140
Blue clay.....	140	280
Pennsylvanian system:		
Shale and soapstone.....	260	540
Shale and sandstone with hard layers like below.....	65	605
Hard layers of yellow red, greenish gray and dark and black sandy rock, some sandstone layers between.....	20	625
Same as above.....	13	638
		Total depth

Log of well of H. F. Fickel Fee No. 1. Location: NW. 1/4 NE. 1/4 sec. 18, T. 60 N., R. 22 W., Grundy County, Mo. Well No. (15), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene and Recent series:				
Dirt.....	125		125	

GRUNDY COUNTY—Log of well of H. F. Fickel Fee No. 1—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pennsylvanian system:				
Cherokee group:				
Hard rock.....	4	6	129	6
Dirt.....	10		139	6
Hard rock.....		6	140	
Soapstone.....	9		149	
Hard rock.....	1		150	
Soapstone.....	20		170	
Sandstone.....	9		179	
Coal.....	1	5	180	5
Soapstone.....	27		207	5
Coal.....	1		208	5
Soapstone.....	22		230	5
Coal.....		10	231	3
Soapstone.....	5		236	3
Sand, petrified.....	8		244	3
Hard rock.....		10	245	1
Soapstone.....	6		251	1
Hard rock.....		9	251	10
Coal.....	3	6	255	4
Fire clay.....	2		257	4
Sand rock.....	1	6	258	10
Fire clay.....	6		264	10
Soft shale.....	14		270	10
Coal.....		6	279	4
Shale.....	10		289	4
Hard rock.....	1	6	290	10
Soapstone.....	3		293	10
Shale.....	21		314	10
Sandstone.....	20		336	10
Soapstone.....	40		374	10
Sand shale.....	30		404	10
Sand stone.....	40		444	10
Hard rock.....	1	6	446	4
Soapstone.....	20		466	4
Sandstone, white porous.....	30	8	497	
			Total	depth

KNOX COUNTY.

Log of Geo. S. Washburn well. Location: SW. cor. SE. 1/4 sec. 25, T. 61 N., R. 10 W., Knox County, Mo. Elevation: 729 feet (aneroid). Completed 1901. Well No. (1), Pl. I.

	Thickness. Ft.	Depth. Ft.
Drift.....	190	190
Limestone.....	100	290
Shale.....	80	370
Limestone.....	355	725
		Total depth

KNOX COUNTY—Continued.

Log of J. W. Ronner well. Location: SE. 1/4 sec. 31, T. 61 N., R. 10 W., Knox County, Mo. Elevation: 740 feet (estimated). Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
Yellow clay, sandy.....	25	25
White limestone.....	135	160
Soft blue shale.....	104	264
Limestone and flint, white, hard.....	256	520
White soft sandstone.....	3	523
		Total depth

Log of Orville Smith No. 1 Snelling. Location: NW. 1/4 NE. 1/4 sec. 35, T. 61 N., R. 11 W., Knox County, Mo. Elevation: 775 feet (aneroid). Completed July, 1938. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	115	115
Mississippian system:		
Osage group:		
Burlington-Keokuk formations:		
Limestone, white.....	140	255
Kinderhook group:		
Hannibal formation:		
Sandstone, fine.....	10	265
Shale, gray.....	10	275
No samples.....	80	355
Louisiana formation:		
Limestone, dense gray.....	10	365
No samples.....	90	455
Devonian system:		
Callaway formation:		
Dolomitic limestone, sandy.....	15	470
Limestone, very sandy.....	5	475
Dolomite, buff finely granular.....	25	500
Cooper formation:		
Limestone, lithographic.....	95	595
		Total depth

Correlations and descriptions from sample study.

Log of City of Edina well. Location: SW. cor. sec. 18, T. 62 N., R. 11 W., Knox County, Mo. Elevation: 816 feet (aneroid). Completed, spring of 1915. Well No. (4), Pl. I.

No log available. Total depth 804 feet. Water had salty taste.

KNOX COUNTY—Continued.

Log of Midland Oil and Gas Company's W. H. Nooning well. Location: NE. 1/4 SW. 1/4 NE. 1/4 sec. 3, T. 62 N., R. 13 W., Knox County, Mo. Elevation: 781 feet (aneroid). Completed March, 1908. Log by R. F. Ammons. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Black soil or silt.....	11	11
Black loose sand.....	7	18
Conglomerate mass, sand, wood gravel and water.....	53	71
Yellow clay.....	18	89
Black jack or black shale.....	30	119
Light shale with some sand.....	11	130
Lime, bed rock (water at bottom).....	25	155
Gray shale with some sand.....	15	170
Black shale.....	3	173
Lime.....	10	183
Shale, gray.....	3	186
Lime.....	114	300
Salt sand.....	14	314
Lime.....	100	414
Sand, fine, gray.....	7	421
Lime.....	91	512
Shale, blue and red.....	188	700
Lime (artesian water at 873).....	173	873
Lime.....	82	955
Red sand.....	11	966
White sand.....	74	1040
Shale.....	4	1044
Oil-bearing sand.....	6	1050
Water-bearing sand.....	30	1080
Lime, brown and seems broken.....	228	1308
		Total depth

(The base of the "Mississippi lime" is probably at 512 feet.)

Log of Midland O. & G. Company's G. W. Pulis No. 1 well. Location: SE. 1/4 sec. 12, T. 62 N., R. 13 W., Knox County, Mo. Elevation: 775 feet (estimated). Completed 1909. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	4	4
Sand and gravel.....	8	12
Hard dark clay.....	85	97
Sand and gravel.....	15	112
Hard sand.....	60	172
Limestone and flint shells.....	84	256
Shale.....	2	258
Limestone.....	60	318
Shale.....	162	480
Limestone.....	74	554
Shale.....	15	569
Magnesian limestone with water at bottom.....	84	653
Limestone.....	76	729
Red sandstone.....	11	740
Shale—estimated (should be limestone).....	122	862
Sandstone.....	24	886
		Total depth

KNOX COUNTY—Continued.

Log of Prudential Life Insurance Company's No. 1 Black. Location: SE. cor. sec. 22, T. 62 N., R. 13 W., Knox County, Mo. Elevation: 850 feet (estimated). Completed August, 1938. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Blue dirt.....	122	122
Sand.....	30	152
Blue dirt.....	22	174
Mississippian system (Meramec Group):		
Warsaw formation:		
Limestone.....	26	200
Dolomite.....	5	205
Limestone, cherty.....	35	240
Dolomite, cherty.....	10	250
No samples.....	5	256
		Total depth

Correlations and descriptions below 174 feet from sample study.

Log of J. E. Anderson well. Location: NE. 1/4 sec. 32, T. 63 N., R. 10 W., Knox County, Mo. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift, clay, sand.....	130	130
Gray limestone.....	30	160
Green shale.....	40	200
Limestone and flint.....	154	354
Sandstone ? white.....	1	355
		Total depth

Log of Virgil Kaser well. Location: SW. 1/4 NE. 1/4 sec. 6, T. 63 N., R. 12 W., Knox County, Mo. Elevation: 838 feet (aneroid). Completed 1912. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift clay and probably a little coal measures.....	200	200
Slate and coal.....	5	205
Limestone, shelly on top.....	30	235
Green shale.....	5	240
Limestone.....	25	265
Slate and a little coal.....	3	268
Light colored shale.....	22	290
Black shale and coal.....	3	293
Shale.....	50	343
Limestone with flint.....	121	464
		Total depth

KNOX COUNTY—Continued.

Log of J. J. Childress well. Location: SE. cor. NE. 1/4 NE. 1/4 sec. 8, T. 63 N., R. 12 W., Knox County, Mo. Elevation: 837 feet (aneroid). Completed 1910. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay and drift.....	173	173
Limestone.....	97	270
Blue shale.....	3	273
Limestone.....	30	303
White shale.....	10	313
Limestone.....	57	370
Hard blue granite.....	4	374
Limestone and flint.....	94	468
White sandstone.....	10	478
		Total depth

"Hard blue granite" at 370, probably flint. Top of "Mississippi lime" at 173 feet.

Log of John Longworth well. Location: SW. 1/4 sec. 10, T. 63 N., R. 12 W., Knox County, Mo. Elevation: 810 feet (estimated). Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift clay.....	100	100
Limestone.....	100	200
Shale.....	50	250
Limestone.....	150	400
Sandstone (water).....	4	404
		Total depth

Log of Midland O. & G. Company's No. 1 Thomas Early well. Location: NE. 1/4 NE. 1/4 sec. 22, T. 63 N., R. 12 W., Knox County, Mo. Elevation: 756 feet (aneroid). Completed 1908. Well No. (12), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	60	60
Limestone.....	72	132
Shale.....	52	184
Limestone, water.....	122	306
Gritty limestone.....	72	378
Limestone.....	75	453
Shale.....	236	689
Light colored limestone.....	142	831
Brown limestone.....	69	900
Sandstone.....	44	944
Shale.....	7	951
Sandstone.....	31	982
Limestone.....	468	1450
		Total depth

(The base of the "Mississippi lime" is probably at 453 feet, and the sandstone from 900 to 982 feet may be the St. Peter-Everton formations.)

KNOX COUNTY—Continued.

Log of Atchison, Topeka and Santa Fe Railway well, at Baring, Mo. Location: NW. 1/4 NE. 1/4 sec. 26, T. 63 N., R. 12 W., Knox County, Mo. Elevation: 803 feet (aneroid). Completed 1912. Well No. (13), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Blue clay.....	100	100
Mississippian system:		
Osage group:		
Limestone, cherty.....	175	275
Sandstone, gray micaceous.....	5	280
No samples.....	130	410
Kinderhook group:		
Chouteau formation:		
Limestone, lithographic, gray, some chert.....	55	465
No samples.....	45	510
Devonian system:		
Limestone, little chert.....	205	715
Limestone, cherty.....	145	860
No sample.....	5	865
Ordovician system:		
Kimmswick formation:		
Dolomite, some chert.....	70	935
No sample.....	5	940
Plattin formation:		
Limestone, cherty.....	5	945
St. Peter formation:		
Sandstone, white.....	45	990
Everton? formation:		
Dolomite, white.....	10	1000
No sample.....	10	1010
Sandstone, white.....	29	1039
(Canadian system of E. O. Ulrich):		
Jefferson City, Cotter formations:		
Dolomite, very sandy.....	66	1105
No samples.....	75	1180
Dolomite, cherty and sandy.....	60	1240
Dolomite, cherty, small amount of sand.....	210	1450
No samples.....	102	1552
(Ozarkian system of E. O. Ulrich):		
Gasconade formation:		
Dolomite, cherty.....	140	1692
Gunter member:		
Sandstone, poorly sorted.....	150	1842
No samples.....	283	2125

The above correlation is based on a study of an incomplete set of samples. A log of this well, based on a study of a more complete set of samples, appears in "Underground Water Resources of Iowa," Vol. XXI, P. 620, Iowa Geological Survey. It is reprinted on the following pages:

KNOX COUNTY—Continued.

Record of Strata in the Atchison, Topeka and Santa Fe Railway well at Baring, Missouri.

	Thickness, Ft.	Depth, Ft.
Pleistocene (100 feet thick; top 808 feet above sea level);		
Till, blue predominantly clayey.....	100	100
Carboniferous (Mississippian):		
Saint Louis limestone and Osage stage (365 feet thick; top 708 feet above sea level):		
Chert, with white limestone and chalcedonic and crystalline silica; in sand.....	175	275
Shale, green gray, highly arenaceous; with minute irregular grains of crystalline quartz, calcareous.....	5	280
"Limestone, white;" no sample.....	65	345
Sandstone, very coarse; very imperfectly rounded grains of quartz and other minerals; water heading at 180 feet below curb.....	15	360
Chert; fine sand of particles of cryptocrystalline silica with some white limestone and some crystalline quartz; water at 375 feet.....	15	375
Marl, light yellow; rapid effervescence, large siliceous and argillaceous residue.....	35	410
Limestone, light drab, fine-grained.....	55	465
Kinderhook, stage (33 feet thick, top, 343 feet above sea level)		
"Shale"; no sample.....	28	493
"Blue clay"; no sample.....	5	498
Devonian (217 feet thick; top 310 feet above sea level);		
"Limestone"; no sample.....	12	510
Limestone, gray; rapid effervescence; earthy, fossiliferous, with joints of crinoid stems and fragments of shells of brachiopods; in flaky chips.....	205	715
Silurian (150 feet thick; top 93 feet above sea level);		
Limestone and sandstone; limestone, light yellow gray, rapid effervescence; sandstone, fine-grained, larger grains of pure quartz and well rounded, a few secondary enlargements; much cryptocrystalline silica in chips; water at 860 feet.....	145	860
"Sand"; no sample.....	5	865
Ordovician:		
Galena limestone (69 feet thick; top 57 feet below sea level)		
Dolomite or magnesian limestone, cherty; in brown crystalline sand; water at 900 feet.....	69	934
Decorah shale (4 feet thick; top 126 feet below sea level)		
"Shale"; no sample.....	4	938
Platteville limestone (6 feet thick; top 130 feet below sea level)		
Limestone, light gray; rapid effervescence; some chert; in small chips.....	6	944
Saint Peter sandstone (46 feet thick; top at 13 feet below sea level)		
Sandstone, light yellow, fine grained; of pure quartz, grains moderately well rounded, some showing secondary enlargements; 4 samples; water at 965 feet.....	46	990
Prairie du Chien stage (702 feet thick, top 182 feet below sea level)		
Dolomite, light yellow; in sparkling sand.....	10	1000
"Slate Blue"; no sample.....	9	1009
Sandstone, buff, very fine; grains imperfectly rounded.....	30	1039
Sandstone, coarser, heavily rusted; water bearing.....	2	1041
Dolomite, buff and light brown, cherty, highly arenaceous; 3 samples.....	67	1108
Dolomite, light brown and gray, oolitic, cherty, somewhat arenaceous; 3 samples; water bearing at 1140 feet.....	97	1205
Dolomite, light buff, highly arenaceous.....	35	1240
Dolomite, light buff, somewhat arenaceous.....	78	1318
Dolomite, light buff, highly arenaceous and cherty.....	90	1408
Dolomite, buff; some sand in drillings.....	86	1494

KNOX CO.—Record of Strata in the A., T., and Santa Fe Ry. well at Baring, Mo.—Cont.

	Thickness, Ft.	Depth, Ft.
Dolomite, light gray; water heading at 126 feet below curb.	21	1515
"Limestone" (dolomite) no sample water at 1535 feet	20	1535
Dolomite, cherty, somewhat arenaceous; 2 samples	37	1572
Marl, light buff, in concrete powder; and dolomite, in fine meal	4	1576
Dolomite, light buff, cherty	14	1590
Dolomite, light yellow	35	1625
Dolomite, light brown	17	1642
Dolomite, rusted grains with some chert and a few grains of quartz sand	4	1646
Dolomite, buff with some chert, minute grains of quartz sand and a little glauconite; 2 samples	20	1666
Dolomite, buff, cherty, 2 samples	26	1692
Cambrian (150 feet penetrated; top 884 feet below sea level)		
Sandstone, light yellow, in clean quartz sand; grains well rounded, larger grains from .6 to 1 millimeter	8	1700
Sandstone, light yellow, coarser; 3 samples	60	1760
Sandstone, light yellow, with some green shale	14	1774
Marl, light yellow-gray, calcareo-argillaceous	8	1782
Sandstone, whitish	11	1793
Sandstone, buff, rounded grains, with an admixture of marl; 2 samples	49	1842

Log of Midland Oil and Gas Company's No. 1 Wm. Gibson. Location: SW. 1/4 SE. 1/4 sec. 30, T. 62 N., R. 12 W., Knox County, Mo. Completed about 1908. Elevation: 825 feet (estimated). Well No. (14), Pl. I.

No log available; total depth reported to be between 700 and 800 feet.

LEWIS COUNTY.

Log of G. W. and O. W. Tomlinson well. Location: SE. 1/4 SE. 1/4 sec. 27, T. 60 N., R. 6 W., Lewis County, Mo. Elevation: 525 feet (estimated). Completed June, 1915. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples	470	470
Limestone, gray, crystalline with some sand (Devonian ?)	20	490
No samples	229	719
		Total depth

(Well flowed at 710 feet; estimated top of St. Peter sandstone at approximately 710 feet.)

LEWIS COUNTY—Continued.

Log of William Mensendick well. Location: 3 miles southeast of Ewing, Mo.; sec. 21 (?), T. 60 N., R. 7 W., Lewis County, Mo. Completed 1905. Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent or Pleistocene series:		
Yellow clay.....	18	18
Mississippian system:		
Meramec and Osage groups:		
White limestone.....	35	53
Shale.....	4	57
Limestone.....	13	70
Shale.....	50	120
Gray limestone.....	100	220
White limestone.....	80	300
Shale.....	5	305
		Total depth

Log of the W. H. Thomas No. 2 well at La Grange, Mo. Originally known as the "La Grange Mineral Prospecting Company" well. Location: Approximately SW. 1/4 sec. 30, T. 61 N., R. 5 W., Lewis County, Mo. Elevation: 580 feet (estimated). Completed January, 1888. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	15	15
Limestone.....	200	215
Shale.....	65	280
Limestone, soft.....	65	345
Shale, soft; slate or soapstone.....	150	495
Dry "Trenton" (?) rock.....	150	645
Limestone.....	155	800
Sandstone, white.....	50	850
		Total depth

The base of the "Mississippi Lime" is probably at 215 feet, and the sandstone from 800 feet to 850 feet is probably the St. Peter sandstone.

Log of the Silas Lake well at La Grange, Mo. Location: Approximately SW. 1/4 NW 1/4 sec. 31, T. 61 N., R. 5 W., Lewis County, Mo. Elevation: 480 feet (estimated). Completed in 1913. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Alluvium.....	20	20
Limestone with flint.....	68	88
Limestone with flint.....	5	93
Shale, yellow, blue.....	72	165
Limestone, brown.....	20	185
Limestone, gray.....	25	210
Shale.....	150	360
Limestone.....	158	518

LEWIS COUNTY—Log of the Silas Lake well at La Grange, Mo.—Continued.

	Thickness, Ft.	Depth, Ft.
Limestone with galena.....	2	520
Limestone.....	14	534
Sandstone.....	8	542
Limestone.....	10	552
		Total depth

The base of the "Mississippi Lime" is probably at 93 feet.

Log of W. H. Thomas No. 1 well at La Grange, Mo. Location: NW. 1/4 SW. 1/4 SW. 1/4 sec. 31, T. 61 N., R. 5 W., Lewis County, Mo. Elevation: 481 feet (estimated). Completed in 1887. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	15	15
Limestone.....	80	95
Shale.....	70	165
Limestone, soft.....	55	220
Slate, soft; shale, or soapstone.....	155	375
Limestone, dry.....	110	485
"Trenton rock (?)".	200	685
Sandstone, white, very soft.....	115	800
		Total depth

The base of the "Mississippi Lime" is probably at 95 feet, and the sandstone from 685 feet to 800 feet is probably the St. Peter sandstone.

Log of Charles Mensondick well. Location: NE. 1/4 sec. 6, T. 61 N., R. 7 W., Lewis County, Mo. Completed 1919. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
No log.....	882	882
Sandstone ("Top layer of the St. Peters").....	12	894
"Rock".....	14	908
"Bottom layer of St. Peters".....	80	988
		Total depth

LEWIS COUNTY—Continued.

Log of city of Monticello well. Location: SE. cor. NW. 1/4 sec. 6, T. 61 N., R. 7 W., Lewis County, Mo. Elevation: 670 feet (estimated). Completed 1934. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene or Recent:		
No samples.....	20	20
Mississippian system:		
Meramec group:		
St. Louis formation:		
Sandstone, fine grained, white.....	5	25
Limestone.....	35	60
Warsaw formation:		
Shale.....	35	95
Limestone, somewhat cherty.....	30	125
Osage group:		
Burlington-Keokuk formations:		
Limestone, cherty.....	55	180
Limestone, very cherty.....	7	187
Dolomitic limestone, very cherty.....	43	230
Limestone, very cherty.....	30	260
Limestone, less cherty.....	30	290
Limestone.....	10	300
Limestone, cherty.....	22	322
		Total depth

Correlations and descriptions from sample study.

Log of Alex Stephenson well. Location: SE. 1/4 NE. 1/4 SW. 1/4 sec. 14, T. 61 N., R. 8 W., Lewis County, Mo. Elevation: 634 feet (aneroid). Completed July, 1936. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Soil and drift.....	40	40
Mississippian system:		
Meramec and Osage groups:		
Sandstone.....	5	45
Limestone, little chert.....	55	100
Limestone and shale with chert (Warsaw ?).....	45	145
Limestone and chert (Keokuk-Burlington ?).....	160	305
		Total depth

(Above correlations based on examination of a poor set of samples and incomplete driller's log.)

LEWIS COUNTY—Continued.

Log of Lewis County Infirmary well. Location: SW. 1/4 SE. 1/4 NW. 1/4 sec. 15, T. 61 N., R. 8 W., Lewis County, Mo. Elevation: 712 feet (aneroid). Completed 1936. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Dirt.....	80	80
Brown shell.....	25	105
Limestone.....	55	160
Soapstone*.....	40	200
Lime and flint.....	80	280
		Total depth

*One sample "soapstone" examined; gray, fissile shale probably from Warsaw formation.

Log of S. D. Mattingly well. Location: SW. 1/4 NW. 1/4 sec. 4, T. 61 N., R. 9 W., Lewis County, Mo. Elevation: 734 feet (aneroid). Completed 1908. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Glacial drift.....	105	105
Mississippian system:		
Meramec and Osage groups:		
Soapstone.....	15	120
Limestone.....	280	400
Kinderhook group (?):		
Shale.....	20	420
		Total depth

Log of Canton Oil and Gas Company's well No. 2. Location: SW. 1/4 NW. 1/4 sec. 14, T. 62 N., R. 6 W., Lewis County, Mo. Elevation: 516 feet (aneroid). Completed 1915. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	20	20
Mississippian system:		
Meramec and Osage groups:		
Limestone and dolomite, cherty.....	220	240
Kinderhook group:		
Hannibal formation:		
Sandstone, very fine, somewhat shaly.....	50	290
Shale, gray—green.....	50	340
Louisiana formation:		
Limestone, lithographic gray.....	20	360
Dolomite, tan sucrose.....	20	380
No samples.....	20	400
Grassy Creek formation:		
Shale, dark gray.....	20	420
Shale, green.....	20	440
Shale, dark gray.....	20	460
No samples.....	65	525

LEWIS COUNTY—Log of Canton Oil and Gas Company's well No. 2—Continued.

	Thickness, Ft.	Depth, Ft.
Devonian system:		
Callaway formation:		
Limestone, dense gray.....	25	550
No samples (may include Maquoketa).....	145	695
Ordovician system:		
Dolomite, tan crystalline.....	5	700
Limestone, gray dense.....	35	735
No samples.....	60	795
Dolomite, gray crystalline.....	5	800
No samples.....	60	860
Limestone, gray dense.....	5	865
No sample.....	5	870
St. Peter formation:		
Sandstone, white, rounded and frosted.....	5	875
No samples.....	53	928
		Total depth

Correlations and descriptions from sample study.

Log of T. M. Long well. Location: SE. 1/4 NE. 1/4 sec. 28, T. 62 N., R. 6 W., Lewis County, Mo. Completed 1918. Well No. (12), Pl. I.

No log available, Total depth, 850 feet.

Log of well at Culver-Stockton College. Location: Canton, Mo.; SW. 1/4 NW. 1/4 sec. 35, T. 62 N., R. 6 W., Lewis County, Mo. Elevation: 609 feet (aneroid). Completed 1890. Well No. (13), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	860	860
Ordovician system:		
"St. Peter" formation (?):		
Sandstone.....	40	900
		Total depth

Log of Canton Oil and Gas Company's No. 1 Ferguson. Location: NW. 1/4 SW. 1/4 sec. 35, T. 62 N., R. 6 W., Lewis County, Mo. Elevation: 608 feet (aneroid). Completed 1914. Well No. (14), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	115	115
Mississippian system:		
Meramec and Osage groups:		
Warsaw, Keokuk, Burlington formations:		
Limestone, white, somewhat cherty.....	85	200
Limestone, white, more cherty.....	35	235
Dolomite, cherty.....	55	290
Limestone, white, non-cherty.....	45	335

LEWIS COUNTY—Log of Canton Oil and Gas Company's No. 1 Ferguson—Continued.

	Thickness, Ft.	Depth, Ft.
Kinderhook group:		
Hannibal formation:		
Sandstone, slightly shaly, fine-grained.....	65	400
No samples (shale ?).....	30	430
Louisiana formation:		
Limestone, lithographic with some brown finely granular dolomite.....	40	470
Grassy Creek formation:		
Shale, dark gray.....	20	490
Shale, gray—green.....	25	515
No samples.....	45	560
Shale, dark gray to tan.....	32	592
Devonian system:		
Callaway formation:		
Limestone, gray dense.....	8	600
No samples.....	20	620
Limestone, brown, finely crystalline.....	20	640
Limestone, dark gray, dense.....	20	660
Limestone, tan, finely granular sucrose, somewhat dolomitic.....	10	670
Limestone, tan lithographic, a few grains of sand.....	60	730
		Total depth

Correlations and descriptions from sample study.

Log of Mrs. E. S. Smith well. Location: In northeast corner of town of Monticello, Mo.; SE. 1/4 sec. 31, T. 62 N., R. 7 W., Lewis County, Mo. Elevation: 670 feet (estimated). Well No. (15), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	920	920
Ordovician system (?):		
St. Peter formation (?):		
Sandstone, rounded and frosted grains.....	132	1052
		Total depth

(One sample, marked 920 to 1052, examined.)

Log of Carscadden well. Location: SW. 1/4 NE. 1/4 sec. 27, T. 63 N., R. 6 W., Lewis County, Mo. Elevation: 625 feet (aneroid). Completed 1916. Well No. (16), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	840	840
"St. Peter" sandstone.....	101	941
		Total depth

LINN COUNTY.

Log of Bucklin Coal Shaft. Location: Sec. 2 (?), T. 57 N., R. 18 W., Linn County, Mo.
Shaft No. (1), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	29	10	29	10
Pennsylvanian system:				
Pleasanton group:				
Shale.....	23	6	53	4
Henrietta group:				
Limestone.....	3	10	57	2
Clay.....	3	1	60	3
Limestone and shale.....	3	2	63	5
Shale, black.....	1	2	64	7
Limestone.....	2	5	67	
Shale, black.....	1	6	68	6
Sandstone.....	3	3	71	9
Limestone.....	7		78	9
Clay, black (horizon of Lexington coal).....	4	3	83	
Limestone.....	6	6	89	6
Sandstone.....	13	6	103	
Shale.....	8	6	111	6
Limestone.....	2	6	114	
Shale, black, slaty.....	2	11	116	11
Coal (Summit).....		7	117	6
Clay, white.....	6	6	124	
Limestone.....	2		126	
Cherokee group:				
Shale, dark brown (Horizon of Mulky coal).....	3	6	129	6
Clay.....	3		132	6
Sandstone.....	16		148	6
Shale.....	17		165	6
Coal 19".....				
Sandstone 6".....	2	4	167	10
Coal 3".....				
Shale.....	1	8	169	6
Limestone.....	6	7	176	1
Sandstone.....	41	8	217	9
Shale.....	10		227	9
Coal (Lower Ardmore).....	2	6	230	3*
			Total	depth

*Base of Cherokee not reached.

Log of Landbreth coal shaft at Marceline. Location: Cen. (?) sec. 20, T. 57 N., R. 18 W., Linn County, Mo. Elevation: 778 feet. Shaft No. (2), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	25		25	
Pennsylvanian system:				
Cherokee group:				
Shale.....	25		50	
Coal (upper Bevier).....	1	4	51	4

LINN COUNTY—Log of Landbreth coal shaft at Marceline—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Sandstone.....	4		55	4
Shale, black, "slaty".....	2		57	4
Coal (lower Bevier).....		2	57	6
Clay.....	2		59	6
Limestone, hard.....	1	10	61	4
Sandstone.....	30		91	4
Shale.....	35		126	4
Coal (lower Ardmore), mined.....	2	4	128	8
Clay, with boulders.....	6		134	8
Sandstone and shale.....	35		169	8
Shale, black, "slaty".....	4		173	8
Clay.....	4		177	8
Shale.....	22		199	8
Coal (Eureka).....	2	8	202	4*
			Total	depth

*Base of Cherokee not reached.

Log of George W. Early et al. well No. 1. Location: C. S. 1/2 sec. 30, T. 57 N., R. 18 W., Linn County, Mo. Elevation: 786 feet (aneroid). Drilling started October, 1907. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Surface.....	20	20
Pennsylvanian system:		
Sandstone.....	5	25
Clay.....	2	27
Sand.....	5	32
White shale.....	18	50
Coal.....	1	51
Fire clay.....	2	53
Lime.....	2	55
Shale.....	2	57
Sandstone.....	6	63
Shale.....	7	70
Hard lime.....	2	72
Shale.....	56	128
Soapstone.....	2	130
Sandy shale.....	10	140
White shale.....	10	150
Black shale.....	28	178
Sandy shale—gas.....	5	183
Dark shale.....	50	233
Mississippian system:		
Limestone.....	40	273
Shelly lime and shale.....	10	283
Lime and flint.....	92	375
White sand.....	5	380
Flinty lime.....	165	545
Green shale.....	2	547
Lime.....	45	592
Green shale.....	2	594

LINN COUNTY—Log of George W. Early et al. well No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Devonian system:		
Lime.....	107	701
Green shale.....	3	704
Lime.....	20	724
Green shale.....	5	729
Lime.....	70	799
Green shale.....	5	804
Dolomite, sandy.....	16	820
Ordovician and older:		
Lime.....	30	850
Green shale.....	2	852
Lime.....	97	949
White sand.....	155	1104
Limestone.....	900	2004
		Total depth

Note: Sandstone from 949 to 1104 is probably St. Peter and Everton.

Log of shaft of Marceline Coal and Mining Co., Mine No. 1. Location: SE. 1/4 SW. 1/4 sec. 32, T. 57 N., R. 18 W., Linn County, Mo. Elevation: 832 feet. Shaft No. (4), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift clay.....	25		25	
Pennsylvanian system:				
Henrietta group:				
Shale.....	10		35	
Limestone.....	5		40	
Shale, dark above, light below.....	10	6	50	6
Limestone.....	5	2	55	8
Sandstone.....	19		74	8
Shale.....	9		83	8
Limestone, hard.....	3		86	8
Shale, black, "slaty" (horizon of Summit coal)...	4	7	91	3
Clay.....	5	9	97	
Limestone.....	2	3	99	3
Cherokee group:				
Shale.....	1		100	3
Shale, black, with boulders (horizon of Mulky coal).....	3		103	3
Clay.....	3		106	3
Shale, calcareous.....	2		108	3
Sandstone.....	13		121	3
Shale.....	16		137	3
Coal (Bevier).....	1	6	138	9
Clay.....	3		141	9
Limestone.....	1		142	9
Sandstone, soft.....	6		148	9
Coal.....		4	149	1
Clay.....	2		151	1
Shale, sandy at top.....	10	4	161	5

LINN COUNTY—Log of shaft of Marceline Coal and Mining Co., Mine No. 1—Cont.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Sandstone.....	15		176	5
Shale.....	13		189	5
Coal (Tebo).....	2	4	191	9*
			Total	depth

*Base of Cherokee not reached.

Log of well three-fourths mile E. of Brookfield. Location: NE. 1/4 SE. 1/4 sec. 5, T. 57 N., R. 19 W., Linn County, Mo. Completed 1890 (?). Well No. (5), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Soil, clay and 6" of sand at bottom.....	75		75	
Pennsylvanian system:				
Slate, black.....		6		
Coal.....	3	4		
Clay with niggerheads.....	16		92	
Hard gray limestone.....	18-20			
Shale, drab.....	50		143	
Coal.....	2			
Fire clay with one or two layers of rock.....	60		205	
Shale, dark.....	15-20		223	
Fire clay.....	1	2	225	
Sandstone.....	2	6		
Mississippian system:				
Limestone, hard, gray.....	62		290	
Soapstone and limestone.....	35		325	
"Flint" took 10 days to penetrate.....		3		
Limestone, compact, with fossils.....	1			
"Flint".....		3		

Thicknesses and depths are shown as reported.

Log of shaft and drill hole at Brookfield. Location: Northwest corner of city in sec. 6 (?), T. 57 N., R. 19 W., Linn County, Mo. Shaft No. (6), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Surface deposits (the rhomboidal limestone should have come in here, 17 feet below the surface, but for some reason it was not found).....	30		30	
Hard rock, next below No. 42, and found in the bed of the creek near by.....	1	10	31	10
Fire clay and shales.....	16		47	10
"Soapstone".....	25		72	10
Coal (Nutter's).....	1	3	74	1

LINN COUNTY—Log of shaft drill hole at Brookfield—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Fire clay and shales.....	14		88	1
Concretions.....	6		94	1
Hard rock.....	1	8	95	9
"Soapstone".....	52	8	148	5
Coal (working seam).....	2	4	150	9
Brown fire clay and shales.....	16		166	9
Concretions.....	14		180	9
Fire clay.....	10		190	9
Sand rock (lowest rock at Joabs Creek).....	8		198	9
Fire clay.....	3		201	9
"Soapstone".....	4		205	9
"Slate".....		8	206	5
Fire clay (bottom of shaft).....	5		211	5
Below this a boring penetrated the following:				
"Soapstone".....	8		219	5
Fire clay.....	4		223	5
"Soapstone".....	14		237	5
Fire clay.....	4		241	5
"Soapstone".....	2		243	5
Coal.....	2	1	245	6
Fire clay.....		5	245	11
Coal.....		6	246	5
Fire clay and shales.....	15		261	5
Sandstone.....	8		269	5
"Soapstone".....	10		279	5
Hard rock; pyrites.....		8	280	1
"Soapstone".....	10		290	1
"Slate" and shales.....		6	290	7
Concretions.....	4		294	7
Hard rock (not bored through).....	2		296	7
			Total	depth

Log of Leo Shaffer Mine Shaft. Location: On property of Geo. Sebring; NW. 1/4 sec. 9, T. 57 N., R. 19 W., Linn County, Mo. Shaft No. (7), Pl. I.

	Depth, feet.
Sand.....	0 to 32
Sand and gravel.....	32 to 35
Yellow clay.....	35 to 38
Blue clay.....	38 to 55
Rock.....	55 to 57 ½
Slate.....	57 ½ to 90 ½
Coal (18" to 20").....	90 ½ to 92
Sandstone and fire clay.....	92 to 95
Mixed rock (described as being hard to shoot and like fresh concrete when wet. Probably calcareous shale).....	95 to 100
Sandstone.....	100 to 103
Cap rock about 20".....	103 to 105
Sandstone grading into shale.....	105 to 136
Soapstone.....	136 to 161
Coal (30").....	161 to 163 ½
Fire clay.....	163 ½ to 166 ½
Mixed rock (mostly limestone).....	166 ½ to 170
Total depth in limestone.....	170

LINN COUNTY—Continued.

Log of Henderson Produce Company's well at Laclede plant. Location: sec. 5, T. 57 N., R. 20 W., Linn County, Mo. Elevation: 791 feet. Completed 1934. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Surface clay, sand, etc., wood at bottom (water cased off).....	182	182
Pennsylvanian system:		
Shale.....	40	222
Sandrock, water, fresh and soft, 3 G. P. M.....	30	252
Mississippian system:		
Lime.....	8 ±	260 ±
		Total depth

Log of Pauley, Linton, and Wyett's Wickizer well No. 1. Location: SW. 1/4 SE. 1/4 sec. 22, T. 58 N., R. 18 W., Linn County, Mo. Elevation: 915 feet. Completed Jan. 8, 1931. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Clay, yellow.....	25	25
Clay and lime boulders, yellow.....	10	35
Clay and sand, yellow.....	33	68
Gravel bed, yellow (water).....	6	74
Yellow clay.....	6	80
Pennsylvanian system:		
Lime, gray.....	5	85
Sand.....	10	95
Pink shale.....	5	100
Lime.....	4	104
Shale, dark-gray.....	9	113
Lime.....	4	117
Gray shale.....	20	137
Lime.....	4	141
Shale (showing coal).....	6	147
Lime.....	5	152
Gray shale.....	8	160
Lime.....	3	163
Gray, sandy shale.....	27	190
Lime.....	20	210
Gray shale.....	50	260
Shale, pink (red bed).....	5	265
Brown shale.....	15	280
Gray shale.....	40	320
Black shale.....	35	355
White sand.....	15	370
No samples.....	15	385
Mississippian system:		
St. Louis formation:		
Limestone, white to tan, lithographic, sandy and oolitic in upper part.....	40	425
No samples.....	10	435
Warsaw ? formation:		
Limestone, tan, highly fossiliferous with red chalcadonic chert and green shale.....	45	480
No samples.....	5	485

LINN COUNTY—Log of Pauley, Linton and Wyett's Wickizer well No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Warsaw formation:		
Limestone, light tan, coarsely crystalline with gray and white mottled fossiliferous chert.....	65	550 Total depth

Note: This record is a driller's log to 370 feet, and is based on a study of samples from 370 feet to 550 feet.

Log of C. E. Wyett et al. Finney well No. 1. Location: Cen. W. 1/2 NE. 1/4 SE. 1/4 sec. 32, T. 58 N., R. 18 W., Linn County, Mo. Elevation: 851 feet. Commenced Jan., 1931. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Clay, yellow.....	40	40
Pennsylvanian system:		
Shale, blue-gray.....	30	70
Lime, sandy.....	6	76
Shale, gray.....	4	80
Lime, hard.....	6	86
Lime, sandy.....	14	100
Shale, dark.....	7	107
Lime.....	5	112
Shale (showing of coal).....	5	117
Shale, gray.....	2	119
Lime, hard.....	5	124
Shale, gray.....	5	129
Shale, gray sandy.....	100	229
Lime.....	2	231
Shale, gray, sandy.....	4	235
Shale, gray.....	15	250
Shale, brown.....	5	255
Shale, gray.....	5	260
Shale, gray, sandy.....	10	270
Shale, brown, covy.....	14	284
Lime.....	3	287
Shale, gray.....	3	290
Shale, black.....	20	310
Shale, dark.....	7	317
Sand (Sandy lime).....	5	322
Shale, gray, sandy.....	15	337
Sand, soft.....	8	345
Mississippian system:		
St. Louis formation:		
Limestone, sandy, oolitic. Oolites small sub-rounded.....	15	360
No samples.....	10	370
Limestone, dense white to light tan.....	10	380
Limestone, white, sandy, very oolitic.....	15	395
Limestone, dense sub-lithographic, sandy.....	5	400
No samples.....	5	405
Warsaw ? formation:		
Limestone, tan to brown, highly fossiliferous, with green shale and red, chalcedonic chert.....	20	425
No samples.....	10	435

LINN COUNTY—Log of C. E. Wyett et al. Finney well No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Warsaw formation:		
Limestone, coarsely crystalline, with blue to gray fossiliferous chert.	60	495
Keokuk-Burlington formations:		
Limestone, white to light gray and tan, coarsely crystalline, cherty. Chert dense, white to light tan, sparingly fossiliferous.	105	600 Total depth

Note: This record is a driller's log to 345 feet, and is based on a study of samples from 345 feet to 600 feet.

Log of Ed. Yazel Fee No. 1. Location: 10 miles east of Linneus, sec. 2 (?), T. 58 N., R. 19 W., Linn County, Mo. Completed Sept. 3, 1936. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Soil and clay.	20	20
Yellow mud.	15	35
Gray mud.	20	55
Yellow mud.	10	65
Gray mud.	20	85
Mud and sand.	20	105
Mud and gravel (water at 110).	10	115
Mud and sand (overnight level at 65).	5	120
Gray mud.	6	126
Coarse sand and some gravel (dry).	3	129
Coarse sand and some gravel (dry).	4	133
Mud and some gravel (dry).	8	141
Sand and mud (little water, set 149' of 8" pipe).	7	148
Mud and little gravel (dry).	17	165
Gray mud (dry).	8	173
Mud and gravel.	7	180
Mud, gravel, and sand (little water and sand running in overnight level at 165').	15	195
Mud and little sand.	6	201
Gray mud (set 215' of 6" pipe).	14	215
Lime, shell gray.	1	216
Gray shaly mud and little gravel (little red bed showing 216-217)	7	223
Lime, shell brown.	1	224
Mud and gravel (little water, 15 gal. per hour).	7	231
Lime, brown.	2	233
Shale, white.	2	235
Pennsylvanian system:		
Lime, gray.	3	238
Shale, white.	12	250
Shale, white, yellow, and red.	5	255
Shale, white, green, and some red.	10	265
Shale, gray, and some red.	4	269
Shale, gray, very sticky (light shale 280-285).	11	285
Dark gray shale.	9	294

LINN COUNTY—Continued.

Log of John Roberson Fee No. 1. Location: sec. 5, T. 58 N., R. 19 W., Linn County, Mo. Completed 1913. Well No. (12), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow and blue clay.....	146	146
Pennsylvanian system:		
Blue soapstone.....	120	266
Soft gray sandstone.....	30	296
Black slaty shale.....	25	321
Red shale.....	10	331
Yellow shale.....	6	337
Black shale.....	40	377
Red shale.....	5	382
Soft limestone.....	8	390
Very hard limestone.....	6	396
White sandstone.....	7	403
(5 gal. water)		Total depth

Water can be lowered 100 feet by pumping.

Log of shaft and drill hole at St. Catherine. Location: SW. 1/4 sec. 35, T. 58 N., R. 19 W., Linn County, Mo. Elevation: Approximately 802 feet. Shaft No. (13), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene and Recent series:				
Clay.....	14		14	
Pennsylvanian system:				
Rotten "slate".....	6		20	
Flinty sandstone.....	3		23	
Coal.....	1	4	24	4
Clay.....	2	5	26	9
"Soapstone".....	22		48	9
Hard limestone.....	1		49	9
Blue sand.....	6		55	9
"Soapstone".....	40		95	9
Coal (bottom of shaft).....	2	3	98	
Below this a boring was made and passed through the following:				
Fire clay.....	3		101	
Hard flinty sandrock.....	8		109	
"Soapstone".....	60		169	
Black slate.....	4	6	173	6
Coal.....	2	6	176	
Fire clay.....	4		180	
"Soapstone".....	35		215	
Coal.....	3		218	
			Total	depth

LINN COUNTY—Continued.

Log of City of Linneus well, Linn County, Mo. Completed: July, 1935. Note: From hearsay at the time this well was drilled, it is my understanding that this well was drilled on the schoolhouse grounds or *about* in the NW. 1/4, NE. 1/4 sec. 6, T. 58 N., R. 20 W. It is also my understanding that it was drilled near the old bored well. The latter reported 75 feet to bedrock which agrees closely with this well. The elevation of the bored well by stadia hand-level (based on elevation at Burlington R. R. station) is 829 feet. This well is close to that figure. (F. C. Greene.) Well No. (14), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Clay	15	15
Red sand	3	18
Clay	15	33
Red sand	12	45
Clay	15	60
Soapstone	12	72
Gravel	5	77
Pennsylvanian system:		
Yellow shale	6	83
White shale	20	103
Black shale	26	129
Hard black rock	5	134
Black shale	25	159
White shale	10	169
Hard black rock	1	170
Red shale	10	180
White soapstone	10	190
Black shale	45	235
Black rock	1	236
Black shale	10	246
Gray shale	30	276
Black shale	10	286
Black rock	5	291
Gray shale	25	316
Black shale	20	336
Gray shale	15	351
Black shale	40	391
Gray shale	25	416
Sandstone	10	426
Mississippian system:		
St. Louis formation:		
Limestone, sandy, dense, tan and white. Sand white, sub- rounded, somewhat frosted. Sparingly oolitic in lower 10'	44	470
Warsaw ? formation:		
Limestone, tan, highly fossiliferous with green shale and red chalcedonic chert	40	510
No samples	10	520
		Total depth

Note: Based on driller's log to 426 feet; samples from 426 feet to 510 feet.

LINN COUNTY—Continued.

Log of Linn County Infirmary No. 1. Location: NW. 1/4 NW. 1/4 sec. 1, T. 58 N., R. 21 W., Linn County, Mo. Completed 1905. Well No. (15), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay and boulders.....	52	52
Pennsylvanian system:		
Blue limestone.....	5	57
Hard white limestone.....	5	62
Soapstone.....	70 or 80	142
Hard limestone.....	7	149
Black shale.....	15	164
Red shale.....	10	174
Yellow shale.....	5	179
White sandstone (2 gal. water at 203').....	25	204
Gray sandstone.....	17	221
		Total depth

Water can be lowered by pumping.

Log of W. A. Couch Fee No. 1. Location: NE. 1/4 sec. 3, T. 58 N., R. 21 W., Linn County, Mo. Completed 1907. Well No. (16), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene or Recent series:		
Black loam.....	2	2
Yellow clay.....	12	14
Pennsylvanian system:		
White hard limestone.....	5	19
Blue limestone.....	8	27
Soapstone.....	65	92
Black shale.....	25	117
Red shale.....	10	127
Yellow shale.....	8	135
Blue limestone.....	5	140
"Cream colored" rock.....	3	143
Hard limestone (water—1 gal.).....	7	150
Gray limestone.....	2	152
		Total depth

Water can be lowered by pumping.

Log of Thos. Stevenson Fee No. 1. Location: NW. 1/4 NW. 1/4 sec. 3, T. 58 N., R. 21 W., Linn County, Mo. Completed 1909. Well No. (17), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Black loam.....	2	2
Yellow clay.....	28	30
Pennsylvanian system:		
Hard white limestone.....	5	35
Blue limestone.....	8	43

LINN COUNTY—Log of Thos. Stevenson Fee No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Soapstone.....	65	108
Black shale.....	25	133
Red shale.....	10	143
Yellow shale.....	8	151
Blue shale.....	5	156
Yellow "rock".....	3	159
Hard limestone (2 gal. water at 164').....	7	166
Gray limestone.....	65	231
Soapstone.....	125	356
Black shale.....	8	364
Red shale.....	10	374
Yellow shale.....	4	378
Mississippian system:		
"Miss. limestone".....	200	578
Sand rock (water bearing fine and white).....	5	583
		Total depth

Water can be lowered by pumping, 100'.

Log of Jas. Hamilton Fee No. 1. Location: SW. 1/4 SW. 1/4 sec. 16, T. 58 N., R. 21 W., Linn County, Mo. Completed 1906. Well No. (18), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Black loam.....	2	2
Yellow clay.....	40	42
Sand (½ gal. water).....	3	45
Pennsylvanian system:		
Blue limestone.....	5	50
Soapstone.....	80	130
Black shale.....	8	138
Red shale.....	4	142
Yellow shale.....	4	146
Hard limestone.....	3	149
Hard "flinty" limestone (2½ gal. water).....	2	151
Soft gray limestone.....	35	186
Black slate.....	10	196
Coal—20" to.....	2	198
Blue soapstone.....	100	298
Black shale.....	22	320
Red shale.....	16	336
Coffee-colored shale.....	12	348
Shale.....	12	360
Hard white limestone.....	7	367
Sandstone (7½ gal. water).....	7	374
		Total depth

Water can be lowered 74' by pumping.

LINN COUNTY—Continued.

Log of Chas. Chapman Fee No. 1. Location: NE. 1/4 NE. 1/4 sec. 10, T. 58 N., R. 22 W., Linn County, Mo. Completed 1909. Well No. (19), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Black loam.....	3	3
Yellow clay.....	50	53
Blue clay.....	35	88
(some water here)		
"Black jack".....	4	92
Pennsylvanian system:		
Blue limestone.....	3	95
Soapstone.....	50	145
Gray limestone.....	105	250
Black shale.....	25	275
Red shale.....	15	290
Hard limestone.....	2	292
Soft gray sandstone.....	8	300
(10 gal. salt water)		

Water can be lowered 40' by pumping.

Log of John H. Guyer Fee No. 1. Location: NE. 1/4 sec. 8, T. 59 N., R. 19 W., Linn County, Mo. Completed 1907. Well No. (20), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Yellow clay.....	50		50	
Dry sand.....	8		58	
Blue clay.....	20		78	
Pennsylvanian system:				
Blue limestone (2 shale partings).....	4		82	
Blue soapstone.....	80		162	
Soft gray sandstone (water—1 gal. per min.).....	12		174	
Red shale.....	8		182	
Hard white limestone.....	2		184	
Black shale.....	18		202	
Red shale.....	12		214	
Black shale.....	2		216	
Coal.....	1	4	217	4
Limestone (water—3 gal. per minute).....	2		219	4
Soapstone.....	2	8	222	
			Total	depth

Water can be lowered by pumping.

LINN COUNTY—Continued.

Log of T. H. Brown Fee No. 1. Location: NE. 1/4 sec. 22, T. 59 N., R. 20 W., Linn County, Mo. Completed 1909. Well No. (21), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series and Pennsylvanian system:		
Yellow clay.....	90	90
Red sand.....	16	106
Blue clay.....	98	204
"Black jack".....	8	212
Sand.....	2	214
Black rock.....	1	215
Sand (water).....	2	217
Blue soapstone.....	—	—
Water comes from sand at 215-217.		Total depth

Log of Weaver Thorne Fee No. 1. Location: NW. 1/4 sec. 29, T. 59 N., R. 20 W., Linn County, Mo. Completed 1912. Well No. (22), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	55	55
Red sand.....	10	65
Pennsylvanian system:		
Hard blue limestone.....	3 1/2	68 1/2
Blue-gray soapstone.....	149 1/2	218
Hard white limestone.....	5	223
Black shale.....	20	243
Red shale.....	10	253
Soft brown sandstone.....	61	314
Hard white limestone (1 gal. per min. water).....	1	315
Blue and gray shale.....	50	365
Black shale.....	25	390
Very hard gray limestone.....	15	405
Sandrock (water 2 gal. min.).....	12	417
Blue soapstone.....	—	446
		Total depth

Water can be lowered 70' by pumping.

Log of J. L. Kirby Fee No. 1. Location: SW. 1/4 SW. 1/4 sec. 17, T. 59 N., R. 21 W., Linn County, Mo. Completed 1907. Well No. (23), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Black loam.....	3	3
Yellow clay.....	68	71
Pennsylvanian system:		
Sand.....	79	150
Blue soapstone.....	105	255
Black shale.....	25	280

LINN COUNTY—Log of J. L. Kirby Fee No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Red and yellow shale.....	12	292
Limestone.....	3	295
Black shale.....	20	315
Soft blue limestone.....	12	327
Soft black shale.....	14	341
Mississippian (?) system:		
Limestone.....	2	343
Very hard white limestone.....	5	348
White sandstone (salt water).....	5	353
		Total depth

Water can be lowered 75' by pumping.

Log of Alexander Brinkley Fee No. 1. Location: NW. 1/4 sec. 34, T. 59 N., R. 21 W.,
Linn County, Mo. Completed 1907. Well No. (24), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Black loam.....	5	5
Yellow clay.....	22	27
Pennsylvanian system:		
Hard white limestone.....	6	33
Blue limestone.....	4	37
Gray shale.....	5	42
Soapstone.....	125	167
Hard limestone.....	3	170
Black shale.....	25	195
Soapstone.....	6	201
Red shale.....	8	209
Yellow shale.....	10	219
Blue limestone.....	4	223
White limestone.....	3	226
Light red shale.....	35	261
Black shale and soapstone.....	20	281
Hard limestone.....	7	288
Black shale.....	14	302
Red shale.....	4	306
Mississippian system:		
Very hard limestone.....	5	311
Light sandstone.....	9	320
Salty water in last sandstone.		Total depth

Water can be lowered 70' by pumping.

LIVINGSTON COUNTY.

Log of John R. Williams Fee No. 1. Location: NW. 1/4 sec. 19, T. 56 N., R. 24 W.,
Livingston County, Mo. Completed 1901. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene or Recent series:		
Clay.....	25	25
Sand.....	4	29
Pennsylvanian system:		
Rock.....	2	31
Clay.....	4	35
Sandrock.....	35	70
Limestone.....	6	76
Blue shale.....	4	80
Limestone.....	8	88
Sandstone.....	15	103
Blue shale.....	10	113
Limestone.....	6	119
Slate.....	3	122
Shale.....	4	126
Limestone.....	6	132
Shale.....	5	137
Sandstone.....	40	177
Blue shale.....	50	227
Plastic shale.....	40	267
Sandy shale.....	20	287
Red shale.....	6	293
Sandstone.....	15	308
Black shale.....	12	320
Blue shale.....	5	325
Sandstone.....	15	340
Black shale.....	15	355
Sandstone.....	25	380
Slate.....	2	382
Coal.....	3	385
Fire clay.....	2	387
Hard rock.....	5	392
Saline stratum.....	33	425
Black shale.....	8	433
		Total depth

Stopped in St. Louis limestone (?).

Surface elevation about 800 feet.

Saline water rises to 65 feet below surface.

Log of Johnson & Company's well. Location: sec. 2 (?), T. 57 N., R. 24 W., Living-
ston County, Mo. Completed prior to 1873. Well No. (2), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Soil and yellow clay.....	35	6	35	6
Pennsylvanian system:				
Dry sandstone.....	23	6	59	
Colt, gray sandstone.....	2		61	
Blue boulder clay.....	7		68	

LIVINGSTON COUNTY—Log of Johnson & Company's well—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Soft sandstone.....	66		134	
Gray shale.....	2	2	136	2
Gray limestone.....	1	4	137	6
Gray shale.....	3	4	140	10
Dark shale.....	5	4	146	2
Blue shale.....	1	3	147	5
Hard limestone.....	1	5	148	10
Dark shale.....	2	3	151	1
Hard limestone.....	1	1	152	2
Soft shale.....	1	2	153	4
Hard slate.....	1	6	154	10
Coal.....		6	155	4
Shale.....	2	5	157	9
Gray limestone.....	1	10	159	7
Gray shale.....	6	6	166	1
Shale.....	9	4	175	5
Black smut.....	1	8	177	1
Gray shale.....	2	8	179	9
Dark shale.....	1	8	181	6
Limestone.....	1	4	182	10
Gray shale.....	1	4	184	2
Limestone.....		10	185	
Gray shale.....		8	185	8
Limestone.....		6	186	2
Gray shale.....	1	6	187	8
Hard band.....		3	187	11
Gray shale.....	3	11	191	10
Blue limestone.....	1	1	192	11
Shale.....	3	10	196	9
Black smut.....	2		198	9
Dark soft shale.....	1	6	200	3
Dark hard shale.....		2	200	5
Dark soft shale.....	1	1	201	6
Blue shale.....	8	10	210	4
Red shale.....	5	3	215	7
Dark shale.....	16	7	232	2
Blue shale.....	7		239	2
Hard argillaceous limestone.....		6	239	8
Gray shale.....		3	239	11
Soft shale.....		10	240	9
Gray sandstone.....	4	3	245	
Brown bituminous shale.....		9	245	9
Black bituminous shale.....	2	8	248	5
Calcareous band.....	3		248	8
Dark, soft shale.....	7		249	3
Hard calcareous band.....		8	249	11
Dark shale.....	10	3	260	2
Gray calcareous shale.....	5	3	265	5
Fire clay.....	3	10	269	3
Clay and particles of coal.....	7	2	276	5
Sandy shale and black bituminous particles.....	1	6	277	11
Clay shale.....	2	6	280	5
Very hard dark micaceous sandstone.....	1	6	281	11
Hard band with blue clay partings.....	1	9	283	8
Hard blue shale.....	2		285	8
Argillaceous gray limestone.....	1	6	287	2
Dark sandy shale.....	1	2	288	4
Sandstone, light colored.....	2		290	4
Blue shale.....		10	291	2

LIVINGSTON COUNTY—Log of Johnson & Company's well—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Dark blue shale, 1½" of coal.....	2	5	293	7
Sandstone.....	1	5	295	
Limestone, blue, passing into hard gray at bottom...	3		298	
Clay.....		4	298	4
Particles of coal.....		1	298	5
			Total	depth

Log of City of Chillicothe well at City Light Plant. Location: SE. 1/4 NE. 1/4 sec. 2, T. 57 N., R. 24 W., Livingston County, Mo. Elevation: 739 feet (aneroid). Completed 1911. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
No samples.....	20	20
Sand, medium coarse, angular, arkosic, with tan silt...	10	30
No samples.....	4	34
Clay and silt, gray, fine-grained, calcareous.....	90	124
Pebbles and coarse sand. Subangular, polished sand with feldspar, garnet, fossiliferous chert, limestone and granite pebbles.....	14	138
Pennsylvanian system:		
Cherokee group:		
Shale, gray to green, slightly calcareous.....	13	151
Shale, gray, to dark gray somewhat carbonaceous.....	93	244
No samples.....	12	256
Shale, dark gray to black.....	7	263
Shale, gray.....	38	301
Sand, medium coarse-grained angular.....	20	321
Shale, gray to black.....	10	331
No samples.....	24	355
Sand, medium coarse-grained, angular.....	5	360
Sand, aggregates, medium coarse-grained, with gray shale and siderite (clay ironstone).....	4	364
Shale, black.....	36	400
Mississippian system:		
Meramec and Osage groups:		
Warsaw, Keokuk and Burlington groups:		
Limestone, tan-white, crystalline, cherty.....	45	445
Limestone, white, crystalline, cherty.....	150	560
Kinderhook group:		
Chouteau formation:		
Limestone, dark gray, dense.....	80	640
Grassy Creek formation:		
Shale, green, contains sporangites.....	10	650
Devonian system:		
Limestone, dark gray to tan crystalline.....	20	670
Limestone, light gray to white, finely crystalline.....	40	710
Limestone, tan, lithographic.....	110	820
Dolomite, brown, granular, a few sand grains.....	40	860
Limestone, tan, dense.....	3	863
No samples.....	10	873
Dolomite, brown, crystalline, some sand, especially in last five feet.....	67	940
No samples.....	10	950

LIVINGSTON COUNTY—Log of City of Chillicothe well at City Light Plant—Cont.

	Thickness, Ft.	Depth, Ft.
Devonian and older:		
Sand, white chert, some gray dolomite, drillers log terms this as "bouldry and cavey".....	110	1040
Ordovician system:		
Kimmswick formation:		
Dolomite, brown and gray, crystalline (show of oil, see note at bottom).....	58	1098
St. Peter formation:		
Sandstone, white.....	47	1145
Everton formation:		
Shale, green, sandy.....	8	1153
Sandstone, white, some green shale.....	41	1194
Jefferson City formation: (Canadian system of E. O. Ulrich)		
Dolomite, white to brown, with dense white chert....	11	1205
		Total depth

(Correlation and descriptions from sample studied).

Note: Apparently a little oil in last limestone. The water had a coal oil smell in the upper part of it but this was thought at first to be caused by oil dropping from the casing. A thick yellow scum rising on the water was thought to be from rust on the casing. Lower down after repeated bailing, sand from the bottom on being washed impregnated the water so that a film arose showing the characteristic peacock colors by reflected light. Oil trace. (This note was made on drillers log in the interval 1098 to 1145 feet.)

Log of S. R. McCreary's Fee No. 1. Location: NE. 1/4 sec. 8, T. 57 N., R. 25 W., Livingston County, Mo. Completed 1914. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene or Recent series:		
Drift.....	11	11
Pennsylvanian system:		
Gray limestone with some shale.....	100	111
Soapstone.....	3	114
Blue sandstone.....	80	194
Blue shale.....	276	470
Gray sandstone.....	20	490
		Total depth

Salt water in lower sandstone.

Log of Samuel Moore's Fee No. 1. Location: sec. 16, T. 57 N., R. 25 W., Livingston County, Mo. Completed 1914. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene or Recent series:		
Drift.....	14	14
Pennsylvanian system:		
Limestone, some shale.....	100	114
Soapstone.....	10	124

LIVINGSTON COUNTY—Log of Samuel Moore's Fee No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Blue shale.....	14	138
Blue sandstone.....	47	185
Gray sandstone (some water).....	70	255
Hard limestone.....	2	257
Soapstone.....	2	259
Slate.....	5	264
Coal 20".....		
Fire clay.....	6	270
Limestone.....	2	272
Shale, limestone and sandstone (water in sandstone).....	78	350
Slate.....	8	358
Coal.....	4	362
Limestone.....	8	370
		Total depth

Log of Fish No. 1. Location: SE. 1/4 SE. 1/4 sec. 21, T. 57 N., R. 25 W., Livingston County, Mo. Completed Sept. 25, 1918. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent series:		
Black soil.....	3	3
Black gumbo.....	7	10
Pennsylvanian system:		
Kansas City group:		
Gray limestone.....	15	25
Gray limestone.....	5	30
Pleasanton, Henrietta and Cherokee groups:		
Black shale.....	10	40
White shale.....	5	45
Brown shale.....	30	75
Brown shale.....	30	105
Gray hard sandstone.....	10	115
Brown soft sandstone.....	55	170
Brown shale.....	50	220
Brown lime sand and shale.....	25	245
Gray sandstone and some lime.....	15	260
Brown shale with breaks of lime.....	10	270
Brown sandstone and some shale.....	20	290
Brown sand and shale.....	5	295
Red rock.....	1	296
Hard brown lime and shale.....	4	300
Brown lime selvage and breaks of shale.....	25	325
Black shale and selvage.....	10	335
Black shale.....	25	360
White lime and selvage.....	20	380
Brown shale.....	20	400
Red rock.....	2	402
Brown shale.....	8	410
Blue shale.....	10	420
Brown hard sandstone.....	10	430
Black shale.....	10	440
Blue shale.....	10	450
White sandstone.....	10	460
Black shale.....	10	470
Brown sandstone.....	10	480

LIVINGSTON COUNTY—Log of Fish No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Black shale with breaks of brown sand.....	15	495
White sandstone (struck water at 510).....	15	510
Black.....	5	515
Black shale and brown sand.....	5	520
White, hard sandstone.....	25	545
White sand and brown shale.....	10	555
Brown sandstone and black shale.....	10	565
Brown sandstone.....	5	570
White sand and white shale.....	5	575
White sandstone.....	15	590
Gray limestone.....	2	592
Brown sandstone.....	3	595
		Total depth

Log of C. E. Adams well No. 1. Location: SW. 1/4 NW. 1/4 sec. 28, T. 58 N., R. 23 W.,
Livingston County, Mo. Elevation: 825 feet (estimated). Completed prior to
1907. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	58	58
Pennsylvanian system:		
Cherokee formation:		
Shale, gray to black, some limestone.....	3	61
Limestone and gray shale.....	69	130
Coal and sand.....	2	132
Shale, gray, some limestone.....	58	190
Shale, black.....	4	194
Shale, gray, some limestone.....	36	230
Shale, red.....	8	238
Shale, black and gray.....	13	251
Shale, gray.....	46	297
Coal.....	3	300
No sample.....	48	348
Sandstone.....	3	351
Shale, dark gray to black.....	79	430
Mississippian system:		
Meramec and Osage groups:		
Warsaw? Keokuk and Burlington formations:		
Limestone, white crystalline.....	12	442
Shale, gray and white.....	39	481
Limestone, cherty, white, crystalline.....	41	522
Sand, green shale, limestone.....	62	584
Limestone, white crystalline.....	12	596
Chert and dark shale.....	20	616
Kinderhook group:		
Chouteau formation:		
Limestone, gray-tan, dense.....	20	636
Limestone, white, cherty.....	9	645
No samples.....	69	714
Grassy Creek formation:		
Shale, green containing sporangites.....	48	762
Devonian system:		
Limestone, white crystalline.....	4	766
Limestone, gray lithographic.....	13	779
Limestone, white to tan, finely crystalline.....	21	800

LIVINGSTON COUNTY—Log of C. E. Adams well No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Dolomite, brown granular.....	46	846
Limestone, white to tan, dense, a few sand grains.....	8	854
Dolomite, tan-gray, finely crystalline.....	27	881
Limestone, lithographic, rounded and frosted sand.....	25	906
Dolomite, gray-white, crystalline.....	11	917
Sand and dense white chert.....	33	950
Sand, dense white chert and green shale.....	32	982
Ordovician system:		
Decorah formation (?):		
Shale, containing black organic material.....	8	990
Unclassified:		
Sand and brown crystalline dolomite with dark sandy shale at bottom.....	75	1,065
Dolomite, brown crystalline.....	11	1,076
St. Peter formation:		
Sandstone, white with rounded and frosted grains.....	25	1,101
		Total depth

(Correlation and descriptions based on a study of samples, some of which were taken at long intervals.)

Log of J. J. Phillips Fee No. 1. Location: sec. 7, T. 59 N., R. 22 W., Livingston County, Mo. Completed 1909. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Clays.....	137	137
Pennsylvanian system:		
Shale soapstone.....	231	368
Hard yellow rock.....	10	378
Mississippian system:		
Miss. limestone.....	302	680
? (water).....	3	683
		Total depth

MACON COUNTY.

Log of coal test 2 miles north of Woodville. Location: Cen. SW. 1/4 SE. 1/4 sec. 15, T. 56 N., R. 13 W., Macon County, Mo. Well No. (1), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	25		25	
Pennsylvanian system:				
Shale, light, sandy, thin sandstone layer near base...	25		50	
Sandstone, with shale partings.....	9	6	59	6
Shale, dark at top, remainder light and sandy.....	5	6	65	

MACON COUNTY—Log of coal test 2 miles north of Woodville—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Sandstone, with shale partings	23		88	
Limestone	3	1	91	1
Coal		3	91	4
Sandstone	4	8	96	
Shale, light, sandy in lower half	10	5	106	5
Coal		7	107	
Clay	1	3	108	3
Shale, light, sandy	3	9	112	
Sandstone	3	6	115	6
Shale, light	1	10	117	4
Limestone	2	4	119	8
Shale, light, sandy, sandstone layers in middle	3	4	123	
Shale, dark, sandy	1	10	124	10
Coal		9	125	7
Clay		8	126	3
Sandstone	3	9	130	
Limestone	3	1	133	1
Shale, dark in center, light above and below	35	5	168	6
Coal		8	169	2
Clay	1	10	171	
Sandstone	5	3	176	3
			Total	depth

Log of coal test at Cox. Location: Cen. NE. 1/4 NW. 1/4 sec. 29, T. 56 N., R. 13 W., Macon County, Mo. Well No. (2), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Bored well	60		60	
Pennsylvanian system:				
Henrietta group:				
Sandstone	3	4	63	4
Shale, broken	4	2	67	6
"Hard stone"	2	6	70	
Shale, light at top, blue at bottom	10	9	80	9
Limestone	4	1	84	10
Cherokee group:				
Shale, light at top, blue at bottom	2	2	87	
Shale, black, "slaty"	4		91	
Coal (Mulky)	1	3	92	3
Clay	1	9	94	
Shale, light	5		99	
Coal (Bevier)	1		100	
Clay	1	6	101	6
Sandstone	2	6	104	
Shale, blue, with one-foot sandstone layer	22	8	126	8
Shale, black, "slaty"	1	6	128	2
Shale, light, sandy	3		131	2
Coal (lower ardmore)		8	131	10
Clay	1	2	133	
Shale, light, sandy, one-foot sandstone layer near top	7	10	140	10
Sandstone, with thin shale parting	11	2	152	

MACON COUNTY—Log of coal test at Cox—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Shale, light, sandy in lower half.....	26		178	
Sandstone.....	3	6	181	6
Shale, in greater part light and sandy.....	20		201	6
Shale, blue.....	18	6	220	
Coal (Eureka).....	1	8	221	8
			Total	depth

Note: Base of Cherokee not reached.

Log of coal test 3 miles south of Carbon. Location: SE. 1/4 NW. 1/4 sec. 6, T. 56 N., R. 13 W., Macon County, Mo. Well No. (3), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	77	8	77	8
Pennsylvanian system:				
Henrietta group:				
Limestone.....	3		80	8
Cherokee group:				
Shale, blue.....	1		81	8
Shale, black, "slaty".....	4	8	86	4
Coal (Mulky).....	1	6	87	10
Clay.....	3		90	10
Shale, light.....	5	2	96	
Coal (Bevier).....	1	7	97	7
Clay.....		9	98	4
Sandstone.....	1	4	99	8
Shale, light, sandy.....	2	4	102	
Limestone.....	1	2	103	2
Shale, light, sandy, with thin sandstone layer....	9	10	113	
Shale, dark.....	2	6	115	6
Shale, blue at top, sandy at bottom.....	9	6	125	
"Rock", black.....		10	125	10
Shale, dark, sandy.....	3	3	129	1
Coal (lower ardmore).....		11	130	
Shale, with thin sandstone layer near top.....	11		141	
Sandstone.....	12	4	153	4
Shale, variegated, with thin sandstone layer near top.....	14	8	168	
Sandstone.....	8	4	176	4
Coal, 12 inches	3	2	179	6
Sandstone, 20 inches } (Eureka).....				
Coal, 6 inches }				
Clay.....		6	180	
Shale, light, sandy.....	1	2	181	2
Sandstone.....	27	10	209	
			Total	depth

Note: Base of Cherokee not reached.

MACON COUNTY—Continued.

Log of R. Y. Powell No. 1. Location: Cen. W. line SE. 1/4 SE. 1/4 sec. 28, T. 56 N., R. 15 W., Macon County, Mo. Elevation: 850 feet. Completed 1907. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	45	45
White clay.....	10	55
Pennsylvanian system:		
White lime.....	12	67
Coal.....	2	69
White shale.....	15	84
Black shale.....	20	104
White shale.....	20	124
Yellow clay.....	20	144
Mississippian system:		
Meramec and Osage groups:		
White lime.....	20	164
White shale (232'-13" casing).....	68	232
Coarse lime.....	20	252
White lime.....	28	280
Sand and lime.....	30	310
Sand and lime.....	20	330
White lime.....	100	430
Kinderhook group:		
Gray lime.....	90	520
Green lime.....	20	540
Devonian system:		
White lime.....	70	610
Lime and sand shells.....	30	640
Ordovician system?		
White lime.....	20	660
Lime and sand shells.....	20	680
Lime and sand shells.....	90	770
St. Peter and Everton formations:		
White sand.....	62	832
Dark shale.....	6	838
Light shale.....	6	844
Unclassified Ordovician to Pre-Cambrian:		
White lime.....	231	1,075
Hard white lime.....	52	1,127
Hard dark lime.....	5	1,132
Hard gray lime.....	182	1,314
White sand.....	13	1,327
White lime.....	173	1,500
Hard white and gray lime.....	500	2,000
Hard white and gray lime.....	70	2,070
Brown shale.....	25	2,095
Black shale.....	35	2,130
Green shale.....	15	2,145
Gray lime.....	23	2,168
Dark shale.....	2	2,170
Black lime.....	10	2,180
Gray lime.....	12	2,192
Hard black sand.....	43	2,235
Gray lime.....	15	2,250
Lime and sand shells.....	55	2,305
Red sand.....	45	2,350
White sand.....	12	2,362
Pink sand.....	100	2,462
Brown sand.....	38	2,500
Red sand.....	50	2,550
Pink sand.....	40	2,990

MACON COUNTY—Log of R. Y. Powell No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Red sand.....	21	2,611
Hard red sand.....	9	2,620
Red sand.....	80	2,700
Red sand.....	100	2,800
White sand (6 ½ casing).....	6	2,806
Gray lime.....	79	2,885
Gray lime.....	7	2,892
Sand.....	3	2,895
Sand.....	5	2,900
Dark gray sand.....	27	2,927
Dark gray sand.....	4	2,931
Light gray sand.....	69	3,000
		Total depth

The above correlations are based on a poor drillers log. In addition to the above, the sand reported from 1,314 to 1,327 feet suggests Roubidoux, the top of the Davis is suggested at 2,070 feet, the top of the Bonne Terre may be at 2,145 feet, the top of the La Motte at 2,305 feet, and the top of the granite at 2,611 feet.

Log of coal test near Carbon. Location: NW. 1/4 SW. 1/4 sec. 18, T. 57 N., R. 13 W., Macon County, Mo. Well No. (6), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	35	8	35	8
Pennsylvanian system:				
Henrietta group:				
Limestone (mulky sump-rock).....	1	10	37	6
Shale, light-colored.....	9		46	6
Sandstone.....		10	47	4
Cherokee group:				
Coal (Bevier).....		2	47	6
Sandstone.....	1		48	6
Shale, light-colored, drab.....	5	6	54	
Shale, blue.....	6		60	
Sandstone.....	1	4	61	4
Shale, black, "slaty".....	1	4	62	8
Shale, sandy.....	3	3	65	11
Coal (lower ardmore).....	1	4	67	3
Clay.....	1	9	69	
Shale, sandy.....	17		86	
Sandstone.....	3		89	
Shale, light-colored, sandy.....	7	6	96	6
Sandstone, shale partings.....	10	6	107	
Shale, light-colored, sandy.....	21	9	128	9
Coal, 30 inches } (Eureka).....	3	8	132	5
Clay, 5 inches }				
Coal, 9 inches }				
Clay.....	1	7	134	
Shale, light-colored, sandy.....	1	10	135	10
			Total	depth

Note: Base of Cherokee not reached.

MACON COUNTY—Continued.

Log of T. E. Wardell well No. 1. Location: 4 miles northwest of Macon, Macon County, Mo. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Surface rock, soil to joint clay.....	54	54
Pennsylvanian system:		
Gray sandstone.....	40	94
Soft shale, gray; small vein of water rises 20 feet.....	66	160
Hard slate.....	1	161
Coal.....	3	164
Mississippian system:		
Blue lime rock.....	26	190
White lime rock, very hard.....	70	260
Lime rock which was very hard to drill; struck water in seam of rock at 290 feet; water rises within 90 feet of surface.....	40	300
		Total depth

Log of coal shaft at Eureka. Location: SW. 1/4 SE. 1/4 sec. 18, T. 57 N., R. 14 W., Macon County, Mo. Elevation: Approximately 780 feet. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Drift.....	21	21
Pennsylvanian system:		
Henrietta group:		
Limestone.....	3	24
Shale, black, "slaty".....	3 1/2	27 1/2
Coal (summit).....	1	28 1/2
Clay.....	7 1/2	36
Sandstone.....	2 1/2	38 1/2
Shale.....	9 1/2	48
Limestone, hard, blue, known as "Bluestone".....	3	51
Cherokee group:		
Shale, black, "slaty".....	4	55
Coal (mulky).....	1 1/2	56 1/2
Clay.....	5 1/2	62
Shale, sandy, with some sandstone.....	8 1/2	70 1/2
"Cement rock".....	2	72 1/2
Shale, sandy.....	3	75 1/2
Coal, 13 inches	2	77 1/2
Clay, 1 inch		
Coal, 10 inches		
Clay.....	1/2	78
Limestone.....	3	81
Shale.....	2 1/2	83 1/2
Limestone, with six-inch shale parting.....	2	85 1/2
Shale, black, "slaty".....	6	91 1/2
Limestone.....	1/2	92
Shale, black in lower part.....	11	103
Limestone.....	1/2	103 1/2
Shale, black.....	5 1/2	109
Coal (lower ardmore).....	2	111
Clay.....	11	122
Sandstone.....	6	128
Shale, with thin layers of limestone and sandstone.....	7 1/2	135 1/2

MACON COUNTY—Log of coal shaft at Eureka—Continued.

	Thickness, Ft.	Depth, Ft.
Shale, black, "slaty".....	5	140 ½
Clay.....	12 ½	153
Shale, black and "slaty" at top and bottom.....	13	166
Coal, 24 inches	6	172
Clay, 6 to 60 inches } (Eureka).....		
Coal, 24 inches		
		Total depth

Note: Base of Cherokee not reached.

Log of City of Macon No. 1. Location: NE. ¼ NE. ¼ sec. 21, T. 57 N., R. 14 W., Macon County, Mo. Elevation: Approximately 830 feet. Completed 1888. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Drift.....	36	36
Pennsylvanian system:		
Shale, blue, calcareous, argillaceous.....	9	45
Limestone, hard brittle, conchoidal fracture.....	1	46
Black shale, breaking into graphite-like mud.....	2	48
Coal with a few fragments of shale.....	1	49
Blue shale or clay containing a little grit.....	6	55
Tenacious blue clay.....	10	65
Gray calcareous shale with a few fragments of limestone.....	5	70
Black laminated shale.....	3	73
Coal.....	2	75
Tenacious blue clay, little grit.....	34	109
Black graphite-like clay, with bits of gray clay.....	17	126
Dark gray or black clay, derived from calcareous shale with fragments of limestone.....		
Firm black calcareous shale.....	2	128
Slightly calcareous gray clay with shaly scales.....	8	136
Calcareous gray clay.....	19	155
Slightly calcareous dark gray shale.....	30	185
Mississippian system and older:		
Light gray limestone.....	28	213
Light gray sub-crystalline limestone.....	7	220
Light gray slightly calcareous shale and clay.....	53	273
Dark gray, slightly calcareous clay.....	3	276
Calcareous gray shale.....	6	282
Light gray cherty limestone.....	5	287
Light gray limestone, gray calcareous shale and chert.....	3	290
Limestone, light gray, cherty.....	30	320
Bluish gray calcareous shale.....	5	325
Limestone, light gray, cherty and dark gray calcareous shale...	10	335
Light gray and dark gray nodular calcareous shale.....	40	375
Light gray, siliceous limestone and chert.....	21	399
Light buff rock pulverulent containing crystals of carbonate of lime and iron, leaving a residue after treatment with acid....	14	410
Dark gray arenaceous shale, light gray calcareous shale and crystals of calcite.....	72	482
Light gray arenaceous and calcareous shale with light buff powder like above.....	27	509
Blue sparry limestone with fossil markings.....	23	532

MACON COUNTY—Log of City of Macon No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Shaley blue limestone.	43	575
Light gray and dark blue shaley limestone.	60	635
Blue limestone.	17	652
Light blue sparry limestone.	112	764
Light blue cherty and arenaceous limestone.	36	800
Gray spongy limestone, and fine fissil blue shale.	95	895
Massive blue shale or indurated clay.	100	995
Fine calcareous sand.	5	1,000
		Total depth

This log is given by W. J. McGee in "Notes on the Geology of Macon County, Missouri" Trans. St. Louis Acad. of Science, Vol. 5, 1892, pp. 305-336, who states: "the various strata exposed naturally and penetrated by the drill in Macon County may be tentatively classified as in the following table, in which there is also introduced, chiefly to indicate the possible extent of the personal equation in influencing the classification, the section predicted when the drill was in the 35-foot limestone."

"Section of Northern Missouri Strata:

	Thickness, Ft.	Predicted thickness, Ft.
Carboniferous:		
Lower coal:		
Shales, clay beds, limestones, coal seams, etc.	215	215
St. Louis:		
1. Limestones.	35	60
Keokuk:		
2. Somewhat calcareous shales.	62	100
3. Cherty limestone and associated shales.	54	
Burlington:		
4. Nodular calcareous shales.	40	225
5. Siliceous limestones, calcareous shales, etc.	157	
Kinderhook:		
6. Shaly and non-siliceous limestones.	232	175
Devonian:		
Hamilton:		
(Not recognized).		75
Silurian:		
Niagara:		
7. Cherty limestones passing into shales.	131	225
Hudson River:		
8. Shales or indurated clays.	100	200
9. Sandstone.	...	
Trenton:		
(Not reached).		450
St. Peter:		
(Not reached).		50
Total thickness.	1,026	1,775

Discrepancy (assuming bore to half penetrate Hudson River). 149 feet"

The section, correlations, and predicted thicknesses given above are from McGee's report as noted.

MACON COUNTY—Continued.

Log of M-K-T Coal Company's shaft No. 46. Location: SW. cor. NW. 1/4 sec. 29, T. 57 N., R. 15 W., Macon County, Mo. Elevation: Approximately 860 feet. Shaft No. (11), Pl. I.

	Thickness,		Depth,	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift clay.....			20	
Clay, hard reddish yellow.....	45		65	
Clay, hard, blue.....	41		106	
Pennsylvanian system:				
Henrietta group:				
Shale.....	9	6	115	6
Iron band rock.....	2	6	118	
Shale, black, fissile.....	2		120	
Coal (summit).....	1		121	
Clay.....	6		127	
Shale.....	10		137	
Limestone.....	4		141	
Cherokee group:				
Shale, black, fissile.....	4		145	
Coal (Macon City).....	2		147	
Ss. and shales.....	16	6	163	6
Coal (Bevier operated).....	4	3	167	9
			Total	depth

Note: Base of Cherokee not reached.

Log of Bianchi Fee No. 1. Location: SE. 1/4 SW. 1/4 sec. 12, T. 57 N., R. 15 W., Macon County, Mo. Elevation: Approximately 870 feet. Completed Sept. 13, 1937. Well No. (12), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Clay.....	140	140
Pennsylvanian system:		
Blue limestone, hard.....	4	144
Soapstone.....	8	152
Shale blue.....	2	154
Slate.....	8	160
Coal.....	4	164
Fire clay.....	4	168
Shale light.....	32	200
Shale black.....	8	208
Limestone.....	3	211
Drilled by other driller mostly shale.....	64	275
Sand.....	1	276
Shale.....	6	282
Limestone.....	3	285
Shale, light.....	15	300
Mississippian system:		
Limestone.....	100	400
		Total depth

MACON COUNTY—Continued.

Log of Northwestern Coal & Mining Company's coal test No. 11 near Bevier. Location: sec. 15 (?), T. 57 N., R. 15 W., Macon County, Mo. Completed 1917. Well No. (13), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Yellow clay.....	31		31	
Blue clay.....	2		33	
Pennsylvanian system:				
Cherokee group:				
Black shale.....		6	33	6
Coal.....	1	5	34	11
Sandstone.....	6	1	41	
Sandstone.....	9	6	50	6
Nothing (old mine).....	4	6	55	
Mud from old workings.....	8		63	
Fire clay.....	2		65	
Limestone.....	4		69	
Soft, gray shale.....	4		73	
Limestone.....	1		74	
Gray limestone.....	1		75	
Mixed shale.....	6	6	81	6
Limestone.....		6	82	
Black shale.....	6		88	
Gray shale.....	3	6	91	6
Coal.....	1	11	93	5
Fire clay.....	3	7	97	
Sandstone.....	8		105	
Gray shale.....	16		121	
Gray shale.....	7		128	
Sandstone with gray shale partings.....	31		159	
Dark shale.....	2		161	
Gray shale.....	3		164	
Black shale.....	7	10	171	10
Coal.....		2	172	
Coal.....	2	4	174	4
Slaty coal.....		4	174	8
Fire clay.....	3	4	178	
Coarse sandstone.....	8	6	186	6
Mississippian system:				
Hard limestone.....	12	6	199	
			Total	depth

Log of coal test at Bevier. Location: 300 yards east of railroad station; sec. 15, T. 57 N., R. 15 W., Macon County, Mo. Elevation: 781 feet. Well No. (14), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Black dirt.....		4		4
Yellow clay.....	16	5	16	9
Light clay.....	3	7	20	4

MACON COUNTY—Log of coal test at Bevier—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pennsylvania system:				
Cherokee group:				
Sand	3	8	24	
Light sand shale.....	1	10	25	10
Sandstone.....	6	6	32	4
Light shale.....	2	4	34	8
Sandstone.....		10	35	6
Light sand shale.....	1	3	36	9
Sandstone.....	1	9	38	6
Light sand shale.....	2	8	41	2
Blue shale.....		2	41	4
Coal.....	2	11	44	3
Fire clay.....	1	1	45	4
Limestone.....	3	6	48	10
Light shale.....	2	2	51	
Sandstone.....	1		52	
Light sand shale.....		10	52	10
Limestone.....	2	11	55	9
Light shale.....		11	56	8
Limestone.....		4	57	
Dark shale.....	4	2	61	2
Blue shale.....	2	10	64	
Limestone.....		3	64	3
Dark shale.....	1	6	65	9
Blue shale.....	2	3	68	
Black slate.....	3		71	
Coal.....	1	2	72	2
Sandstone.....		3	72	5
Fire clay.....	1	2	73	7
Light sand shale.....	1	5	75	
Sandstone.....	4	10	79	10
Light shale.....	2	8	82	6
Light sand shale.....	6	4	88	10
Sandstone.....	5	8	94	6
Sandstone.....	7	2	101	8
Shale partings.....	19	4	121	
Sandstone.....	37		158	
Coal.....		10	158	10
Fire clay.....		7	159	5
Sandstone.....		8	160	1
Black slate.....		6	160	7
Sandstone.....	11	3	171	10
Coal.....		2	172	
Mississippian system (?):				
Sandstone.....	5		177	
Limestone.....	19	8	196	8
Sandstone.....	1	10	198	6
Green shale.....	2	6	201	
Limestone.....	7		208	
Sandstone.....	25		233	
Limestone.....	7	6	240	6
			Total	depth

MACON COUNTY—Continued.

Log of coal test. Location: SW. 1/4 SW. 1/4 sec. 19, T. 57 N., R. 15 W., Macon County, Mo. Well No. (15), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	98		98	
Pennsylvanian system:				
Cherokee group:				
Limestone (Bevier sumprock).....	3	6	101	6
Shale, light at top, blue and "slaty" at bottom.....	6	6	108	
Limestone.....	1		109	
Shale, "slaty", blue at top, black at bottom.....	8		117	
Limestone.....	1		118	
Shale.....	4	2	122	2
Coal (lower Ardmore).....	1	7	123	9
Clay.....	3	3	127	
Limestone.....			Total	depth

Note: Base of Cherokee not reached.

Log of coal test. Location: NW. cor. NE. 1/4 NE. 1/4 sec. 20, T. 57 N., R. 15 W., Macon County, Mo. Well No. (16), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	79		79	
Pennsylvanian system:				
Cherokee group:				
Limestone (Bevier sumprock).....	5		84	
Shale, soft.....	8		92	
Shale, dark.....	6		98	
Limestone.....	1		99	
Shale, blue.....	9	7	108	7
Coal (Lower Ardmore).....	1	4	109	11
Clay.....	1	1	111	
			Total	depth

Note: Base of Cherokee not reached.

MACON COUNTY—Continued.

Log of Northwestern Coal & Mining Company's coal test at shaft No. 8. Location: SE. 1/4 sec. 22, T. 57 N., R. 15 W., Macon County, Mo. Well No. (17), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	55		55	
Pennsylvanian system:				
Cherokee group:				
Shale, gray, "slaty" (laminated).....	51		106	
Sandstone.....	26		132	
Coal (Bevier).....	4		136	
Clay.....	1	2	137	2
Sandstone, and shale.....	2	10	140	
Limestone, blue.....	4		144	
Shale.....	3		147	
Limestone.....	2		149	
Shale.....	8		157	
Shale, in part black and "slaty".....	2		159	
Coal (Lower Ardmore).....		6	159	6
Shale.....	26	6	186	
Limestone.....	2	6	188	6
Shale.....	24	6	213	
Coal (Eureka).....	1	2	214	2
Sandstone, blue.....	16	10	231	
Shale, gray and red.....	9		240	
Mississippian system:				
Limestone, gray, hard (Mississippian).....	16		256	
			Total	depth

Log of M-K-T Coal Company's coal test (?) at Mine No. 46. Location: SE. 1/4 NE. 1/4 sec. 23, T. 57 N., R. 15 W., Macon County, Mo. Completed June, 1895. Well No. (18), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Surface clay.....	9	9
Yellow clay.....	21	30
Joint clay.....	30	60
Yellow clay.....	10	70
Sandy clay.....	10	80
Yellow clay.....	9	89
Pennsylvanian system:		
Henrietta group:		
Soapstone.....	15	104
Sandy shale.....	6	110
Fire clay.....	5 1/2	115 1/2
Limestone (Rhomboidal).....	1 1/2	117
Black slate.....	2	119
Coal (Summit).....	1	120
Fire clay.....	4 1/2	124 1/2
Sand shale.....	3 1/2	128
Fire clay, hard.....	6	134
Cherokee group:		
Limestone.....	4	138
Black slate.....	5	143

MACON COUNTY—Log of M-K-T Coal Company's test (?) at Mine No. 46—Continued.

	Thickness, Ft.	Depth, Ft.
Coal (Mulky).....	1 ½	144 ½
Fire clay.....	4	148 ½
Sandy shale.....	18 ½	167
Coal, present worked vein (Bevier).....	2	169
Fire clay.....	6	175
Bed rock (limestone).....	6	181
Fire clay.....	2 ½	183 ½
Fire clay and bowlders.....	7 ½	191
Black slate.....	10	201
Fire clay and bowlders.....	2	203
Soapstone.....	2	205
Coal (Lower Ardmore).....	2	207
Green clay and soapstone.....	2	209
Fire clay.....	16	225
Soapstone.....	19	244
Limestone.....	3	247
Soft black slate.....	10	257
Coal (Eureka).....	1 ½	258 ½
Fire clay.....	4 ½	263
Green slate.....	3	266
Fire clay.....	2	268
Mississippian system: (Contact uncertain):		
Blue flint.....	0 ½	268 ½
Sandstone.....	22 ½	291
Limestone.....	5	296
Soapstone.....	2	298
Sandstone.....	6	304
Limestone.....	26	330
Fire clay.....	5	335
Sandstone.....	4	339
Limestone.....	2	341
Sandstone.....	21	362
Limestone, hard.....	20	382
Limestone.....	68	450
		Total depth

Log of coal test southeast of Bevier. Location: Cen. NW. 1/4 sec. 25, T. 57 N., R. 15 W., Macon County, Mo. Well No. (20), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	103		103	
Pennsylvanian system:				
Henrietta group:				
Limestone.....	2		105	
Shale, blue.....	1	4	106	4
Coal (Summit).....		8	107	
Shale, clayey.....	6		113	
Limestone.....	1		114	
Shale, blue.....	8		122	
Limestone.....	3		125	

MACON COUNTY—Log of coal test southeast of Bevier—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Cherokee group:				
Shale, black.....	5		130	
Coal (Mulky).....	1	6	131	6
Sandstone.....	19	6	151	
Coal, 34 inches } (Bevier).....	4		155	
Clay, 2 inches }				
Coal, 12 inches }				
Clay.....	1		156	
			Total	depth

Note: Base of Cherokee not reached.

Log of coal test near Callao. Location: NW. cor. SW. 1/4 sec. 24, T. 57 N., R. 16 W., Macon County, Mo. Well No. (21), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	127		127	
Pennsylvanian system:				
Cherokee group:				
Shale, yellow at top, light below.....	14		141	
Shale, dark, and sandstone.....	2	4	143	4
Coal (Eureka ?).....		7	144	11
Clay.....	2	1	146	
Shale, black, "slaty".....	1		147	
Shale, gray and dark.....	11	5	158	5
Coal.....		1	158	6
Shale, dark blue.....	5		163	6
Coal, shaly.....		7	164	1
Shale, black.....	5	5	169	6
Sandstone, dark.....	7		176	6*
			Total	depth

*Note: Base of Cherokee not reached.

Partial log of shaft at Lingo. Location: sec. 6, T. 57 N., R. 17 W., Macon County, Mo. Shaft No. (22), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series (?):				
Depth from surface.....	53		53	
Pennsylvanian system:				
Henrietta group:				
Limestone, impure (sump-rock of Lexington coal horizon).....	4		57	

MACON COUNTY—Partial log of shaft at Lingo—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Interval, about.....	16		73	
Limestone, blue.....	2		75	
Shale, black, "slaty".....	2	6	77	6
Coal (Summit).....		6	78	
Clay.....	8	6	86	6
Limestone.....	1	6	88	
Cherokee group:				
Shale, brown, "slaty".....	1	6	89	6
Coal (Mulky).....		1	89	7
Clay.....	15		104	7
Sandstone.....	12		116	7
Shale, sandy at top.....	16		132	7
Coal, 30 inches	4	4	136	11
Clay, hard, average, 8 inches } (Bevier).....				
Coal, 14 inches				
Clay.....	1	6	138	5
Limestone.....	4		142	5
			Total	depth

Note: Base of Cherokee not reached.

Log of O. E. Walkup's Fee No. 1 at Ten Mile. Location: sec. 29, T. 58 N., R. 13 W., Macon County, Mo. Completed 1906 (?). Well No. (23), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	4	4
Light clay.....	12	16
Yellow clay (water).....	51	67
Pennsylvanian system:		
Soft yellow limestone.....	10	77
Light shale.....	2	79
Yellow sandstone.....	2	81
Blue sandy shale.....	9	90
White sandy shale.....	8	98
Dark shale.....	11	109
Blue shale.....	4	113
Black slate.....	1	114
Limestone.....	2	116
Black shale.....	11	127
Hard blue limestone.....	1	128
Black slate (water).....	2	130
Coal (Summit ?).....	3	133
Fire clay.....	1	134
Light shale.....	3	137
Red sandstone.....	6	143
White shale.....	5	148
Red sandstone (water).....	9	157
Light sandy shale.....	3	160
		Total depth

MACON COUNTY—Continued.

Log of Frank Gibbs Fee No. 1. Location: sec. 6, T. 59 N., R. 14 W., Macon County, Mo. Completed Nov. 3, 1921. Well No. (25), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Surface.....	20		20	
Sand and gravel.....	4		24	
Sandy clay.....	17		41	
Pennsylvanian system:				
Limestone.....	3		44	
Gray shale.....	2		46	
Limestone.....	1	6	47	6
Light shale.....	1	6	49	
Limestone.....	2	6	51	6
Gray shale.....	8		59	6
Limestone.....	2		61	6
Lime shale.....	18		79	6
Limestone.....	2		81	6
Shady coal.....	9		90	6
Light shale.....	2	6	93	
Limestone.....	1	6	94	6
Light shale.....	5	6	100	
Limestone.....	2		102	
Light shale.....	1		103	
Shady coal.....	1	5	104	5
Fire clay.....	2		106	5
Lime clay.....	38	7	145	
Gray shale.....	5		150	
Light shale.....	42	3	192	3
Coal.....	2	6	194	9
Fire clay.....	2	6	197	3
Limestone.....	2		199	3
Light shale.....	40		239	3
Dark shale.....	5	1	244	4
Coal (Lower Ardmore).....	1	4	245	8
Fire clay.....	2	2	247	6
			Total	depth

Log of Quincy Harrington's Sylvan Dale Stock Farm No. 1. Location: NW. 1/4 SE. 1/4 sec. 10, T. 59 N., R. 14 W., Macon County, Mo. Elevation: 885 feet (estimated). Completed July 16, 1936. Well No. (26), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	95	95
Pennsylvanian system:		
Cherokee group:		
Shale, gray, with siderite oolites.....	15	110
Shale, red, calcareous.....	10	120
Limestone, brown, with some gray shale.....	5	125
Sandstone, green, to gray, argillaceous, calcareous?.....	20	145
Sandstone, as above with some black shale.....	20	165
No samples.....	10	175
Limestone, dark gray, with much gray shale. Calcareous fossils.....	10	185
Shale, black, with some small mica flakes.....	10	195

MACON COUNTY—Log of Quincy Harrington's Sylvan Dale Stock Farm No. 1—Cont.

	Thickness, Ft.	Depth, Ft.
Shale and impure coal.....	5	200
Shale, gray, soft.....	5	205
No samples.....	20	225
Shale, gray, with siderite oolites.....	5	230
Sandstone with red and green shales and much siderite.....	10	240
No samples.....	105	345
Mississippian system:		
Warsaw formation:		
Limestone, white to light gray, crystalline, cherty.		
Chert dark to light gray, mottled, fossiliferous....	25	370
(Note: Driller reports top of lime at 275 feet which is probably near the top of the Warsaw formation.)		
Keokuk-Burlington formations:		
Limestone and dolomitic limestone, white to light gray and tan, crystalline, cherty. Chert white to light gray, dense, with some fossils.....	95	465
No sample.....	8	473
		Total depth

Correlation and descriptions are based on a study of samples.

Log of coal test at La Crosse. Location: sec. 18, T. 60 N., R. 15 W., Macon County, Mo. Well No. (29), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Black dirt.....	1		1	
Yellow clay.....	9		10	
Sand and gravel.....	8		18	
Blue clay.....	11		29	
Sand.....	2		31	
Blue clay.....	3	2	34	2
Blue clay.....	3	10	38	
Sand and gravel.....	8		46	
Blue clay and gravel.....	6		52	
Yellow clay.....	12		64	
Blue clay.....	11		75	
Blue clay and gravel.....	7		82	
Blue clay.....	18		100	
Pennsylvanian system:				
Blue shale.....	36		136	
Light sand shale.....	7		143	
Light shale.....	1	5	144	5
		2	144	7
Faulty formation.....	5		149	7
Soft sandstone.....	3	5	153	
Blue shale.....	9		162	
Soft sandstone.....	10		172	
Light shale.....	2		174	
Sandstone.....	12		186	
Light sand shale.....	11		197	
Soft sandstone.....	3		200	
Hard sandstone.....	1		201	
			Total	depth

MACON COUNTY—Continued.

Log of Bert D. Nortoni coal test at New Cambria. Location: NE. cor. NW. 1/4 SE. 1/4 sec. 19, T. 60 N., R. 15 W., Macon County, Mo. Well No. (30), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Black dirt.....		6		6
Yellow clay.....	10		10	
Sand.....	3		13	
Blue clay.....	2		15	
Yellow clay.....	7		22	
Yellow clay.....	2		24	
Pennsylvanian system:				
Sandstone.....	12		36	
Coal.....		1	36	1
Sandstone.....		11	37	
Blue clay.....	6		43	
Coal.....		3	43	3
Blue clay.....	14	9	58	
Blue shale.....	8		66	
Limestone.....	2		68	
Light shale, sand.....	2		70	
Hard sandstone.....	2	6	72	6
Light sand shale.....	3	6	76	
Sandstone.....	1		77	
Blue shale.....	2		79	
Light shale.....	4		83	
Hard sandstone.....	2		85	
Black slate.....	2		87	
Light shale.....	3		90	
Black slate.....	1		91	
Light sand shale.....	7		98	
Black slate.....	3		101	
Light shale.....	2		103	
Blue shale.....	4		107	
Sandstone.....	1		108	
Blue shale.....	2		110	
Black slate.....	2	6	112	6
Fire clay.....	1	6	114	
Light shale.....	4		118	
Sandstone.....	1	6	119	6
Light shale.....	6	6	126	
Blue sand shale.....	11		137	
Shale, various colors.....	4		141	
Blue sand shale.....	4		145	
Light sand shale.....	7	6	152	6
Sandstone.....	2	6	155	
Light sand shale.....	8		163	
Blue sand shale.....	12		175	
Black shale.....	3		178	
Sandstone.....	1		179	
Light shale.....	3	6	182	6
Limestone.....	1	2	183	6
Light sand shale.....	1	4	185	
Sandstone.....	5		190	
Blue sand shale.....	8		198	
Red shale.....		5	198	5
Blue sand shale.....	9	7	208	
Black slate.....	2		210	
Red shale.....	1		211	
Sandstone.....	6		217	

MACON COUNTY—Log of Bert D. Nortoni coal test at New Cambria—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Coal.....		1	217	1
Clay mixture, almost, if not quite fire clay.....		3	217	4
Sandstone.....	4	8	222	
			Total	depth*

*3" standpipe put in at 64 ft. 2½" standpipe put in at 110 ft. Work done with hydraulic pump churn drill.

Log of John M. Denison's Fee No. 1. Location: NW. 1/4 sec. 20, T. 60 N., R. 17 W., Macon County, Mo. Completed 1914. Well No. (31). Pl. I.

	Thickness Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	80	80
Blue clay.....	70	150
Pennsylvanian and Mississippian (?) system:		
Fine sand.....	30	180
Coarse sand (some water).....	20	200
Limestone (white on top, blue at bottom).....	100	300
Missing.....		
Slate.....	25	325
Coal.....	3	328
Limestone and shale.....	194	522
		Total depth

MARION COUNTY.

Log of Dr. Vernet well. Location: NW. 1/4 NE. 1/4 SW. 1/4 sec. 30, T. 57 N., R. 4 W., Marion County, Mo. Elevation: 608 feet (aneroid). Completed 1904. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Soil and clay.....	41	41
Mississippian system:		
Osage and Kinderhook groups:		
Shale and limestone (base "Mississippi lime" at 50 ft.).....	154	195
Devonian system:		
Limestone, blue.....	105	300
Slate, black.....	33	333
Sand, salt-water.....	14	347
Ordovician system:		
Kimmswick, Decorah, Platin, and Joachim formations:		
Limestone.....	254	601
St. Peter formation:		
Sand, mineral water.....	96	697

MARION COUNTY—Log of Dr. Vernet well—Continued.

	Thickness, Ft.	Depth, Ft.
(Canadian system of Ulrich):		
Jefferson City formation (?):		
Limestone and hard, fine sand.....	478	1175
Roubidoux formation (?):		
Limestone and hard, fine sand.....	30	1205
Sand.....	20	1225
Magnesian limestone.....	50	1275
Sand, hard, white.....	10	1285
(Ozarkian system of Ulrich):		
Gasconade formation (?):		
Magnesian limestone.....	104	1389
No record.....	46	1435
		Total depth

Log of International Shoe Company's well No. 3. Location: NE. 1/4 NW. 1/4 SW. 1/4 sec. 28, T. 57 N., R. 4 W., Marion County, Mo. Elevation: 475 feet (aneroid). Completed 1927. Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	58	58
Devonian system:		
Dolomite, light gray fine grained.....	2	60
Limestone, gray-tan dense.....	40	100
Limestone, gray, dense.....	20	120
Limestone, dark gray, dense.....	10	130
Limestone, light gray, dense.....	5	135
Limestone, light gray, dense asphaltic.....	5	140
Limestone, gray-tan, dense.....	5	145
Limestone, tan dense, with rounded and frosted white sand.....	10	155
Sandstone, white with a little dense limestone.....	15	170
Limestone, sand, green shale and chert.....	30	200
Ordovician system:		
Kimmswick formation:		
Limestone, white, finely crystalline.....	35	235
Limestone, gray-tan with some brown crystals of dolomite.....	110	345
Decorah formation:		
Limestone, tan-gray dense fossiliferous.....	30	375
Plattin formation:		
Limestone, gray, dense.....	25	400
Limestone, gray, dense a little green shale.....	5	405
Limestone, gray, dense.....	5	410
Limestone, gray, dense slightly oolitic.....	5	415
Joachim formation:		
Dolomite, gray dense.....	20	435
Dolomite, sandy.....	10	445
St. Peter formation:		
Sandstone, white rounded and frosted grains.....	75	520
Everton formation ?:		
Dolomite, non cherty.....	70	590
(Canadian system of E. O. Ulrich):		
Cotter formation:		
Dolomite, slightly sandy, contains oolitic chert.....	235	825
Swan Creek member:		
Dolomite, sandy.....	10	835

MARION COUNTY—Log of International Shoe Company's well No. 3—Continued.

	Thickness, Ft.	Depth, Ft.
Jefferson City formation:		
Dolomite, contains oolitic chert.....	160	995
Roubidoux formation:		
Dolomite, sandy, cherty.....	110	1105
(Ozarkian system of E. O. Ulrich):		
Gasconade and Van Buren formations:		
Dolomite, cherty.....	205	1310
Gunter member:		
Dolomite, slightly sandy.....	40	1350
		Total depth

Correlation and descriptions from sample study.

Log of Zimmerman Baking Company's well. Location: 8th and Broadway, Hannibal, Mo.: NW. 1/4 NE. 1/4 SE. 1/4 sec. 29, T. 57 N., R. 4 W., Marion County, Mo. Elevation: 497 feet (aneroid). Completed 1925. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Soil, sand and gravel.....	112	112
Mississippian system:		
Kinderhook group:		
Shale.....	6	118
Devonian system:		
Limestone.....	50	168
Sandstone.....	20	188
Ordovician system:		
Kimmswick, Decorah, Plattin, and Joachim formations:		
Limestone.....	292	480
St. Peter formation:		
Sandstone (B.N.R.).....	25	505
		Total depth

Log of Cave Springs well. Location: NE. 1/4 SE. 1/4 SW. 1/4 sec. 34, T. 57 N., R. 4 W., Marion County, Mo. Elevation: 492 feet (aneroid). Completed 1889. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Soil.....	17	17
Mississippian system:		
Kinderhook group:		
Louisiana formation:		
Limestone, lithographic.....	9	26
Grassy Creek formation:		
Soapstone and slate.....	40	66

MARION COUNTY—Log of Cave Springs well—Continued.

	Thickness, Ft.	Depth, Ft.
Devonian system (?):		
Sandstone.....	14	80
"Hard rock".....	30	110
Black slate.....	13	123
Limestone.....	4	127
Shale.....	6	133
Sandstone.....	7	140
Ordovician system (?):		
Maquoketa formation (?):		
Soapstone.....	55	195
Slate.....	5	200
Kimmswick formation (?):		
"Trenton" limestone.....	180	380
Decorah formation (?):		
Limestone, dark gray.....	20	400
		Total depth

Log of Robert Breeding No. 1 well. Location: C. SE. 1/4 SW. 1/4 sec. 27, T. 57 N., 5 W., Marion County, Mo. Elevation: 724 feet (aneroid). Completed 1924. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil and limestone.....	152	152
Shale.....	90	242
Limestone.....		
Shale.....	418	660
Limestone.....		
Sandstone.....	21	681
		Total depth

(Shale from 90 to 242 feet probably is Hannibal formation; sandstone from 660 to 681 feet probably is St. Peter formation.)

Log of Fred Rener No. 2 well. Location: SW. 1/4 NE. 1/4 sec. 32, T. 57 N., R. 5 W., Marion County, Mo. Elevation: 699 (Estimated). Completed: November, 1936. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	20	20
Mississippian system:		
Osage group:		
Burlington formation:		
Limestone, tan and white; white chert.....	30	50
Sedalia formation:		
Dolomitic limestone and light gray-green sand and siltstone.....	10	60
Kinderhook group:		
Hannibal formation:		
Sandstone, gray, fine-grained; and gray shale.....	20	80
		Total depth

Correlation and descriptions based on a study of samples of cuttings.

MARION COUNTY—Continued.

Log of C. Way well. Location: SE. 1/4 SE. 1/4 NW. 1/4 sec. 8, T. 57 N., R. 6 W., at Woodland, Marion County, Mo. Elevation: 677 feet (aneroid). Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	10	10
Limestone.....	50	60
Shale.....	140	200
Limestone.....	150	350
Blue Shale.....	20	370
Limestone.....	130	500
Shale.....	5	505
Sandstone, white, coarse.....	5	510
		Total depth

Log of Albert Kaden well. Location: NW. 1/4 SE. 1/4 sec. 21, T. 57 N., R. 6 W., Marion County, Mo. Elevation: 692 feet (aneroid). Completed 1934. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Shale.....	140	140
Limestone.....	40	180
Shale.....	20	200
Limestone, broken.....	37	237
		Total depth

(One sample of dolomitic limestone marked, 143 to 168 feet, was examined and probably is Devonian.)

Log of John Kruse well. Location: NE. 1/4 SE. 1/4 sec. 22, T. 57 N., R. 6 W., Marion County, Mo. Elevation: 690 feet (aneroid). Completed 1914. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Limestone.....	50	50
Shale.....	8	58
		Total depth

The base of the "Mississippi lime" is probably at 50 feet, and the shale below 50 feet apparently is the Hannibal shale.

MARION COUNTY—Continued.

Log of J. P. Moss well. Location: NE. 1/4 SW. 1/4 NE. 1/4 sec 25, T. 57 N., R. 7 W., Marion County, Mo. Elevation: 708 feet (aneroid). Completed 1907. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	35	35
Limestone, hard, fine.....	25	60
Shale.....	334	394
Limestone.....		
Shale.....		
Limestone.....		
		Total depth

Log of A. C. Bross well. Location: NW. 1/4 SW. 1/4 SE. 1/4 sec. 17, T. 58 N., R. 5 W., Marion County, Mo. Elevation: 571 feet (aneroid). Completed 1904. Well No. (12), Pl. I.

No record. Total depth reported to be 700 feet. Well probably was completed in upper part of St. Peter sandstone.

Log of Mathias Rothweiler well. Location: SW. 1/4 SE. 1/4 SE. 1/4 sec. 30, T. 58 N., R. 5 W., Marion County, Mo. Elevation: 618 feet (aneroid). Well No. (13), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	40	40
Limestone.....	140	180
Shale.....	2	182
		Total depth

(Base of "Mississippi lime" and top of Hannibal shale at 180 feet.)

Log of W. W. Gilkinson well. Location: near C sec. 32, T. 58 N., R. 6 W., Marion County, Mo. Elevation: 620 feet (aneroid). Well No. (14), Pl. I.

No record. Total depth reported to be 550 feet.

Log of Palmyra Oil Test. Location: at Palmyra, Mo., in NW. 1/4 SE. 1/4 NW. 1/4 sec. 36, T. 58 N., R. 6 W., Marion County, Mo. Elevation: 661 feet (aneroid). Completed "about 1885." Well No. (15), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Soil.....	16	16
Mississippian system:		
Osage group:		
Keokuk and Burlington formations:		
Flint and limestone.....	23	39
Flint and limestone.....	50	89
Flint and limestone, blue, white.....	61	150
Lime shell (base of "Mississippi lime").....	10	160

MARION COUNTY—Log of Palmyra Oil Test—Continued.

	Thickness, Ft.	Depth, Ft.
Kinderhook group:		
Hannibal formation:		
Shale, blue.....	125	285
Louisiana formation:		
Shell flint and limestone.....	15	300
Grassy Creek formation:		
Shale, dark.....	55	355
Devonian and Ordovician systems:		
Lime shell.....	15	370
"Trenton limestone".....	330	700
St. Peter formation:		
Sandstone, salt-water.....	100	800
(Canadian system of E. O. Ulrich:)		
Jefferson City formation (may include Everton in upper part):		
Limestone (dolomite ?).....	130	930
Sandstone.....	10	940
Limestone (dolomite ?).....	15	955
Sandstone.....	15	970
Limestone (dolomite ?).....	115	1085
Lime (dolomite ?) and sand.....	15	1100
Lime and sandstone, mostly, lime (dolomite ?).....	125	1225
Lime (dolomite ?) and sandstone.....	75	1300
Roubidoux formation (top estimated at 1275 feet):		
Sandstone, coarse.....	75	1375
(Ozarkian system of E. O. Ulrich; includes Eminence formation):		
Gasconade formation:		
Limestone (dolomite ?).....	195	1570
Gunter member:		
Sandstone.....	25	1595
Sandstone, yellow.....	10	1605
Cambrian system:		
Eminence formation:		
Lime (dolomite ?) and sand (no change).....	78	1683
		Total depth

This record printed in Palmyra, Mo., newspaper in "about 1889."

Log of Philadelphia city well. Location: SE. 1/4 SW. 1/4 NE. 1/4 sec. 12, T. 58 N., R. 8 W., Marion County, Mo. Elevation: 707 feet (aneroid). Well No. (16), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift clay and flint boulders.....	62	62
Limestone.....	25	87
Shale.....	73	150
		Total depth

This well apparently was completed in the Hannibal (Kinderhook) shale formation, and base of "Mississippi lime" is at 87 feet.

Log of Richter Brothers well. Location: NE. 1/4 SW. 1/4 sec. 2, T. 59 N., R. 6 W., Marion County, Mo. Well No. (17), Pl. I.

No record. Total depth reported to be 852 feet.

MARION COUNTY—Continued.

Log of Fabius River Development Company's No. 1 Tate. Location: NE. cor. SW. 1/4 sec. 22, T. 59 N., R. 6 W., Marion County, Mo. Elevation: 492 feet (Plane-table). Completed October 1938. Well No. (18), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	6	6
Mississippian system:		
Osage group:		
Burlington and Keokuk formations:		
Limestone, cherty.....	44	50
Limestone, dolomitic, cherty, glauconitic.....	10	60
Limestone, cherty.....	10	70
Limestone, dolomitic, cherty.....	15	85
Limestone, cherty.....	35	120
Limestone, a little chert.....	28	148
Kinderhook group:		
Hannibal formation:		
Sandstone, gray, very fine grained.....	7	155
Shale, gray.....	45	200
Shale, green.....	5	205
Shale, gray.....	55	260
Louisiana formation:		
Limestone, gray lithographic with some brown dolomite.....	20	280
Grassy Creek formation:		
Shale, green, contains sporeangites.....	85	365
Devonian system:		
Callaway formation:		
Limestone, tan, lithographic.....	20	385
Limestone, dolomitic, tan sucrose.....	5	390
Limestone, dark gray, dense, very fossiliferous.....	15	405
Dolomite, tan sucrose, some fine sand.....	20	425
Cooper formation:		
Limestone, tan lithographic some fine sand.....	25	450
Ordovician system:		
Maquoketa formation:		
Shale, green.....	5	455
Shale, dark gray.....	13	468
Kimmswick formation:		
Limestone, gray, crystalline, with tan dolomite crystals.....	167	635
Decorah formation:		
Limestone, gray dense, fossiliferous.....	30	665
Joachim formation:		
Dolomite, dense gray.....	10	675
Limestone, gray, sandy.....	5	680
St. Peter formation:		
Sandstone, white, rounded and frosted grains.....	10	690
		Total depth

Correlation and descriptions based on a study of very good sample-set.

Log of E. C. Clark well. Location: NW. 1/4 sec. 32, T. 59 N., R. 7 W., Marion County, Mo. Elevation: 605 feet (estimated). Well No. (19), Pl. I.

No record. Total depth reported to be 600 feet.

MARION COUNTY—Continued.

Log of C. H. Mohr No. 2 well. Location: SW. cor. SE. 1/4 sec. 21, T. 59 N., R. 8 W., Marion County, Mo. Elevation: 671 feet (aneroid). Well No. (20), Pl. I.

	Thickness, Ft.	Depth, Ft.
Clay.....	45	45
Blue shale.....	150	195
Limestone.....	60	255
Gray shale.....	35	290
Limestone.....	220	510
Red sand, some oil and gas.....	15	525
Limestone.....	125	650
White sandstone; mineral water.....	10	660
Hard rock.....	2	662
Sandstone.....	213	875
		Total depth

Log of John W. Shull well. Location: NE. 1/4 NW. 1/4 SE. 1/4 sec. 27, T. 59 N., R. 8 W., Marion County, Mo. Elevation: 620 feet (aneroid). Well No. (21), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	80	80
Shale.....	60	140
Limestone.....	330	470
		Total depth

Log of C. H. Mohr No. 1 well. Location: NE 1/4 NW. 1/4 NE. 1/4 sec. 28, T. 59 N., R. 8 W., Marion County, Mo. Elevation: 654 feet (aneroid). Well No. (22), Pl. I.

	Thickness, Ft.	Depth, Ft.
Blue shale; fresh water.....	165	165
Hard limestone.....	60	225
Gray shale.....	72	297
Limestone, very hard.....	188	485
Red sandstone.....	10	495
Limestone.....	30	525
Sandstone.....	10	535
Limestone.....	10	545
Sandstone.....	140	685
Blue shale.....	15	700
Sandstone.....	20	720
		Total depth

MERCER COUNTY.

Log of M. S. Wilson's W. H. Odneal No. 1. Location: SE. cor. NW. 1/4 NE. 1/4 sec. 33, T. 64 N., R. 22 W., Mercer County, Mo. Elevation: 858 feet. Drilled 1911-1913. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Surface.....	50	50
Yellow clay.....	75	125
Red soil with little sand.....	75	200
Pennsylvanian and Mississippian systems:		
Limestone.....	50	250
Water sand.....	15	265
Limestone.....	100	365
Joint clay (red) caves.....	25	390
White limestone.....	450	840
Dark gray sand, very hard.....	5	845
Red clay.....	10	855
Limestone, sandy.....	50	905

A few cuttings from this well are correlated as follows:

540 } (Ste. Genevieve?)
570 }

671 Spergen
690 Warsaw?
735 Warsaw

795 } Keokuk-Burlington
830 }

Log of Coal test on Keating farm. (Serial No. 4.) Location: NW. 1/4 NE. 1/4 sec. 8, T. 64 N., R. 24 W., Mercer County, Mo. Elevation: 836 feet. Completed: 1914 with core drill. Well No. (7), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene and Recent series:				
Surface.....	8		8	
Pennsylvanian system:				
Kansas City group:				
(Bastard) limestone.....	1		9	
Soft light shale.....	2		11	6
White limestone.....	4	6	16	
Pleasanton group:				
Green shale.....	3		19	
Dark shale.....	11	6	30	6
Coal (Ovid).....		4	30	10
Light shale.....	4	2	35	
Dark shale.....	4		39	
Limestone.....	3		42	
Light shale.....	6		48	
Dark slate.....	6		54	
Soft gray sandstone.....	82		136	
Green shale.....	17		153	

MERCER COUNTY—Log of Coal test on Keating farm—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Henrietta group:				
White limestone.....	1		154	
Red shale.....	8		162	
Lime shale.....	6		168	
Variegated shale.....	10		178	
Black shale.....	6		184	
Coal } (Lexington).....		6	184	6
Shale }.....		6	185	
Coal }.....	1	8	186	8
Fire clay.....	3		189	8
Limestone.....	6	4	196	
Soft sandstone.....	16		212	
Sandy slate.....	7		219	
Coal (Summit).....		9	219	9
Hard limestone.....	6	3	226	
Cherokee group:				
Lime shale.....	5		231	
Coal (Mulky).....		4	231	4
Fire clay.....	3	6	234	10
Light shale.....	5		239	10
Soft gray sandstone.....	55	2	295	
Coal (upper bench of Bevier).....		5	295	5
Fire clay.....	4	7	300	
Sand shale.....	10		310	
Dark slate.....	9		319	
Coal (lower bench of Bevier).....	1	4	320	4
Fire clay.....	3	8	324	
Light shale.....	9		333	
Black slate.....	2		335	
Coal.....		10	335	10
Fire clay.....	2	2	338	
Sandstone.....	10	6	348	6
Light shale.....	3	6	352	
Sand shale.....	2		354	
Fire clay shale.....	1		355	
Lime shale.....	4		359	
Black slate.....	3		362	
Coal.....		10	362	10
Fire clay.....	1	2	364	
Dark slate.....	6		370	
Coal.....	1	6	371	6
Light shale.....	2	6	374	
Hard dark slate.....	76		450	
Sand slate.....	6		456	
Black slate.....	4	6	460	6
Fossiliferous sandstone.....	7	6	468	
Sand slate.....	1		469	
Dark slate.....	3		472	
Gray sandstone.....	6		478	
Sandy fire clay.....	4		482	
Black slate.....		4	482	4
Gray sandstone.....	3	6	485	10
Black slate.....	4	8	490	6
Coal.....		9	491	3
Fire clay.....	3	5	494	8
Sandy slate.....	3	4	498	
Black slate.....	2	2	500	2
Coal.....	1	2	501	4
Sandy fire clay.....	1	2	502	6
Gray sandstone.....	3	6	506	

MERCER COUNTY—Log of Coal test on Keating farm—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Black slate.....	6	6	512	6
Fire clay.....	2		514	6
Sandstone.....	3	6	518	
Black slate.....		11	518	11
Coal.....	2	6	521	5
Binder (Cainesville).....	2	2	523	7
Coal.....	2	7	526	2
Fire clay.....	1	10	528	
Light shale.....	2		530	
			Total	depth

This log is selected from a group of logs of wells drilled with a core drill in the vicinity of Princeton (Wells Nos. (2), (3), (4), (5), (6), (7), (8), (9), (12), (13), (14), (15) and (16), Pl. I.) as it shows the relation of the lower beds to the Hertha limestone.

Log of Fred Morck's L. H. Bussel No. 1. Location: Cen. SE. 1/4 sec. 18, T. 64 N., R. 25 W., Mercer County, Mo. Elevation: 820 feet. Well No. (11), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Surface.....	160		160	
Quick sand, light.....	20		180	
Blue clay.....	22		202	
Pennsylvanian system:				
Lime, gray, hard.....	3		205	
Shale, soft.....	30		235	
Sandstone, gray, soft.....	3		238	
Limestone, light, soft.....	15		253	
Limestone, light, hard.....	2		255	
Clay, white, soft.....	11		266	
Sandrock, gray, soft.....	4		270	
Shale, light, medium.....	16		286	
Shale, dark, medium.....	4		290	
Sandrock, gray, medium.....	14		304	
Shale, light.....	13		317	
Slate, light, medium.....	4		321	
Coal.....	1	4	322	4
Fire clay, light, soft.....	7		329	4
Shale, light, medium.....	11		340	4
Slate, black, medium.....	9		349	4
Coal, black, medium.....		8	350	
Fire clay, gray, medium.....	9		359	
Coal, dirty.....	1		360	
Fire clay, medium.....		6	360	6
Light shale, medium.....	21	6	382	
Clay, light, medium.....	2		384	
Sandy shale, light, medium.....	9		393	
Slate, black, soft.....	3		396	
Coal, black.....		6	396	6
Fire clay, gray, soft.....	7	6	404	
Dark shale, soft.....	8		412	
Sand, gray medium.....	17		429	

MERCER COUNTY—Log of Fred Morck's L. H. Bussel No. 1—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Slate, black, hard, changed to coal.....	2	6	431	6
Coal.....		10	432	4
Fire clay, gray, soft.....	8	8	441	
Slate, black, hard.....	2		443	
Fire clay, black, soft.....	5		448	
Shale, light, hard.....	5		453	
Sand rock, black, hard.....		8	453	8
Shale, dark, hard.....	22	4	476	
Slate, black, hard.....	14		490	
Coal, hard.....		7	490	7
Fire clay, gray, soft.....	9	5	500	
Shale, light, medium.....	8	6	508	6
Slate, black, hard.....	6	6	515	
Fire clay, black, soft.....	4		519	
Slate, black, hard.....	1	6	520	6
Shale, light, medium.....	8		528	6
Slate, black, hard.....	1	6	530	
Shale, dark, sand.....	2		532	
Slate, black, medium.....	1	8	538	8
Coal, black, hard.....	1		534	8
Slate, black, hard.....		4	535	
Coal, black, hard.....		10	535	10
Slate, black, hard.....	2	2	538	
Coal, black, hard.....		8	538	8
Shale, dark, medium.....	10	4	549	
Coal, dark, hard.....	2		551	
Fire clay, dark, hard.....	4		555	
Slate, black, hard.....	14		569	
Shale, dark.....	9		578	
Coal, dirty.....		8	578	8
			Total	depth

Log of North Central Oil and Gas Company's Berndt No. 1. Location: Cen. NW. 1/4 NE. 1/4 sec. 1, T. 66 N., R. 24 W., Mercer County, Mo. Elevation: 1036 feet. Completed: Nov. 11, 1930. Well No. (17), Pl. I.

	Thickness. Ft.	Depth. Ft.
Pleistocene series:		
Clay and sand.....	90	90
Pennsylvanian system:		
Pleasanton group:		
Shale.....	48	138
Sandy lime.....	4	142
Sandy shale.....	13	155
Shale, gray.....	55	210
Shale, dark.....	8	218
Henrietta group:		
Sandy lime.....	7	225
Lime shells and shale.....	39	264
Slate (Lexington horizon).....	2	266
Lime.....	13	279
Shale.....	2	281
Lime.....	4	285
Sandy lime.....	5	290
Lime.....	4	294

MERCER COUNTY—Log of North Central Oil and Gas Company's Berndt No. 1—Cont.

	Thickness, Ft.	Depth, Ft.
Shale.....	17	311
Lime (Lower Fort Scott).....	6	317
Cherokee group:		
Shale.....	4	321
Sandy shale (Squirrel).....	49	370
Shale, gray.....	20	390
Shale, dark.....	5	395
Shale, shows coal.....	3	398
Shale, black.....	5	403
Limey sand (Rich Hill).....	9	412
Sandy shale.....	8	420
Shale, black.....	5	425
Shale.....	22	447
Shale, gray.....	4	451
Lime, brown.....	3	454
Shale, black.....	10	461
Shale, gray.....	19	480
Shale, black.....	25	505
Shale.....	8	513
Red rock.....	2	515
Shale.....	20	535
Shale, black.....	35	590
Sand.....	10	600
Shale, black.....	5	605
Lime and shale.....	22	627
Sand, water.....	18	645
Shale, dark.....	15	660
Sand.....	8	668
Shale.....	12	680
Sandy shale.....	15	695
Shale.....	59	759
Sand.....	8	767
Lime.....	3	770
Sand, white, water.....	12	782
Shale.....	8	790
Shale, black.....	23	813
Sand, some lime.....	17	830
Shale.....	3	833
Sand, white, fine.....	34	867
Mississippian system:		
Lime.....	91	958
		Total depth

Dry and abandoned.

Casing Record:

10" — 125'

8" — 464'

6" — 756'

MERCER COUNTY—Continued.

Log of A. B. Anderson's Fee No. 1. Location: NW. 1/4 SW. 1/4 sec. 19, T. 66 N., R. 23 W., Mercer County, Mo. Elevation: 1085 feet. Completed 1913. Well No. (18), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	186		186	
Pennsylvanian system:				
Clay shale, blue.....	6		192	
Clay shale, dark blue.....	1		193	
Coal.....		3	193	3
Clay shale, light.....	3		196	3
Limestone.....	4		200	3
Clay shale, light blue.....	107		307	3
Shale, light greenish, with limestone nodules.....	43		350	3
Shale, dark blue.....	44		394	3
Limestone, blue.....		10	395	1
Shale, dark blue.....	2		397	1
Shale, black, bituminous.....	4	2	401	3
Limestone, blue.....		8	401	11
Shale, black, bituminous.....	2		403	11
Clay shale, light blue.....	5		408	11
			Total	depth

Log of coal test on Clone Duncan farm. Location: NW. 1/4 NW. 1/4 sec. 32, T. 67 N., R. 23 W., Mercer County, Mo. Elevation: 1086 feet. Completed 1911, with core drill. Well No. (19), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	237		237	
Pennsylvanian system:				
Shale, sandy to argillaceous, green to drab.....	230		467	
Shale, red purple and green.....	4		471	
Shale, black, soft.....		4	471	4
Shale, olive green.....	3		474	4
Limestone, gray to green, fine-grained.....	4		478	4
Shale, dark gray or brown, streaks of black shale near bottom.....	6		484	4
Shale, blue-gray, sandy.....	3		487	4
Sandstone, light bluish gray, micaceous.....	24		511	4
Shale, black, bituminous.....		3	511	7
Shale, gray at top, dark drab at base, sandy to argillaceous.....	14	3	525	10
Limestone, gray.....		10	526	8
Shale, dark drab, no sand or mica.....	2	2	528	10
Coal, bony, poor quality.....		10	529	8
Shale, drab, fine-textured.....	12	6	542	2
Sandstone, gray, shaley, fine-grained.....	2	4	544	6
Shale, dark gray, micaceous.....	17	2	561	8
Coal, fair.....		11	562	7
Shale, gray, fine-textured, some pyrite.....	15		577	7
Coal, bony, poor.....		4	577	11

MERCER COUNTY—Log of coal test on Clone Duncan farm—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Shale, gray, fine-grained.....	3	4	581	3
Sandstone, gray, fine-grained.....	6	2	587	5
Shale, gray, dark at base, sandy streak in middle....	2	6	589	11
Shale, black, bituminous.....		6	590	5
Coal, only fair.....	2	9	592	2
Shale, dark gray to blue, argillaceous.....	12	4	604	6
Coal.....	1	9	606	3
Shale, light gray.....	4		610	3
Shale, dark blue.....	9		619	3
Coal.....		10	620	1
Shale, light gray.....	4	4	624	5
Shale, mostly dark blue.....	30	6	654	11
Shale, sandy, blue and white, with much water.....	27	5	682	4
			Total	depth

MONROE COUNTY.

Log of City of Monroe City well No. 2. Location: NW. 1/4 SW. 1/4 NW 1/4 sec. 18, T. 56 N., R. 7 W., Monroe County, Mo. Elevation: 743 feet (aneroid). Completed 1913. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	90	90
Limestone.....	120	210
Shale.....	20	230
Shale, blue.....	10	240
Limestone.....	180	420
Sandstone, white (fresh-water).....	15	435
Shale.....	27	462
Limestone.....	125	587
Sandstone.....	9	596
Shale, blue.....	71	667
Shale (?), record lost.....	759	1426
Limestone.....	254	1680
Limestone, shale and sandstone.....	78	1758
Shale.....	28	1786
Limestone.....	198	1984
Limestone to bottom.....	166	2150
		Total depth

(This is a very poor log. Sulpho-saline water reported at 690 feet.)

MONROE COUNTY—Continued.

Log of Jackson well at Monroe City. Location: sec. 13, T. 56 N., R. 8 W., Monroe County, Mo. Elevation: 755 feet (estimated). Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
Gravel.....	17	17
Fire clay.....	19	36
Limestone, white.....	36	72
Sandstone, white.....	78	150
Limestone, brown.....	25	175
Shale, blue.....	110	285
Limestone, brown.....	24	309
Limestone, light brown.....	6	315
Mud, blue.....	16	331
Limestone, gray.....	39	370
Limestone, white.....	6	376
Limestone, blue.....	47	423
Limestone, white.....	29	452
Sandstone, "oil".....	6	458
Limestone, white.....	59	517
Shale, light brown.....	34	551
Limestone, gray.....	2	556
Sandstone, water.....	5	561
Shale, blue.....	4	565
Limestone, gray.....	25	590
Sandstone, white.....	85	675
Sandstone, blue.....	95	760
		Total depth

Base of "Mississippi lime" at 175 feet.

Sandstone from 675 to 760 may be St. Peter.

Log of Northwestern Mutual Life Insurance Co. No. 1 Levings. Location: SW. cor. sec. 17, T. 55 N., R. 9 W., Monroe County, Mo. Elevation: 715 feet (aneroid). Completed 1938. Well No. (3), P. I.

	Thickness, Ft.	Depth, Ft.
No Samples.....	145	145
Mississippian system:		
Osage group:		
Burlington formation:		
Dolomite, gray crystalline, cherty.....	5	150
Limestone, white crystalline, cherty.....	20	170
Limestone, white, crystalline, cherty dolomitic.....	15	185
Sedalia formation:		
Limestone, gray, crystalline, dolomitic.....	5	190
Limestone, white, crystalline.....	5	195
Dolomite, tan, crystalline.....	10	205
Kinderbrook group:		
Chouteau formation:		
Limestone, dark gray crystalline to dense, some dense gray chert.....	80	285
Grassy Creek formation:		
Shale, gray-green.....	15	300
		Total depth

Correlation and descriptions based on a study of samples.

PIKE COUNTY.

Log of Ashburn Oil Test No. 1 well. Location: SW. 1/4 SW. 1/4 NE. 1/4 sec. 13, T. 55 N., R. 3 W., Pike County, Mo. Elevation: 584 feet (aneroid). Completed: 1902. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Ordovician system:		
Maquoketa formation (?):		
"Oil", slate and shale.....	160	160
Kimmswick, Decorah, Platin and Joachim formations:		
Hard limestone.....	20	180
Limestone.....	60	240
Fine limestone.....	60	300
Very hard limestone.....	80	380
Soft limestone.....	40	420
Gray limestone.....	60	480
Brown limestone.....	20	500
White limestone.....	10	510
St. Peter formation:		
White St. Peters sandstone.....	70	580
White sandstone.....	85	665
		Total depth

PUTNAM COUNTY.

Log of Dome Development Company's Alexander No. 1. Location: SW. 1/4 NE. 1/4 SE. 1/4 sec. 19, T. 65 N., R. 16 W., Putnam County, Mo. Elevation: 916 feet (plane-table). Completed 1918 or 1919. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Soil.....	5	5
Clay.....	95	100
Pennsylvanian system:		
Shale.....	150	250
Lime.....	5	255
Shale.....	45	300
Lime.....	6	306
Shale.....	61	367
Mississippian system:		
Lime.....	38	405
Sand, water.....	7	412
Shale (Warsaw ?).....	33	445
Lime.....	260	705
Sand.....	5	710
Lime.....	65	775
Clay, blue (Grassy Creek?).....	20	795
Devonian system (may include some Ordovician at base):		
Lime, showing oil.....	33	828
Sand.....	7	835
Lime.....	185	1015
Sand.....	80	1095
Lime.....	10	1105
Sand.....	40	1145
Lime.....	12	1157
Sand, salt water.....	38	1195
		Total depth

PUTNAM COUNTY—Continued.

Log of the Putnam County Oil and Gas Company's Don Crooks No. 1 well. Location: NW. 1/4 SW. 1/4 NE. 1/4, sec. 19, T. 65 N., R. 16 W., Putnam County, Mo. Elevation: 997 feet (plane-table). Well No. (1A), Pl. I.

Note: No log of this drilling is available. The total depth is reported to have been 1400 feet. Location indicated by C. E. Husted, Worthington, Mo.

Log of Putnam County Oil and Gas Company's No. 1 Miller. Location: SW. 1/4 NW. 1/4 NW. 1/4 NE. 1/4 sec. 28. T. 65 N., R. 16 W., Putnam County, Mo. Elevation: 813.2 feet (plane-table). Completed: October, 1922. Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	25	25
Pleistocene series:		
Polished sand, igneous chips.....	17	42
Pennsylvanian system:		
Cherokee group:		
Shale, gray, some coal.....	1	43
Shale, gray, sandy.....	14	57
Shale, gray to black.....	20	77
Coal (Bevier).....	1	78
Shale, gray.....	5	83
No samples.....	6	89
Shale gray, with limestone (Horizon of Ardmore).....	16	105
Sand, gray fine.....	5	110
Shale, gray.....	10	120
Limestone.....	1	121
Shale, red.....	10	131
Shale, gray.....	2	133
Coal (Lower Ardmore).....	2	135
Shale, gray.....	1	136
No samples.....	9	145
Sand, very fine.....	7	152
Shale, gray.....	8	160
Shale, green, sandy.....	8	168
Sand, very fine grained.....	18	186
No sample.....	14	200
Shale, black.....	11	211
Sand, very fine.....	4	215
No sample.....	10	225
Shale, black and gray.....	10	235
Shale, sandy.....	25	260
Mississippian system:		
Meramec group:		
St. Louis? formation:		
Limestone, dove gray lithographic, with free calcareous oolites.....	3	263
No samples.....	27	290
Shale, gray green.....	4	294
Limestone, lithographic, gray.....	7	301
Warsaw formation:		
Limestone, crystalline, gray fossiliferous, with gray and white chert.....	79	380
Limestone, dolomitic sand and somewhat shaly.....	2	382
Burlington-Keokuk formations:		
Limestone, white and brown with considerable white chert.....	86	468
Limestone, white, dolomitic, cherty.....	66	534
Limestone, gray, finely crystalline, very little chert.....	40	574
Sedalia formation?:		
Limestone, gray, dense, non-cherty.....	16	590

PUTNAM CO.—Log of Putnam Co. Oil and Gas Company's No. 1 Miller—Continued.

	Thickness, Ft.	Depth, Ft.
Kinderhook group:		
Chouteau formation:		
Limestone, dark gray dense, with dense gray chert. . .	92	682
Grassy Creek (?):		
Shale, green, with pyrite and pink chert.	7	689
Devonian system:		
Limestone, dense, white to light tan, a little rounded and frosted white sand, some black lime.	35	724
Limestone, finely crystalline to dense, gray to tan, with a little pink quartzose chert.	15	739
Limestone, dense gray-tan, with some black lime, also dark shale. Limestone contains ostracods.	21	760
Limestone, gray and black, contains tentaculites? and bryozoa.	20	780
Limestone, white and gray, dense.	8	788
Limestone, tan-gray, dense contains ostracods, some black lime.	12	800
Limestone, white, dense to finely crystalline, contains ostracods.	64	864
Limestone, tan lithographic.	12	876
Limestone, dolomitic, gray to tan finely crystalline to sucrose.	72	948
Limestone, dense gray, some dolomitic brown finely crystalline.	12	960
Limestone, tan, lithographic.	45	1005
Sandstone, white, grains rounded and frosted, some angular.	3	1008
Dolomite, white, sandy.	19	1027
Sandstone, white, grains well sorted, rounded and frosted	34	1061
Ordovician system:		
Galena (?) formation:		
Dolomite, blue-gray to tan, crystalline sandy.	59	1120
Kimmswick formation:		
Dolomite, gray, crystalline, with white chert.	8	1128
Dolomite, blue-gray crystalline a little chert.	64	1192
Dolomite, gray-tan, in coarse chips, with calcite, a little green shale.	8	1200
Decorah? formation:		
Dolomite, brown granular, calcite and pyrite.	44	1244
St. Peter formation:		
Dolomite and sand.	7	1251
Sand white and green shale.	27	1278
Everton formation:		
Shale, green.	12	1290
Sand, white, a little green shale.	20	1310
Cotter and Jefferson City formations (Canadian system of E. O. Ulrich):		
Dolomite, brown to white, crystalline, contains dense white and oolitic chert.	190	1500
		Total depth

Correlation and descriptions based upon a study of an excellent set of samples.

Log of the Putnam County Oil and Gas Company's Willis Cowell No. 1 well. Location: SE. 1/4 SW. 1/4 SE. 1/4 NE. 1/4, sec. 29, T. 65 N., R. 16 W., Putnam County, Mo. Elevation: 877 feet (plane-table). Well No. (2A), Pl. I.

Note: No log of this drilling is available. The total depth is reported to have been 1000 feet.

PUTNAM COUNTY—Continued.

Log of the Putnam County Oil and Gas Company's Albert Stein No. 1 well. Location: SW. 1/4 SE. 14/ NW. 1/4, sec. 29, T. 65 N., R. 16 W., Putnam County, Mo. Elevation: 863 feet (plane-table). Well No. (2B), Pl. I.

Note: No log of this drilling is available. The total depth is reported to have been 1000 feet.

Log of Dome Development Company's Gowdie (or Goudie) No. 1. Location: SW. 1/4 SE. 1/4 sec. 32, T. 65 N., R. 16 W., Putnam County, Mo. Elevation: 927 feet (plane-table). Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series and		
Pennsylvanian system:		
Soil.....	2	2
Clay.....	48	50
Sand.....	20	70
Blue mud.....	100	170
Gravel.....	1	171
Fire clay.....	30	201
Gravel.....	10	211
Lime-W.....	1	212
Shale.....	40	252
Slate.....	10B	262
Lime.....	8	270
Shale.....	30	300
Sands.....	5	305
Shale.....	35	340
Mississippian System:		
Undifferentiated:		
Lime.....	40	380
Shale-W.....	15	395
Lime-flint.....	35	430
Slate, big water.....	2	432
Shale, set 8 1/4" casing at 436'.....	6.5	438.5
Shale.....	1.5	440
Lime.....	60	500
Shale.....	3	503
Lime.....	57	560
Sands, water.....	30	590
Lime.....	10	600
Shale.....	3	603
Lime.....	5	608
Sands, water.....	7	615
Lime.....	10	625
Sand.....	5	630
Lime.....	30	660
Sands, Moravian water.....	10	670
Lime.....	30	700
Sands.....	2	702
Shale.....	3	705
Lime.....	35	740
Sand-W-showing rainbow.....	8	748
Lime, set 6 1/4" casing at 753'.....	17	765
Sands, showing rainbow.....	1	766
Grassy Creek(?):		
Blue clay.....	18	784
Devonian System:		
Sand.....	2	786
Shale.....	3	789
Sand.....	4	793
Shale.....	7	800

PUTNAM COUNTY—Log of Dome Development Company's Gowdie No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Lime.....	8	808
Sand.....	16	824
Lime.....	1	825
Sand, bottom of well showing oil.....	9.5	834.5
		Total depth

Poor log; correlations in doubt.

Log of Frank E. Messler's No. 1 Hickman. Location: NW. 1/4 SW. 1/4 NE 1/4 sec. 25, T. 65 N., R. 17 W., Putnam County, Mo. Elevation: 859 feet (plane-table). Completed September 13, 1929. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series.....	55	55
Pennsylvanian system:		
Cherokee group.....	228	283
Mississippian system:		
Meramec group:		
St. Louis? and Warsaw formations.....	123	406
Osage group:		
Burlington and Keokuk formations.....	169	575
Sedalia formation.....	25	600
Kinderhook group:		
Chouteau formation.....	105	705
Grassy Creek(?) shale.....	20	725
Devonian system:		
(Sandstone 40 feet thick at base).....	370	1095
Ordovician system:		
Upper Galena formation.....	30	1125
		Total depth

The above formational summary was made from a study of the samples. The lithology is so similar to that found in the Putnam County Oil and Gas No. 1 Miller, located in SW 1/4 NW 1/4 NE 1/4 sec. 28, T. 65 N., R. 16 W., Putnam County, that the reader is referred to that log for details.

Log of coal test near Unionville. Location: NW 1/4 SE. 1/4 sec. 3, T. 65 N., R. 19 W., Putnam County, Mo. Well No. (5), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	116		116	
Pennsylvanian system:				
Henrietta group:				
Shale, green.....	10	8	126	8
Shale, mixed.....	8	9	135	5
Limestone.....	3	2	138	7

PUTNAM COUNTY—Log of coal test near Unionville—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Shale, light to gray.....	10	5	149	
Limestone.....	1	7	150	7
Shale, gray.....	3	10	154	5
"Clod".....	2	3	156	8
Shale, dark.....		6	157	2
Coal.....	1	7	158	9
Clay (Lexington).....		2	158	11
Coal.....	1		159	11
Clay.....	1	3	161	2
				Total depth

Log of Z. T. Branford Coal test No. 1. Location: SW 1/4 NW. 1/4 sec. 10, T. 65 N., R. 19 W., Putnam County, Mo. Well No. (7), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Drift.....	74	9	74	9
Pennsylvanian system:				
Henrietta group:				
Rock.....		10	75	7
Shale, mixed.....	6	2	81	9
Shale, gray.....	4	4	86	1
Limestone, bastard.....	1	7	87	8
Shale, gray.....	1	7	89	3
Limestone.....	1	3	90	6
Shale, dark.....		10	91	4
Coal.....		2	91	6
Fire clay.....	5	6	97	
Lime shale.....	1	11	98	11
Limestone.....	1		99	11
Shale, light.....		6	100	5
Limestone.....	3	7	104	
Sand shale, light.....	11	4	115	4
Shale, gray.....	5	11	121	3
Cap rock.....		9	122	
Shale.....	1	2	123	2
Black jack.....		5	123	7
Shale, gray.....	4	11	128	6
Shale, light.....	3		131	6
			Total	depth

PUTNAM COUNTY—Continued.

Log of Albert Holteane's Fee No. 1. Location: SE. 1/4 NW. 1/4 sec. 35, T. 65 N., R. 22 W., Putnam County, Mo. Elevation: 992 feet. Completed: 1914. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay	50	50
Blue clay	40	90
Yellow clay	12	102
Blue clay	18	120
Sand (some water)	2	122
Blue clay	98	220
Quick-sand	20	240
Blue clay	22	262
Gravel (some water)		
		Total depth

Log of well at old Power House of Pickle Factory (now abandoned) at Unionville, Mo. Location: Cen. S. 1/2 sec. 34, T. 66 N., R. 19 W., Putnam County, Mo. Elevation: 1069 feet (plane-table). Completed 1897. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Clay and soil	220	220
Pennsylvanian system:		
Cherokee group:		
Shale, black, "slaty"	5	225
"Rock"	4	229
Clay	4	233
Shale, black, "slaty"	12	245
Clay	32	277
Sandstone	30	307
Shale, black, "slaty"	3	310
Shale	42	352
Shale, clay and "slate"	57	409
Black cuttings	21	430
Shale, etc.	90	520
Sandstone	25	545
Mississippian system:		
White cuttings, hard, water bearing, probably Mississippian limestone		700
		Total depth

PUTNAM COUNTY—Continued.

Log of Mendota Coal Company's coal test No. 3. Location: NE. 1/4 SW. 1/4 sec. 35, T. 67 N., R. 18W., Putnam County, Mo. Elevation: 868 feet (aneroid). Well No. (10), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene and Recent series:				
Drift and soil.....	16		16	
Pennsylvanian system:				
Henrietta group:				
Shale, blue at top, light below.....	6		22	
Limestone.....	4		26	
Shale, light.....	2		28	
Limestone.....	2		30	
Cherokee group:				
Shale, black at top, sandy and light below.....	7		37	
Sandstone.....	2		39	
Shale, sandy at top.....	27		66	
Limestone.....	1		67	
Shale, light at top, blue below.....	15		82	
Coal (Bedford).....		10	82	10
Clay, sandy.....	2	2	85	
Sandstone.....	5		90	
Shale, sandy.....	7		98	
Shale, blue.....	5		102	
Coal (Bevier).....	1	9	103	9
Clay.....	2	3	106	
Shale, light.....	4		110	
Limestone.....	3		113	
Shale, sandy.....	2		115	
Shale, black.....	8		123	
Shale, light.....	3		126	
Coal (Lower Ardmore).....	1	6	127	6
Clay.....	3	6	131	
Sandstone.....	4		135	
Shale, brown to light, sandy near top.....	9		144	
Sandstone.....	1		145	
Shale, red at top, blue in middle, sandy at base..	10		155	
Sandstone, hard.....	4		159	
Shale, variegated, sandy at top.....	9		168	
Sandstone, with shale partings.....	12		180	
Shale and sandstone.....	19		199	
Shale, blue.....	6		205	
Coal.....		2	205	2
Shale, sandy at top, variegated.....	14	10	220	
Shale, blue.....	11		231	
Coal.....		7	231	7
Clay.....	1	5	233	
Sandstone.....	12		245	
Shale, blue, sandy in middle.....	17		262	
Coal.....		7	262	7
Sandstone.....	3	5	266	
Shale, light at top, blue below.....	9	7	275	7
"Rock", black.....	3		278	7
Shale, sandy.....	2	5	281	
Coal.....		2	281	2
Clay.....		10	282	
Shale, sandy.....	4		286	
Shale, blue.....	2		288	
Coal.....		5	288	5
Clay.....	1	7	290	
Shale, light, sandy at base.....	6		296	

PUTNAM COUNTY—Log of Mendota Coal Company's coal test No. 3—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Sandstone, hard.....	2		298	
Shale, sandy.....	2		300	
Sandstone, hard.....	2		302	
Shale, calcareous.....	4		306	
Shale, sandy.....	6		312	
Shale, green.....	2		314	
Shale, variegated.....	4		318	
Shale, calcareous.....	3		321	
Shale, light.....	1		322	
Shale, calcareous.....	5		327	
Sandstone, hard.....	3		330	
Shale, calcareous.....	2		332	
Limestone.....	4	6	336	6
			Total	depth

Beds below 290 feet may include Mississippian (?).

RALLS COUNTY.

Log of Bernie Smith well. Location: Cen. NW. 1/4 NE. 1/4 sec. 6, T. 55 N., R. 4 W., Ralls County, Mo. Elevation: 637 feet (aneroid). Completed August, 1936. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Limestone.....	180	180
Sandstone.....	80	260
		Total depth

(One sample of sandstone from "near bottom of hole" apparently is St. Peter.)

Log of Atlas Portland Cement Company's well at Spalding. Location: NW. 1/4 NE. 1/4 sec. 26, T. 56 N., R. 6 W., Ralls County, Mo. Elevation: 559 feet (aneroid). Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	610	610
Ordovician system:		
Roubidoux formation: (Canadian system of E. O. Ulrich)...	85	695
Gasconade and Van Buren formations: (Ozarkian System of E. O. Ulrich).....	215	910
Gunter member.....	50	960
Cambrian system:		
Eminence formation: (Ozarkian system of E. O. Ulrich).....	120	1080
Derby-Doe Run formation.....	245	1325
Davis formation.....	305	1630
Bonne Terre formation.....	215	1845
La Motte formation.....	330	2175
		Total depth

Correlation and descriptions are based on a study of samples. For details of lithology see log of Atlas Portland Cement Company's No. 1 Jones well in sec. 28, T. 55 N., R. 4 W., Ralls County, Mo., total depth 2205 feet. See Ralls County Well No. (15).

RALLS COUNTY—Continued.

Log of Howard Meyers well. Location: SE. 1/4 NE. 1/4 NE. 1/4 sec. 28, T. 55 N., R. 6 W., Ralls County, Mo. Elevation: 720 feet (aneroid). Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	35	35
Shale.....	50	85
Limestone.....	50	135
Soapstone, shale.....	100	235
Limestone.....	100	335
Shale.....	20	355
Sandstone, white; water-bearing.....	10	365
		Total depth

Owner reports well was completed in white limestone.

(Base of "Mississippi lime" at 135 feet. Top of Devonian(?) limestone at 235. Top of Kimmswick(?) at 355 feet.)

Log of Center Oil and Gas Company's No. 1 Gardner. Location: SE. 1/4 NE. 1/4 SE. 1/4 sec. 32, T. 55 N., R. 6 W., Ralls County, Mo. Elevation: 745 feet (aneroid). Completed 1922. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Mississippian system:		
Osage group:		
Burlington formation:		
Limestone, brown, crystalline.....		26
No samples.....	14	40
Clay, yellow and gray.....	3	43
Limestone, light brown crystalline.....	24	67
Kinderhook group:		
Hannibal formation:		
Shale, blue-gray.....	90	157
Devonian system:		
Limestone, gray shaly.....	48	205
Sandstone, white, well rounded grains.....	10	215
Limestone, dark gray, finely crystalline.....	8	223
Limestone, light gray to brown, dense, some green shale.....	11	234
Ordovician system:		
Kimmswick formation:		
Limestone, white and light brown crystalline.....	99	333
Decorah formation:		
Limestone, brown, with bituminous shale.....	27	360
Limestone, fossiliferous, brown shale.....	15	375
Limestone, fossiliferous, with blue-gray and gray-black shale.....	5	380
Plattin formation:		
Limestone, light tan, dense.....	35	415
Joachim formation:		
Dolomite, light brown, finely crystalline, slightly sandy.....	30	445
Dolomite, buff, fine grained, sandy.....	11	456
St. Peter formation:		
Sandstone, white, grains frosted.....	26	482
Everton formation?:		
Dolomite, light gray dense, little sand and green shale.....	85	567

RALLS COUNTY—Log of Center Oil and Gas Company's No. 1 Gardner—Continued.

	Thickness, Ft.	Depth, Ft.
(Canadian system of E. O. Ulrich): Cotter formation: Dolomite, gray to tan, finely crystalline contains oolitic chert.....	76	643 Total depth

Correlation and descriptions are based on a study of samples.

Log of Center Oil and Gas Company's No. 2 Gardner. Location: SE. 1/4 NE. 1/4 SE. 1/4 sec. 32, T. 55 N., R. 6 W., Ralls County, Mo. Elevation: 744 feet (aneroid). 150 feet from No. 1 well. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Poor set of samples above 580 feet; for this part of section see log of No. 1 well.		
Ordovician system: (Canadian system of E. O. Ulrich) Cotter formation: Dolomite, gray to tan, finely crystalline, contains oolitic chert.....	175	755
Jefferson City formation: Dolomite, brown to gray, cherty, contains some sand..	220	975
Roubidoux formation: Dolomite and sandstone, very cherty.....	120	1095
(Ozarkian system of E. O. Ulrich) Gasconade and Van Buren formations: Dolomite, no sand, very cherty.....	195	1290
Gunter member: Dolomite, non cherty, some sand.....	50	1340
Cambrian system: (Ozarkian system of E. O. Ulrich) Eminence formation: Dolomite, gray some chert, little sand.....	163	1503 Total depth

Correlations and descriptions are based on a poor set of samples.

Log of Pearl Sims well. Location: SE. 1/4 SW. 1/4 SW. 1/4 sec. 3, T. 56 N., R. 4 W., Ralls County, Mo. Elevation: 772 feet (aneroid). Completed 1931. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	73	73
Limestone.....	20	93
Shale.....	114	207
Limestone.....	44	251
Shale.....	174	415
Limestone.....	265	680
"St. Peter sandstone".....	34	714
		Total depth

(Log by driller from memory. Top of Hannibal shale at 93 feet.)

RALLS COUNTY—Continued.

Log of Ernest Christ well. Location: SE. 1/4 NE. 1/4 SW. 1/4 sec. 23, T. 56 N., R. 4 W., Ralls County, Mo. Elevation: 779 feet (aneroid). Completed 1931. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	40	40
Limestone.....	69	109
Shale.....	90	199
Limestone.....	46	245
Shale.....	32	277
Limestone.....	135	412
Sandstone.....	3	415
Limestone.....	215	630
		Total depth

(Log by driller from memory. Top of Hannibal shale at 109 feet.)

Log of R. L. Tomkins well. Location: NE. 1/4 SW. 1/4 NE. 1/4 sec. 31, T. 56 N., R. 4 W., Ralls County, Mo. Elevation: 616 feet (aneroid). Completed 1927. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Limestone.....	194	194
Sandstone.....	6	200
		Total depth

(Sandstone probably is St. Peter.)

Log of Henry Ta bert well. Location: SW. 1/4 sec. 6, T. 56 N., R. 5 W., Ralls County, Mo. Completed 1937. Well No. (10), Pl. I.

	Thickness, Ft.	Depth, Ft.
Dirt.....	22	22
Limestone.....	80	102
Shale.....	70	172
No log.....	325	497
Sandstone.....	23	520
		Total depth

Well bottomed in St. Peter sandstone.

RALLS COUNTY—Continued.

Log of Dr. J. W. Opp well. Location: NW. 1/4 NE. 1/4 NE. 1/4 sec 14, T. 56 N., R. 5 W., Ralls County, Mo. Elevation: 691 feet (aneroid). Completed 1937. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Recent and Pleistocene series:		
Clay, brown, sandy.....	4	4
Clay, yellow, sandy.....	36	40
Mississippian system:		
Kinderhook group:		
Grassy Creek formation:		
Shale, gray-blue.....	25	65
Devonian system:		
Dolomite, gray, sucrose.....	35	100
Limestone, dark gray, dense.....	25	125
Limestone, white, finely crystalline to dense.....	10	135
Sand, white, medium, rounded and frosted.....	20	155
Limestone, white, lithographic; some rounded and frosted sand.....	4	159
		Total depth

(Description and correlation based on a study of samples of cuttings.)

Log of Robert Scyoc well. Location: SE. 1/4 SE. 1/4 NE. 1/4 sec. 19, T. 56 N., R. 5 W., Ralls County, Mo. Elevation: 669 feet (aneroid). Completed 1930. Well No. (12), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil.....	8	8
Sandstone.....	12	20
Limestone.....	230	250
Sandstone.....	21	271
		Total depth

(Sandstone from 8 to 20 feet is Devonian.)

Log of Homer Glascock well Location: SW. 1/4 NW. 1/4 NE. 1/4 sec. 2, T. 56 N., R. 6 W., Ralls County, Mo. Elevation: 732 feet (aneroid). Well No. (13), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	510	510
Sandstone.....	25	535
		Total depth

(Sandstone probably is St. Peter.)

RALLS COUNTY—Continued.

Log of Mutual Benefit Life Insurance Company's W. F. Lehenbauer No. 1 well. Location: SW. 1/4 NE. 1/4 SE. 1/4 sec. 6, T. 56 N., R. 6 W., Ralls County, Mo. Elevation: 715 feet (aneroid). Completed 1938. Well No. (14), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	55	55
Mississippian system:		
Kinderhook group:		
Grassy Creek formation:		
Shale, gray.....	5	60
Devonian system:		
Callaway formation:		
Dolomite, gray-tan, sucrose, slightly sandy.....	28	88
Cooper formation:		
Limestone, white, finely crystalline.....	8	96
Limestone, gray, dense.....	8	104
Limestone, gray, dense, cherty.....	12	116
Limestone, dark gray-tan, dense.....	24	140
Limestone, tan, lithographic.....	20	160
Limestone, tan, lithographic, some chert.....	8	168
Limestone, tan, lithographic with some sand and green shale.....	8	176
Limestone, white, dense, with sand and green shale...	4	180
Ordovician system(?):		
Kimmswick formation(?):		
Limestone, white, finely crystalline to dense with sand and green shale.....	8	188
Limestone, white, finely crystalline to dense.....	56	244
Limestone, white, finely crystalline with crystals of brown dolomite.....	4	248
		Total depth

(Descriptions and correlation are based on a study of samples of cuttings.)

Log of Atlas Portland Cement Company's No. 1 Jones. Location: NE. 1/4 NE. 1/4 sec. 28, T. 55 N., R. 4 W., Ralls County, Mo. Elevation: 500 feet (estimated). Well No. (15), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	15	15
Ordovician system:		
Joachim formation:		
Dolomite, dense, gray, sandy.....	35	50
St. Peter formation:		
Sandstone, white, rounded and frosted grains.....	95	145
Everton formation:		
Dolomite, gray, with some green shale.....	45	190
(Canadian system of E. O. Ulrich):		
Cotter formation:		
Dolomite, some chert and a little sand. Chert is oolitic...	140	330
Jefferson City formation:		
Dolomite, cherty with some sand.....	225	555
Roubidoux formation:		
Dolomite, very sandy and cherty.....	120	675

RALLS COUNTY—Log of Atlas Portland Cement Company's No. 1 Jones—Continued.

	Thickness, Ft.	Depth, Ft.
(Ozarkian system of E. O. Ulrich):		
Gasconade and Van Buren formations:		
Dolomite, gray crystalline very cherty.....	225	900
Gunter member:		
Dolomite, sandy.....	55	955
Cambrian system:		
Eminence formation (Ozarkian system of E. O. Ulrich):		
Dolomite, gray crystalline, cherty.....	120	1075
Derby-Doe Run formation:		
Dolomite, very pure.....	235	1310
Davis formation:		
Dolomite, sandy, shaly and glauconite in lower 100 feet....	300	1610
Bonne Terre formation:		
Dolomite, slightly sandy.....	110	1720
Dolomite, very sandy.....	125	1845
La Motte formation:		
Sandstone, white in upper portion, pink in lower portion....	330	2175
Arkose, weathered granite.....	10	2185
Pre-Cambrian:		
Granite, red, contains much magnetite.....	20	2205
		Total depth

Correlation and descriptions are based on a study of samples.

Log of Albert Rowland (formerly R. M. Spalding) well. Location SW. 1/4 NW. 1/4 SW. 1/4 sec. 25, T. 56 N., R. 6 W., at Spalding, Ralls County, Mo. Elevation: 560 feet (estimated). Completed 1823. Well No. (16), Pl. I.

	Thickness, Ft.	Depth, Ft.
No record.....	300	300
Soft sandstone.....	30	330
		Total depth

Sandstone probably is St. Peter.

RANDOLPH COUNTY.

Log of C. L. Carpenter well on old Darby farm. Location: NW. 1/4 SW. 1/4 sec. 18, T. 55 N., R. 13 W., Randolph County, Mo. Elevation: 843 feet (aneroid). Completed February, 1938. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
No samples.....	45	45
Pleistocene series:		
Polished sand grains, igneous chips.....	7	52
Pennsylvanian series:		
Cherokee group:		
Limestone, gray, dense.....	3	55
Shale, black.....	5	60
Shale, black, some coal.....	5	65

RANDOLPH COUNTY—Log of C. L. Carpenter well on old Darby farm—Continued.

	Thickness, Ft.	Depth, Ft.
Limestone, dolomitic, gray, dense.....	5	70
Shale, black, some coal (Bevier).....	5	75
Limestone, dense, gray (Ardmore).....	10	85
Shale, gray.....	10	95
No sample.....	5	100
Shale, black.....	10	110
Shale, black, some coal (Lower Ardmore).....	5	115
Shale, sandy, gray.....	5	120
Limestone, light gray, finely crystalline.....	5	125
Shale, sandy.....	5	130
Shale, gray.....	5	135
Shale, gray, some coal.....	5	140
Shale, gray.....	10	150
Mississippian system:		
Osage group:		
Warsaw formation:		
Limestone, crystalline, very fossiliferous, contains red chert.....	10	160
Dolomite, gray, finely crystalline, contains red chert, fossiliferous.....	10	170
Limestone, gray, crystalline, very fossiliferous, con- tains red chert.....	12	182
Dolomite, gray, finely crystalline, somewhat cherty...	32	214
Burlington-Keokuk formations:		
Limestone, brown, finely crystalline, white chert.....	36	250
Limestone, white, crystalline, cherty, fossiliferous....	66	316
Limestone, white dolomitic and cherty.....	12	328
		Total depth

Correlation and descriptions based upon a study of an excellent sample set.

SCHUYLER COUNTY.

Log of Albert Bittner's Fee No. 1. Location: SW. 1/4 SE. 1/4 sec. 19, T. 65 N.,
R. 15 W., Schuyler County, Mo. Elevation: 987 feet. Completed 1910-11.
Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Clay.....	165	165
Pennsylvanian system:		
Shale, gray.....	80	245
Coal.....	5	250
Fire clay.....	5	255
Shale and sandstone.....	70	325
		Total depth

SCHUYLER COUNTY—Continued.

Log of Queen City (city well.) Location: E. side of square, sec. 27, T. 65 N., R. 15 W., Schuyler County, Mo. Elevation: About 1000 feet. Completed 1898. Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series and Pennsylvanian system:		
Drift.....	260	260
White sand (water).....	25	285
Hard rock.....	2	287
		Total depth

Log of W. A. Pruner's Whitlock No. 1. Location: NE. 1/4 SE. 1/4 sec. 29, T. 66 N., R. 14 W., Schuyler County, Mo. Elevation: 957 feet (aneroid). Completed 1898. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Drift clay and pebbles.....	245	245
Drift sand.....	10	255
Pennsylvanian system:		
Shale.....	5	260
		Total depth

(Measured depth of 210 in 1934; lower 50 feet filled with sand. Fine, gray, "ashy" sand.)

Log of Harry Hardin's Fee No. 1. Location: About sec. 33, T. 66 N., R. 14 W., Schuyler County, Mo. Completed 1898. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	10	10
Bluish white clay.....	10	20
Blue clay.....	100	120
Pennsylvanian system:		
Shale.....	60	180
Soft limestone and soapstone.....	80	260
		Total depth

SCHUYLER COUNTY—Continued.

Log of Arthur Davis Fee No. 1. Location: SW. 1/4 sec. 4, T. 66 N., R. 15 W., Schuyler County, Mo. Completed 1897. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Soil and yellow clay.....	10	10
Blue clay.....	140	150
Sand (some water).....	8	158
Blue clay.....	52	210
Coarse sand (water).....	10	220
		Total depth

Log of Consolidated School District, Lancaster School No. 1. Location: SE. 1/4 SW. 1/4 sec. 24, T. 66 N., R. 15 W., Schuyler County, Mo. Elevation: 944 feet. Completed September 22, 1934. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Fill material, yellow, soft (from cistern dug near location).....		4 1/2
Clay, yellow, soft (contains a few pebbles).....	24 1/2	29
Clay with thin sand seams, yellow, soft (white sand in very thin seams. Little water).....	1	30
Clay, yellow, soft (same as 4 1/2-29).....	19	49
Clay, black, soft (probably coal and shale in drift).....	3	52
Clay, yellow to gray, soft (gradual change from yellow to gray).....	13	65
Clay, gray, soft (contains few pebbles).....	82	147
Clay and gravel, gray, soft (drill hit harder at 147' indicating harder clay).....	3	150
Clay, gray, soft.....	15	165
Clay and gravel, gray, soft (gradual increase in gravel).....	5	170
Clay and gravel, gray, soft.....	12	182
Fine gravel, gray, soft (started casing at 182. (No water).....	5	187
Clay, gray, soft.....	25 1/2	212 1/2
Coarse sand, gray, soft (bailing test 4 1/2 gallons per minute)....	4 1/2	217
Fine sand, gray, soft (125' of water in hole over night. S. W. L. 94').....	2	219
Sand and clay, gray, soft (sampled water at 227 feet).....	26	245
Clay, brownish gray, soft (casing was driven from 205 to 227. Believe much sand and gravel mixed with lower samples this way).....	7	252
S. W. L. at 247' after standing over night 9 22 34, 100'.		
Clay and gravel, gray, soft.....	3	255
Pennsylvanian series:		
Shale, gray, tough.....	2	257
Total depth.....		257 in shale.

Bailing Test: Hole was bailed dry, let stand 15 minutes. Water raised 37 feet. Bailed dry again. Bailed out 162 gals. 26 minutes elapsed between end of first bailing and end of second bailing. 6 gals. water per minute S. W. L. 100'. Sampled water during test.

SCHUYLER COUNTY—Continued.

Log of well on Schuyler County farm. Location: sec. 23 (?), T. 66 N., R. 15 W., Schuyler County, Mo. Completed 1904. Well No. (7) Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Soil.....	3	3
Yellow clay with pockets of sand and gravel.....	22	25
Blue clay.....	216	241
		Total depth

Log of W. P. Hall's Fee No. 1. Location: N. 1/2 sec. 23 (?), T. 66 N., R. 15 W., Schuyler County, Mo. Completed 1905. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow clay.....	25	25
Blue clay.....	335	360
Pennsylvanian system:		
Black shale or coal.....	1	361
		Total depth

(Water came in at base of blue clay).

SCOTLAND COUNTY.

Log of the Midland Oil and Gas Company's A. J. Ammons No. 1 well. Location: NW. 1/4 SW. 1/4 SE. 1/4 sec. 10, T. 64N., R. 10W., Scotland County, Mo. Elevation: 671 feet (aneroid). Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Black soil.....	12	12
Sand and gravel.....	20	32
Dark gravel, water-bearing.....	20	52
Blue clay.....	18	70
White sand.....	10	80
Blackjack gumbo.....	65	145
Sand, water-bearing.....	15	160
Limestone, hard, yellowish.....	20	180
Sand.....	36	216
Limestone, hard.....	10	226
Blue shale.....	10	236
Limestone, hard.....	13	249
Sandstone, water-bearing.....	35	284
Shale, soft, pyrite.....	29	313
Sandstone, light color.....	3	316
Shale.....	5	321
Hard blue limestone.....	79	400
Flinty limestone.....	50	450
Sandstone.....	7	457

SCOTLAND CO.—Log of the Midland Oil & Gas Co.'s A. J. Ammons No. 1 well—Cont.

	Thickness, Ft.	Depth, Ft.
Flinty limestone.....	56	513
Shale.....	15	528
Limestone.....	25	553
Shale.....	220	773
Limestone.....	35	808
Shale.....	70	878
Limestone.....	39	917
Fossil limestone.....	105	1022
Sandstone, water.....	7	1029
Fossil limestone.....	71	1100
White sugary sandstone.....	73	1173
Shale.....	5	1178
Sandstone.....	18	1196
Limestone.....	42	1238
		Total depth

(Top of "Mississippi lime" probably is at 160 feet, with base of "Mississippi lime" at 553 feet. Sandstone from 1100 to 1196 may be the St. Peter-Everton formations.)

Log of Adam Fehr No. 1. Location: SE. 1/4 sec. 16, T. 64 N., R. 10 W., Scotland County, Mo. Elevation: 757 feet (aneroid). Completed 1906. Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soil and clay.....	28	28
Shale.....	20	48
"Black Jack".....	60	108
Sand and gravel.....	80	188
Shale.....	20	208
Limestone.....	97	305
Shale.....	11	316
Limestone.....	22	338
Limestone.....	14	352
White limestone.....	60	412
Reddish white limestone.....	40	452
Sandy shale.....	3	455
Sandstone.....	12	467
Limestone.....	70	537
		Total depth

SCOTLAND COUNTY—Continued.

Log of Memphis Coal Company's Struble D.D.H. Location: NE. 1/4 NW. 1/4 SW. 1/4 sec. 5, T. 65 N., R. 11 W., Scotland County, Mo. Elevation: 800 feet (estimated). Completed 1900. Depths given to nearest foot. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Boulder drift.....	18	18
Glacial drift.....	216	234
Blue clay shale.....	1	235
Sandstone.....	1	236
Water-bearing sand shale.....	5	241
Sandstone.....	1	242
Black shale and coal.....	1	243
White clay shale.....	3	246
Black shale.....	3	249
Fossil shale.....	1	250
Blue sand shale.....	21	271
Gray sand shale.....	4	275
Limestone.....	17	292
		Total depth

(Top of Mississippian may be at 275 feet.)

Log of Memphis Coal Company's Sigler D.D.H. Location: NW. 1/4 sec. 6, T. 65 N., R. 11 W., Scotland County, Mo. Elevation: 780 feet (estimated). Completed 1887. (Depths given to nearest foot). Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	158	158
Shale, gray, sandy.....	8	166
Sandstone.....	1	167
Rock, hard, ferruginous.....	2	169
Shale, gray.....	9	178
Shale, dark blue.....	7	185
Shale, black, carbonaceous with coal streaks.....	3	188
Shale, gray.....	6	194
Shale, blue, sandy.....	8	202
Shale, gray.....	7	209
Shale, dark.....	3	212
Rock (limestone).....	1	213
Shale, blue.....	9	222
Shale, gray, sandy below.....	14	236
Shale, green and blue, sandy.....	18	254
Shale, with calcareous concretions, sandy.....	7	261
Sandstone.....	8	269
(No record).....	5	274
Sandstone, dark, blue shale partings.....	11	285
Shale, gray, sandy.....	2	287
Limestone, gray.....	4	291
Sandstone, hard.....	11	302
Limestone.....	7	309
		Total depth

SCOTLAND COUNTY—Continued.

Log of City of Memphis well. Location: NW. 1/4 sec. 7, T. 65 N., R. 11 W., Scotland County, Mo. Elevation: 798 feet (aneroid). Completed 1914. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Soll.		
Yellow clay.	100	100
Blue clay.	110	210
Quicksand (water).	3	213
Soft formation, like clay.	13	226
Dark brown sand rock, some water.	107	333
Hard gray limestone.	47	380
Hard grayish sandstone (water).	10	390
Hard gray limestone.	30	420
Soft, blue shale.	30	450
Hard, gray, limestone.	250	700
Shale, bluish.	150	850
Hard, gray limestone.	350	1200
		Total depth

(The base of the "Mississippi lime" is at 700 feet.)

Log of Memphis Coal Company's No. 3 Witty D.D.H. Location: NW. 1/4 sec. 1, T. 65 N., R. 12 W., Scotland County, Mo. Elevation: 700 feet (estimated). Completed 1901. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.	18	18
Sand.	22	40
Drift.	36	76
Blue clay shale.	4	80
White clay shale.	5	85
Sand shale.	6	91
Black shale.	3	94
White clay shale.	2	96
Blue clay shale.	7	103
Coal.	1	104
Sand shale.	1	105
White clay shale.	8	113
Gray shale.	5	118
Blue shale.	6	124
Limestone, fossiliferous.	1	125
Blue shale.	2	127
Coal.	1	128
White clay shale.	3	131
Gray sand shale.	4	135
Blue clay shale.	5	140
Coal.	1	141
White clay shale.	3	144
Blue clay shale.	12	156
Coal.	1	157
White clay shale.	2	159
Blue clay shale.	2	161
Limestone, fossiliferous.	1	162

SCOTLAND COUNTY—Log of Memphis Coal Company's No. 3 Witty D.D.H.—Cont.

	Thickness, Ft.	Depth, Ft.
Black shale and coal.....	1	163
White clay shale.....	4	167
Gray sandstone.....	3	170
Limestone.....	3	173
		Total depth

Depths given to nearest foot.

Log of Memphis Coal Company's No. 1 Witty D.D.H. Location: NW. cor. NE. 1/4 NE. 1/4 sec. 2, T. 65 N., R. 12 W., Scotland County, Mo. Elevation: 720 feet (estimated). Completed 1901. Well No. (7), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	67	67
Sandstone.....	17	84
Shale, black.....	6	90
Coal.....	1	91
Shale, white.....	1	92
Shale, black.....	9	101
Limestone, fossiliferous.....	1	102
Shale, black.....	8	110
Coal.....	1	111
Shale, white.....	4	115
Shale, sandy gray.....	9	124
Shale, black.....	4	128
Shale, white, sandy.....	6	134
Sandstone.....	13	147
Shale, black.....	3	150
Limestone.....	3	153
		Total depth

Depths given to nearest foot.

Log of Memphis Coal Company's No. 2 West D.D.H. Location: SE. 1/4 NE. 1/4 sec. 12, T. 65 N., R. 12 W., Scotland County, Mo. Elevation: 700 feet (estimated). Completed 1900. Well No. (8), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	26	26
Sand.....	9	35
Blue drift.....	85	120
Blue and brown clay shale.....	6	126
Coal.....	1	127
White clay shale.....	3	130
Gray clay shale.....	4	134
Dark blue shale.....	15	149
White clay shale.....	4	153
Rock.....	2	155
Blue sand shale.....	11	166
		Total depth

Depths to nearest foot.

SCOTLAND COUNTY—Continued.

Log of Memphis Coal Company's No. 1 Leach. Location: SE. cor. sec. 36, T. 66 N., R. 12 W., Scotland County, Mo. Elevation: 740 feet (estimated). Completed 1901. Well No. (9), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	164	164
Shale, white and blue.....	13	177
Limestone.....	1	178
Shale and sandstone.....	24	202
Coal.....	1	203
Shale and sandstone.....	28	231
Limestone.....	4	235
		Total depth

Depths given to nearest foot.

SHELBY COUNTY.

Log of Hilleary Brothers well. Location: NE. 1/4 sec. 12, T. 56 N., R. 9 W., Shelby County, Mo. Elevation: 740 feet (estimated). Completed December, 1937. Well No. (1), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Yellow dirt.....	50	50
Blue dirt.....	20	70
Pennsylvanian system (?):		
Cherokee group (?):		
Soapstone.....	20	90
Mississippian system:		
Meramec group:		
Warsaw formation:		
Limestone and flint.....	25	115
Limy shale and chert.....	15	130
Osage group:		
Keokuk-Burlington formation:		
Limestone and flint.....	5	135
		Total depth

Log of Clarence Oil and Gas Company's No. 1 well. Location: SE. 1/4 SW. 1/4 NE. 1/4 sec. 17, T. 57 N., R. 12 W., at Clarence, Shelby County Mo. Elevation: 824 feet (aneroid). Completed 1910. Well No. (2), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift clay.....	90	90
No record.....	730	820
Coarse white sandstone.....	20	840
		Total depth

(Sandstone from 820 to 840 feet is probably the St. Peter. Reported fresh water at 200 feet, strong flow of brackish water at 450 feet, and abundance of sulpho-saline water at 825 feet.)

SHELBY COUNTY—Continued.

Log of Moss Brothers well No. 1. Location: SW. 1/4 NW. 1/4 sec. 25, T. 58 N., R. 10 W., Shelby County, Mo. Elevation: 766 feet (aneroid). Completed 1900. Well No. (3), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	80	80
Sandstone.....	60	140
Limestone and chert.....	50	190
Brown limestone.....	47	237
Shale.....	200	437
White limestone.....	185	622
Sandstone.....	8	630
		Total depth

Base of "Mississippi lime" at 237 feet, top of Devonian at 437 feet.

Log of E. A. Callison well No. 1. Location: SE. 1/4 sec. 32, T. 58 N., R. 12 W., Shelby County, Mo. Completed 1911. Well No. (4), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift, clay.....	140	140
Limestone and flint to bottom.....	528	668
		Total depth

Poor log, given from memory.

Log of J. H. Moore well No. 1. Location: NW. 1/4 SW. 1/4 sec. 10, T. 59 N., R. 10 W., Shelby County, Mo. Elevation: 766 feet (aneroid). Completed 1907. Well No. (5), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Clay, gray to buff.....	108	108
Mississippian system:		
Osage group:		
Burlington-Keokuk formations:		
Limestone, gray, fine-grained, cherty.....	32	140
Limestone, gray, less chert.....	70	210
Hannibal formation:		
Shale, gray.....	116	316
Louisiana formation:		
Limestone, brown, dense.....	8	324
Grassy Creek formation:		
Shale, gray-green.....	51	375
Devonian system:		
Callaway formation:		
Limestone, tan, lithographic.....	124	499
Limestone, dark gray, dense, fossiliferous.....	10	509
Limestone, gray, slightly sucrose, dolomitic.....	50	559
Limestone, tan, lithographic.....	9	568
Limestone, tan, lithographic, cherty.....	45	613
		Total depth

Correlation and descriptions from sample study.

SHELBY COUNTY—Continued.

Log of Lester Smoot well No. 1. Location: SE. cor. NW. 1/4 sec. 12, T. 59 N., R. 10 W., Shelby County, Mo. Elevation: 742 feet (aneroid). Completed 1907. Well No. (6), Pl. I.

	Thickness, Ft.	Depth, Ft.
Drift.....	16	16
Shelly flint.....	11	27
Limestone.....	68	95
Brown limestone.....	12	107
Shale.....	125	232
White limestone.....	50	282
Brown limestone.....	231	513
Coarse limestone.....	8	521

Base "Mississippi lime" at 107 feet. Top Devonian at 232 feet.

SULLIVAN COUNTY.

Log of John N. Opel's Fee No. 1. Location: Near center of W. line sec. 15, T. 61 N., R. 19 W., Sullivan County, Mo. Completed 1914. Well No. (1), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series and Pennsylvanian system:				
Yellow clay.....	55		55	
Sand (some water).....	1		56	
Blue clay.....	5		61	
Yellow clay.....	49		110	
Blue shale.....	10		120	
Sand (some water).....	2		122	
Blue shale.....	3		125	
Hard gray limestone.....		4	125	4
Shale and limestone (small quantities of water at 140, 160, 200, and 240).....	115±		240	
Red, brown shale and limestone.....	54		294	
Black slate.....	4		298	
Coal.....		5	298	5
Coarse sand and gravel (water-bearing).....	3±		301	
Blue shale.....	5		306	
Hard gray limestone.....	8		314	
Soft sandstone, brown and gray.....	20		334	
Shale and thin limestone.....	66		400	
Hard limestone (water).....	6		406	
Shale.....	15		421	
			Total	depth

SULLIVAN COUNTY—Continued.

Log of coal test on Lloyd Lambert farm. Location: NW. 1/4 NW. 1/4 sec. 26, T. 61 N., R. 20 W., Sullivan County, Mo. Well No. (2), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Dirt and clay			46	
Sand, blue, "slippery" (cased thru this)	3		49	
Pennsylvanian system:				
Soapstone, blue	6		55	
Coal		3	55	3
Soapstone, blue	45	3	100	3
Shale, red and hard		3	100	6
Soapstone, blue	21		121	6
Limestone	2	6	124	
Slate		4	124	4
Coal		7	124	11
Soapstone, blue	9		133	11
Limestone	2	6	136	5
Slate		4	136	9
Coal	1		137	9
Soapstone, blue	21	8	159	5
Limestone	2	6	161	11
Soapstone, blue		4	162	3
Slate	1	6	163	9
Coal	1	4	165	1
Mud, soft, blue		6	165	7
Coal	3	2	168	9
Fire clay, white	1	2	169	11
Limestone (bed rock) at			169	11
			Total	depth

Log of coal test on Guy Head Farm. Location: SE. 1/4 SE. 1/4 sec. 28, T. 61 N., R. 20 W., Sullivan County, Mo. Well No. (3), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Dirt and clay			28	6
Pennsylvanian system:				
Sandstone (water from crack S. W. L. 14 feet strong)	1	4	29	10
Slate	2	6	32	4
Soapstone, black	2	6	34	10
Limestone, blue	3		37	10
Soapstone, blue	22	2	60	
Limestone	1	4	61	4
Soapstone, blue	37	8	99	
Coal	1	2	100	2
Soapstone, blue	12	10	113	
Coal		8	113	8
Soapstone, blue	3	4	117	
Limestone	2	6	119	6
Soapstone, blue	7		126	6
Limestone	1	4	127	10
Soapstone, blue	1	4	129	2

SULLIVAN COUNTY—Log of coal test on Guy Head Farm—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Limestone.....	4	10	134	
Soapstone, blue.....	10		144	
Slate.....	2	6	146	6
Limestone.....		6	147	
Soapstone, black and blue.....	2		149	
Coal.....	2	2	151	2
Soapstone.....	5	4	156	6
Sandstone, white.....	2	8	159	2
Limestone, dark blue, hard.....	3	4	162	6
Mud, blue.....		1	162	7
Limestone as above.....	1	4	163	11
Soapstone, blue.....		8	164	7
Coal.....		9	165	4
Soapstone, blue.....	2	6	167	10
Total depth in soapstone.....			167	10

Log of Milan Land and Coal Company's coal test. Location: NW. 1/4 SW. 1/4 sec. 2, T. 62 N., R. 20 W., Sullivan County, Mo. Elevation: 834 feet. Completed 1891. Well No. (5), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Gumbo.....	15		15	
Clay.....	12		27	
Sand and gravel.....	45		72	
Pennsylvanian system:				
Henrietta group:				
Blue clay.....	5		77	
Soapstone.....	2		79	
Black slate.....	2		81	
Poor coal.....	1	4	82	4
Fire clay.....	1		83	4
Soapstone.....	8		91	4
Hard rock.....	3	1	94	5
Soapstone.....	16	10	111	3
Black clay and soapstone.....	8		119	3
Hard rock.....		10	120	1
Slate and coal.....	2	6	122	7
Soapstone.....	6	4	128	11
Shale and clay.....	10		138	11
Rock.....		8	139	7
Cherokee group:				
Soapstone.....	4	6	144	1
Soft shale.....	6		150	1
Shale rock.....	2	6	152	7
Shale.....	15	8	168	3
Shale rock.....		7	168	10
Shale.....	15	5	184	3
Soapstone.....	5	10	190	1
Hard rock.....		10	190	11
Coal.....	3	6	194	5
Fire clay.....	1	4	195	9
Clay and shale.....		9	196	6*
			Total	depth

*Base of Cherokee not reached.

SULLIVAN COUNTY—Continued.

Log of W. R. Morgan's coal test one-half mile southeast of Milan. Location: SW. 1/4 SW. 1/4 (?) sec. 2, T. 62 N., R. 20 W., Sullivan County, Mo. Well No. (6), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Gumbo.....	10		10	
Sand.....	6		16	
Blue clay.....	27		43	
Black sand.....	2		45	
Pennsylvanian system:				
Pleasanton group:				
Shale.....	8	4	53	4
Black slate.....		6	53	10
Light blue shale.....	13		66	10
Brown shale.....	1	4	68	2
Gray shale.....	5		73	2
Red and blue shale.....	3		76	2
Soapstone.....	2		78	2
Gray shale.....	3	11	82	1
Henrietta group:				
Limestone.....	2	9	84	10
Soapstone.....	3	3	88	1
Limestone.....	4	5	92	6
Soapstone.....	1	2	93	8
Rock.....		10	94	6
Soapstone.....	1	8	96	2
Rock.....	1	9	97	11
Soapstone.....	1		98	11
Shale rock.....	5	2	104	1
Blue shale.....	1		105	1
Soapstone.....	2	3	107	4
Limestone.....	2		109	4
Shale.....		6	109	10
Hard rock.....	1		110	10
Light shale.....	2		112	10
Black slate.....	2		114	10
Soapstone.....	3		117	10
Shale and rock mixed.....	3		120	10
Hard flinty rock.....	1	9	122	7
Blue slate.....	15		137	7
Dark shale.....	4	1	141	8
Rock.....		5	142	2
Black shale.....	3	2	145	3
Rock.....		5	145	8
Dark shale.....	2		147	8
Light shale.....	5		152	8
Rock.....	1		153	8
Light blue shale.....	1	4	155	
Hard rock.....	1	9	156	9
Blue shale hard.....	1	6	158	3
Dark shale.....	2		160	3
Hard, light blue shale.....	10	5	170	8
Rock.....		8	171	4
Shale.....	1		172	4
Cherokee group:				
Soapstone.....	6		178	4
Coal and slate.....		8	179	
Green shale.....	3		182	
Shale.....	33	6	215	6
Coal.....	3	3	218	9
Bench rock.....		6	219	3

SULLIVAN COUNTY—Log of W. R. Morgan's coal test Southeast of Milan—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Black band.....		6	219	9
Coal.....		7	220	4
Fire clay.....	2		222	4*
			Total	depth

*Base of Cherokee not reached.

Log of Joe Dixon's coal test on Phoenix Mutual Life Insurance Company's (Al Brown) farm. Serial No. 2. Location: Near NE. cor. SW. 1/4 SW. 1/4 sec. 11, T. 62 N., R. 20 W., Sullivan County, Mo. Completed 1938. Well No. (8), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene and Recent series:				
Top soil.....	20		20	
Sand.....	2		22	
Blue drift.....	6	8	28	8
Sand and gravel.....	7		35	8
Pennsylvanian system:				
Sand rock.....		7	36	3
Gravel and sand.....		4½	36	7½
Gray rock.....		6	37	2½
Light clay.....	3	7½	40	10
Cloudy rock.....	1	6	42	4
Clay.....		6	42	10
Light rock.....	1	6	44	4
Blue shale.....	5	1	49	5
Gray shale.....	1		50	5
Lime rock.....	4	2½	54	7½
Soapstone.....	17	4	71	11½
Cap rock.....		9	72	8½
Slate.....	1		73	8½
Coal.....	1	4	75	½
Clay.....		7	75	7½
Sand rock.....	1	2	76	9½
Light clay.....	6	10	83	7½
Rock.....		3	83	10½
Dark clay.....		9	84	7½
Hard rock.....	2		86	7½
Soft top clod.....		6	87	1½
Slate (Should have had trace of coal at this point. Very odd.).....	2	½	89	2
Shale.....	3	2	92	4
Soapstone.....	10		102	4
Hard rock.....	3	10	106	2
Red shale.....	5	1	111	3
Blue shale.....	2	6	113	9
Gray rock.....	1		114	9
Shale.....	1	1	115	10
Rock.....	1		116	10
Shale.....	6	1	122	11
Soapstone.....	12	6	135	5
Shale.....	17	7	153	

SULLIVAN COUNTY—Log of Joe Dixon's coal test—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Coal.....	1	8	154	8
Clay band.....		2	154	10
Bat or bone.....		7	155	5
Coal.....	1	5	156	10
Clay.....	2	9	159	7
Gray rock.....	4	5	164	
Clay.....	2		166	
Lime rock.....		8	166	8
			Total	depth

Total amount of rock in this hole—22' 10 1/2".

Log of Joe Dixon's coal test on Mrs. Hulda Swearingen farm. Serial No. 1. Location: NW. cor. NE. 1/4 SE. 1/4 sec. 15, T. 62 N., R. 20 W., Sullivan County, Mo. Completed July 28, 1938. Well No. (9), Pl. I.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Pleistocene series:				
Top soil and gumbo.....	12		12	
Blue clay drift.....	38		50	
Gravel.....	1		51*	
Pennsylvanian system:				
Henrietta group:				
Gray shale.....	3		54	
Gravel.....		6	54	6
Rock.....	2		56	6
Gravel.....		6	57	
Rock.....	1		58	
Soapstone.....	3		61	
Rock.....	2	8 1/2	63	8 1/2
Gray shale.....	2		65	8 1/2
Rock.....		2 1/2	65	11
Blue shale seam.....		1 1/2	66	1
Rock.....	2	1 1/2	68	2 1/2
Blue shale.....		6	68	8 1/2
Sand rock.....	2	6	71	2 1/2
Soapstone.....		7	71	9 1/2
Clay seam.....		2 1/2	72	
Rock.....		7 1/2	72	7 1/2
Brown shale.....	1		73	7 1/2
Blue shale.....	3		76	7 1/2
Rock.....	4	1	80	8 1/2
Blue shale.....	1	4	82	1/2
Soapstone.....	1	4	83	4 1/2
Blue shale.....	2	5	85	9 1/2
Light shale.....	2	3	88	1/2
Rock.....	1	9	89	9 1/2
Dirty seam.....		8	90	5 1/2
Rock.....	3	1/2	93	6
Clay seam.....		10	94	4
Rock.....	3	9	98	1

SULLIVAN COUNTY—Log of Joe Dixon's coal test—Continued.

	Thickness.		Depth.	
	Ft.	In.	Ft.	In.
Soapstone.....	13		111	1
Cap rock.....		7 ½	111	8 ½
Slate.....	2		113	8 ½
Coal (Summit).....		10	114	6 ½
Blue clay.....	7		121	6 ½
Gray rock.....	2	6	123	½
Gray shale.....	2		125	½
Blue shale.....	2	6	127	6 ½
Gray shale.....	2		129	6 ½
Rock.....	2	6	132	½
Cherokee group:				
Light shale.....	7		139	½
Soapstone.....	5		144	½
Dark shale.....	12		156	½
Rock.....		6	156	6 ½
Blue shale.....	28		184	6 ½
Cap rock.....		11	185	5 ½
Coal (Bevier).....	2	7	188	½
Clay.....	2		190	** ½
			Total	depth

*Contact in doubt.

**Base of Cherokee not reached.

Log of Mrs. Bertha Roach Fee No. 1. Location: sec. 27, T. 62 N., R. 22 W., Sullivan County, Mo. Completed October, 1936. Well No. (10), P. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Surface.....	10	10
Yellow mud, sandy.....	40	50
Blue mud, sandy.....	30	80
Gravel and sand—water.....	25	105
Pennsylvanian system:		
Gray shale.....	10	115
Dark shale.....	5	120
Light shale.....	15	135
Gray shale.....	35	170
Black slate.....	1	171
Gray shale.....	20	191
Dark shale.....	3	194
Light shale.....	11	205
Lime shell.....	2	207
Black shale.....	7	214
Lime.....	3	217
Black slate.....	4	221
Gray shale.....	4	225
Light shale.....	22	247
Blue shale soft.....	2	249
Gray shale, sandy.....	8	257
Red bed.....	2	259
Lime.....	1	260
Gray shale.....	3	263
Gray lime.....	1	264
Gray shale.....	6	270

SULLIVAN COUNTY—Log of Mrs. Bertha Roach Fee No. 1—Continued.

	Thickness, Ft.	Depth, Ft.
Brown shale.....	10	280
Light shale.....	5	285
Gray shale, sandy.....	25	310
Black shale.....	7	317
Light shale.....	3	320
Gray shale.....	21	341
Lime.....	1	342
Blue shale.....	8	350
Black shale.....	10	360
Lime.....	2	362
Gray sand—water.....	4	366
Lime.....	1	367
Gray sandy shale.....	8	375
Gray shale.....	10	385
Dark shale.....	5	390
Gray sandy shale.....	13	403
Sand.....	21	424
Dark shale.....	10	434
Sand.....	6	440
Lime.....	6	446
Blue shale.....	6	452
Sand.....	23	475
		Total depth

Log of Humphrey Canning Company's No. 1 Fee. Location: NE. 1/4 SW. 1/4 sec. 36, T. 62 N., R. 22 W., Sullivan County, Mo. Completed 1934. Well No. (11), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series:		
Top soil.....	2	2
Sandy, brown clay.....	48	50
Loose clay, little fine sand.....	15	65
Sandy, brown clay.....	30	95
Loose, blue clay with grit.....	55	150
Loose, blue clay with fine sand.....	2	152
Loose, blue clay with little grit.....	14	166
Coarse sand full of clay-main water.....	2	168
Blue clay.....	3	171
Streaks blue clay and boulders with fine sand.....	16	187
Blue, shaley clay.....	3	190
Pennsylvanian system:		
Rock.....		190
		Total depth

SULLIVAN COUNTY—Continued.

Log of Paul Purdy Fee No. 1. Location: NE. 1/4 sec. 31, T. 64 N., R. 21 W., Sullivan County, Mo. Completed 1896. Well No. (12), Pl. I.

	Thickness, Ft.	Depth, Ft.
Pleistocene series and Pennsylvanian system:		
Yellow clay	30	30
Yellow clay and sand	30	60
Yellow clay	10	70
Blue clay	120	190
Soft, light rock	4	194
Blue clay and sand	10	204
Hard limestone	10	214
Limestone and shale	101	315
Very hard, gray limestone	1	316
Brown, slaty shale	4	320
Coal	3	323
Fire clay	7	330
Hard limestone	4	334
Limestone and shale	8	342
		Total depth

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