MISSOURI
BUREAU OF GEOLOGY
AND MINES

BIENNIAL REPORT *of the*

STATE GEOLOGIST

TRANSMITTED BY THE

BOARD OF MANAGERS OF THE BUREAU
OF GEOLOGY AND MINES TO THE
FIFTY-FIFTH GENERAL
ASSEMBLY, 1929

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

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BOARD OF MANAGERS

His Excellency, Sam A. Baker, Governor of Missouri, ex-officio President of the Board, Jefferson City.
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Dr. E. M. Shepard, Springfield, Secretary and Chairman of Publications Committee.
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LETTER OF TRANSMITTAL

To the President, Sam A. Baker, and the Honorable Members of the Board of Managers of the Bureau of Geology and Mines:

Gentlemen:—I have the honor to submit herewith a brief report covering the work of the Bureau of Geology and Mines for the years 1927 and 1928.

Respectfully submitted,

H. A. BUEHLER,

State Geologist.

TABLE SHOWING INCREASE IN VALUE OF MINERAL OUTPUT DURING THE PAST 28 YEARS.

	1898.	1906.	1916.	1926.
Lead ore	$3,011,055	$10,697,582	$24,172,965	$33,121,920
Zinc	2,927,321	9,115,006	24,228,596	3,902,700
Coal	3,148,826	6,118,733	9,044,505	8,950,984
Clay and clay products	3,256,207	7,062,068	8,629,879	19,886,881
Cement	No production	3,000,000	6,333,567	12,917,342
Limestone	437,874	1,988,334	1,990,419	4,416,006
Marble	No production	No data	156,942	1,446,983
Sand and gravel	No data	1,036,378	877,634	2,980,242
Lime	297,401	916,693	956,300	2,218,943
Chats	No data	No data	433,456	382,080
Barytes	61,875	93,479	365,111	946,595
Copper	None	10,489	95,005	150,780
Mineral waters	59,341	96,545	109,814	41,955
Iron ore	123,345	158,109	116,484	532,536
Silver	No production	20,950	85,178	56,160
Miscellaneous	.....	178,170	1,384,617	328,585
Total value	$13,323,245	$40,492,536	$78,980,472	$92,280,692

Miscellaneous includes: In 1906, natural gas, sandstone, granite; in 1916, mineral paints, tripoli, granite, natural gas, petroleum, pyrite, cobalt, nickel and tungsten; in 1926, tripoli, quartz, granite and miscellaneous stone.

CHAPTER I

WORK OF THE BUREAU OF GEOLOGY AND MINES DURING 1927 AND 1928.

The work of the Bureau of Geology and Mines or Geological Survey has for its main objectives, (1) the development of the mineral resources, (2) the completion of an accurate topographic map, and (3) the development of the water powers of the State. The activities of the department therefore cover three fundamental engineering branches of the State government.

The state-wide importance and something of the rapidity of growth of the mineral industries during the past thirty years is shown by the tabulation on the opposite page. With an output valued at approximately $90,000,000 per year the importance of mining to the continued prosperity of the State is indicated, and every endeavor is made by this Bureau to increase the production of our rich mineral deposits. In this regard the Geological Survey stands in the same relation to mining, as the Department of Agriculture does to farming.

APPROPRIATIONS.

The appropriations covering the activities of this Bureau are made under three separate funds, as follows:

(1) Geology and Mining (Support)
(2) Topographic Mapping
(3) Water Power and Flood Control

There has been no increase in the funds available for this department during the past eight years, and during the past four years there has been a material decrease. Due to general over-appropriation of the anticipated revenue for the past two years, a total of $40,000 was withheld, which amount approximates one-third of the total appropriation to the Bureau. The following tabulation shows the funds requested by the Board of Managers, the amount appropriated, the amount withheld, and the amount available during the present biennium:

Fund.	Requested.	Appropriated.	Withheld.	Available.
Support	$91,300.00	$76,700.00	$25,000.00	$51,700.00
Topography	45,000.00	30,000.00	20,000.00	10,000.00
Water Power	30,000.00	20,000.00	None.	20,000.00

The amount available for each branch of the work during the past four biennial periods is shown in the tabulation below:

Biennium.	Geology and mining.	Topographic mapping.	Water power.
1921-22	$68,300.00	$30,000.00	$20,000.00
1923-24	68,300.00	30,000.00	20,000.00
1925-26	58,300.00	25,000.00	20,000.00
1927-28	51,700.00	10,000.00	20,000.00

The above figures show the vital reductions made during the past four years in both the Geology and Mining and Topographic Mapping funds. The Water Power fund is just sufficient to cover the cost of the present gaging stations and cannot be reduced without virtually discontinuing this branch of the service. During the present biennium with a reduction of $20,000 or two-thirds of the Topographic fund, this work was reduced to an absolute minimum of one topographic party and one primary traverse party during 1928. The Geology and Mining branch has during the past two bienniums reduced the permanent force by three geologists, and during the past year transferred the chemist to work in the Water Power branch, and for several months furloughed the draftsman and engineer to the State Game and Fish Department to map the State Parks. This reduction in the working force was necessary because of the lack of funds, even though the demands on the Bureau were greater than at any former period.

PERSONNEL.

Mr. W. F. Pond, assistant state geologist, resigned early in the biennial period to accept appointment as State Geologist of Tennessee. Mr. H. S. McQueen, geologist, was appointed

to the position of Assistant State Geologist. Because of the lack of funds no appointment has been made to fill the position of geologist. Only two summer field parties have been employed during the past two years.

In the Water Power branch the same number of engineers have been employed. The Federal field parties in topographic mapping have been reduced to a minimum.

The following is a roster of the full time employees and summer field parties:

GEOLOGY AND MINING.

Permanent Staff:

H. A. Buehler, State Geologist,
H. S. McQueen, Assistant State Geologist,
J. M. Thiel, Geologist, Joplin Branch,
C. O. Reinoehl, Draftsman,
H. W. Mundt, Chemist,
Jean I. McCaw, Clerk-Stenographer,
E. E. Hawkins, Janitor.

Summer Field Parties:

C. L. Dake and assistant,
Josiah Bridge and assistant.

Topographic Mapping:

F. W. Hughes and party,
C. R. Fisher and party.

Water Power and Flood Control:

H. C. Beckman, District Engineer,
V. L. Austin, Junior Engineer,
A. L. Hill, Junior Engineer.
H. G. Jones, Computer.

In addition to the above, temporary employees have been utilized for additional stenographic, janitor, and drafting work, as needed.

COOPERATION.

Cooperation was carried on during the biennial period with the following state and national bureaus:

(1) With the United States Geological Survey:
   (a) In studying the geology of the Ozark region.
   (b) In topographic mapping.
   (c) In surface water supply investigations.

(2) With the United States Bureau of Mines in collecting complete statistics covering the mineral production of the state.

(3) With the United States Census Bureau in gathering statistics covering the manufactured products derived from mineral production.

(4) With the United States Weather Bureau of St. Louis in maintaining gaging stations and reporting flood conditions on Missouri streams.

(5) With the State Board of Health in providing sanitary city water supplies and in determining bacteriological content of surface streams and springs.

(6) With the State Fair Board in maintaining a mineral and forestry exhibit at the State Fair.

(7) With the State Museum Commission in collecting and installing exhibits.

(8) With the State Park Commission in surveying State Parks.

(9) With drainage districts, corporations and cities in maintaining gaging stations for the purpose of determining run-off and water supply.

(10) With the Ceramic Engineering Department of the Missouri School of Mines and the Missouri Refractories Association in studying the clay resources and making laboratory tests.

(11) With the engineering branch of the U. S. Army in mapping dam sites along the Mississippi and Meramec rivers.

The State Geologist is also ex-officio member of the State Highway Commission, and State Museum Commission.

PUBLICATIONS.

The results of the systematic field investigations of the Bureau are published in reports and maps by which means the data collected is placed in the hands of those interested. The demand for these volumes has exhausted the edition of many of the older reports. During the present biennial period the following publications were issued:

Water Power and Flood Control Records:

This volume includes the data collected by the Water Power branch during the five preceding years and covers all earlier records collected by the Federal Geological Survey and the University Engineering Experiment Station. It is the first comprehensive report covering flow of the major streams in the state, and in view of the intense interest in the development of water power, has been in constant demand. The chapter on water analyses covering the major springs and rivers, and the chapter on springs, which gives the location, flow, and general character of all of the larger springs of the state, were printed as separates and are available to the general public who do not desire the mass of engineering data in the body of the detailed report. The map accompanying this report shows the drainage area of all the major streams, as well as the location of the larger springs of the state.

Early Mississippian Formations in Missouri:

The Mississippian series is one of the most important divisions of the geological column in the state, and various formations have been described independently in many of the older reports. At the present time the Bureau is endeavoring to make detailed studies of the major divisions of the geological column, and publish this information in a series of reports which will finally outline accurately the stratigraphy of the state. The report covering the lower formations of the Mississippian was published late in the biennial period. It is the result of preliminary field work and will be followed by more detailed reports as work is continued. The volume gives a preliminary correlation of the various formations of the Mississippian outcropping in northeast, central, southwest and southeast Missouri. It contains many fossil lists which are valuable for correlation purposes.

Potosi, Edgehill, Eminence and Cardareva Quadrangles:

Detailed geological maps covering the above quadrangles are now in press and the reports covering these areas are being prepared for early publication. These quadrangles include very important geological provinces in southeast Missouri. They show the relations of the sedimentary and igneous rocks outcropping in the region of the principal mining districts in that part of the state The maps and cross sections illustrate the very interesting dips of the sedimentary formations adjacent to the igneous rocks. Working out the detailed geology of these areas has resulted in a better knowledge of the geological succession in the Ozark region, a succession which heretofore has presented one of the most difficult problems in the stratigraphy of south Missouri.

Biennial Report:

In addition to the usual brief outline of the work of the department, the biennial report includes a summary of the mineral production and a list of the mineral producers for the years 1926 and 1927. Missouri is continually forging ahead in mineral production, and the statistics showing this progress are summarized every two years in the biennial report. There is also a brief appendix describing the dipping sedimentary formations of southeast Missouri, where these are in contact with exposed granite and porphyry knobs. This dip, which at times is as high as 15 to 20 degrees, is explained as due to original deposition, and not to injection of the igneous rocks. This is an important conclusion and has special bearing on the possibility of ore deposits in that part of the state.

In Appendix II, there is described a water sampler perfected by H. W. Mundt, chemist. Studies of flood control and water power development in the Ozark region involve the problem of determining the amount of sediment transported by the various streams. This is an important matter where such mud-laden streams as the Missouri are under consideration. All former methods of sampling apparently involved considerable error. It is believed that the Mundt machine obtains an accurate sample.

Appendix III, describes the geology of a restricted area at Perry, Ralls County. This study was made in cooperation with the Chamber of Commerce of Perry, and the results here

show a good quality of plastic fire clay and flint fire clay in an area underlain by a coal seam having a thickness of 26 inches.

FIELD INVESTIGATIONS.

Due to the restricted appropriation, no new major field investigations were started, and a number of activities already under way have not received continuous attention. The following activities include the major investigations in addition to mapping the quadrangles mentioned in the foregoing paragraphs.

Joplin Office:

The branch office at Joplin has been continued during the biennial period. Quarters are courteously furnished by the Joplin Chamber of Commerce, without charge. One member of the staff maintains his headquarters in Joplin and devotes his time principally to the mining district and the geology of the southwest part of the state. The Bureau has now ready for publication nine township maps on a scale of four inches to the mile, covering the major portion of the lead and zinc district in Jasper County. As far as possible all drill records have been collected and are on file at the office for consultation. The maps will be published as soon as funds are available.

Clay Investigations:

Due to the restriction of funds and decrease of personnel, the investigation of the geology of the clay deposits has not proceeded with the speed commensurate with the importance of the industry. One of the principal points of interest has been studied geologically, namely, the area in the vicinity of Perry, Ralls County. Under the advice of the Survey, diamond drill holes have been put down which indicate some twenty feet of good Cheltenham clay overlain by a variable thickness of coal suitable for burning purposes. This investigation has shown that there are possibilities of good clay in the east central basin in an area considerably farther north than present developments, and that this territory is worthy of much closer investigation. Tests show that a good grade of fire brick can be made by a combination of the plastic and flint fire clays found in this particular area. (See Appendix III. of this report).

Mississippi River Dam Sites:

In cooperation with the engineering department of the U. S. Army, five dam sites on the Mississippi River were investigated in detail, for the purpose of determining whether the local geology would permit of such structures for flood prevention. In each instance the geology is quite complicated, and shows faulting and structure that might prove unfavorable in such development. The investigations have shown, however, that much detailed geology should be done in the adjacent territory. The sites covered are located between the City of St. Louis and Commerce in the southeast part of the state.

Drilling Data:

Much time has been devoted to collecting cuttings from deep drill holes, and especially from those being drilled for municipal water supplies. Through cooperation with the State Board of Health, drillers are requested to send cuttings to the Geological Survey, in order that this department can determine the depth to which casing should be set in order to prevent any possibility of surface contamination. This work is of the greatest importance in assuring municipalities of a future supply of pure water. In many cases where water has not been encountered at depths considered ample by local authorities, it has been possible for the representatives of this department to point out that a good water supply would be obtained at somewhat greater depth, and by continued drilling a number of wells which would otherwise have proven failures have been brought in with an ample flow. It has also been possible to advise shooting certain wells to increase the flow to the necessary amount required. This has been done with success.

In making a study of the cuttings in order to determine the formations passed through, it has been found that by dissolving a part of the material, there remains an insoluble residue which is apparently quite characteristic for each formation, and that by a study of residues of this character it will be possible to determine with much more accuracy many of the dolomitic formations in at least the southern portion of the state, where identification in drill holes is extremely difficult. The department is now able in many areas to determine with a great deal of accuracy the depth to the principal water bearing horizons, and in conjunction with this work is preparing a map showing

the general depth of these horizons throughout the southern part of the state.

That the geology of many areas is an important factor in water supply, is indicated by a recent investigation by the department. The City of Mansfield drilled a well 1080 feet deep; after 14 months the water was down below the working barrel, and after lowering the pump to the bottom of the hole, the well was again pumped dry in a few days. The Gunter sandstone shown by the drilling was of normal thickness and in the southwest part of the state usually gives a strong, pure water supply. The action of the Mansfield well was quite out of the ordinary, and the City contemplated drilling another well within a short distance. Upon investigation by one of the assistants, it was found that there are three faults in the vicinity of the city, which fault down a block some two hundred feet, and that the original well was drilled within this downfaulted block. The underground supply was therefore restricted to this comparatively narrow block, which was sealed off by the formations on each side. The second well contemplated would have encountered the same conditions and would have been a failure if drilled. A location was designated by the geologist outside the fault blocks, which if drilled will no doubt give the normal supply of water.

TOPOGRAPHIC MAPPING.

The Fulton quadrangle in Callaway County was mapped on a twenty foot contour interval. Primary levels were run on the Mexico quadrangle, and primary traverse carried from Mexico to the Mississippi River. Additional traverse covering a considerable area in southern Pike and nothern Lincoln counties was completed. Due to the restricted appropriation it was not possible to cover additional areas.

WATER RESOURCES INVESTIGATIONS.

The work of the Bureau during the biennial period relating to the water resources of the State has consisted principally of a continuation of the stream flow investigations for use in water-power, flood-control, drainage, and water-supply developments. These investigations have been carried on, as in the past, in cooperation 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 $6,950 to its cost. Thirteen new gaging stations were established, nearly all of them at the request of cooperating parties. Two stations were discontinued. At this time sixty-nine gaging stations are being maintained on the principal streams of the State at the places shown on the accompanying map. At each station a local resident reads a gage once or twice a day to determine the height of the water. 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.

All the stream flow records collected under this cooperative arrangement during 1921 to 1926, together with those collected by the United States Geological Survey during 1903 to 1906, by the Engineering Experiment Station of the University of Missouri during 1912 to 1920, and by the Mississippi River Commission and United States Army Engineers on Mississippi River along the Missouri line, have been published in an appendix to the previous biennial report under the title "Water Resources of Missouri." The report also gives the results of measurements of the flow of 60 of the larger springs of the State, the drainage area of 650 streams, and the results of chemical analyses of samples of water from the principal rivers and springs.

During the biennial period the Bureau has received many requests for stream flow records for use in planning water-power, flood-control, drainage, and water-supply developments. The records have been used in planning water-power developments exceeding 700,000 horse power as follows:

The West Missouri Power Company is now constructing a dam on Osage River at Osceola, which will be about 13 feet high, 400 feet long, and develop 1,700 horse power.

The Missouri Hydro-Electric Power Company has obtained final license from the Federal Power Commission and a certificate of convenience and necessity from the Missouri Public Service Commission to make a hydro-electric development on Osage River, four miles above Bagnell, Miller County. The company has given an option on its entire assets to Stone & Webster, Inc., and Dillon, Reed & Company, who expect in the near future to exercise the option, resume the construction work which was started in 1925, and complete the project. Under the revised plans of these companies the dam will be about 105 feet high and create a lake having a length of 130 miles and shore line

of 1400 miles. The plant will have an initial installed capacity of 210,000 horse power, with provision for an ultimate capacity of 350,000 horse power.

The Empire District Electric Company has obtained permits from the State and Federal Government for a hydro-electric plant on White River at Table Rock near Branson. The dam is to be about 197 feet high, 900 feet long, and will create a lake of 29,000 acres. The plant will have a generating capacity of about 220,000 horse power.

The Gasconade River Power Company has a preliminary permit and applied for an additional one for the construction of two hydro-electric plants on Gasconade River between Jerome and Rich Fountain. The total capacity of the proposed plants is about 100,000 horse power.

The Missouri Hydro-Electric Power Company has preliminary permits for the construction of two or more dams on Current River between the mouth of Jacks Fork and Doniphan. The total capacity of the proposed plants is about 100,000 horse power.

Willis H. Meredith of the Black River Hydro-Electric Company has a preliminary permit for the construction of a dam on Black River, three miles above Leeper, Wayne County, which is intended to serve for the development of electrical power and to reduce floods along the lower stretches of the river. Surveys for the project have been made. The tentative plan is to install a plant which will develop about 30,000 horse power.

The location of these proposed hydro-electric projects and the approximate areas of the lakes that would be created by the dams are shown on the accompanying map. The total capacity of the plants exceeds 700,000 horse power and the estimated cost exceeds $75,000,000. The construction of these projects would be of great benefit to the State by extending the use of electrical service, stimulating manufacture, and creating in the Ozark region some wonderful pleasure-resort districts, which would be visited each year by many thousands of pleasure seekers. Progress toward their construction has necessarily been slow on account of the large amount of capital involved, but each company is actively working on its plans to build them. The stream flow records which are being collected serve as the basis for the design and financing of these projects and in a large measure determine their feasibility. Without such records the projects would not be given serious consideration.

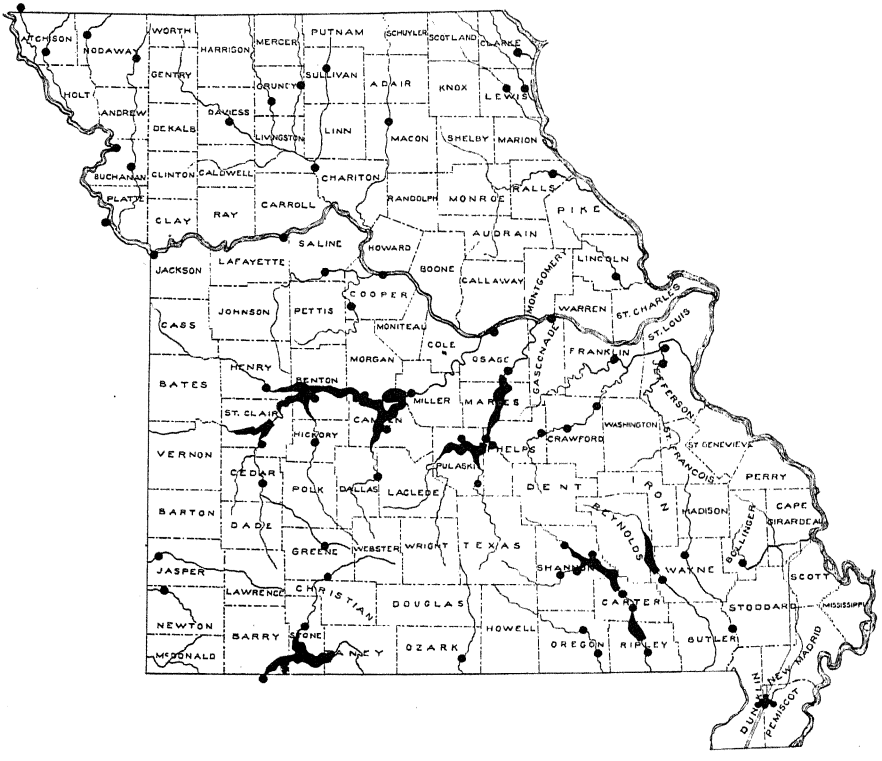
The disastrous floods which have visited Missouri, together with this entire region of the country, during the past few years have made flood-control a matter of great importance. The frequent and costly losses from floods which have occurred in the State, which during 1927 and 1928 alone are estimated at more than $10,000,000 have created a widespread demand for relief. The stream flow records which are being collected by the Bureau are indispensable to the intelligent designing of flood-control works. They show the magnitude, duration, and frequency of the floods, so that the engineers can definitely determine the size of the channels, levees, or storage reservoirs, which would be necessary to handle them. Without such records the plans would have to be based largely upon estimates, which would probably result in many costly errors. During the biennial period the Bureau has received many requests from engineers in private practice for use in flood-control studies.

In connection with the bill passed by the last Congress for flood-control work along Mississippi River, the United States Army Engineers have been instructed to investigate and report upon the feasibility of improving all the important streams of the country for the combined purposes of flood control, power development, and navigation. They are now making such studies of all the larger streams of Missouri and in this work they are using the stream flow records which are being collected by the Bureau.

The records have also been used during the biennial period in locating municipal water supplies. The Springfield City Water Company has cooperated with the Bureau in maintaining gaging stations on both the James and Little Sac Rivers, and has used these records in planning the project on the latter stream, which it is now constructing at an estimated total cost of about $575,000 in order to furnish an additional supply of water for the City of Springfield.

The Bureau has received numerous requests from the State Highway Commission for stream flow records for use in designing new bridges for the State highway system.

The United States Army Engineers are now making extensive improvements on Missouri River in order to make commercial navigation on a large scale possible. For use in this work and in their flood control studies they desired records of flow at more places than the Bureau was collecting them. For this reason



Map showing location of gaging stations and lakes to be created by proposed hydro-electric developments.

they have engaged the services of the United States Geological Survey (with whom the Bureau cooperates) to establish and maintain six additional gaging stations for the cost of which they reimburse the Survey.

The widespread interest throughout the State in the stream gaging work 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 making development of the streams for water power, flood control, drainage, water supply, and other purposes. In order to permit expansion of the work these parties, during the biennial period, contributed $5,100 (exclusive of the $6,950 contributed by the United States Geological Survey). The following list gives the names of those who cooperated and the number of gaging stations they helped to maintain during a part of or for the entire biennial period:

Little River Drainage District	7
United States Army Engineers	7
United States Weather Bureau	7
Missouri Hydro-Electric Power Co	4
Empire District Electric Co	4
Missouri Game and Fish Department	4
Central Missouri Power and Water Co	2
Gasconade River Power Co	2
Springfield City Water Co	2
Black River Hydro-Electric Co	1
Chicago Great Western Railroad	1
Total	41

At the time this report goes to press these parties are cooperating in maintaining 33 of the 69 gaging stations.

APPROPRIATIONS REQUESTED.

The appropriations request for the coming biennial period by the Board of Managers in shown in the following tabulation:

Geology and Mining (for salaries of permanent and temporary employees, field and traveling expenses, equipment, chemicals, stationery, engraving maps, and printing reports) $91,300.00

Topographic Mapping	(for making topographic maps in cooperation with the U. S. Geological Survey, the latter to meet the state appropriation dollar for dollar).....	$85,000.00
Water Power and Flood Control	(for engineers' salaries, office expenses, equipment, traveling and field expenses, etc.) (The U. S. Geological Survey appropriates $6,750.00 in cooperation).....	20,000.00
	Total.....	$196,300.00

The amount asked for the Geology and Mining fund is the same as requested two years ago. It covers the salaries of a permanent staff and summer field parties as employed six years ago, and provides for the publication of reports and maps now on hand, and those that will be completed during the next two years. There are reports and maps now ready for printing that have not been issued due to the lack of funds.

The Water Power and Flood Control fund is the same as the amount received during the past eight years. This amount, together with the appropriation made by the Federal Geological Survey, has been found to be just sufficient to carry on the engineering investigations needed to gather the data covering stream flow. With the gaging stations now installed the amount would not be sufficient except that at approximately 50% of the stations the gage readers are paid by cooperating parties interested in power development, flood control, or municipal water supply.

It is planned to do some additional work on the ground water resources. This investigation should be attacked with some vigor, as the data is of the greatest importance in obtaining pure, sanitary, municipal supplies.

The request covering topographic mapping is approximately twice the former amount. This is due to the fact that this branch of the work was practically stopped during the present biennium, as two-thirds of the appropriation was withheld.

There are requests for maps covering a greater area than can possibly be covered even with the appropriation asked. This work is done in cooperation with the United States Geological Survey, which department meets the state appropriation dollar for dollar, and furnishes the topographic engineers for the field work. Under this arrangement it is not necessary for the state to maintain a staff of engineers for this branch of the service. The request covers mapping in the (1) clay regions of east central Missouri, (2) in the southeast Ozark region, (3) along Mississippi River north of the Missouri, and (4) in southwest Missouri. During recent years a large area has been mapped in northwest Missouri. About 25% of the state is now covered by accurate surveys.

VALUE OF MINERAL PRODUCTION OF MISSOURI, 1919-1927.

Commodity.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.
Lead ore	$12,107,731	$20,284,921	$11,825,280	$14,934,548	$19,692,318	$25,037,380	$32,125,281	$33,121,920	$25,043,760
Zinc	2,429,235	2,142,564	491,365	952,411	1,403,365	1,010,059	1,488,593	3,902,700	2,398,336
Coal	12,766,366	22,230,000	13,915,500	11,153,000	11,575,000	8,154,000	8,281,000	8,950,984	8,698,000
Clay products	11,016,333	17,443,458	10,579,034	11,552,982	18,509,937	16,826,511	18,544,117	18,259,171	17,225,214
Cement	9,264,017	10,980,453	8,034,540	10,457,557	13,237,141	13,515,267	14,155,795	12,917,342	11,117,047
Limestone	1,759,129	2,776,936	2,269,457	2,409,202	3,173,622	3,624,089	4,085,883	4,416,006	4,002,987
Marble	360,287	616,550	627,729	816,098	1,085,122	1,229,160	1,439,604	1,446,983	1,108,159
Sand and gravel	873,333	1,356,352	1,018,325	1,063,370	2,007,529	2,053,436	3,595,187	2,980,242	2,875,530
Lime	1,333,085	1,735,002	1,169,391	1,402,337	1,830,937	1,711,180	1,860,244	1,428,412	1,437,140
Lime, hydrated	402,620	584,283	487,169	551,187	674,848	642,995	750,710	790,531	752,280
Clay	1,004,033	1,413,189	938,135	1,238,622	1,624,789	1,441,457	1,463,880	1,571,026	1,693,792
Chats	206,353	167,028	259,571	306,252	431,884	520,269	399,002	382,080	526,933
Barytes	640,398	1,013,570	217,913	421,568	629,097	604,390	749,927	946,595	797,465
Copper	300,799	278,307	17,749	107,649	29,776	23,948	1,718	150,780	59,081
Mineral waters	39,641	50,892	45,670	40,149	38,145	30,000	32,000	41,955	29,452
Tripoli	8,926	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Iron ore	223,144	230,827	169,516	244,928	247,975	405,622	(a)	532,536	(a)
Granite	(a)	114,663	81,389	85,093	83,804	108,084	137,348	(a)	90,133
Silver	101,249	121,130	69,902	212,656	145,361	69,475	57,538	56,160	132,638
Sandstone	(b)	(a)	(b)	(a)	(a)	(b)	(b)	(b)	(b)
Natural gas	3,000	2,600	2,130	780	3,000	3,000	3,100	(b)	(b)
Pottery	20,817	31,084	89,657	96,513	94,985	95,936	77,090	56,684	69,849
Miscellaneous (b)	118,184	169,680	4,484	21,062	130,427	132,875	327,289	328,585	559,962
Totals	$54,978,580	$83,743,489	$52,224,249	$58,018,949	$76,649,062	$77,239,133	$89,575,306	$92,280,692	$78,617,757

(a) Included in miscellaneous.
(b) No production.
1919 includes pyrites, granite, potash and petroleum.
1920-1922 includes pyrites, tripoli, potash, petroleum, sandstone and miscellaneous stone.
1923 includes mineral waters, petroleum, sandstone and tripoli.
1924 includes asphaltic sandstone, miscellaneous stone and tripoli.
1925 includes iron, ground silica, miscellaneous stone and tripoli.
1926 includes ground silica, miscellaneous stone, granite and tripoli.
1927 includes ground silica, miscellaneous stone, iron and tripoli.

PLATE II

MISSOURI GEOLOGICAL SURVEY

H. A. Buehler, State Geologist

MAP SHOWING LOCATION OF MINERAL DEPOSITS

CHAPTER II

MINERAL PRODUCTION OF MISSOURI.

By H. S. McQUEEN.

In 1926, the mineral industry in this State enjoyed the greatest year in its history, the total value of the production $92,280,692, surpassing the former record of $91,056,173, established during the war year of 1917. A decrease in the value of the production was noted in 1927 as compared to 1926, a considerable part of which may be attributed to the reduction in the price of lead, which on the average was lower than in the preceding year. A decrease in value may also be noted in practically all lines of the mineral industry. The value of the production of clay was the only one of the major branches of the industry to show an increase. This is attributed to increased activity in the mining of diaspore clay, a record production of 40,085 tons being reported in this year.

The statistics were collected in cooperation with the United States Bureau of Mines and the United States Bureau of Census. In all cases where there are less than three producers the figures are concealed to avoid revealing the production of any individual.

ASPHALTIC SANDSTONE.

There has been no production of asphaltic sandstone in the State during 1926 and 1927. Sporadic attempts have been made to develop the deposits in western Missouri, and diamond drilling has indicated a considerable tonnage in Vernon County, and a recently constructed plant is reported at Liberal, Barton County. The western Missouri deposits are described in general in Volume XVI, The Occurrence of Oil and Gas in Missouri; and the deposits in Vernon County in Volume XIX, which describes the Geology and Mineral Resources of that County. These reports may be had upon application to the Geological Survey.

BARYTES.

The production of barytes in Missouri has shown a steady increase since 1921. The value of the production in 1926 was $946,545 and, excepting 1920 when the production was valued

at $1,013,570, this was the best year enjoyed by this branch of the mineral industry. The total was 51 per cent of the total quantity in the United States; and the State led the other states by a comfortable margin. The value of barytes in 1927 was less than in 1926, being $797,465. Statistical data and a list of producers and refiners are given below.

The Missouri ore occurs chiefly as masses embedded in red residual clays. The Washington County field produces the major portion of the State total. In this part of the State the ore appears to be restricted in the main to areas underlain by the Potosi formation, the distribution of which is shown on the Potosi quadrangle, mapped by the Geological Survey. The map should be of value in future explorations in this part of the State. It will be available for distribution in the near future.

In Morgan and Miller counties, similar deposits are found in residual clays overlying the Gasconade formation, and in Hickory and Polk counties, the dolomitic limestones of the Jefferson City formation are the underlying rock. Steam shovels and up-to-date washing and grinding plants are now in use in the Washington County part of the field, and a mill has been recently constructed south of Versailles, Morgan County. A considerable tonnage is still mined by individual tiff diggers, who sell the ore to buyers of barytes.

The uses of the mineral are extensive. The principal use is in the manufacture of lithopone, a white paint pigment, containing approximately 70 per cent barium sulphate and 30 per cent zinc calculated as zinc sulphide. It is also used in the manufacture of Titanox, a paint containing an intimate mixture of barium sulphate and titanium oxide. Ground barytes is used as a filler in rubber goods, oil cloth, linoleum, and also in the paint industry. Barytes is also used for the manufacturer of barium chemicals of which barium sulphate (blanc fixe) is the most important. This chemical is used as a pigment or filler in paint, oil cloth, glazed paper, rubber goods, linoleum, lithographic inks, in lake colors, and extensively as a pigment by the United States Navy in "battleship" gray, which contains approximately 45 per cent barium sulphate.

CRUDE BARYTES SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 1926.

	Short tons.	Value.	Per cent.	Av. value per ton.
Missouri	118,919	$946,595	51	$7.96
Georgia	77,654	532,706	33	6.86
Tennessee	20,910	155,780	9	7.45
Other states[1]	15,392	108,212	7	7.03
Totals	232,875	$1,743,293	100	$7.49

[1]Arizona, California, Illinois, Kentucky, Nevada, Virginia and Wisconsin.

BARYTES—TABLE OF PRODUCTION, 1909-1927.

Year.	Number producers reporting.	Stock on hand Dec. 31.	Shipments, tons (short).	Value.	Average per ton.
1909	.....	.....	$34,815	$119,818	$3.44
1910	.....	.....	25,431	85,624	3.32
1911	.....	.....	21,500	81,380	3.79
1912	.....	.....	24,530	117,035	4.77
1913	.....	.....	31,131	117,638	3.75
1914	.....	.....	33,317	117,738	3.53
1915	.....	.....	39,113	158.597	4.05
1916	.....	.....	58,407	365,111	6.25
1917	.....	.....	59,046	391,363	6.62
1918	.....	.....	49,094	393,738	8.02
1919	.....	8,090	73,247	640,398	8.74
1920	70	3,154	99,654	1,013,570	10.17
1921	68	10,136	25,200	217,913	8.64
1922	61	5,202	66,421	421,568	6.35
1923	85	6,111	81,701	629,097	7.70
1924	70	2,222	77,189	604,390	7.83
1925	83	4,919	101,056	794,927	7.87
1926	82	4,968	118,919	946,595	7.96
1927	.....	.....	111,456	797,465	7.15

PRODUCERS OF REFINED BARTYES IN MISSOURI.

Ground Barytes:

C. P. DeLore Co., St. Louis, Mo.
National Pigments & Chemical Co., St. Louis, Mo.
Point Milling & Manufacturing Co., Mineral Point, Mo.

Barium Chemicals:

Titanium Pigment Co. (Inc.), Carondelet Sta., St. Louis, Mo.

PRODUCTION OF BARYTES IN MISSOURI, BY COUNTIES, FOR 1923-1926.

County.	1923.		1924.		1925.		1926.	
	Quantity sold.	Value.	Quantity sold.	Value.	Quantity sold.	Value.	Quantity sold.	Value.
Cole	(a)	(a)	(a)	(a)	2,778	$23,714	4,742	$37,071
Jefferson	2,467	$20,003	1,740	$12,074	3,745	29,647	5,924	45,402
St. Francois	521	3,682	435	3,053	2,027	15,657	260	1,820
Washington	62,987	484,307	56,288	443,221	84,211	660,693	101,770	812,400
Other counties (b)	785	6,068	1,644	13,011	1,967	15,415	2,204	17,601
Undistributed	14,941	115,037	17,082	133,031	6,328	49,801	4,019	32,301
Totals	81,701	$629,097	77,189	$604.390	101,056	$749,927	118,919	$946,595

(a) Cole included with other counties in 1923 and 1924.

(b) Other counties include Cole, Franklin, Miller and Morgan in 1923; Benton, Cole, Franklin, Hickory and Polk in 1924; Franklin, Hickory and Morgan in 1925.

(b) Other counties include Cooper, Franklin, Morgan, Miller and Polk, 1926.

PRODUCERS OF CRUDE BARYTES.

Producer.	Location of mine.
COLE COUNTY—	
J. C. Johnson	Lohman
O. S. Reaves	Henley
National Pigments & Chemical Co	Henley
C. J. Emmerich	Henley
Cole County Producing Co	Lohman
Alpha Mining Co	Lohman
COOPER COUNTY—	
Garnett Bros	Blackwater
FRANKLIN COUNTY—	
J. H. Johnson	Morrelton
C. C. Rose and H. O. Hollow	Sullivan
JEFFERSON COUNTY—	
C. P. De Lore Co	Vineland
Joshua Cole	Blackwell
G. F. Engledow	Blackwell
Valle Mining Co	Valle Mines
Lessees of Taussig Land	Frument
W. A. Jones	Melzo
Andrew Oliver	De Soto
MILLER COUNTY—	
Miller Co. Mining and Royalty Co	Brumley
MORGAN COUNTY—	
H. B. Hart	Versailles
POLK COUNTY—	
Westerman Bros	Bolivar
ST. FRANCOIS COUNTY—	
L. E. Cole	Blackwell
C. E. Boyer	Blackwell
R. B. Cole	Blackwell
Mrs. P. C. Aly	Blackwell
Ode Engledow	Blackwell
WASHINGTON COUNTY—	
C. H. & F. A. Clancy	Baryties
Washington Land & Mining Co	Bliss
Aubuchon Mining Co	Cadet
John Long & Son	Cadet
M. E. Rhodes	Cadet
White & Bros	Cadet, Old Mines
Anthony Recar	Cruise

PRODUCERS OF CRUDE BARYTES—Continued.

Producer.	Location of mine.
WASHINGTON COUNTY—Continued.	
Geo. Cook	Fertile
A. E. Stocking	Fletcher, Richwoods
St. Joe Lead Co	Hopewell
Mrs. Agnes M. Boas	Mineral Point
Arthur Dale	Mineral Point
Eagle-Picher Lead Co	Mineral Point
Hugh McGregor	Mineral Point
Southeast Mo. Lead Co	Mineral Point
Joe Patashnick	Mineral Point
Point Mining & Mfg. Co	Mineral Point
P. C. Walton & Co	Mineral Point
Mrs. M. J. Waugh	Mineral Point
Gratz & Stocking	Baryties
James Donald	Blackwell
McGready & Cole	Fertile
J. Armstrong	Hopewell
Ode Engledow	Blackwell
Adolph Portell	Cadet
Pierce and Stocking	Richwoods
Theodore Walther	DeSoto
W. P. Marclay & Son	Bliss
Jno. Wallace	Mineral Point
D. B. Graves	Old Mines
G. A. Johnson	Richwoods
E. F. Cordia	Potosi
C. P. De Lore Co	Mineral Point, Cadet, Potosi
Andrew White	Mineral Point
Murphy & Alden	Old Mines
C. M. Wells	Old Mines
T. F. Blount & Co	Potosi
T. F. Blount	Mineral Point
B. G. Casey	Potosi
Evans & Russell	Potosi
Rev. Clark Martin	Potosi
National Pigments & Chemical Co	Potosi, Cadet, Tiff
J. W. Settle & Co.	Potosi
J. W. Towl	Potosi
Thurman & Banta	Tiff, Cadet, Potosi
Geo. W. Welch	Vineland
Steve Kelso	Richwoods
S. D. Boyer	Tiff
Geo. Carr & Geo. Wallace	Belgrade
C. A. Stocking	De Soto
D. N. Baker	Mineral Point
C. C. Rose & H. O. Hollow	Richwoods

CEMENT.

The Portland cement industry is an important contributor to the total value of the mineral production in Missouri; as shown by the table, the value of the production in 1926 was $12,917,342, and in 1927 was $11,117,047.

There is an abundance of limestone and shale adapted to the manufacture of cement in this State, and fortunately deposits of both are well located with respect to points of consumption and transportation facilities. As shown by the list of producers, four plants are located in the eastern part of the State on or near the Mississippi River. One plant is located in the western part of the State, near Kansas City.

The raw materials used are from different formations of the State's geologic column. Limestone and shale of Mississippian age are utilized at Hannibal; Mississippian limestone and Pennsylvanian shale at St. Louis; Ordovician limestone and alluvial clay at Cape Girardeau; and Pennsylvanian limestone and shale at Kansas City. The widespread distribution of suitable raw materials indicates that the State will be an important producer for years to come.

The passage of the $75,000,000 road bond issue in November 1928 will result in renewed activity in the construction of concrete roads in the State, and an increased demand for cement may be expected.

Statistics of the production and value of cement produced from 1917 to 1927, and a list of producers are given below.

PRODUCTION OF PORTLAND CEMENT, 1917-1927.

Year.	Barrels.				Price per barrel.
	Stock on hand Jan. 1.	Manufactured.	Sold.	Value.	
1917	.....	5,882,240	5,800,988	$8,248,007	$1.435
1918	404,624	4,738,596	4,515,695	7,132,470	1.579
1919	676,552	5,216,347	5,496,164	9,264,017	1.686
1920	160,123	6,017,517	5,605,952	10,980,453	1.96
1921	571,688	4,446,091	4,375,712	8,034,540	1.84
1922	640,932	6,170,633	6,239,144	10,457,557	1.68
1923	636,625	7,305,997	7,143,883	13,237,141	1.85

PRODUCTION OF PORTLAND CEMENT, 1917-1927—Continued.

Year.	Barrels.				Price per barrel.
	Stock on hand Jan. 1.	Manufactured.	Sold.	Value.	
1924.....	774,922	7,871,621	7,711,206	$13,515,267	$1.77
1925.....	921,165	8,331,751	8,168,165	14,155,795	1.73
1926.....	1,084,752	7,653,111	7,639,966	12,917,342	1.69
1927.....	1,097,897	6,778,384	6,929,229	11,117,047	1.60

Stock on hand Dec. 31, 1927—947,052 barrels.

PORTLAND CEMENT PLANTS IN MISSOURI.

Firm name.	Material used.*a*	County.	Town.
Atlas Portland Cement Co....	ls. & sh.....	Ralls.....	Hannibal.
Marquette Cement Mfg. Co ..	ls. & clay.....	Cape Girardeau ...	Cape Girardeau.
Alpha Portland Cement Co...	ls. & clay.....	St. Louis.....	Continental.
Missouri Portland Cement Co.	ls. & sh.....	St. Louis.....	Prospect Hill.
Missouri Portland Cement Co.	ls. & sh.....	Jackson.....	Sugar Creek.

a ls. =limestone; sh. = shale.

CLAY AND CLAY PRODUCTS.

The development of the clay products industry in Missouri, based upon deposits of raw materials in the State has continued during 1926 and 1927. During these years an even greater interest has been manifested in the diaspore clay deposits of the north central Ozark region by the manufacturers of high alumina refractories. The use of diaspore or high alumina clay for this purpose has increased annually, and has resulted in a record production of 40,085 tons in 1927. With the extension of the uses and increased demand for high alumina refractories, serious attention has been given to the location of new deposits in the producing area. In 1926, the Geological Survey published a map showing the area in which diaspore clay might be expected, and also the location of deposits containing this material, and also flint fire clay. A short paper covering these clays was also

prepared for publication in Mining and Metallurgy, a member of the staff of the Survey collaborating in the article.

For some time the opinion had existed that all the deposits containing diaspore clay had been found. It is a known fact that a large number, marked by some surface expression, have been found. There are, however, additional areas favorable for exploration, and in a short time systematic prospecting will be done over many parts of the field. Considerable attention has been given, by the Geological Survey, to these unique sink hole type deposits containing diaspore and flint fire clay, and a report covering the geology is in preparation.

The bedded deposit of plastic and semi-flint fire clay, near the base of the Pennsylvanian series in east-central Missouri has also received considerable attention during the biennial period. The Harbison-Walker Refractories Company, of Pittsburgh, Pennsylvania, has entered this field, having taken over the plant of the Walsh Fire Clay Products Company at Vandalia, Missouri.

Considerable diamond core drilling has been done at or near Mexico, Fulton and Perry. The drilling at the last mentioned place was done as the result of field studies by the Geological Survey, described in appendix III of this report.

The area underlain by the bed of fire clay in east-central Missouri is shown on the map previously mentioned. The production of ball clay from Butler County, in the southeastern part of the State continued throughout 1926 and 1927. This clay is dark-colored but fires to a white or buff color. It is adapted to the manufacture of dinner-ware, floor, wall and art tile, and other high-grade white-ware products. Laboratory work is now under way to determine new uses for this material, and the construction of a clay products plant at Popular Bluff is contemplated.

A small amount of kaolin was produced from pocket-like deposits in Morgan County in 1926-1927. No activity is reported in the kaolin areas of Bollinger County in southeast Missouri.

The Pennsylvanian series, which underlies approximately 20,000 square miles of Missouri, contains deposits of shale and clay suitable for the manufacture of brick, sewer pipe, tile, and other heavy clay products. A considerable industry is in operation in the western part of the State, and also in the eastern part,

in the St. Louis district. Deposits of clay occur in the so-called lowland area of southeast Missouri. These clays are found in the tertiary formations and have been utilized at Illmo, Commerce and Dexter for the manufacture of heavy clay products. Clays suitable for the manufacture of pottery are available in different parts of the State, and each year a small tonnage is utilized by the potteries listed at the end of the discussion.

The expansion of the clay working industries has been noticeable during the past two years. Considerable attention has been given to obtaining higher grade ware at a reduced cost. Effective in this respect are the continuous tunnel kilns which have been installed by fire brick companies in the St. Louis and east-central Missouri districts. A kiln of this type, burning face brick, is also in operation at Jackson. The application of scientific control and research work, in the development of new, or the betterment of old products, has been noticeable.

The tables below show the production and value of clay and clay products in 1926 and 1927. Lists of the producers of each are also given.

VALUE OF CLAY PRODUCTS, 1924-1927.

Product.	1924.	1925.	1926.	1927.
Fire brick	$ 7,354,048	$7,431,975	$8,520,235	$7,842,296
Sewer pipe	2,825,623	(b)	2,819,553	2,431,782
Common brick	1,802,833	2,397,724	1,850,977	1,495,009
Face brick	1,165,734	1,428,726	1,394,055	1,238,249
Hollow building tile or block	448,713	557,349	537,029	346,490
Drain tile	96,796	50,960	85,936	58,481
Pottery	95,936	(b)	56,684	69,849
Miscellaneous (a)	3,132,764	6,754,473	3,051,386	3,743,058
Totals	$16,922,447	$18,621,207	$18,315,855	$17,225,214

(a) "Miscellaneous" includes vitrified brick, enameled brick, architectural terra cotta, tile other than drain tile, silica brick, clay gas retorts, stove lining, wall coping, high alumina brick, flue lining, segment blocks, refractory cement and raw or prepared clay.

(b) Included with "miscellaneous" in 1925.

Year.	Fire Clay.						Miscellaneous. c		Total.	
	Plastic.		Flint.		Diaspore.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1916	254,865	$436,441	179,675	$501,708	*b*	.....	3,963	$48,575	439,583	$988,884
1917	491,674	1,306,721	*a*	.....	*b*	.....	5,593	79,617	497,267	1,386,338
1918	365,339	942,547	87,453	159,105	*b*	.....	11,654	91,444	464,446	1,192,996
1919	217,905	804,376	121,928	177,750	*b*	.....	1,552	21,907	341,385	1,004,033
1920	329,563	1,130,266	111,165	266,814	*b*	.....	8,256	16,109	448,984	1,413,189
1921	159,831	627,289	95,963	302,485	*b*	.....	989	8,361	256,783	938,135
1922	259,011	711,087	137,470	406,637	13,384	$109,229	12,263	11,669	412,128	1,238,622
1923	338,010	1,252,003	142,584	301,474	10,617	54,450	4,586	16,862	495,797	1,624,789
1924	376,328	1,175,847	68,392	199,688	9,252	47,407	5,598	18,515	459,570	1,441,457
1925	340,870	1,138,664	91,015	201,728	15,177	102,064	5,944	20,624	453,006	1,463,880
1926	336,809	1,225,961	97,157	212,487	18,483	100,823	8,297	31,755	460,746	1,571,026
1927	282,865	1,247,273	86,570	193,185	40,085	229,093	6,970	24,241	416,490	1,693,792

a Fire clay not divided in 1917.
b Diaspore clay not separated before 1922.
c Includes kaolin, stoneware clay and clay for miscellaneous uses.
Includes ball clay, stoneware and clay for miscellaneous uses, 1926.
Includes kaolin, ball clay, stoneware and clay for miscellaneous uses, 1927.

PRODUCERS OF CLAY IN MISSOURI, 1926-1927.

Operator.	Type of clay mined.	Location.
AUDRAIN COUNTY—		
Farber Fire Brick Co.	Plastic fire clay.	Farber.
A. P. Green Fire Brick.	Flint fire clay, plastic fire clay.	Mexico.
Walsh Fire Clay Products.	Plastic fire clay.	Vandalia.
Mo. Fire Brick Co.	Plastic fire clay.	Farber.
BOONE COUNTY—		
Edwards Brick Co.	Plastic fire clay.	Columbia.
BUTLER COUNTY—		
Mo. Clay Mining Co.	Ball clay.	Poplar Bluff.
CALLAWAY COUNTY—		
A. P. Green Fire Brick.	Flint fire clay.	Fulton.
Fulton Fire Brick Co.	Plastic fire clay.	Fulton.
FRANKLIN COUNTY—		
F. A. Toelke.	Flint fire clay.	Gerald.
Western Fire Brick Co.	Flint fire clay.	Gerald.
Hydraulic-Press Brick.	Flint fire clay.	Johnson Spur.
Gasconade Flint Clay Co.	Flint fire clay.	Beaufort.
General Chemical Co.	Flint fire clay.	Gasconade Co., Maries & Osage Co.
GASCONADE COUNTY—		
A. P. Green Fire Brick.	Diaspore.	Hermann.
Gen. Refractories.	Flint fire clay.	Owensville.
General Chemical Co.	Flint fire clay	Owensville.
Laclede-Christy Clay Products Co.	Diaspore and flint fire clay.	Canaan, Owensville, and Rosebud.
Dewitt C. Terrill.	Flint fire clay, diaspore.	Owensville.
Gasconade Clay Products.	Flint fire clay.	Rosebud.
Louis Hidel.	Flint fire clay.	Rosebud.
John Wehmeyer, lessee.	Flint and plastic fire clay.	Rosebud.
E. W. Roussett.	Flint fire clay.	Rosebud.
Hydraulic-Press Brick.	Flint fire clay.	Johnson Spur.
HENRY COUNTY—		
James W. Edwards.	Stoneware clay and Misc.	Calhoun.
MARIES COUNTY—		
General Chemical Co.		Belle.
Gasconade Flint Clay Co.	Flint fire clay.	Belle.
Wm. J. Crouch Mining Co.	Diaspore.	Belle.

PRODUCERS OF CLAY IN MISSOURI, 1926-1927—Continued.

Operator.	Type of clay mined.	Location.
MONTGOMERY COUNTY—		
Wellsville Fire Brick Co	Plastic fire clay	Wellsville.
Parker-Russell Mng. & Mfg. Co	Flint and plastic fire clay.	Wellsville.
New Florence Fire Brick Co	Flint fire clay	New Florence.
MORGAN COUNTY—		
Geo. H. Hubbard	Kaolin	Versailles.
W. S. Dickey Clay Mfg. Co	Flint fire clay	Versailles.
OSAGE COUNTY—		
General Chemical Co	Flint fire clay	Belle.
Gasconade Flint Fire Clay Co	Flint fire clay	Chamois
PHELPS COUNTY—		
Jno. Gray	Flint fire clay, diaspore	St. James.
C. R. Forbes	Flint fire clay, diaspore	Rolla.
Athletic Mn. & Sm. Co	Diaspore	St. James.
ST. LOUIS COUNTY—		
Laclede-Christy Clay Products Co	Plastic fire clay	Christy, Cheltenham, St. Louis.
Geo. W. Gittins Clay Products Co	Plastic fire clay	Clayton
Frederick E. Bausch	Plastic fire clay	Clayton.
Evan & Howard Fire Brick Co	Flint fire clay	Overland.
Volz Fire Clay Co	Plastic fire clay	Clayton.
Glencoe Clay Co	Flint and plastic fire clay.	Glencoe.
Murray & Siems	Flint and plastic fire clay.	Oakhill.
St. Louis Vitrified & Fire Brick Co.	Plastic fire clay	Maryland Hts.
ST. LOUIS CITY—		
Highlands Fire Clay Co	Flint and plastic fire clay.	St. Louis.
Parker-Russell Mng. Co	Plastic fire clay	St. Louis.
Schwetye Fire Clay	Plastic fire clay	St. Louis.
Walsh Fire Clay Products Co	Flint and plastic fire clay.	St. Louis.
Williams Fire Clay Co	Plastic fire clay	St. Louis.
WARREN COUNTY—		
Aug. G. Hummel	Flint fire clay	

PRODUCERS OF CLAY PRODUCTS, 1926-1927

Operator.	Name of Product.	Location. of works
AUDRAIN COUNTY—		
Farber Clay & Mining Co.	Fire brick.	Farber.
A. P. Green Fire Brick Co.	Fire brick.	Mexico.
Western Stove Lining Co.	Stove lining.	Mexico
Walsh Fire Clay Products Co.	Fire brick.	Vandalia.
BARTON COUNTY—		
Universal Brick & Tile Co.	Common brick.	Oskaloosa.
Oskaloosa Brick Co.		Oskaloosa.
Venetian Brick Co.		Oskaloosa.
BOONE COUNTY—		
Edwards Brick Co.	Face brick; common brick; hollow building tile.	Columbia.
BUCHANAN COUNTY—		
Coates Brick & Tile Co.		St. Joseph.
St. Joseph Pressed Brick Co.	Common brick; hollow building tile or block.	St. Joseph.
Moorehead Brick & Tile Co.	Common brick; hollow building tile or block.	St. Joseph.
CALLAWAY COUNTY—		
Fulton Fire Brick Co.	Fire brick.	Fulton.
CAPE GIRARDEAU COUNTY—		
Cape Girardeau Press Brick Co.	Common brick.	Cape Girardeau.
Kasten & Sons Press Brick Co.	Common brick; face brick.	Jackson.
CARROLL COUNTY—		
Carrollton Brick and Tile Mfg. Co.	Common brick.	Carrollton.
CASS COUNTY—		
Harrisonville Brick and Tile Co.	Face brick; hollow building tile or block.	Harrisonville.
COLE COUNTY—		
Mo. State Board Penal Institutions.	Common brick.	Jefferson City.
COOPER COUNTY—		
Missouri State Reformatory.	Common brick.	Boonville.
GASCONADE COUNTY—		
Korff Bros. Brick Mfg. Co.	Common brick.	Rosebud.
HENRY COUNTY—		
W. S. Dickey Clay Mfg. Co.	Drain tile; hollow building tile or block; sewer pipe; wall coping; segment blocks.	Deepwater.

PRODUCERS OF CLAY PRODUCTS, 1926-1927—Continued.

Operator.	Name of Product.	Location of works.
HOWARD COUNTY—		
Fayette Brick and Tile Co.	Common brick; drain tile; hollow building tile or block; fire brick.	Fayette.
JACKSON COUNTY—		
Hydraulic Press Brick Co.	Face brick.	Kansas City.
Builders Brick and Mfg. Co.	Common brick.	Kansas City.
W. S. Dickey Clay Mfg. Co.	Sewer pipe; hollow building tile block; wall coping; miscellaneous.	Kansas City.
Lyle Brick Co.	Common brick.	Kansas City.
B-V Brick Co.	Common brick.	Vale.
United Clay Products.	Common brick; face brick; hollow building tile.	Kansas City, Vale.
Kansas City Brick Co.	Common brick; face brick; hollow building tile or block.	Vale.
Norton Brick and Tile Co.	.....	Kansas City.
Fredericksen Floor and Wall Tile Co.	Floor tile.	Independence.
Ballou Brick Co.	.....	Kansas City.
Kansas City Terra Cotta and Faience Co.	Architectural terra cotta.	Kansas City.
JEFFERSON COUNTY—		
Festus Pressed Brick Co.	Common brick.	Festus.
JOHNSON COUNTY—		
Johnson County Brick Co.	Common brick; face brick.	Knobnoster.
LAFAYETTE COUNTY—		
Higginsville Brick & Tile Co.	Common brick; hollow building tile or block.	Higginsville.
LINCOLN COUNTY—		
Winfield Tile & Brick Works.	Drain tile; common brick.	Winfield.
LIVINGSTON COUNTY—		
Shale Hill Brick & Tile Co.	Drain tile; hollow building tile or block.	Utica.
MONTGOMERY COUNTY—		
New Florence Fire Brick Co.	Fire brick.	New Florence.
Wellsville Fire Brick Co.	Fire brick.	Wellsville.

PRODUCERS OF CLAY PRODUCTS, 1926-1927—Continued.

Operator.	Name of Product.	Location of works.
MORGAN COUNTY—		
W. S. Dickey Clay Mfg. Co.	Fire brick	Versailles.
PIKE COUNTY—		
Philip Schurfeld	Common brick; drain tile; hollow building tile or block	Louisiana.
ST. LOUIS COUNTY—		
Alton Brick Co	Common brick; face brick; hollow building tile or block	Maryland Hts.
Evans & Howard Fire Brick Co	Fire brick	Clayton.
Continental Brick Co	Common brick	Continental.
Wm. H. Warmann	Common brick	Eden.
St. Louis Vitrified & Fire Brick Co.	Fire brick	Maryland Hts.
Excelsior Press Brick Co	Common brick	Brentwood.
Jacob Maes	Common brick	Luxemburg.
Missouri Pressed Brick & Imp. Co.	Common brick	St. Louis.
Walsh Fire Clay Products Co	Fire brick	St. Louis.
Mutual Press Brick Co	Common brick	Shrewsbury.
American Press Brick Co	Common brick	Wellston.
Hydraulic Press Brick Co	Common brick	
ST. LOUIS CITY—		
Missouri Fire Brick Co	Fire brick	Cheltenham.
Blackmar & Post Pipe Co	Sewer pipe	St. Louis.
Evans & Howard Fire Brick Co	Drain tile; sewer pipe; fire brick	St. Louis.
Hydraulic Press Brick Co	Common brick; vitrified brick for paving and other uses; fire brick; face brick; enameled brick; hollow building tile or block	St. Louis.
Laclede-Christy Clay Products Co	Sewer pipe; hollow building tile or block: clay gas retorts; fire brick; miscellaneous	St. Louis.
Mitchell Clay Mfg. Co	Fire brick	St. Louis.
Mound City Roofing Tile Co	Roofing tile	St. Louis.
Parker-Russell Mng. & Mfg. Co	Hollow building tile or block; fire brick; clay gas retorts; silica brick	St. Louis.
Progress Press Brick Co	Common brick; face brick.	St. Louis.
H. H. Schweer Brick Co	Common brick	St. Louis.

PRODUCERS OF CLAY PRODUCTS, 1926-1927—Continued.

Operator.	Name of Product.	Location of works.
ST. LOUIS CITY—*Continued.*		
Superior Press Brick Co	Common brick; face brick	St. Louis.
Winkle Terra Cotta Co	Architectural terra cotta	St. Louis.
Walsh Fire Clay Products Co	Fire brick	St. Louis.
SCOTT COUNTY—		
Post Bros. Tile Co	Drain tile	Commerce.
Illmo Pressed Brick Co	Common brick	Illmo.
STODDARD COUNTY—		
Dexter Brick & Tile Co	Common brick	Dexter.

PRODUCERS OF POTTERY, 1926-1927

Operator.	Name of Product.	Location.
ST. LOUIS COUNTY—		
Missouri Pottery & Supply Co	Red earthenware	St. Louis.
St. Louis Pottery & Mfg. Co	Red earthenware	St. Louis.
National Lead Co	Corroding pots	St. Louis.
Western Pottery Co	Red earthenware	St. Louis.
SHELBY COUNTY—		
J. B. Cluskey	Stoneware	Lakenan.
STODDARD COUNTY—		
Evans Pottery	Stoneware and yellow and Rockingham ware	Dexter.

COAL.

The production and value of coal in Missouri in 1926 and 1927 was slightly greater than in the two preceding years. This branch of the mineral industry, while not the largest in the State, maintains a consistent record of production, even in the face of adverse conditions that have affected the industry in general.

Approximately 20,000 square miles of the State are underlain by the Coal Measures or Pennsylvanian series, in the lower part of which especially are a number of workable beds of coal. In parts of the State the coal beds are sufficiently close to the surface to permit steam shovel operations, and the tonnage produced in the counties in the southwest part of the State are obtained largely in this manner. Stripping operations are also being conducted near Highbee and near Fulton, in the central part of the State, and plans are being made for working the coal at Perry, Ralls County, by the same method.

During the biennial period the Survey has had a number of request for information regarding possible strip coal areas, and some field activity has been shown by several operators.

The tables given below show the total production of the State, as well as that for the individual counties for the years 1920 to 1926, with detailed tables for 1925 and 1926. A list of producers, compiled by the State mine inspector, is also given.

COAL PRODUCED IN MISSOURI, 1920-1926.

County.	1920.	(a) 1921.	1922.	1923.	(a) 1924.	(a) 1925.	1926.
Adair	777,986	527,804	221,703	251,783	154,295	188,828	191,525
Audrain (including Ralls in 1925 and 1926).	18,626	10,538	17,526	15,959	16,920	22,300	26,024
Barton	965,757	726,347	658,092	704,090	739,854	947,844	1,142,740
Bates	115,621	39,690	147,047	119,934	207,847	263,710	242,594
Boone, Chariton, Moniteau and Callaway (b).	18,950	16,128	13,557	12,200	19,338	15,527	26,742
Caldwell, Clay, Dade and Platte (p)	(c) 86,617	91,646	88,113	95,292	99,625	(d)	(p)69,429
Callaway	58,462	32,191	41,255	26,602	(l)	28,389	35,394
Chariton	(d)	(d)	(e)	(e)	(e)	(e)	(m)
Cooper, Howard, Moniteau, Morgan and Pettis	29,300	4,514	(g)	(k)	(k)	(k)	(k)
Dade	6,342	(h)	(h)	(h)	(k)	(k)	(k)
Grundy, Harrison and Schuyler (i)	23,080	11,654	(i) 31,259	12,210	10,191	11,565	(m) 21,706
Henry	203,200	95,279	115,374	115,094	111,731	66,458	67,622
Johnson	45,434	15,240	44,201	58,500	(d)	(k)	11,878
Lafayette	885,569	540,421	416,383	511,277	326,497	355,419	359,436
Linn	142,290	89,747	53,807	27,964	21,829	15,739	31,844
Macon	720,227	473,985	352,137	571,350	181,598	60,766	77,056
Putnam	30,867	13,921	(d)	12,869	8,547	15,737	8,354
Randolph	422,903	324,836	158,692	233,529	138,224	113,752	181,808
Ray	578,694	476,117	423,881	518,633	408,202	449,931	463,392
Vernon (q)	74,771	42,026	30,648	7,824	(d)	(d)	(q) 50,951
Other counties (d)	61,869	19,537	53,657	19,102	36,182	138,250	.....

COAL PRODUCED IN MISSOURI, 1920-1926—Continued.

County.	1920.	(a) 1921.	1922.	1923.	1924.	1925.	1926.
Small mines	103,000	(k)	75,418	88,939	(k)	(k)	(k)
Tons	5,369,565	(a) 3,551,621	2,924,750	3,403,151	2,480,880	2,694,215	3,008,495
Value	$22,230,000	$13,915,500	$11,153,000	$11,575,000	$8,154,000	$8,281,000	$8,950,984
Average value per ton	$4.16	$3.92	$3.81	$3.40	$3.29	$3.07	$2.98

(a) Exclusive of product of wagon mines. (b) 1919-1921, 1925-1926 Boone only, Chariton given elsewhere; production reported from Moniteau in 1922 only; Callaway in 1924 only. (c) Production for Dade given separately. (d) Other counties include Franklin, Ralls and St. Clair in 1919; Chariton, Ralls and St. Clair in 1920; Chariton, Franklin, Ralls and St. Clair in 1921; Franklin, Lincoln, Putnam, Ralls and St. Clair in 1922; Cass, Lincoln, Ralls and St. Clair in 1923; Johnson, Ralls and Vernon, in 1924; Caldwell, Chariton, Clay, Cooper, Platte, St. Clair and Vernon in 1925. (e) Grouped with Boone and Moniteau. (f) No production in Morgan for 1919. (g) No production reported from Cooper, Howard, Morgan and Pettis; Moniteau given with Boone and Chariton. (h) Production for Dade given with Caldwell, Clay and Platte. (i) Not including Schuyler in 1919-1921. (k) No production reported. (l) Included with Boone, etc., in 1924. (m) Includes Caldwell, Chariton, Harrison and Schuyler in 1926; no production reported for Grundy in 1926. (p) 1926 Clay only; Caldwell given elsewhere; no production reported for Dade, and Platte. (q) Includes St. Clair in 1926.

COAL PRODUCED IN MISSOURI IN 1925.[1]

County.	Net tons.				Value.		Number of employes.				Average number of days worked
							Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total.	Average per ton.	Miners, loaders, and shot-firers.	All others.	Surface.	Total.	
Adair	172,388	11,299	5,141	188,828	$477,000	$2.53	212	93	30	335	190
Audrain and Ralls	16,201	6,056	43	22,300	67,000	3.00	58	17	8	83	155
Barton	920,604	5,329	21,911	947,844	2,654,000	2.80	67	15	597	679	154
Bates	253,914	8,346	1,450	263,710	583,000	2.21	111	20	143	274	183
Boone	.....	15,488	39	15,527	55,000	3.54	26	7	5	38	184
Caldwell, Chariton Cooper and Platte	18,597	16,175	1,474	36,246	176,000	4.86	113	17	16	146	129
Callaway	.....	28,324	65	28,389	104,000	3.66	78	21	29	128	163
Clay	28,120	22,576	342	51,038	210,000	4.11	120	27	14	161	173
Grundy, Harrison and Schuyler	5,694	5,521	350	11,565	48,000	4.15	30	11	5	46	165
Henry	60,035	5,594	829	66,458	178,000	2.68	24	4	59	87	188
Lafayette	304,598	42,539	8,282	355,419	1,269,000	3.57	723	224	85	1,032	155
Linn	5,065	10,534	140	15,739	71,000	4.51	71	12	8	91	151
Macon	44,542	16,064	160	60,766	197,000	3.24	131	43	16	190	141
Putnam	10,201	5,536	.....	15,737	47,000	2.99	75	19	9	103	78

COAL PRODUCED IN MISSOURI IN 1925—Continued.

County.	Net tons.				Value.		Number of employes.				Average number of days worked.
							Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total. quantity.	Total.	Average per ton.	Miners.	All others.	Surface.	Total.	
Randolph	100,523	10,691	2,538	113,752	343,000	$3.02	238	73	22	333	148
Ray	396,765	50,456	2,710	449,931	1,669,000	3.71	917	304	116	1,337	189
St. Clair and Vernon	47,395	571	3,000	50,966	133,000	2.61	.....	.....	51	51	167
Totals	2,384,642	261,099	48,474	2,694,215	$8,281,000	$3.07	2,994	907	1,213	5,114	166

[1]These figures relate only to active mines of commercial size that produced coal in 1925. The number of such mines in Missouri was 154 in 1925.

Methods of mining in 1925: The tonnage undercut by hand was 322,215; shot off the solid, 136, 180; cut by machines, 912,004; mined by stripping, 1,202,201; not specified, 121,615.

Size classes of commercial mines in 1925: There were 6 mines in Class 2 (100,000 to 200,000 tons) producing 26 per cent of the tonnage; 9 in Class 3 (50,000 to 100,000 tons) with 26.1 per cent; 38 in Class 4 (10,000 to 50,000 tons) with 36.3 per cent: and 101 in Class 5 (less than 10,000 tons) producing 11.6 per cent.

COAL PRODUCED IN MISSOURI IN 1926.

County.	Net tons.				Value.		Number of employes.				Average number of days worked.
							Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Miners. (a)	All others.	Surface.	Total.	
Adair	174,435	10,505	6,585	191,525	$521,006	$2.72	226	73	23	322	201
Barton	1,121,748	4,481	16,511	1,142,740	3,157,749	2.76	218	26	515	759	183
Bates	232,656	5,288	4,650	242,594	509,224	2.10	121	19	151	291	178
Boone	.....	26,412	330	26,742	72,775	2.73	60	14	9	83	141
Callaway	.....	35,377	17	35,394	129,308	3.64	100	24	28	152	196
Clay	52,881	16,253	295	69,429	266,618	3.85	158	44	16	218	190
Henry	47,897	(a)	(a)	67,622	176,057	2.60	19	6	61	86	177
Johnson	(a)	(a)	(a)	11,878	33,920	2.86	34	5	5	44	122
Lafayette	304,445	46,238	8,753	359,436	1,260,437	3.51	758	190	72	1,020	159
Linn	(a)	(a)	(a)	31,844	124,312	3.89	114	25	14	153	160
Macon	51,128	25,565	363	77,056	238,616	3.10	163	40	20	223	159
Putnam	5,617	2,737	.....	8,354	23,718	2.87	48	9	6	63	81
Randolph	127,004	(a)	(a)	181,808	491,086	2.70	273	54	30	357	219
Ray	413,377	48,800	1,215	463,392	1,662,119	3.59	937	181	125	1,243	174
Audrain and Ralls	18,027	7,937	60	26,024	84,039	3.21	64	16	9	89	296

COAL PRODUCED IN MISSOURI IN 1926—Continued.

County.	Net tons.				Value.		Number of employes.				Average number of days worked.
							Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employes.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Miners. (a)	All others.	Surface.	Total.	
Caldwell, Chariton, Harrison, Schuyler..	10,517	10,882	307	21,706	66,008	3.46	70	13	8	91	453
Vernon and St. Clair..	.....	3,349	2,600	50,951	133,992	2.70	.....	.....	76	76	254
Totals.....	2,559,732	207,412	41,356	3,008,495	$8,950,984	$2.98	3,363	739	1,168	5,270	174

(a) Total not given to conceal individual producers, but is included in total quantity produced.
(b) Includes also loaders and shot firers.

LIST OF COAL PRODUCERS, 1926.

Compiled by and taken from annual reports of the State Bureau of Mines Inspection department.

Operating company.	P. O. address.
ADAIR COUNTY—	
Adair Coal Company	Kirksville.
Arctic Coal and Mining Company	Box 66, Novinger.
Black Bottom Coal Company	Kirksville.
Blacksmith, Joe & Sons	Connelsville.
City of Kirksville (Pump Station)	Kirksville.
Filkins, J. O., Coal Co	Novinger.
Floyd Brothers Coal Co	Novinger. .
Gates & Bachman Coal Co	Stahl.
Hanlin & Lee Coal Co	R. 1, Novinger.
Hazel Coal Company	Novinger.
Kansas City Midland Coal & Mng. Co	Novinger.
Novinger Brothers & Co	Novinger.
Ray & Williams	Stahl.
Riverside Coal Company	Novinger.
Runyon, I. M	Stahl
Sponsler, J. P	Novinger.
Slope Coal Company	Youngstown.
Sevits, Sanders & Bell	Novinger.
Spring Creek Coal Co	Youngstown.
Thorington, S. S	R. 2, Stahl.
Zucchi, Tony	Kirksville.
AUDRAIN COUNTY—	
Bailey & Crawford	Martinsburg.
Eagle Coal Corporation	Vandalia.
Midway Coal Company	Vandalia.
Moser Coal Company	Martinsburg.
Quisenberry & Son Coal Company	Vandalia.
Vandalia Coal Company	Vandalia.
BARTON COUNTY—	
Alston Coal Company	Pittsburg, Kansas.
Carney Cherokee Coal Co	Mulberry Kansas
Clemens Coal Company	Pittsburg, Kan.
Commerce Coal Company	Pittsburg, Kan.
Custom Coal Company	Mindenmines.
Domestic Fuel Company	Pittsburg, Kan.
Elm Branch Coal Company	Mulberry, Kan.
H. & H. Coal & Mining Co	Arcadia, Kan.
Kilger Coal Company	Mindenmines.
Liberal Coal & Mining Co	Liberal.
Minden Coal Company	522 Main, Joplin.
Modern Coal Company	Mulberry, Kan.
Morgan, L. J., Coal Co	Pittsburg, Kan.
Mulbery Coal Company	205 Globe, Pittsburg.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
BARTON COUNTY—*Continued.*	
Norton, F. J., Coal Company	Mindenmines.
Patterson, W. W., Coal Company	Pittsburg, Kan.
Pittsburg & Midway Coal Mining Co	415 Globe, Pittsburg
Prine & Hodgson Coal Co	Mindenmines.
Radio Coal Company	Mulberry, Kan.
Shoup Coal Co	Mindenmines.
Six Coal Company	Frontenac, Kan.
Stephenson-Fenimore Coal Co	316 Globe, Pittsburg.
United States Coal Co	Pittsburg, Kans.
Victor Coal Company	Pittsburg, Kan.
Western Coal & Mining Co	830 Planters, St. Louis.
BATES COUNTY—	
Arbogast Coal Company	Foster.
Bainter Coal Company	Liberal.
Blue-Jay Coal Mining Company	Kansas City, Kan.
Carney Cherokee Coal Co	Mulberry, Kan.
Davis Coal Co	Mindenmines.
Dickinson Coal & Mining Company	Rich Hill.
Donalson-Ryan Coal Company	Rich Hill.
Eddy-Lynn Coal Co	Rich Hill.
Foster Coal Company	Pleasanton, Kan.
Hall Coal Company	Rich Hill.
J. F. Klaner Coal Company	205 Globe, Pittsburg.
Laughlin-Loyd Coal Company	Foster.
McComb Coal Company	Rich Hill.
Mullies Coal Company	Pleasanton, Kan.
Peacock Coal & Dev. Co	R. 2, Hume.
Ritchie Coal Mining Company No. 1	Rich Hill.
Ritchie Coal Mining Company No. 2	Rich Hill.
Schooley Coal Company.	Foster.
Valentine Coal Co	Kansas City, Kan.
Worland Coal Company	Worland.
BOONE COUNTY—	
Adkerson Coal Mine	Columbia.
Blue Ribbon Coal Company	7th & Ash, Columbia.
Boone County Mining Company	Columbia.
Boyd Coal Company	Columbia.
Chorlton Coal to	Columbia.
Clark Coal Company	R. 2, Columbia.
Keene, E. B.	Columbia.
Hinton Coal Company	R. 6, Columbia.
Ed. Tharp	Columiba.
Jno. Tharp	Columbia.
Lewis Coal Mine	Brown Station.
Neinaber Coal Mine	R. 7, Columbia.
Richards Coal Mine	Columbia.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
BOONE COUNTY—*Continued.*	
Shock Coal Mine	Columbia.
Smarr Feed & Coal Company	207 N. 8th ,Columbia.
Smarr Coal Company	1703 Paris, Columbia.
Wallas Coal Company	R. 6, Columbia.
White Coal Mine	R. 6, Clark
CALDWELL COUNTY—	
Caldwell Coal Company	Hamilton.
CALLAWAY COUNTY—	
Bybee Coal Company	R. 3, Fulton.
Davis, Thomas	Stephens.
Harris, C. A., Coal Co	Fulton.
Hill-Gohring Coal Co	Fulton.
Reed, J. F. & Sons	Fulton.
Nickles, C. M	Stephens.
Nickelson, C. M. Co	Fulton.
Pierson, Clyde	Fulton.
Simmons Coal Co	Fulton.
Trigg-Crowson Coal Co	Fulton.
CEDAR COUNTY—	
Henson, J. M. & Son	Humansville.
CHARITON COUNTY—	
Chariton Co. Coal Company	G. D. Marceline.
Kinzle, Will	Keytesville.
Lunce Brothers Coal Co	Salisbury.
Perkins, Roy	Keysteville.
Peoples Coal Co	Prairie Hill.
White, Mark, Houston Mine	R. 1, Salisbury.
Slater & Teter	Perry Hill.
Prairie Hill Mine	Prairie Hill.
CLAY COUNTY—	
Fairplay Coal & Dev. Company	Excelsior Springs.
Missouri City Coal Company	Missouri City.
Mosby Block Coal Company	Mosby.
COOPER COUNTY—	
Battino, Chas	Boonville.
GRUNDY COUNTY—	
Trenton Mining Co	Trenton.
HARRISON COUNTY—	
Melbourne Mining Co	Melbourne.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
HENRY COUNTY—	
Cahal & Irwin	Calhoun.
Missouri Public Service Company	Clinton.
Milo Park Coal Company	Deepwater.
Reliance Coal Corporation	Clinton.
Standard Coal Company	R. 3, Clinton.
Tebo Coal Company	Clinton.
West Mo. Power Co	Pleasant Hill.
HOWARD COUNTY—	
Howard County Mining Co	1330 Grant, K. C.
JOHNSON COUNTY—	
Bowen Coal & Mining Co	Windsor
Bristle Ridge Coal Co	R. 7, Warrensburg.
Kramer Coal Co	Montserrat.
Perry & Jenkins Coal Co	Knobnoster.
LAFAYETTE COUNTY—	
Ashinhurst, Robt	R. 1, Lexington.
Atwood Mine	Lexington.
Atlas Coal Co	Waverly.
Bettien A. W	Napoleon.
Corder Coal Co	Corder.
Dixon, J. W	Mayview.
Eppes, L. W. Coal Co	Mayview.
Fallman, Ed	Wellington.
Farmers Fuel Company	400 Rialto, K. C.
Gann, R. B	Higginsville.
George Frank	Higginsville.
Goring & Gann Coal Company	Higginsville.
Graham Coal Mine	Odessa.
Hamilton & Son	Higginsville.
Hartwig & Semler	Wellington.
Fred Hearn Coal Co	Dover.
Holman Coal Company	Lexington.
Imperial Coal Company	Corder.
Jelicic & Hotmer Coal Co	Wellington.
Kelso Coal Company	R. 1, Higginsville.
Lynch & Son Coal Co	Higginsville.
Mantino Coal Company	Wellington.
Dover Coal Mine	Dover.
Napoleon Coal Mine	Napoleon.
Peek, H. S	Lexington.
Perry Coal Company	Lexington.
Powell Brothers Coal Mine	Higginsville.
Riley & Jones Coal Co	Corder.
Sand Springs Coal Company	Lexington.
Schowengerdt Coal Co	Mayview.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
LAFAYETTE COUNTY—*Continued.*	
Sherron, G. W., Coal Co	Wellington.
Stolin Coal Co	Corder.
Summers, Emmet, Coal Co	Corder.
Tyler Coal Mine	Aullville.
Wegener & Son Coal Co	Higginsville.
Western Coal & Mining Co:	
South Mine	Lexington.
West Mine	Lexington.
East Mine	Lexington.
Woodrow Mine	Lexington.
Wilcoxon Coal Company	Lexington.
Wilson Mining Company	Corder.
Winfrey & Devlin Coal Co	Corder.
Wrzceiona, Chas. A., Coal Co	Higginsville.
LINN COUNTY—	
Brookfield Home Coal Co	Brookfield.
Bucklin Coal Company	Bucklin.
Crandall & Rash	Brookfield.
Co-Operative Coal Company	Marceline.
Kinney & Wilson	Brookfield.
Landreth Coal Company	Box 404, Marceline.
Schaefer Coal Company	Brookfield.
Sunshine Co-Operative Coal Co	Brookfield.
Wine Coal Company	Brookfield.
MACON COUNTY—	
Ash, Louis	Bevier.
Bevier Coal Company	Bevier.
Bischof Coal Company	Bevier.
Black Diamond	Excello.
Central Coal and Coke Co	Kansas City.
Flowers, Charles	Macon.
Gilstrap & Miller	New Cambria.
Home Coal Company of Macon	Box 222, Macon.
Isaacson, Alfred, Coal Co	Callao.
Johnson Coal Company	New Cambria.
Lingo Coal Company	New Cambria.
Lucus Brothers	R. 2, Excello.
Macon Co-op. Coal and Mining company	Box 22, Macon.
Mears Coal Company	Macon.
Midway Fuel Company	Bevier.
Morell Coal Company	R. 4, Callao.
Mulky Block Coal Co	Macon.
Riley Brown Coal company	Jacksonville.
R. O. Terrell Coal Company	R. 4, Callao.
Roberts Coal Company	Macon.
Truitt Coal Mine	R. 2, Bevier.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
MONROE COUNTY—	
Bishop Coal Mine	R. F. D., Holliday.
Duvall Coal Mine	Madison.
Montgomer & Company	Paris.
Maxey Coal Mine	Madison.
Maxey, James W	Madison.
MONTGOMERY COUNTY—	
Hays Coal Mine	Wellsville.
PUTNAM COUNTY—	
Aitken & Kingston	R. 7, Unionville.
Anders Brothers	R. 8, Unionville.
Ball Coal Company	R. 2, Coatseville.
Billingston Brothers	Stahl.
Brooks Mining Company	R. 8, Unionville.
Choate, Andy	Unionville.
Daisyville Coal Mine	R. F. D., Powersville.
Dole, Bert & Son	Mendota.
Dole, Bert & Son	Mendota.
Dixon Coal Mine	R. 8, Unionville.
Garr Coal Company	Coatesville.
Gray, William	R. 3, Unionville.
Guffy, J. H	Unionville.
Herndon & Duncan	Unionville.
Holman Coal Mine	R. F. D., Livonia.
Hurley Coal Company	R. 2, Livonia.
Mathes & Son Coal Mine	Livonia.
Maulsby & Probasco	Unionville.
McFarland Coal Mine	Livonia.
Mendota Block Coal Company	Mendota.
Missouri Block Coal Company	Unionville.
Murray, J. E	Powersville.
Ledford Coal Mine	Stahl.
Ray, Weaver	R. 1, Livonia.
Rowland Brothers	Worthington.
Salsberry, Jake	Unionville.
Shrake, Ollie	Livonia.
Salsberry, Jacob	R. 4, Unionville.
Stockton Coal Company	Livonia.
Stockton Coal Mine	Unionville.
Taylor & Stockton Coal Company	Livonia.
Tietsort, James	R. 2, Livonia.
Trent, Leland	R. 8, Unionville.
Trent & Thorn	Unionville.
Walnut Coal Company	Unionville.
Willett, J. E	R. 6, Unionville.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
RALLS COUNTY—	
Clark Coal Company	Perry.
Boudener Coal Company	Perry.
Davis Coal Mine	Perry.
Howard, Frank	Perry.
Hurley Coal Mine	Perry.
Mills, Jess	Perry.
Perry Coal Company	Perry.
RANDOLPH COUNTY—	
Allsup, H. W	R. 4, Moberly.
Anderson Mine	Moberly.
Brewer Coal Mine	Moberly.
Burgin J. W	Moberly.
Busy Bee Co-operative Coal Co	Huntsville.
Cabel Coal Mine	Huntsville.
Cannon Coal Mine	Clark.
Cronan, R	Moberly.
Doleshy Mine	Moberly.
Dougherty, J. C	Higbee.
Eravi Coal Mine	Moberly.
Frazier Coal Mine	Huntsville.
Harris Coal Mine	Clifton Hill.
Harrison, Hill Coal Company	Moberly.
Headrick Coal Mine	Moberly.
Hill Coal Company	Huntsville.
Home Co-operative Coal Company	Huntsville.
Johnson Coal Mine	Huntsville.
Kaufman Coal Company	Huntsville.
Kerr & Kraft Coal Company	Huntsville.
Kribbs Brothers	Moberly.
Long & Son Coal Company	Clifton Hill.
Marriott Coal Company	Moberly.
Mea Brothers Coal Company	Moberly.
Moberly Fuel and Transfer Company	Moberly.
Moniteau Coal Company	Higbee.
Oglesby & Jackson	Perry.
Pickett Coal Mine	Huntsville.
Powell S. G	Perry.
Rodger Brothers	Huntsville.
Shifflet Coal Mine	Huntsville.
Slaughter Coal Company	Renick.
Sours, G. S	Moberly.
Summers & St. Clair	Huntsville.
Sunderland G. A	R. 6, Moberly.
Tharp Coal Mine	Huntsville.
Turner, Wm	Perry.
Williams Coal Mine	Moberly.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
RAY COUNTY—	
Berry, W. A., & Company	Camden.
Boyce, Thos. Jr	Richmond.
Bryant & Melling, Dought Coal Company	Richmond.
Bryce, J. W., & Son	R. 4, Richmond.
Bucklinger, J. F	R. 3, Hardin.
Clark, T. J., Coal Company	Hardin.
Clark & Falknor	Hardin.
Clark Lampton Coal Company	Hardin.
Clay, Coal & Mining Co	Excelsior Springs.
Collier, J. W	Hardin.
Conrow & Williams	Richmond.
Crispin Coal Company	Richmond.
Edgar Coal Company	Norborne.
East Side Coal and Mining Co	Camden.
Elmira Coal Co	511 Interstate, K. C.
Fowler Coal and Mining Company	Richmond.
Hubbell-Hamilton Coal Co	Richmond.
Hugh Blair Mining Company	R. 1, Rayville.
Leibold & Davidson Coal Company	R. 3. Hardin.
Loeven, T. J., Coal Company	Hardin.
Mercantile Coal and Mining Company	Richmond.
Ottman & Dickson Coal Company	Richmond.
Pickering Coal Company	Richmond.
Quick Coal Company	Hardin.
Ray County Coal Company	Richmond.
Rayville Coal Company	Rayville.
Seek & Bryan Coal Company	R. 4, Norborne.
Thomas Brothers Coal Company	Orrick.
Three "W" Coal Company	Henrietta.
Valkema Coal Company	Richmond.
Vibbard Coal Mining Company	Vibbard.
Massey Coal Company	Richmond.
Strider Floyd	Richmond.
SALINE COUNTY—	
C. L. Coal Company	Nelson.
Fizer Coal Mine	Slater.
ST. CLAIR COUNTY—	
Collins Marion	Osceola.
Greathouse, F. L	Osceola.
Humphrey Coal Mine	Osecola.
Miller and Butcher	Osecola.
Miller, J. M	Osceola.
Roberts, C. L	Osceola.
Sanders & Hoover	Osceola.
Seymour & Collins	Osceola.
Smith Coal Mine	Osceola.

LIST OF COAL PRODUCERS, 1926—Continued.

Operating company.	P. O. address.
SCHUYLER COUNTY—	
Dotson & Veach	Coatesville.
McDade and Hoover	Coatesville.
Livonia Coal Company	Coatesville.
Walter Coal Company	Coal City, Iowa.
VERNON COUNTY—	
Bainter Coal Company	Liberal.
Horton Coal Company	Horton.
Highway Coal Company	Rich Hill.
N. & S. Coal Company	Pittsburg.
WARREN COUNTY—	
Burnett & Company	St. Charles.
Keenan Coal Mine	Warrenton.

COPPER, COBALT AND NICKEL.

There has been no production of cobalt or nickel in the Fredericktown district during the past two years, and the only copper produced was recovered from a middling product obtained in milling southeast Missouri lead ores.

Two interesting occurrences of metallic copper have been noted during the past year. At the Mason-Rohrer flint-diaspore clay pit, near Belle, thin flakes of metallic copper occur in a bed of fire clay, which carries black spots of asphaltic like organic material. This is the first occurrence of copper noted in any of the pits to date. A sample of crystallized metallic copper has been sent to this office, which is reported to have been found at the Ruepple mine in Franklin County. While not commercial these are interesting occurrences of the native metal not heretofore noted.

IRON ORE.

The production of iron ore during the past two years has come almost exclusively from Iron Mountain and the Ruepple mine of the Southern Acid and Sulphur Company, located in Franklin County. Some limonite or brown iron ore was also produced by the Iron Hill Ore Company, from the Barrett Mine in Wayne County during the biennial period. Some prospecting has been carried on in the central red ore district, but no new

properties have come into production. There has been very little work done on the brown ore of southeast Missouri during the period, although at the present time work is progressing on the rehabilitation of the property formerly owned by the Missouri Iron and Steel Company at Brandsville. Plans to reconstruct the furnace and operate the Carson Mine are under way.

A rather extensive campaign of development has been under way during the past year at Iron Mountain. This work is under the direction of the M. A. Hanna Company of Cleveland, and is still in progress. The concentrating plant has been in continuous operation during the past year, the finished product being shipped to the St. Louis Coke and Chemical Company at East St. Louis.

LEAD ORE.

The value of lead ore mined decreased in 1926 and 1927, and the output of concentrates was below the 1925 production. The tons of crude ore hoisted in southeast Missouri was greater than any preceding year, although the lead content was less than formerly. The market price was lower.

The following tables showing production and value are reproduced from the reports of the United States Bureau of Mines.

Considerable wildcat drilling has been carried on in Madison, Washington, and adjoining counties. Formerly all prospecting in the southeast Missouri district was done by diamond drills as the formations encountered were free from chert. During the past few years churn drills have been utilized to some extent as holes can be drilled in wildcat territory more cheaply and in certain soft strata, where core recovery is poor, the results with the churn drill are probably more reliable.

During the past year the St. Joseph Lead Company has erected a mill on the Mine Lamotte tract north of Fredericktown. The St. Louis Smelting and Refining Company has continued an extensive drilling campaign on the Schulte and adjoining lands near the same city. Drilling has recently been resumed on the leases of the Missouri Lead Company, the former campaign having been stopped some two years ago.

Some development work has been done in Miller, Morgan, and adjoining counties although the activities near Linn Creek have been abandoned.

PRODUCTION OF LEAD IN MISSOURI 1925-1927.

District.	1925.				1926.				1927.			
	Galena.		Carbonate.		Galene.		Carbonate.		Galene.		Carbonate.	
	Quant. (short tons).	Value.	Quant. (short tons).	Value.	Quant. (short tons).	Value.	Quant. (short tons).	Value.	Quant. (short tons).	Value.	Quant. (short tons).	Value.
Southwestern Missouri:												
Aurora, Bryceville and Wentworth (f)	.....	.....	.....	.....	.....	.....	12	$1,014	18	$1,440	.....	.....
Carthage and Carl Junction (a)	25	$2,600	.....	.....	.....	.....	.....	.....	2	170	.....	.....
Duenweg, Porto Rico (d)	385	45,162	.....	.....	1,238	$136,180	.....	.....	1,225	110,100	.....	.....
Granby	473	48,435	.....	.....	481	48,220	.....	.....	235	17,085	.....	.....
Joplin and Smithfield (b)	1,169	130,733	277	$23,510	1,595	167,162	147	12,500	559	45,072	200	$12,000
Oronogo	184	19,210	.....	.....	139	12,090	.....	.....	147	10,057	.....	.....
Spring City and Seneca	.....	.....	.....	.....	122	13,398	33	1,629	.....	.....	.....	.....
Spring City and Spurgeon	254	27,749	109	9,581	.....	.....	.....	.....	73	6,192	100	6,000
Smithfield, Zincite and Belleville (f)	.....	.....	.....	.....	1,042	113,185	.....	.....	164	14,826	.....	.....
Thoms Station	28	3,242	.....	.....	.....	.....	.....	.....	325	24,802	.....	.....
Waco	151	14,526	.....	.....	75	7,634	.....	.....	168	12,803	.....	.....
Webb City, Carterville and Prosperity (g)	492	57,669	.....	.....	360	36,494	.....	.....	180	15,202	.....	.....
Dade and Hickory counties	.....	.....	.....	.....	43	4,400	.....	.....	10	850	.....	.....
Other counties (e)	22	2,422	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	3,183	$351,748	386	$33,091	5,095	$538,763	192	$15,143	3,106	$258,599	300	$18,000
Southeastern and Central Missouri	314,530	31,740,442	.....	.....	300,480	28,239,733	.....	.....	279,441	23,360,294	.....	.....
	317,713	$32,092,190	386	$33,091	305,575	$28,778,496	192	$15,143	282,547	$23,618,893	300	$18,000

(a) Carl Junction in 1925 and 1927 only.
(b) Smithfield in 1925 only; Joplin only in 1926 and 1927.
(c) Spring City in 1925 only.
(d) Duenweg in 1926 only.
(e) Barry, Hickory and Ozark in 1925.
(f) Includes Smithfield and Zincite in 1926; Smithfield and Belleville in 1927.
(g) Does not include Prosperity in 1926 and 1927.

TENOR OF CRUDE LEAD ORE AND CONCENTRATES IN SOUTHWEST MISSOURI, 1925-1926.

	1925.	1926.
Total crude ore, short tons	662,200	1,025,500
Total lead concentrates in crude ore, per cent	0.54	0.54
Lead content of crude ore, per cent	0.41	.39
Average lead content of galena concentrates, per cent	76.8	76.8
Average lead content of carbonate concentrates, per cent	60.0	60.0
Average value per ton:		
Galena concentrates	$110.51	$105.74
Carbonate concentrates	85.73	78.87

VALUE AND TENOR OF LEAD ORES, 1923-1927.

Year.	All Missouri.		Southeast Missouri only.				
	Total concentrates.	Total value concentrates.	Total crude ore.	Galena concentrates in crude ore.	Lead in crude ore.	Average lead in concentrates.	Average value per ton concentrates.
1923	262,442	$19,692,318	5,314,900	4.88	3.21	65.9	74.94
1924	296,004	25,037,380	6,059,700	4.83	3.26	67.6	84.55
1925	317,972	32,112,009	6,209,800	5.06	3.43	67.6	100.91
1926	305,767	28,793,639	6,261,600	4.80	3.32	69.0	93.98
1927	282,847	23,636,893	6,310,200	4.42	3.17	71.7	83.62

LIME.

Missouri is one of the important centers of the lime manufacturing industry, ranking fourth among the states in the Union in 1926, the total value being $2,218,943. In 1927 the total value was $2,189,420.

Extensive deposits of high grade limestone capable of yielding an excellent quality of high calcium lime are available in this State. The bulk of the production reported comes from Ste. Genevieve County, where the oolitic limestone of the Spergen formation of Mississippian age, and the light-colored limestone of the Kimmswick formation of Ordovician age are available. The lime in this county and the geological formations are described in considerable detail in a report recently prepared by the Geological Survey. A map showing the distribution of the rock formations accompanies the report.

The Burlington limestone, of Mississippian age, is utilized at Pierce City, Ash Grove, Galloway, and Osceola, in the southwest part of the State, and near Hannibal, in the northeast part of the State. The Kimmswick limestone is burned in the St. Louis district.

The lime manufactured in Missouri has a high calcium content, and is low in magnesium. The product is especially fitted for uses requiring a high grade chemical lime. The uses of the lime are varied, and increase annually. Besides those given in the statistical tables given below there may be mentioned, calcium carbide, insecticides, gas and by-product coke, calcium acetate, purification of mineral and organic greases, bleaching powder, acetic acid, soaps, glue works, silica and sand lime brick, and in alkali works.

In 1927, twelve plants with a toal of 85 kilns, and a capacity of 1323 tons of lime per day were in operation in the State.

Tables covering the production and value of lime in 1925, 1926 and 1927, and a list of producers are given below. A table showing the total value of the production from 1926 to 1927 is also given.

PRODUCTION AND VALUE OF LIME, 1916-1927.

Year.	Lime.			Hydrated lime.		
	Quantity (tons).	Value.	Average value per ton.	Quantity (tons).	Value.	Average value per ton.
1916.....	199,260	$956,300	$4.81	24,647	$128,903	$5.24
1917.....	234,936	1,435,914	6.48	32,120	219,600	6.88
1918.....	166,795	1,376,046	8.25	34,942	345,754	9.90
1919.....	141,504	1,333,095	9.42	39,245	402,620	10.26
1920.....	157,126	1,735,002	11.04	51,987	584,283	11.24
1921.....	113,291	1,169,391	10.32	45,903	487,169	10.61
1922.....	147,960	1,402,337	9.48	56,024	551,187	9.84
1923.....	182,503	1,830,937	10.03	63,823	674,848	10.57
1924.....	182,814	1,711,180	9.36	60,651	642,995	10.60
1925.....	202,058	1,860,244	9.21	71,290	750,710	10.50
1926.....	180,016	1,428,412	7.93	83,451	790,531	9.47
1927.....	183,374	1,437,140	7.81	84,402	752,280	8.91

OUTPUT, VALUE AND USES OF LIME BURNED IN 1925-1927. (*a*)

Use.	1925.		1926.		1927.	
	Quantity (tons).	Value.	Quantity (tons).	Value.	Quantity (tons).	Value.
Building, chemical.....	94,910	$881,105	123,057	$1,096,531	101,763	$929,260
Paper mills....	15,766	174,265	13,824	123,224	18,381	144,935
Tanneries.....	3,291	31,936	*b*	*b*	2,384	20,615
Metallurgy....	34,553	281,596	26,537	177,817	27,456	189,949
Water treating.	32,267	321,527	32,087	252,414	31,909	267,664
Other.....	92,561	920,525	67,962	568,957	85,883	636,997
Totals....	273,348	$2,610,954	263,467	$2,218,943	267,776	$2,189,420

(*a*) Including hydrated lime.
(*b*) Included under other use to conceal individual totals in 1926.

PRODUCERS OF LIME IN MISSOURI, 1926-1927.

Producers.	Location.
GREENE COUNTY—	
Ash Grove Lime and Portland Cement Co	Ash Grove and Galloway.
The Marble Head Lime Co	Springfield.
LAWRENCE COUNTY—	
Pierce City Lime Co	Pierce City.
MARION COUNTY—	
The Marblehead Lime Co	Hannibal.
RALLS COUNTY—	
Bluff City Lime and Stone Co	
ST. CLAIR COUNTY—	
Osceola White Lime Co	Osceola.
STE. GENEVIEVE COUNTY—	
Arrowhead Manufacturing Co	Brickeys.
Peerless White Lime Co	Mosher.
Ste. Genevieve Lime and Quarry Co	Ste. Genevieve.
Western Lime Works	Ste. Genevieve.
Bluff City Lime and Stone Co	Ste. Genevieve.
ST. LOUIS COUNTY—	
Glencoe Lime and Cement Co	Mincke, Glencoe.
Centaur Lime Co	Glencoe.

MINERAL WATERS.

Excelsior Springs, Clay County, continues to be the center of the mineral water industry in Missouri, the bulk of the total production being reported from this famous watering place. Production is also reported from a number of other counties, and there are, no doubt, many mineral springs that are used locally, but not exploited commercially.

The springs given below reported the production of mineral waters in 1926 and 1927. The accompanying table shows the value of the production from 1912 to 1927.

PRODUCTION OF MINERAL WATERS, 1912-1927.

Year.	Value.
1912	$81,114
1913	84,316
1914	74,793
1915	83,363
1916	109,814
1917	57,175
1918	38,478
1919	39,641
1920	50,892
1921	45,670
1922	40,149
1923	38,145
1924	30,000
1925	32,000
1926	41,955
1927	29,452

MINERAL SPRINGS REPORTING PRODUCTION IN 1926-1927.

Proprietor.	Name of spring.	Location.
BERRY COUNTY—		
W. H. Cloe, manager	Radium Springs	Near Seligman.
CEDAR COUNTY—		
Wm. Reed	Eldorado Springs	Eldorado Springs.
CLAY COUNTY—		
Crystal Mineral Water Company	Crystal Mineral Springs	Excelsior Springs.
Excelsior Saline Water Company	Excelsior Saline	Excelsior Springs.
Mrs. H. Varney	Lithia No. 1	Excelsior Springs.
Salt Sulphur Water Company	Salt Sulphur Wells	Excelsior Springs.
Natrona Springs Water Company	Natrona Wells	Excelsior Springs.
Mrs. Callerman	Soda Saline Well	Excelsior Springs.
Sulpho-Saline Water Company		Excelsior Springs.
COOPER COUNTY—		
A. E. Windsor	Chouteau Springs	Chouteau Springs
JACKSON COUNTY—		
Ulrich & Boisin	Crystal Springs	Kansas City.
JEFFERSON COUNTY—		
Bokert Springs Mineral Water Co.	Bokert Springs	De Soto.

MINERAL SPRINGS REPORTING PRODUCTION IN 1926-1927—Continued.

Proprietor.	Name of spring.	Location.
MERCER COUNTY—		
J. S. Haymaker	Haymaker	Lineville.
PIKE COUNTY—		
The Bowling Green Mineral Spring Company	B. B., Epzo, Fronzo and Bowling Green Lithia Water	Bowling Green
Amos and Margaret Turner	Hornet	Bowling Green.
ST. LOUIS COUNTY—		
Belcher Water, Bath and Hotel Company	Belcher Artesian Well	St. Louis.
Old Orchard Mineral Springs	Old Orchard Mineral	St. Louis.
SALINE COUNTY—		
Missouri Mineral Water Company	Sweet Springs	Sweet Springs.

PETROLEUM AND NATURAL GAS.

Missouri has never been classed as an important producer of these fuels, although small quantities have been obtained from shallow wells drilled into the Pennsylvanian series in Western Missouri. The production in recent years has been so small and so intermittent that no attempt has been made to collect the statistics covering the production and value. However, during the next few years at least, some production will be reported, for drilling on the Belton anticline south of Kansas City has resulted in opening a gas field of sufficient size to warrant the construction of a pipe line into Kansas City. Small showings of oil and gas have been obtained in the Belton area from time to time, but little success was had, and it remained for systematic drilling to develop the field. Oil has also been found in some of the new wells, and the chances of small production appear to be favorable. The Belton structure has been known for some time and was described in Volume XVI, 2nd Series, published by the Geological Survey.

A small production of gas has also been obtained near Lees Summit in Jackson County, and no doubt other favorable localities occur in the area underlain by the Pennsylvanian series in Western Missouri.

Several deep tests have been put down in the northwest part of the State. Here the Pennsylvanian series has a total known thickness of at least 1700 feet, and the lower part contains sand bodies favorable for the accumulation and storage of oil and gas. Structural features favorable for the storage of these fuels are also present, but detailed mapping has been hindered by the thick mantle of glacial drift which covers the northwest part of the State. Deep tests in this area are being watched with considerable interest. Small quantities of gas have also been obtained from shallow wells in Vernon County, the geology of which has been described in a survey report. Reports covering the State in general, and a large area in northwestern Missouri have also been issued.

PYRITES.

Commercial deposits of pyrites are found in the red hematite region of the Central Ozarks. There is no production from this region at the present time, due to the abundance of native sulphur produced in Louisiana and Texas. Formerly sulphur was recovered from the ores produced at the cobalt nickel mines of the North American Lead Company, near Fredericktown. The ore was shipped to St. Louis for roasting and the calcines returned to Fredericktown for treatment.

SAND AND GRAVEL.

The value of the production of sand and gravel in 1926 and 1927, and the various uses of the output are shown in the tables given below.

With the exception of the north part where lenses of sand and gravel are only present locally, the State is well supplied with deposits of these materials. Sand and gravel are present along the Mississippi and Missouri Rivers, and also along most of the streams in the Ozark region. High grade sand used for the manufacture of plate glass, and in general foundry practice is obtained from the St. Peter sandstone, which outcrops in a continuous belt from west of St. Louis to Northern Scott County in southeast Missouri.

The sand and gravel deposits of the State have been described in detail in Volume XV, published by the Survey, copies of which may be had upon application.

A list of producers of sand and gravel, and statistics covering the production and value for 1926 and 1927 are given below.

OUTPUT AND VALUE OF SAND AND GRAVEL FOR 1926-1927.

	1926.		1927.	
	Quantity. (Short tons.)	Value.	Quantity. (Short tons.)	Value.
Building sand	1,022,297	$595,522	852,775	$553,902
Building gravel	845,347	601,187	1,207,632	754,441
Paving sand	1,135,697	670,516	672,383	411,159
Paving gravel	786,571	511,273	845,819	550,980
Glass sand	145,383	204,067	99,026	144,259
Molding sand	86,035	60,362	96,961	66,239
Engine sand	25,422	17,526	26,439	17,606
Other sands (*a*)	225,045	190,278	165,495	145,549
Railroad ballast	340,155	129,511	862,943	231,395
Totals	4,611,952	$2,980,242	4,829,473	$2,875,530

(*a*) Includes grinding and polishing and other sand in 1924; grinding and polishing, fire or furnace and other sand in 1925.

(*a*) Includes blast, cutting and grinding, other gravel and other sand in 1926.

(*a*) Includes cutting and grinding sand, blast sand, fire or furnace and other sand in 1927.

PRODUCTION OF SAND AND GRAVEL, 1913-1927.

Year.	Quantity (short tons).	Value.	Average value per ton.
1913	4,126,126	$1,109,233	$0.27
1914	3,528,678	1,020,903	.29
1915	2,889,211	675,684	.23
1916	3,643,205	877,634	.24
1917	2,274,072	1,101,745	.48
1918	1,743,616	772,753	.44
1919	1,665,295	873,333	.52
1920	1,909,314	1,356,352	.71
1921	1,539,073	1,018,325	.51
1922	1,970,345	1,063,370	.54
1923	3,719,243	2,007,529	.54
1924	4,081,200	2,053,436	.50
1925	5,523,605	3,595,187	.65
1926	4,611,952	2,980,242	.64
1927	4,829,473	2,875,530	.59

LIST OF SAND AND GRAVEL PRODUCERS, 1926-1927.

Operator.	Name of product.	Location.
BOLLINGER COUNTY—		
Lutesville Sand and Gravel Co. . .	Paving sand, gravel.	Lutesville.
BUCHANAN COUNTY—		
Pioneer Sand Co.	Building sand, paving. . . .	St. Joseph.
BUTLER COUNTY—		
Randles Sand and Gravel Co. . . .	Building sand and gravel. .	Poplar Bluff.
Energy Coal and Supply Co.	Building sand, paving sand, gravel.	Poplar Bluff.
CAPE GIRARDEAU COUNTY—		
Cape Girardeau Sand Co.	Building sand.	Cape Girardeau.
COLE COUNTY—		
Jefferson City Sand and Gravel Co.	Building sand.	Jefferson City.
COOPER COUNTY—		
Missouri River Sand and Gravel Co.	Building sand, paving sand.	Boonville.
FRANKLIN COUNTY—		
The St. Louis Material and Supply Co.	Building sand, gravel.	Moselle and Pacific
W. W. Goran.	Molding sand.	Gray Summit.
Denton Sand and Gravel Co. . . .	Paving and road making. .	Pacific.
Pioneer Silica Products Co.	Glass.	Pacific.
Tavern Rock Sand Co.	. . . . .	Pacific.
Ed. E. Squier Co.	. . . . .	Pacific.
HOWARD COUNTY—		
Glasgow Sand Co.	Building sand.	Glasgow.
JACKSON COUNTY—		
Stewart Sand Co.	Building sand.	Kansas City.
Woods Bros. Const. Co.	Paving and road making. .	Kansas City.
JASPER COUNTY—		
Independent Gravel Co.	Structural sand, paving and road making.	
JEFFERSON COUNTY—		
Pittsburg Plate Glass Co.	Glass sand.	Crystal City.
American Silica Sand and Mining Co.	Molding sand, glass sand. .	Herculaneum.
Silica White Sand Co.	Molding sand, grinding and polishing sand.	Silica.

LIST OF SAND AND GRAVEL PRODUCERS, 1926-1927—Continued.

Operator.	Name of product.	Location.
JEFFERSON COUNTY—*Continued.*		
Denton Sand and Gravel Co.	Building and paving sand and gravel	Pacific.
Hematite Sand and Gravel		Hematite.
Missouri Silica Mining and Mfg. Co.	Molding sand	237 Frisco Bldg., St. Louis, Mo.
LEWIS COUNTY—		
Keokuk Sand Co.	Structural sand	Keokuk, Iowa.
Missouri Gravel Co.	Structural paving and road making sand	LaGrange.
State of Missouri Highway Dept.		LaGrange.
LIVINGSTON COUNTY—		
Johnson-Hudson Gravel Co.		Chillicothe.
Sampsel Gravel Co.		Sampsel.
MERCER COUNTY—		
Chicago, Rock Island & Pacific.		Princeton.
MARION COUNTY—		
Lawson Sand Co.	Structural, paving and road making	Hannibal.
PEMISCOT COUNTY—		
Missouri Sand and Gravel Co.	Structural, road making, paving	
PHELPS COUNTY—		
LittlePiney Sand and Gravel Co.	Building sand, gravel	Newburg.
PIKE COUNTY—		
Northeast Missouri Sand and Gravel Co.		Bowling Green.
Chicago & Alton R. R. Co.		Louisiana.
ST. CHARLES COUNTY—		
Tavern Rock Sand Co.	Glass sand	Klondyke.
St. Charles Sand and Material Co.	Paving and road making	St. Charles.
ST. LOUIS COUNTY—		
Missouri Portland Cement Co.	Gravel, building sand	Drake.
Meramec Portland Cement and Material Co.	Building sand, gravel	Sherman.
St. Louis Material and Supply Co.	Building sand, gravel	314 N. Fourth St., St. Louis.
Missouri Pacific Ry. Co.		Jedburg.
Alpha Portland Cement Co.		St. Louis, Valley Park.

LIST OF SAND AND GRAVEL PRODUCERS, 1926-1927—Continued.

Operator.	Name of product.	Location.
St. Louis City—		
W. W. Ruprecht	Structural sand	
John W. Allen & Son	Molding sand	St. Louis (Carondelet).
Missouri Portland Cement	Building sand	St. Louis.
St. Louis Material and Supply Co.	Building sand and gravel	St. Louis.
Stoddard County—		
Halleck & Hill	Paving and road making	Bloomfield.
Wayne County—		
Missouri Pacific Ry. Co.		Leeper.

SILVER.

Each year there is a comparatively small output of silver credited to this State. This metal is recovered in refining the lead obtained from concentrates shipped from the disseminated lead district of southeast Missouri. The recovery usually varies from 70,000 to 175,000 ounces, depending on the quantity of lead refined.

There has been no production of silver from the Einstein mine in Madison County. This property formerly produced galena carrying from 30 to 40 ounces of silver per ton. It is the only known point in Missouri where galena carries commercial quantities of silver.

PRODUCTION OF SILVER IN MISSOURI, 1921-1927.

Year.	Ounces.	Value.
1921	69,902	$ 69,902
1922	212,656	212,656
1923	177,270	145,361
1924	103,694	69,475
1925	86,340	57,538
1926	90,000	56,160
1927	233,931	132,638

STONE.

The stone industry enjoyed its record year in 1926, the value of the production being $6,399,919. The value of the production in 1927 $5,783,526 was less than in 1926, but with the exception of the years 1925 and 1926 was higher than in any preceding years.

Missouri's geological make-up is such that with the exception of an area in thd north central part of the State, underlain by the Coal Measures, deposits of stone suitable for many purposes are available. At present deposits of limestone, marble and granite are being worked. Production of low grade iron ore from Pilot Knob, classified as stone, is also reported in 1926 and 1927. The value of chats, crushed rock from the mill tailings in southeast and southwest Missouri is included in the table showing the value of the output.

The table given below shows the value of the production of stone from 1912 to 1927.

VALUE OF STONE PRODUCED IN MISSOURI, 1912-1927.

Year.	Limestone.	Marble.	Granite.	Sandstone.	Chats.	Total.
1912....	$2,373,725	(a)	$97,776	$15,004	$408,510	$2,895,015
1913....	2,486,020	(a)	42,484	10,195	304,331	2,843,030
1914....	2,160,958	(a)	77,971	3,588	340,616	2,583,133
1915....	2,049,772	(a)	85,624	10,104	346,358	2,491,858
1916....	1,990,419	156,942	80,390	14,991	433,645	2,676,387
1917....	1,679,677	227,520	58,241	6,862	214,007	2,186,307
1918....	1,359,755	238,111	54,523	(b)	135,319	(c) 1,787,708
1919....	1,759,029	360,287	(b)	(d)	206,353	(e) 2,325,669
1920....	2,776,936	616,550	114,663	(b)	167,028	(c) 3,675,177
1921....	2,269,457	627,729	81,389	(d)	259,571	3,238,146
1922....	2,409,202	816,098	85,093	(b)	(f)306,252	(c) 3,593,183
1923....	3,173,622	1,085,122	83,804	(b)	(f)431,884	(c) 4,795,370
1924....	3,624,089	1,229,160	108,084	(d)	520,269	5,473,613
1925....	4,085,883	1,439,604	137,348	(d)	399,002	6,058,874
1926....	4,416,006	1,446,983	(g) 154,850	(d)	382,080	6,399,919
1927....	4,002,987	1,108,159	(g)145,447	(d)	526,933	5,783,526

(a) Included in limestone.
(b) Not given, less than three producers.
(c) Not including sandstone.
(d) No production.
(e) Not including granite.
(f) Revised.
(g) Also includes trap rock.

LIMESTONE.

As shown by the table below, there has been an increase in the use in limestone for various purposes, and consequently an increase in the total value of the production. As compared with the value of 1924 and 1925, there was an increase in the value of limestone used in 1926, for concrete and road making, for riprap, for agriculture limestone, and for purposes indicated in the footnote at the bottom of the table. A decrease in the value of limestone produced in 1927 is indicated by the total shown. The greatest decrease is in limestone used for concrete and road making, attributed in part at least to a less vigorous road making campaign, due to the expenditure of the funds available from the $60,000,000 road bond issue voted in 1922.

The passage of the $75,000,000 bond issue in 1928 will call for an extension of the Highway System, and an increase in the value of limestone used for this purpose may be expected.

A table showing the value of limestone produced in 1924 to 1927, and a list or producers are given below.

VALUE OF LIMESTONE PRODUCED ACCORDING TO USES, 1924-1927.

Purpose.	1924	1925	1926	1927
Rough construction	$4,333	$19,920	$3,440	
Dressed building	.....	.....	.....	b
Rubble	394,687	405,948	327,105	240,311
Riprap	347,758	262,592	597,309	565,165
Railroad ballast	125,070	80,516	78,400	344,006
Concrete and road making	2,433,438	3,003,754	3,107,147	2,522,539
Flux	80,921	(a)	11,952	10,277
Glass factories	46,760	(a)	b	40,092
Agriculture	16,690	54,668	71,523	77,875
Miscellaneous (b)	171,432	258,485	219,130	202,722
Totals	$3,624,089	$4,085,883	$4,416,006	$4,002,987

(a) Less than three producers, concealed under "miscellaneous."

(b) Includes paper mills, lime burners, paving and curbing, sugar factories, whiting filler for asphalt, rubber, and paint, and other uses.

PRODUCERS OF LIMESTONE IN MISSOURI, 1926-1927.

Firm.	Type and uses of stone.	Location of quarry.
ANDREW COUNTY—		
St. Joseph Quarry Co	Concrete	
Wyeth Stone Co	Riprap; road metal and concrete	Wyeth.
Stewart Stone Co	Rubble; riprap; road metal and concrete	Amazonia.
Missouri State Penitentiary	Road metal and concrete	
BOONE COUNTY—		
J. N. Fellows	Riprap, concrete, agricultural	Columbia.
Spencer-Whitlow Co	Concrete, rubble, agricultural	Columbia.
U. S. Engineers Office	Riprap	Wilton.
Missouri State Penitentiary	Riprap, road metal and concrete	
BUCHANNAN COUNTY—		
Reinert Bros	Rubble, riprap, concrete, railroad ballast, agricultural	St. Joseph.
Heumader Quarry Co	Road metal and concrete	
CALLAWAY COUNTY—		
U. S. Engineers office	Riprap	Cedar City.
Aux Vases Quarry Co	Road metal and concrete	
Missouri Limestone Co	Road metal and concrete	Auxvasse.
CAPE GIRARDEAU COUNTY—		
Edward Hely	Concrete, railroad ballast, road making, agricultural	Cape Girardeau.
The Arnold Stone Co	Riprap	Neely's Landing.
John Barrett & Co., Inc	Riprap	Neely's Landing.
Marquette Cement Mfg Co	Road metal and concrete, railroad ballast	Cape Girardeau.
CARROLL COUNTY—		
U. S. Engineers Office	Riprap	
Johnson Hudson Co	Road metal and concrete	
CLAY COUNTY—		
Clay County Crushed Rock Co	Road metal and concrete	Birmingham.
S. H. Atwood & Son	Riprap, road metal and concrete	Liberty.
Lester Clevenger	Riprap	
Consolidated Crushed Stone Corp.	Road metal and concrete	
Consumers Material Corp		
CLINTON COUNTY—		
James J. Atterbery	Road metal and concrete	

PRODUCERS OF LIMESTONE IN MISSOURI, 1926-1927—Continued.

Firm.	Type and uses of stone.	Quarry. location
COLE COUNTY—		
J. W. Keeney	Riprap, road metal and concrete	
Joseph Klug	Rough construction	
Pope Construction Co	Concrete	Cottonrock.
U. S. Engineers Office	Riprap	Osage City.
COOPER COUNTY—		
Blackwater Stone Co	Road metal and concrete	Blackwater.
Missouri State Reformatory	Riprap, road metal and concrete, R. R. ballast	
S. J. White Stone Co	Concrete, riprap	
Missouri, Kansas & Texas Ry	Railroad ballast, riprap	Sweeney.
DAVIESS COUNTY—		
Consumers Material Corp	Road metal and concrete	
Tulsa Stone Co	Road metal and concrete	
FRANKLIN COUNTY—		
City of Washington	Road metal and concrete	Washington.
U. S. Engineers Office	Riprap	Berger.
L. G. Krull	Concrete	
GREENE COUNTY—		
Ash Grove Lime and Portland Cement Co	Road metal and concrete	Ash Grove, Galloway.
Springfield Special Road Dist	Road metal and concrete	
Missouri Crushed Stone Product	Road metal and concrete	
Phenix Marble Co	Rough architectural dressed rubble	Phenix.
Stigall Construction	Road metal and concrete	
J. Samuel Williams	Road metal and concrete	
Greene County	Roadmaking	Springfield.
Horton Stone Co	Roadmaking	Springfield.
Marblehead Lime Co	Lime, roadmaking, railroad ballast, concrete	Springfield.
HARRISON COUNTY—		
Bethany Crushed Stone Co	Riprap, road metal and concrete	
HOWARD COUNTY—		
U. S. Engineer Office	Riprap	Glasgow-Lisbon.
JACKSON COUNTY—		
Kansas City Public Service	Riprap, road metal and	
Kansas City Public Service	Riprap, road metal and concrete	

PRODUCERS OF LIMESTONE IN MISSOURI, 1926-1927—Continued.

Firm.	Type ond uses of stone.	Location of quarry.
JACKSON COUNTY—*Continued.*		
Consumers Material Corp.	.....	
W. A. Ross Const. Co	Road metal and concrete	Independence.
Atlas Rock Crusher Co	Road metal and concrete	Atlas Investment Co. Quarry.
E. H. Bradbury	Riprap, metal and concrete	
Finlay Malborough Realty Co	Rubble	
Frank Flin Const. Co	Rubble	
W. C. Mullin Const. Co	Road metal and concrete	Kansas City.
National Building Material Co	Road metal and concrete	
U. S. Engineer Office	Riprap	Eton.
W. M. Spencer	Concrete, riprap, rubble, agricultural	Independence.
Beyer Crushed Rock Co	Concrete	
Halpin-Dwyer Const. Co	Concrete	Kansas City.
Frank J. O'Hearn	Rubble	Kansas City.
Swenson Const. Co	Rubble, concrete	Kansas City.
McTernan-Halpin Const	Concrete	26th and Grand Av.
Beaver Crushed Rock Co	Road metal and concrete	
H. J. Nichols	Concrete	
Thompson Bros.	Concrete, rubble	
American Rock Crusher Co	Road metal and concrete	Kansas City, Mo.
K. C. Quarries Co	Concrete, flux, railroad ballast	
Consumers Material Corp.	.....	
John Twyman	Road metal and concrete	Independence.
Missouri Portland Cement	Road metal and concrete	
JASPER COUNTY—		
Carthage Marble and Building Stone Co	Dressed building, flagging, rubble, riprap and for sugar factories	Carthage.
Carthage Marble and White Lime Co	Dressed building, curbing, rubble, and for sugar factories	Carthage.
Carthage Crushed Limestone Co.	Whiting, concrete, flux, glass factories, agricultural, miscellaneous	Carthage.
The Ozark Quarries Co	Rubble	
Independent Gravel Co	Whiting, concrete, flux, glass factories, agricultural, miscellaneous	Joplin.
Spring River Stone Co	Dressed building, flagging.	Carthage.
F. W. Steadley & Co	Rough building	
S. E. Kimberlin	Road metal	Reeds.

PRODUCERS OF LIMESTONE IN MISSOURI, 1926-1927—Continued.

Firm.	Type and uses of stone.	Location of quarry.
JEFFERSON COUNTY—		
Peter McLoon & Co	Fluxing, glass factories, riprap	Barnhart.
LAFAYETTE COUNTY—		
Diamond Coal Co	Concrete	Corder.
U. S. Engineer Office	Riprap	
Wegener & Son	Road metal and concrete	
LINCOLN COUNTY—		
Crystal Carbonate Lime Co	Rubble, riprap, whiting, concrete, flux, glass factories, agricultural, miscellaneous	Elsberry.
LIVINGSTON COUNTY—		
Johnson-Hudson Gravel Co	Road metal and concrete.	
MARION COUNTY—		
Geo. A. Brenham	Riprap, road metal	
Marblehead Lime Co	Concrete, flux, railroad, ballast, agricultural	
Central Stone and Coal Co	Concrete, agricultural	
MONITEAU COUNTY—		
U. S. Engineer Office	Riprap	Sandy Hook.
PIKE COUNTY—		
Marblehead Lime Co	Riprap, railroad ballast, roadmaking	Louisiana.
PLATTE COUNTY—		
Park College	Riprap, rough building, paving	Parkville.
Consumers Material Corp	Road metal and concrete	
RALLS COUNTY—		
Bluff City Lime and Stone Co	Riprap, chemicals, lime	Hannibal.
RANDOLPH COUNTY—		
Lynch-McDoland Const	Road metal and concrete	
RAY COUNTY—		
U. S. Engineer Office	Riprap	
ST. CLAIR COUNTY—		
Osceola Lime Co	Road metal and concrete	
ST. CHARLES COUNTY—		
Weldon Springs Lime Co	Riprap, concrete, agricultural	Weldon Spring.
U. S. Engineer Office	Riprap	

PRODUCERS OF LIMESTONE IN MISSOURI, 1926-1927—Continued.

Firm.	Type and uses of stone.	Location of quarry.
STE. GENEVIEVE COUNTY—		
Ste. Genevieve Lime and Quarry Co	Miscellaneous stone	
Cliffdale Quarrying Mfg. Co		
Peerless White Lime Co	Fluxing, sugar factories, glass factories	Mosher.
Arnold Stone Co	Riprap	Ste. Genevieve.
St. Louis Lime and Cement Co. (Arrowhead Mfg. Co.)	Flux	
Ozora Marble Quarries Co	Riprap	Ozora.
Bussen, Abert		Little Rock.
SALINE COUNTY—		
U. S. Engineer Office	Riprap	
ST. LOUIS COUNTY—		
Stolle Stove Company		
Mutual Quarry Co	Rubble	
Florissant Construction Co	Railroad ballast	Brentwood.
Grant Road Quarry Co	Rubble, riprap, road metal and concrete	Mincke.Carondelet.
Denny Road Quarry Co	Paving, rubble, riprap road metal and concrete	Webster Groves.
Edw. Kasselbaum	Riprap, road metal and concrete	
West End Quarry Const	Curbing, rubble, road metal and concrete	Fern Ridge.
Wm. & F. Ruprecht	Rough const. riprap, concrete	
Albert Bussen	Riprap, railroad ballast	Quarantine.
Jas. F. Rothwell	Rubble, riprap, roadmaking, miscellaneous	Vigus.
Sinclair Quarry and Const. Co	Rubble, riprap, roadmaking, paint grinders	Vigus.
New Jamestown Quarry Co	Concrete, agricultural	
John Steffen Bros.	Rough building, concrete, riprap	
ST. LOUIS CITY—		
Bambrick Bros. Constr. Co	Rubble, roadmaking	St. Louis.
Big Bend Quarry	Rubble, riprap, concrete, miscellaneous	Maplewood.
T. E. Cavanaugh	Rubble, concrete	
Felig Construction Co	Concrete, rubble	St. Louis.
Hoffman Bros. Const	Rough building, riprap, roadmaking concrete	St. Louis.
St. Louis Workhouse Quarry	Riprap, roadmaking	St. Louis.
Tower Grove Quarry and Constr. Co	Riprap, roadmaking, concrete	St. Louis.

PRODUCERS OF LIMESTONE IN MISSOURI, 1926-1927—Continued.

Firm.	Type and uses of stone.	Location of quarry.
ST. LOUIS CITY—*Continued.*		
Union Quarry and Constr. Co...	Rubble, concrete.....	
Rock Hill Quarry.....	Curbing, rubble, riprap, road metal and concrete.	
West St. Louis Quarry.....	Road metal and concrete..	
WARREN COUNTY—		
U. S. Engineer Office.....	Riprap.....	Bernheimer.

MARBLE.

Marble quarries located in Jasper, Greene and Ste. Genevieve counties reported production in 1926. The first mentioned produced approximately three-fourths of the State's total. The stone from the first two counties mentioned is obtained from limestones of Mississippian age, and that from Ste. Genevieve County from slightly metamorphosed limestones of Devonian age. The Ste. Genevieve deposits are described in some detail in a report covering that county, recently published by the Bureau. Some field work has also been done on the marble deposits of the State, preparatory to publishing a detailed report.

PRODUCTION OF MARBLE ACCORDING TO USES, 1923-1926.

	1923.		1924.		1925.		1926.	
	Quantity, cubic feet.	Value.	Quantity, cubic feet.	Value.	Quantity, cubic feet.	Value.	Quantity, cubic feet.	Value.
Rough building, exterior	5,820	$16,625	(a)	(a)	(a)	(a)	(a)	(a)
Rough building, interior	100,840	152,014	148,390	$246,109	$184,360	$263,998	155,630	$274,123
Dressed building, exterior	424,300	541,794	346,830	447,034	400,990	511,165	327,410	445,974
Dressed building, interior	118,060	342,446	159,730	447,294	195,990	577,979	172,140	645,452
Monumental, rough	.....	.....	25,660	40,505	(a)	(a)	.....	.....
Monumental, dressed	20,640	32,243	.....	.....	37,310	83,071	32,630	80,698
Other uses	.....	.....	9,490	18,218	3,080	3,391	6,792	736
Totals	669,660	$1,085,122	690,100	$1,229,160	821,730	$1,439,604	694,602	$1,446,983

(a) Included in "other uses."

MARBLE PRODUCERS IN MISSOURI IN 1926-1927.

Producer.	Use.	Quarry location.
GREENE COUNTY—		
Phenix Marble Co	Rough building (interior), interior and exterior dressed building	Phoenix.
JASPER COUNTY—		
Carthage Marble and Building Stone	Interior and exterior building	Carthage.
Carthage Marble White Lime Co.	Interior dressed building	Carthage.
Consolidated Marble and Stone Co	Interior and exterior rough and dressed building	Carthage.
Spring River Stone Co	Interior and dressed building	Carthage.
Ozark Quarries	Interior and exterior dressed building, monumental	
F. W. Steadley & Co	Exterior dressed building, dressed monumental	Carthage.
Joplin Marble Quarry	Rough and dressed building, dressed monumental	
STE. GENEVIEVE COUNTY—		
Ozora Marble Quarries	Interior	Ozora.

GRANITE.

Outcrops of granite are shown on the State geological map in Crawford, Carter, Reynolds, Iron, St. Francois, Ste. Geneviene, and Madison counties, but at present quarries are in operation in only Iron and St. Francois counties. In 1926 and 1927 five producers reported, and the total value, plus a small amount of miscellaneous stone produced at Pilot Knob, is given in the table covering the production of stone.

A list of producers of granite follows:

GRANITE PRODUCERS IN MISSOURI IN 1926-1927.

Name.	Purpose used for	Quarry location.
IRON COUNTY—		
Schneider Granite Co.....	Rough monumental rubble, rough building....	Graniteville.
A. J. Sheahan Granite Co.....	Rough monumental, paving blocks, riprap, road-making.....	Graniteville.
J. H. Brod Granite Company....	Monumental.....	Graniteville.
ST. FRANCOIS COUNTY—		
A. G. Asplof.....	Paving blocks.....	Doe Run.
Missouri Red Granite Co.....	Monumental stone.....	Graniteville.

CHATS.

Great piles of crushed rock, the result of milling the lead and zinc ores, are present in southeast and southwest Missouri. This material is known as chats. In the area first mentioned, chats consists chiefly of dolomite, and in the area last mentioned, consists chiefly of chert or flint. The material from both districts is used for railroad ballast and for general commercial use. An increasing amount of southeast Missouri chats is being used annually for agricultural purposes.

The figures given below are obtained from railroads traversing the two camps, and from an estimate furnished by the largest dealer. An arbitrary value of 25 cents per ton is used in figuring ithe value.

The table below shows the utilization and value of chats from 1911 to 1927.

VALUE AND UTILIZATION OF CHATS IN MISSOURI, 1911-1927.

Year.	Railroad use (tons).	Commercial use (tons).	Total.	Value.
1911	865,011	638,592	1,503,603	$225,540
1912	1,911,705	811,698	2,723,403	408,510
1913	1,231,005	797,884	2,028,889	304,333
1914	1,687,331	583,440	2,270,771	340,616
1915	1,713,884	595,307	2,309,191	346,379
1916	2,268,370	622,600	2,890,970	433,646
1917	1,010,620	416,096	1,426,716	214,007
1918	672,335	274,794	902,129	135,319
1919	827,700	548,057	1,375,757	206,353
1920	448,211	665,311	1,113,522	167,028
1921	585,680	606,643	1,730,473	259,571
1922 (a)	455,755	769,254	1,225,009	306,252
1923 (a)	1,064,050	663,487	1,727,537	431,884
1924	1,411,318	669,757	2,081,075	520,269
1925	964,897	631,112	1,596,009	399,002
1926	875,243	653,056	1,528,299	382,080
1927	1,302,110	805,510	2,107,620	526,933

(a) Revised.

TRIPOLI.

The tripoli quarries at Seneca have been operated at a normal rate during the past two years. This material is found only in a comparatively restricted area in western Newton County and the bordering lands of Oklahoma, across the State line.

The American Tripoli Company and the Independent Gravel Company are the chief producers, the former operates a grinding plant at Seneca and the latter at Carthage.

The ground product is used largely for polishing powders, filters and in dusting foundry castings. The filters are made from solid stone and are very efficient. They can be cleaned by reversing the flow of water.

Mr. P. B. Butler, of Joplin, Missouri, has published an excellent description of these deposits in the December issue of Mining and Metallurgy.

ZINC ORE.

The Waco camp has continued to be the chief producer of zinc ores in the State. The depressed condition of the industry due to the low price of concentrates evidently due to over-

production of spelter has reduced developments to a minimum.

The entire Tri-State district has been under a curtailed production program during the past six months. An almost uniform price of $40 per ton of concentrates has maintained during the period. The following tables reproduced from the reports of the United States Bureau of Mines give the production and value of the output for 1926 and 1927.

PRODUCTION OF ZINC IN MISSOURI, 1925-1927.

District	1925.				1926.				1927.			
	Sphalerite.		Silicate and Carbonate.		Sphalerite.		Silicate and Carbonate.		Sphalerite.		Silicate and Carbonate.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
SOUTHWESTERN MISSOURI:												
Aurora, Bryceville, Wentworth (*e*)	.....	.....	.....	.....	4,572	$233,570	.....	.....	1,386	$47,148	32	$770
Carthage and Carl Junction (*a*)..	171	$6,929	.....	.....	124	5,900	.....	.....	68	2,970	.....	.....
Duenweg, Porto Rico (*g*)	413	20,657	450	$14,000	50	2,300	772	$24,366	57	2,210	162	4,860
Granby.....	1,000	49,095	954	29,296	6,186	290,912	1,036	35,183	228	9,594	583	15,303
Joplin and Smithfield (*b*) (*c*).....	8,541	456,262	390	12,100	6,201	261,409	818	28,346	2,117	79,870	343	8,724
Oronogo.....	127	4,126	2	55	129	4,047	3	87	.....	.....	.....	.....
Spring City, Spurgeon, Seneca (*d*)	.....	.....	428	13,023	10	400	1,000	27,200	.....	.....	207	4,925
Thoms Station	1,275	58,666	.....	.....	.....	.....	.....	.....	6,393	209,109	.....	.....
Waco.....	12,211	679,956	.....	.....	12,027	605,926	.....	.....	7,953	330,185	.....	.....
Webb City, Carterville, Prosperity	157	6,489	.....	.....	412	13,302	.....	.....	146	3,325	.....	.....
Wentworth.....	43	2,408	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Zincite-Smithfield (*f*), Bellville...	.....	.....	.....	.....	15,461	796,353	.....	.....	8,937	409,052	.....	.....

PRODUCTION OF ZINC IN MISSOURI, 1925-1927—Continued.

District.	1925.				1926.				1927.			
	Sphalerite.		Silicate and Carbonate.		Sphalerite.		Silicate and. Carbonate		Sphalerite.		Silicate and Carbonate.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Hickory and Dade counties	.....	.....	.....	.....	.....	.....	40	800	.....	.....	30	1,050
Barry, Hickory and Ozark counties	2,249	134,131	45	1,400	.....	.....	.....	.....	.....	.....	.....	.....
Totals.....	26,187	$1,418,719	2,269	$69,874	45,172	$2,214,119	3,669	$115,982	27,285	$1,093,463	1,357	$35,632
Southeast and Central Missouri....	.....	.....	.....	.....	2,301	101,243	.....	.....	8,390	289,816	.....	.....
Totals.....	26,187	$1,418,719	2,269	$69,874	47,473	$2,315,362	3,669	$115,982	35,675	$1,383,279	1,357	$35,632

(*a*) Carl Junction in 1925, 1927 only.
(*b*) Smithfield in 1925 only.
(*c*) Joplin in 1926, 1927 only.
(*d*) Spring City-Seneca only in 1926, 1927.
(*e*) Does not include Bryceville in 1927.
(*f*) Smithfield-Bellville only 1927, Zincite and Smithfield in 1926 only.
(*g*) Duenweg only in 1926.

TENOR OF CRUDE ZINC ORE AND CONCENTRATES PRODUCED IN SOUTHWEST MISSOURI, 1925-1926.

	1925.	1926.
Total crude ore, short tons	662,200	1,025,500
Total zinc concentrates in crude ore, per cent	4.30	4.76
Zinc content of crude ore, per cent	2.54	2.77
Average zinc content of sphalerite concentrates	60.8	59.6
Average zinc content of silicate and carbonate	38.2	39.3
Average value per ton—		
Sphalerite concentrates	$54.18	$49.01
Silicate and carbonate	31.24	31.61

PRODUCTION OF ZINC ORE IN MISSOURI, 1911-1927.

Year.	Sphalerite.			Carbonate and Silicate.			Total value.
	Quantity short tons.	Value.	Average price per ton.	Quantity short tons.	Value.	Average price per ton.	
1911	217,812	$8,680,559	$39.81	20,119	$447,420	$23.76	$9,157,979
1912	244,986	12,346,922	50.45	22,172	641,881	28.95	12,988,803
1913	225,850	9,180,960	43.10	21,531	483,463	22.45	9,664,423
1914	189,765	7,351,726	38.65	19,648	415,185	21.13	7,766,911
1915	241,111	18,382,520	76.23	25,412	1,243,458	45.00	19,625,978
1916	277,176	22,878,215	82.60	26,894	1,350,381	50.21	24,228,596
1917	231,588	16,453,629	70.80	30,986	1,254,975	40.50	17,708,604
1918	95,555	4,899,347	51.30	17,816	574,136	32.23	5,473,483
1919	51,813	2,108,382	40.69	11,741	320,853	27.33	2,429,235
1920	39,431	1,805,561	45.80	9,494	337,003	35.50	2,142,564
1921	19,490	490,731	25.18	60	634	10.57	491,365
1922	27,844	888,494	31.91	3,008	63,917	21.25	952,411
1923	32,156	1,303,093	40.52	3,774	100,272	26.57	1,403,365
1924	23,261	974,765	41.91	1,453	35,294	24.29	1,010,059
1925	26,187	1,418,719	54.18	2,269	69,874	30.80	1,488,593
1926	47,473	2,315,362	48.77	3,669	115,982	31.61	2,431,344
1927	35,675	1,383,279	38.77	1,357	35,632	26.26	1,418,911

PUBLICATIONS OF THE BUREAU OF GEOLOGY AND MINES.

The following is a complete list of the publications issued by the present Bureau of Geology and Mines and former Geological Surveys. The reports of the second series are given first, since some of these are still available for distribution. A majority of those listed under the headings of Former Surveys are exhausted. The volumes available are distributed at a flat rate of twenty-five cents each. The Biennial Reports are sent at a uniform charge of 10 cents. All publications sent to foreign countries go at the rate of two ounces for one cent.

The reports may be obtained upon application to H. A. Buehler, State Geologist, Rolla, Missouri.

Vol. No.
2nd series.

I. *Geology of Miller County, by E. R. Buckley, A. F. Smith and S. H. Ball, xvi + 207 pp., XVIII pls., including geologic map, 56 figs. 1913.
Describes the topography, general geology, and mineral resources of Miller County, Mo.

II. The Quarrying Industry of Missouri, by E. R. Buckley and H. A. Buehler, xv + 371 pp., LIX pls., including geologic map of Missouri. 1904.
Discusses properties, geology, distribution and laboratory tests of Missouri granites, rhyolites, limestones and sandstones and describes the quarries from which they are obtained.

III. The Geology of Moniteau County, by F. B. Van Horn, ix + 104 pp., XIII pls., including geologic map, 25 figs. 1905.
Describes the topography, general geology and mineral resources of Moniteau County, Mo.

IV. Geology of the Granby Area, by E. R. Buckley and H. A. Buehler, viii + 120 pp., XLII pls., including general geologic, topographic and outcrop, 3 figs. 1906.
Describes the general geology, occurrence of lead and zinc ores of the Granby Area in Newton County, Mo., and discusses the genesis of the ores of southwestern Missouri.

V. *Public Roads, their improvement and maintenance, by E. R. Buckley, xiii + 124 pp., XXX pls. 1907.
Contains specifications for building roads, directions for their construction, improvement and upkeep, a chapter on road materials, etc.

VI. The Lime and Cement Resources of Missouri, by H. A. Buehler, xvi + 255 pp., XXXVI pls., including a geologic map of Missouri, showing location of lime and cement plants. 1907.
Discusses properties, manufacture and production of lime and cement, the distribution of lime and cement resources by counties, including analyses and a chapter on the geological formations of Missouri and their composition.

VII. The Geology of Morgan County, by C. F. Marbut, xiv + 97 pp., XIX pls., including a geologic map of Morgan County, 19 figs. 1908.
Describes the topography, general geology and mineral resources of Morgan County, Mo.

VIII. *The Geology of Pike County, by R. R. Rowley, xiv + 122 pp., XX pls., 13 figs., geologic map of Pike County. 1908.
Describes the topography, general geology, mineral resources and paleontology of Pike County, Mo.

IX. *Geology of the Disseminated Lead Deposits of St. Francois and Washington counties, by E. R. Buckley, 2 pts.; pt. 1, xvi + 259 pp., pls I-XXXIX, 10 figs., pt. 2, pls. XL-CXXI, including a general geologic map of southeastern Missouri. 1909.
Discusses location, history, production, physiography, general geological history, structure, mines, ores, genesis of the ores of southeastern Missouri, with a chapter on barite and galena in the Potosi formation.

*Edition exhausted.

Vol. No.
2nd series.

X. *The Iron Ores of Missouri, by G. W. Crane, xvi + 434 pp., XLVII pls., 29 figs., and geologic map of Missouri showing the location of the iron deposits. 1912.
Discusses the history, development, production, types and distribution of Missouri iron ores and general geology and physiography of the ore-bearing district.

XI. *The Coal Deposits of Missouri, by Henry Hinds, xi + 503 pp., XXIII pls., 97 figs., and maps of the Clinton, Calhoun, Lexington, Bevier, Huntsville and Richmond quadrangles and geological map of Missouri. 1912.
Describes briefly the Pennsylvanian series in Missouri and discusses in detail the mode of occurrence, coal industry, the distribution by counties, analysis, and tests of Missouri coal.

XII. The Geology of the Rolla Quadrangle, by Wallace Lee, xii + 111 pp., X pls., 17 figs., topography and geologic maps of the Rolla Quadrangle. 1913.
Describes the topography, physiographic history, general geology and mineral resources of the Rolla Quadrangle in Phelps and Dent counties, Mo.

X II. *The Stratigraphy of the Pennsylvania Series in Missouri, by Henry Hinds and F. C. Greene, with a chapter on Invertebrate paleontology by G. H. Girty, 500 + pp., XXXII pls., 5 figs. 1915.

XIV. The Geology of Jackson County, by W. E. McCourt, assisted by M. Albertson and J. W. Bennett. 158 pp., XIX pls., including geologic maps and cross sections. 1917.
Describes topography, general geology and mineral resources of county and includes brief discussion of history and settlement.

XV. The Sand and Gravel Resources of Missouri, by C. L. Dake. 250 pp., XLVII pls., including a large number of maps. 1918.
Discusses nature and uses of sand and gravel, types found in Missouri and the Geology of Missouri sands and gravels. A large number of screen tests and analyses are contained in the report.

PVI. The Occurrence of Oil and Gas in Missouri, by Malcolm E. Wilson. 1922.
Discusses the oil and gas possibilities of Missouri.

XVII. *The Devonian of Missouri, by E. B. Branson, J. S. Williams, V. O. Tansey and G. A. Stewart, x + 279 pp., A-H + 71 pls., 10 figs. 1922.
Describes the distribution of the Devonian formations in Missouri and gives detailed descriptions and synonomy of the paleontology. Of interest chiefly to geologists.

XVIII. Structural Reconnaissance of the Mississippi Valley Area from Old Monroe, Missouri, to Nauvoo, Illinois, by Frank Krey, 86 pp., 18 pls. 1924.
This report (in co-operation with the Illinois Geological Survey) gives detailed descriptions of structural conditions in the area as a guide to oil prospecting.

XIX. The Geology of Vernon County, by F. C. Greene and W. F. Fond, ix + 152 pp., 14 pls., 13 figs., geological map of Vernon County. 1926.
Describes the geology and mineral resources of Vernon County.

XX. The Water Resources of Missouri, by H. C. Beckman.
Describes the stream flow of Missouri rivers and contains 206 chemical analyses of surface waters, also state map showing area of drainage basins.

XXI. Early Mississippian Formations in Missouri, by R. C. Moore, 283 pp., 14 pls., 13 figs. 1928.
Describes the stratigraphy and paleontology of the Kinderhook and Osage groups of the Mississippian system.

XXII. The Geology of Ste. Genevieve County, by Stuart Weller and Stuart St. Clair (in press).
Describes the geology and mineral resources of this county; includes geologic and topographic maps.

*The Oil and Gas Possibilities of the Belton Area, by Malcolm E. Wilson.
Describes geology and geologic structure in southwest Jackson and northwest Cass counties. A pamphlet containing 39 pp., III pls., including geologic structure map. 1918. (Incorporated in Vol. XVI, 2nd series.)

*Mineral Resources of Missouri, by H. A. Buehler. A pamphlet of 36 pp., about one-half being illustrations. Brief paragraphs on the distribution of the mineral resources of the state.

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*Edition exhausted.

Biennial Reports.

These reports describe the work of the Bureau and contain a chapter on the mineral production of the state with statistics for the previous two years. Starting with the report to the 52nd General Assembly they also contain an account of the investigation of the water resources of the state with records of stream flow.

*Biennial Report of the State Geologist to the 42nd General Assembly, by E. R. Buckley, 83 + 3 pp., VIII pls. 1903.

Biennial Report of the State Geologist to the 43rd General Assembly, by E. R. Buckley, 56 pp., III pls. 1905.

Biennial Report of the State Geologist to the 44th General Assembly, by E. R. Buckley, 57 pp. 1907.

Biennial Report of the State Geologist to the 45th General Assembly, by H. A. Buehler, 59 pp. 1909.

Biennial Report of the State Geologist to the 46th General Assembly, by H. A. Buehler, 68 pp,, VI pls. 1911.

*Biennial Report of the State Geologist to the 47th General Assembly, by H. A. Buehler, 54 pp., III pls. 1913.

Biennial Report of the State Geologist to the 48th General Assembly, by H. A. Buehler, 62 pp., IV pls. 1915.

Biennial Report of the State Geologist to the 49th General Assembly, by H. A. Buehler, 75 pp., I pl. 1917.

*Biennial Report of the State Geologist to the 50th General Assembly, by H. A. Buehler, 117 pp., IV pls. 1919.

Biennial Report of the State Geologist to the 51st General Assembly, by H. A. Buehler, 87 pp., IV pls. 1921.

Biennial Report of the State Geologist to the 52nd General Assembly, by H. A. Buehler, 133 pp., V pls., 1 map. 1923.

*Biennial Report of the State Geologist to the 53rd General Assembly, by H. A. Buehler, 143 pp., IV pls. 1925.

Biennial Report of the State Geologist to the 54th General Assembly, by H. A. Buehler, 108 pp., III pls. 1927.

Biennial Report of the State Geologist to the 55th General Assembly, by H. A. Buehler. 1929.

Maps.

	Price
Base Map of Missouri, compiled in co-operation with the United States Geological Survey. 1926. Shows elevations of towns. Unmounted	25c
Geological Map of Missouri. Revised 1926	25c
Joplin District township maps: Scale 4 inches to the mile, T. 27 to 29, R. 32 to 34, inclusive, 1922. Each	10c
Ste. Genevieve County Geologic Map, 1922	25c
Caldwell County Topographic Map, 1926	20c
*Lawrence County Topographic Map, 1922	20c
Livingston County Topographic Map, 1924	20c
Perry County Topographic Map, 1926	20c
Platte County Topographic Map, 1914	20c
Ste. Genevieve County Topographic Map, 1922	25c
Topographic Maps of various quadrangles. Each	10c

(An index map will be sent on request.)

Former Surveys.

The following is a list of publications of this Bureau up to the publication of volume 13, 1st series. In this list the publications of the Surveys are arranged in the order in which they were transmitted for publication. *Editions exhausted.

1. **Report of a Geological Reconnaissance* of that part of the State of Missouri adjacent to the Osage River, made to William H. Morell, chief engineer of the State, by order of the Board of Internal Improvement, by Henry King, M. D. Geologist. (Senate Journal, Appendix, 1st Session, 11th General Assembly, pages 506-535.) Jefferson City, 1840.
2. **First and Second Annual Reports* of the Geological Survey of Missouri, by G. C. Swallow, State Geologist, 448 pages, 17 plates, 18 sections, 26 figures and 5 maps, 8 vo. cloth. Jefferson City, December, 1855.

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*Edition exhausted.

3. **Third Report of Progress* of the Geological Survey of Missouri, by G. C. Swallow, 3 pages. Jefferson City, December, 1856.
4. **Fourth Report of Progress* of the Geological Survey of Missouri, by G. C. Swallow, 8 pages. Jefferson City, December, 1858.
5. **Fifth Report of Progress* of the Geological Survey of Missouri, by G. C. Swallow, 13 pages. Jefferson City, December, 1860.
6. **Geological Report of the Southwestern Branch of the Pacific Railroad, State of Missouri,* by G. C. Swallow, xvii + 93 pp., 2 pls., fold map. St. Louis. 1859.
7. **Annual Report of the State Geologist* of the State of Missouri, by Albert D. Hager, 23 pages. Jefferson City, December, 1870.
8. **Report of Geological Survey* of the State of Missouri, 1855-1871, by G. C. Broadhead, F. B. Meek and B. F. Shumard, 327 pages, 29 illustrations and 9 maps, 8 vo. cloth. Jefferson City, March, 1873.
9. **Preliminary Report on the Iron Ores and Coal Fields* from the field work of 1872, by R. Pumpelly, A. Schmidt, G. C. Broadhead and W. B. Potter, 671 pages, 190 illustrations and an atlas with 14 large sheets, 8 vo. cloth. Jefferson City, April, 1873.
10. **Report of the Geological Survey* of the State of Missouri, including field work of 1873-1874, by G. C. Broadhead, 794 pages, 91 illustrations and an atlas of 15 sheets, 8 vo. cloth. Jefferson City, August, 1874.
11. **Industrial Report on Lead, Zinc and Iron,* together with notes on Shannon county and its copper deposits, by Chas. P. Williams, Ph. D., Acting State Geologist, 199 pages and 11 illustrations, 8 vo. cloth. Jefferson City, December, 1876.
12. **Bulletin No. 1.* By Arthur Winslow, G. E. Ladd, A. E. Woodward and G. Hambach, 85 pages and 2 sketch maps. Jefferson City, April, 1890.
13. **Bulletin No. —.* A Bibliography of the Geology of Missouri, by F. A. Samson, 76 pages, 810 titles. Jefferson City, December, 1890.
14. **Bulletin No. 2.* By G. E. Ladd and A. E. Woodward, 101 pages, 4 plages, 3 sections and 2 sketch maps. Jefferson City, December, 1890.
15. **Biennial Report of the State Geologist,* transmitted to the 36th General Assembly, Arthur Winslow, State Geologist, 53 pages, 2 diagrams. Jefferson City, January, 1891.
16. **Builetin No. 4.* A description of some Lower Carboniferous Crinoids from Missouri, by S. A. Miller, 40 pages and 5 plates. Jefferson City, February, 1891.
17. **Builetin No. 5.* By Erasmus Haworth and G. E. Ladd, 86 pages, 5 plates and 5 figures. Jefferson City, July, 1891.
18. **A Preliminary Report on the Coal Deposits of Missouri,* by Arthur Winslow, 226 pages, 131 illustrations and 1 map, 8 vo. cloth. Jefferson City, November, 1891.
19. **Vol. II. A Report of the Iron Ores of Missouri,* by F. L. Nason, 366 pages, 8 plates, 62 illustrations and 1 map, 8 vo. cloth. Jefferson City, December, 1892.
20. **Vol. III. A Report on the Mineral Waters of Missouri,* by Paul Schweitzer, including notes of A. E. Woodward, 256 pages, 33 plates, 11 figures and 1 map, 8 vo. cloth. Jefferson City, December, 1892.
21. **Biennial Report of the State Geologist,* transmitted to the 37th General Assembly, Arthur Winslow, State Geologist, 37 pages, 3 diagrams. Jefferson City, January, 1893.
22. **Vol. IV. Paleontology of Missouri (Part I),* by C. R. Keyes, 271 pages, 32 plates and 9 figures, 8 vo. cloth. Jefferson City, June, 1894.
23. **Vol. V. Paleontology of Missouri (Part II),* by C. R. Keyes, 266 pages, 24 plates and 2 figures, 8 vo. cloth. Jefferson City, June, 1894.
24. **Vol. VI. Lead and Zinc Deposits (Part I),* by Arthur Winslow, 287 pages, 12 plates and 71 figures, 8 vo. cloth. Jefferson City, July, 1894.
25. **Vol. VII. Lead and Zinc Deposits (Part II),* by Arthur Winslow, 383 pages, 29 plates and 268 figures, 8 vo. cloth. Jefferson City, July, 1894.
26. **Vol. VIII. Annual Report with Accompanying Papers,* by C. R. Keyes, 395 pages, 30 plates, 16 figures and 1 map, 8 vo. cloth. Jefferson City, December, 1894.
27. **Biennial Report of the State Geologist,* transmitted to the 38th General Assembly, C. R. Keyes, State Geologist, 60 pages. Jefferson City, January, 1895.
28. **Vol. IX. Reports on Areal Geology (Sheets 1-4),* by R. C. Keyes, A. Winslow, C. H. Gordon, Erasmus Haworth and F. L. Nason, 430 pages, 22 plates, 53 figures, 3 folio plates and 4 maps, 8 vo. cloth. Jefferson City, April, 1896.
29. **Vol. X. Surface Features of Missouri and Bibliography,* by C. R. Keyes, C. F. Marbut and J. E. Todd, 533 pages, 22 plates and 24 figures, 8 vo. cloth. Jefferson City, June, 1896.
30. **Vol. XI. Clay Deposits,* by H. A. Wheeler, E. M., 622 pages, 39 plates, 15 figures and 2 maps, 8 vo. cloth. Jefferson City, November, 1896.

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*Edition exhausted.

31. **Biennial Report of the State Geologist*, transmitted to the 39th General Assembly, C. R. Keyes, State Geologist, 63 pages, 7 plates and 2 figures. Jefferson City, December, 1896.
32. **Vol. XII. Areal Geology (Sheets 5-10)*, E. M. Shepard, C. F. Marbut and G. C. Broadhead, edited by C. F. Marbut, 656 pages, 13 plates, 39 figures and 6 maps, 8 vo. cloth. Jefferson City, December, 1898.
33. **Biennial Report of the State Geologist*. transmitted to the 40th General Assembly, by John A. Gallaher, State Geologist, 68 pages. Jefferson City, December, 1898.
34. **New Year Announcement of the Bureau of Geology and Mines*, by J. A. Gallaher, State Geologist, 27 pages. Jefferson City, January, 1900.
35. *Vol. XIII. Preliminary Report of the Structural and Economic Geology of Missouri*, by John A. Gallaher, State Geologist, 260 pages, 65 plates, 9 sections and 6 figures, 8 vo. cloth. Jefferson City, September, 1900. (Weight, 46 ounces.)
36. **Biennial Report of the State Geologist*, transmitted to the 41st General Assembly, by Leo Gallaher, Act. State Geologist, 55 pages. Jefferson City, January, 1901.

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*Edition exhausted.

FINANCIAL STATEMENT FOR 1927-1928[a]—SUPPORT FUND.

1927.

H. A. Buehler	$5,225.65
Jos. M. Thiel	2,969.57
H. S. McQueen	2,866.26
Office	1,758.77
C. O. Reinoehl	600.00
H. W. Mundt	889.30
C. L. Dake	863.32
Josiah Bridge	1,196.35
E. E. Hawkins	1,160.00
E. M. Shepard	81.16
P. N. Moore	13.60
Jean I. McCaw	900.00
Hugh Stephens Ptg. Co	1,293.42
A. A. Smith	100.00
J. S. Williams	221.73
J. P. Harmon	300.00
Mound City Engraving Co	127.02
G. A. Muilenburg	225.45
Ruth Glass Co	64.802
Total	$20,856.40

1928.

H. A. Buehler	$5,786.41
Jos. M. Thiel	3,030.21
H. S. McQueen	3,371.08
Office	1,861.87
C. O. Reinoehl	907.55
H. W. Mundt	294.97
C. L. Dake	1,579.89
Josiah Bridge	1,453.54
E. E. Hawkins	1,200.00
E. M. Shepard	65.14
Jean I. McCaw	900.00
A. A. Smith	100.00
J. S. Williams	55.13
Mound City Engraving Co	142.98
Frank Whites	125.00
Mo. School of Mines	488.66
Bemis Bag Co	122.04
B. H. Rucker	247.50
T. D. Murphy	181.01
R. E. Peck	210.00
Underwood Typewriter Co	65.55
E. Leitz, Inc	88.85
Hugh Stephens Ptg. Co	1,656.57
Total	$23,933.95

[a]Figures for December, 1928, include only salaries of permanent staff.

FINANCIAL STATEMENT FOR 1927-1928[1]—WATER POWER FUND.

1927.

H. C. Beckman	$2,645.09
Verle L. Austin	2,012.86
W. A. Werner	960.43
H. W. Mundt	1,400.37
Gage Readers	2,236.85
C. O. Reinoehl	40.00
Jean I. McCaw	300.00
Total	$9,585.60

1928.

H. C. Beckman	$1,775.45
Verle L. Austin	908.01
H. W. Mundt	1,973.11
Gage Readers	2,186.05
A. L. Hill	1,158.56
Jean I. McCaw	300.00
C. H. Jennings	351.10
Total	$8,652.28

FINANCIAL STATEMENT FOR 1927-1928[1]—TOPOGRAPHIC FUND.

1927.

W. R. Broaddus	$ 654.71
F. W. Hughes	2,635.23
G. S. Druhot	320.41
C. L. Sadler	77.78
J. L. Saunders	353.71
M. J. Hardin	123.77
Total	$4,165.61

1928.

F. W. Hughes	$3,771.20
Chas. R. Fisher	1,955.42
Total	$5,726.62

[1]Figures for December, 1928, not included.

APPENDIX I

INITIAL DIPS PERIPHERAL TO RESURRECTED HILLS

by

JOSIAH BRIDGE *and* C. L. DAKE

Abstract. Steep dips at the contact of Cambro-Ordovician sediments against pre-Cambrian porphyry knobs are described, and evidence advanced to show that these dips, are in the main, initial, rather than the result of tangential thrust, unequal compacting, or settling from solution.

The important part played by buried topography in the production of local "structural highs" in superimposed sediments has for several years been attracting increasingly widespread attention among geologists. There are perhaps no localities in the United States better suited to show such "domes," in all their various stages of denudation than the St. Francois Mountains of southeast Missouri, and the closely related area of pre-Cambrian rocks in Shannon County.

These areas consist of a large number of more or less isolated knobs of extremely resistant pre-Cambrian rhyolite porphyry, the bases of which are still buried beneath Cambrian sediments, but the tops of which, in a very large number of instances, protrude for several hundred feet above the valley floors of Cambrian sedimentary beds. The present relief reaches a maximum of slightly over 1,000 feet, and the depth of the sediments in the intervening valleys, as revealed by the drill, averages over 500 feet, while in some cases it is nearly double that figure. Reasons will be given later, for believing that the depth of the basins has not been appreciably increased by later deformation, and that the relief on the old pre-Cambrian floor, when Cambrian seas invaded the region, averaged over 1,500 feet, reaching a maximum of not far from 2,000 feet.

A few small areas of residual cherts on the tops of many of the high peaks seem to show rather conclusively that most, if not all, of the peaks were submerged by Cambro-Ordovician seas, and if so, not far from a thousand feet of sediments have been removed, since these peaks were buried.

The fact that most of even the smaller valleys extending back into the porphyry knobs are floored with Cambrian sediments, suggests rather strongly that there has been but little

modification in the form of these knobs by erosion, since they have been stripped of their Cambrian overburden. This conclusion is further strengthened by results of drilling which show, in a number of instances, that slopes of porphyry which still remain buried, at the bases of these knobs, are about as steep as the stripped upper portions.

The present topographic slopes on the porphyry knobs are usually very steep, ranging from vertical cliffs down to inclinations of 10 or 15 degrees. Buried porphyry slopes are known up to at least 45 degrees.

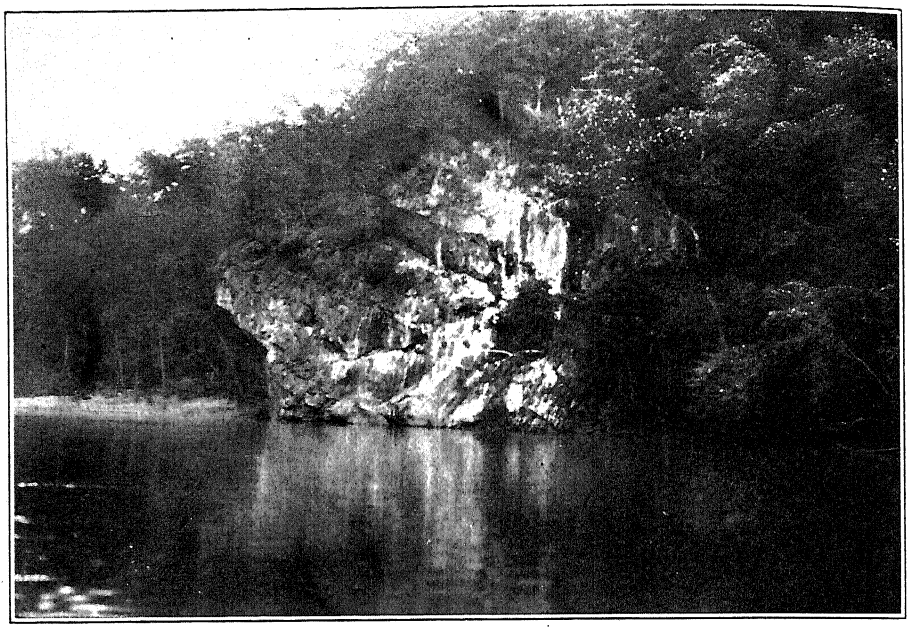
The sedimentary beds now found in contact with old resistant knobs range from basal Lamotte sandstone, through Bonneterre dolomite, Davis shale and limestone, Derby-Doerun dolomite, Potosi dolomite, and Eminence dolomite, of Cambrian age, and the Gasconade dolomite of the lowermost Ordovician. All of these beds carry basal conglomerates of rhyolite pebbles, at numerous localities, and indicate conclusively that the porphyry is older than the overlying sedimentaries.

The Lamotte, in general, consists of well-rounded quartz grains, and is sufficiently free from porphyry detritus to indicate that the bulk of the formation was introduced from some extraneous source, rather than that it was derived from the local peaks. At only a few places, however, is this phase of the Lamotte actually seen in contact with the old knobs, and where it is, the local dips away from the porphyry are low, rarely exceeding ten degrees.

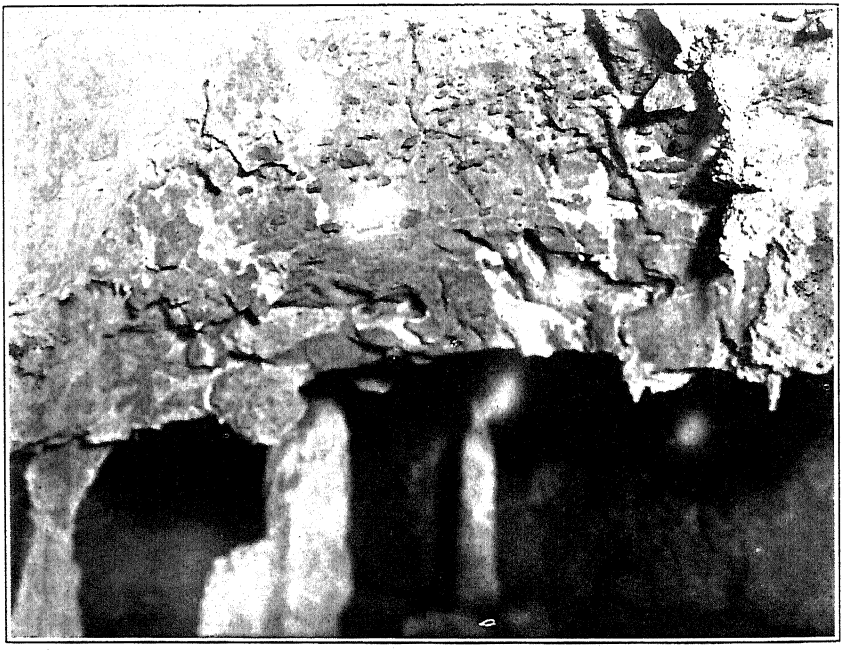
More commonly, the Lamotte, where it is in contact with the buried hills, consists locally of coarse porphyry detritus, in many instances more or less of the nature of an imperfectly reworked talus. In such material, the dips are much higher, reaching in some cases 20 degrees or even more.

Many of the coarse grits and conglomerate of the central mountain area are probably not Lamotte at all, but a shoreward phase of the Bonneterre, where it grades into the coarse detritals resting on the old slopes. In fact such lateral transitions from dolomite through grits to conglomerates have actually been traced in certain instances. They show the same steep dips as do the coarser Lamotte beds.

The steepest dips, however, are where the dolomites, themselves, overlap onto the porphyry slopes (Pl.), at elevations sufficiently high so that most of the detritus had been stripped away, permitting the dolomite beds to rest directly on the



A. Steep dips in the Eminence dolomite, on Current River, SW. ¼ sec. 34, T. 29 N., R. 2 W. The porphyry knob causing these dips is about ⅛ miles down stream (left). About 60′ of beds intervene between this exposure and the porphyry.



B. Porphyry pebbles in the Eminence dolomite. Exposure in the roof of a cave developed along the dolomite-porphyry contact. Dip in this picture is toward the observer and is about 25 degrees. SE. ¼ sec. 2, T. 28N., R. 2 W.

porphyry slopes, with little or no clastic material. In many such instances the dips exceed 20 degrees, 25 degrees is not uncommon, and 30 has been recorded in a few cases.

Not uncommonly it is possible to walk up the outcrop of a single steeply dipping bed through a vertical range of over 100 feet, and in a few instances well over 200 feet.

These dips are entirely without alignment, and in all cases peripheral to the adjacent porphyry slopes. That they are directly related to the old topographic surfaces, and that they have probably not been appreciably accentuated by any subsequent local deformation, seems to be rather conclusively demonstrated by their close conformity to the axes of the old pre-Cambrian drainage lines. This is perhaps most clearly seen along the valleys of Tom Sauk and Little Tom Sauk Creeks and their tributaries in Iron and Reynolds counties. The same is true for that portion of the valley of Current River and its tributaries lying within the area of porphyry knobs in Shannon County. These valleys, as they exist at present, are very clearly essentially coincident with the pre-Cambrian drainage lines, since, down to even the smaller tributaries, and sub-tributaries, they are floored with Cambrian dolomites. Towards the heads of the valleys, the dolomites grade into coarse conglomerate, as might be expected from their topographic situation. Farther down the valleys, and on prominent headlands or spurs of the old erosion surface, the porphyry was swept clean, and the dolomites are in direct contact with the rhyolite. This fact, in itself, lends strength to the contention that the character and steepness of the old slopes were the chief controlling factors in the dips, rather than later deformation. This view is enormously strengthened, however, by the widely observed fact that the dips are towards the axial lines of the valleys; along the tributaries toward the axial lines of the tributaries; and along the sub-tributaries, toward the axial lines of these, in turn. It is inconceivable that any system of folding should have coincided with all these valleys, with their varying directions; and since no one of these lines shows more prominent dips than any other, there seems to be valid reason for believing that none of them have been measurably intensified by later deformation.

This entire lack of alignment, so highly characteristic of the area under discussion, has been pointed out by Blackwelder[2]

[2]Blackwelder, Eliot; The origin of the central Kansas oil domes; Bull. A. A. P. G., vol. 4, no. 1, 1920.

as a fatal defect in the theory of tangential thrust to account for the Kansas domes.

The fact that successively younger and younger beds overlap onto the porphyry peaks, also indicates that they stood as prominences in the seas in which the Cambrian sediments were deposited, and were not raised to their present position above the Cambrian floor by later local sharp folding.

It remains then to find some other explanation than subsequent folding to account for the steep dips everywhere found coincident with old buried topographic slopes on the pre-Cambrian porphyries.

Albertson[3] has invoked the aid of deep seated isostatic adjustments to account for minor domes, but it seems quite incredible that such adjustments could take place in as rigid materials as these pre-Cambrian rocks, on units of such limited extent. Many of the smaller domes are not over 200 or 300 yards across, and even the most enthusiastic proponents of isostasy would hardly attempt to apply the theory in such cases.

Mehl,[4] Blackwelder,[5] and Powers[6] have considered the compacting of younger sediments about already completely lithified hills of older rock, with the concomitant settling of the overlying strata, as the important factor. There would seem to be little doubt that, under favorable conditions, such compacting might account for considerable dip, but the process seems wholly inadequate to account for the high dips so characteristically developed in the St. Francois Mountains, at the immediate contact with the underlying hill, where there is but a few feet of sediment to become compacted.

Another explanation which occurred to the writers was suggested by the work of Stockdale,[7] who concludes that many formations have been greatly thinned in situ by solution, even in some cases up to 40 per cent of the original thickness. Where soluble rocks such as dolomites or limestones lap against buried hills of much less soluble material, solution in the sediments of the inter-peak basins, with accompanying settling of the beds above, might produce steep dips in exactly the same way that

[3]Albertson, M. M., Isostatic adjustments on a minor scale, in their relation to oil domes; Trans. Am. Inst. Mining Eng., vol. LXV, 1921, p. 418.

[4]Mehl, M. G., The influence of differential compression on the attitude of bedded rocks; Science, vol. 51, 1920, p. 520.

[5]Blackwelder Eliot, Loc. cit.

[6]Powers, Sidney, Reflected buried hills and their importance in petroleum geology; Econ. Geol., vol. XVII, no. 4, 1922, pp. 256-258.

[7]Stockdale, P. B., The stratigraphic significance of solution in rocks; Jour. Geol., vol. XXXIV, no. 5, 1926, pp. 399-414.

compacting has been assumed to act. This explanation, however, would certainly not apply to the steep dips in the coarse clastics already described, where there are no intercalated soluble beds. It might, to be sure, be a factor in the dips noted in the dolomites, where they rest on the rhyolites. Another explanation, however, will also be offered which might quite as easily account for the steep dips in the dolomites.

Finally, after consideration of various possibilities, the writers have been forced to the conclusion that these remarkable dips about the porphyries are almost wholly initial or depositional. Those in the coarse clastics are no steeper than are frequently observed in the foreset beds of torrential fans and deltas, and seem to be determined by the steepness of the pre-Cambrian topographic slope on which they were laid down. Wherever these old slopes were too steep to permit the accumulation of debris, excessive dips are absent. In the case of notably asymmetrical knobs, a given formation may rise far up the gentler slope and stop short against the base of the knob on the steeper side, at a much lower elevation.

The steep dips in the dolomites, like those in the clastics, are also believed to be largely initial. Even steeper dips are cited by Cumings and Shrock[8] as being common in the lime muds adjacent to coral reefs, though it is not clear how much of the dip is initial, and how much due to later settling. The conditions most favorable for the development of such dips would be a rather rapid submergence of this rugged pre-Cambrian surface, so that the tops of many of the smaller hills were completely under water before the intervening valleys were filled with sediment. This condition would permit of deposition taking place simultaneously over the entire knob, at widely varying depths, so that contemporaneous beds would be deposited over the entire slope, at correspondingly varying elevations. The lime oozes thus collecting on the slopes would rest at dips up to the maximum angle of repose of such materials and the narrow and winding character of the bays between the higher knobs, in such an archipelago as probably existed, would prevent excessive wave action and favor the accumulation on steep slopes.

The strongly embayed coast of Maine, submerged rapidly enough so that deep bays exist in close proximity to exposed rocky knobs, presents a somewhat close modern analogy to the

[8]Cumings, E. R., and Shrock, R. R., Silurian coral reefs of northern Indiana; Proc. Ind., Acad. Sci., vol. 36, 1926, pp. 71-85.

topographic (not climatic) conditions believed to exist in the St. Francois Mountains when these dips were being formed.

Since most of the drilling in this area has been done in the course of prospecting for lead, the holes have been located well out in the basins and not on the domes. As a result, little evidence is available as to the presistance of these dips upward into the overlying sediments, after the knob has been completely buried. Furthermore, in the area where these knobs are known to occur, most of the higher beds of the series have been completely stripped away until no very great thickness of sedimentary cover exists.

In one instance near Caledonia in Washington County, the discovery of steep quaquaversal dips suggested buried porphyry and this was verified by the finding of porphyry fragments on the dump from a shallow dug well on the crest of the dome. In a nearby case a clearly marked dome shows no prophyry outcrops, but a single large boulder found near the crest probably indicates the site of an old knob which is now just being uncovered. There are several prominent quaquaversal structures in Shannon County, in which no porphyry cores are as yet exposed, but in the light of the many peripheral dips about exposed knobs in the immediate vicinity there seems every reason to believe that buried porphyry knobs exist beneath these domes. There is little on which to base a close estimate of the thickness of the sedimentary beds still concealing these cores, but stratigraphic conditions about exposed knobs suggest that the cover does not greatly exceed 100 feet.

If such domes as are herein described ever persist to any great height above the tops of the old buried hills, it is quite probable that it is only by the aid of unequal compacting, or as a result of solution, since the thinning of beds against the hillsides and the thickening into the adjacent basins, a phenomenon widely observed, would smooth out the inequalities before the tops of the knobs were buried very far below the surface of accumulation.

Conclusions. Steep dips, which almost everywhere occur at the contact of the Paleozoic sediments on the pre-Cambrian porphyry hills of southeast Missouri, are always peripheral to the old topographic slopes, and show no alignment whatever, such as might indicate tangential thrusts. The present valleys, floored with Cambrian, are in general coincident with the pre-Cambrian drainage ways, and the dips are commonly toward the

axial lines of these valleys, both trunk and tributary. The dips are steep, even in the coarse clastic beds in which both compacting and solution are necessarily at a minimum, and at localities where the blanket of sediments is so thin as to preclude either compacting or solution as a competent factor. Consequently initial dips are very strongly indicated. It is doubtful however whether such dips would carry very far upward above the top of the buried knob, and where such initial structures are reflected through any very great thickness of sediments, additional factors must probably be invoked.

September 15, 1928.

APPENDIX II

AUTOMATIC WATER SAMPLER.

By H. W. MUNDT.

The need for a sampling device which will secure a representative sample from any part of the cross section of a stream has been clearly shown in the course of investigations covering the transportation of sediment by the various rivers of the State.

The character and amount of sediment carried by any stream, has a direct bearing on the matter of Power development and Flood control as well as being an important factor in channel obstruction. The disastrous floods of the past year have shown the need of data covering the Missouri streams. Practically no figures are available at the present time.

The use of available samplers indicated a number of faults which could not be corrected. Designing and construction of a sampler which would meet the following requirements was therefore undertaken by the writer.

The sampler should:

1. Open to receive the sample at any particular depth.
2. Close after the sample has been taken.
3. Expose the entire opening of a one pint milk bottle for entrance of the sample.
4. Present no obstruction to the free entrance of the sample.
5. Be simple and durable in construction and operation.
6. Require one or not more than two persons to operate.
7. Be adapted to the use of standard replacements.
8. Have means to adjust volume of sample.

The sampler designed consists essentially of a tripping weight, trigger, spring motor for which a standard door check is used, ratchet and pawl for setting the motor after winding, sprocket and chain drive, timing or checking device for adjusting volume of sample, carriage to hold a one pint milk bottle used as sample container, self adjusting upper valve, lower valve which is set by hand against the mouth of the bottle and is released automatically, and a hanger to which a lead weight of sufficient size may be attached for sinking the sampler and holding it in position at the desired depth. The sampler is illustrated on the accompanying plates and the various parts are named. Figure 1

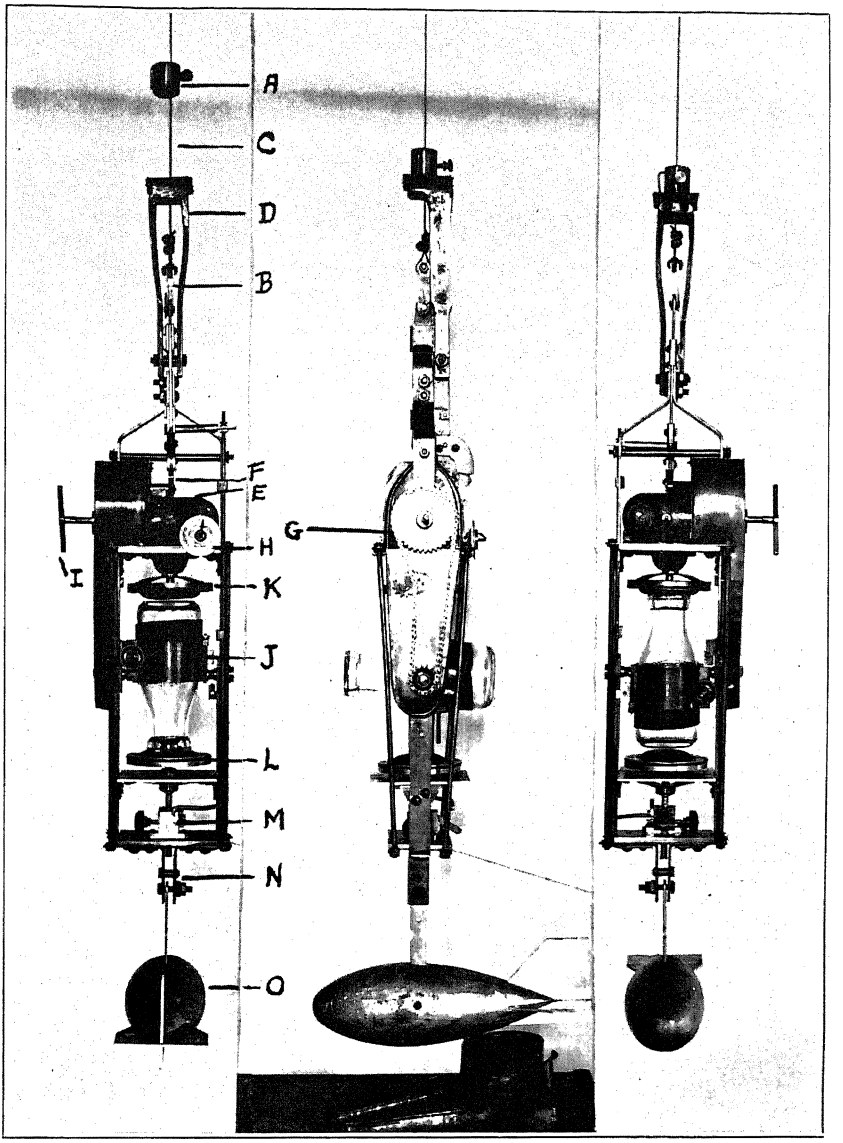


Figure 1. Figure 2. Figure 3.

ILLUSTRATION OF WATER SAMPLER

A. Tripping weight; B. Connector; C. Galvanized aircraft cord; D. Trigger; E. Spring motor (door check); F. Ratchet and pawl (ratchet enclosed); G. Sprocket and chain drive; H. Timing or checking device; I. Key for winding motor; J. Carriage; K. Self-adjusting upper valve; L. Automatic lower valve; M. Setting device for lower valve; N. Hanger; O. Lead weight.

shows the sampler prepared to take a sample. Figure 2 shows the sampler in mid-position after it has been tripped. Figure 3 shows the final position after the sample has been taken.

The operation of the sampler may be briefly described as follows: The trigger is pushed upward as far as possible and the milk bottle is clamped in position, the mouth of the bottle making a tight seal with the upper valve. The motor is wound sufficiently to bring the bottle to an inverted position over the lower valve, and is set by engaging the ratchet and pawl on the motor. The lower valve is raised against the mouth of the inverted bottle until it makes a tight seal and is then set by means of the ratchet and pawl located below the lower valve. The proper amount of lead weight is attached, the timing or checking indicator is set for the desired depth and the sampler is prepared to take a sample.

Suspended by a wire cable, it is lowered to the desired depth and a small weight is allowed to slide down the wire cable. This weight hits the trigger, and the impact trips the spring motor and lower valve simultaneously, permitting the milk bottle to open, revolve thru an arc of 180° and receive the sample as it moves. The mouth of the bottle in reaching the upright position closes by sliding under the valve. The volume of the sample can be adjusted by regulating the speed of the motor for the depth from which the sample is desired. The effect of hydrostatic pressure causes a variation in the speed with which the air and water exchange places at different depths and makes this adjustment necessary.

After the sample has been taken, the sampler is raised, the bottle containing the sample is removed from the carriage, sealed and numbered and another empty bottle is placed in position. The sampler, prepared as previously described, is ready to take another sample.

After thorough trial, it has been found that the sampler can be operated by one person, but where a large number are to be taken, most efficiently by two persons. The operation is positive in every respect at most depths. The entire opening of the milk bottle is exposed toward the current. There are no obstructions to interfere with free entrance of the sample. The volume may be adjusted and standard one pint milk bottles may be used.

APPENDIX III

CLAY AND COAL RESOURCES OF THE PERRY AREA

By H. S. McQUEEN.

The Cheltenham fire clay horizon near the base of the Pennsylvanian series has produced a considerable tonnage of plastic semi flint clay and smaller amounts of non-plastic flint fire clay at Mexico, Farber, and Vandalia, Audrain County; Fulton, Callaway County; and Wellsville, Montgomery County. Field studies of the clay, made in 1927, have indicated a northern extension of this plastic clay seam into the area contiguous to Perry, Ralls County. Outcrops of non-plastic flint fire clay and two seams of coal also occur in this part of the state.

At the request of the Chamber of Commerce of Perry, a reconnaissance geological survey was made by this Bureau to determine the extent of the clay and coal. Samples of each were collected, and firing behavior tests of the clay and analyses of the coal were made by the Missouri Clay Testing and Research Laboratory, and the Mining Experiment Station, both located at Rolla, Missouri. The results obtained are given under the discussion of each. As the result of, and subsequent to the field work, a number of diamond drill holes were put down in the area to obtain additional information regarding the quality and extent of the clay and coal. The location of the holes is indicated on the map. The core drilling was satisfactory to the extent that it substantiated the field work and indicated clay and coal producing areas. However, a very poor core recovery was obtained, and in some instances it was impossible to determine the thickness of the clay or the depth at which it was reached as depth markers had not been carefully placed in the core boxes, before they were submitted to this Bureau for examination.

The geologic map accompanying this report shows the extent of the formations in this area. In the mapping, the Pennsylvanian series has been divided into two parts: The lower part which lies between the 22-26 inch coal bed at the top and the basal chert conglomerate below and which contains the Cheltenham fire clay; and the upper part extending from the base of the 22-26 inch coal to the top of the series. The contact between

MISSOURI BUREAU OF GEOLOGY AND MINES

H. A. Buehler, Director

RECONNAISSANCE GEOLOGIC MAP

of

AREA IN VICINITY OF PERRY, RALLS CO., MO.,

by

H. S. McQueen

LEGEND

Indicates rocks and glacial clays overlying 22-26 inch coal. Also indicates areas underlain by this coal.

Approximate belt of outcrop of 22-26 inch coal.

Rocks underlying 22-26 inch coal. In general outlines area underlain by Cheltenham fire clay.

Burlington limestone.

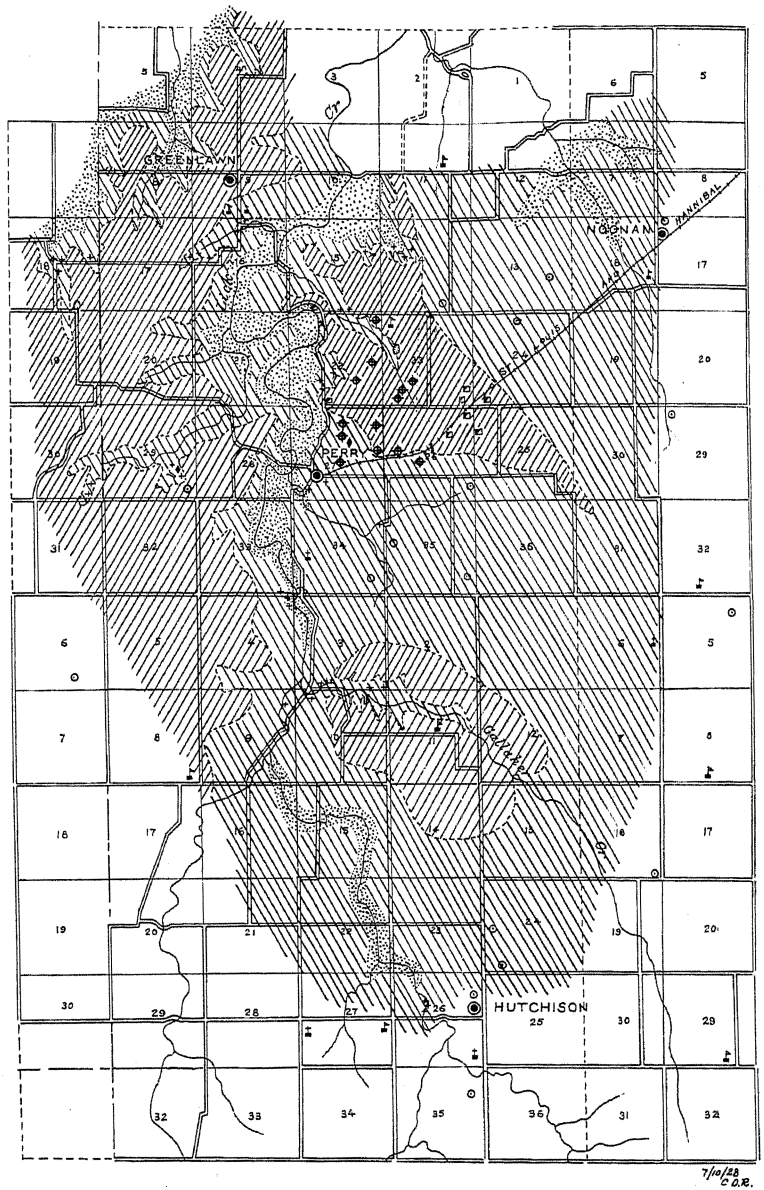
Observed outcrop of Cheltenham plastic fire clay.

Observed outcrop of flint fire clay.

Slope and shaft mines.

Deep wells. No coal reported.

Diamond drill holes



T. 54 N.

T. 53 N.

R. 7 W.

R. 6 W.

the two divisions is shown by a broken line, which also represents the approximate line of outcrop ot the coal mentioned. The areas underlain by the Burlington limestone are also indicated. No clay or coal may be expected in or below the rocks of this formation. Outcrops of flint and plastic fire clay are indicated on the map. Slope and shaft mines, and strip coal pits are also indicated, as well as a number of drilled water wells, the records of which have been invaluable in the areas of no outcrops.

The area studied, as shown on the accompanying geologic map, covers parts of Ts. 53 and 54 N., Rs., 6 and 7 W. It is a part of the glacial plain of north Missouri, and in general presents a rolling appearance, except near the larger streams where the country is moderately dissected. The geologic formations are well exposed in the broken parts of the area, and outcrops of the fire clay and coal beds are numerous. In the case of the last mentioned, the nature of the topography has permitted slope and drift mining. Shaft mining is employed in the drift covered areas.

The oldest rocks exposed are the cherty limestones of the upper part of the Burlington formation of Mississippian age, numerous outcrops of which occur along Lick Creek and its larger tributaries. The limestones are light gray in color, and crystalline; nodules and lenses of chert are common.

The Burlington formation is overlain by the Pennsylvanian series, which is composed of conglomerate, clay, coal, shale and limestone. It is the most important series from the standpoint of economic resources. The following record of a diamond drill hole shows the character of the Pennyslvanian in this area:

RECORD OF DIAMOND CORE DRILL HOLE, BARGER FARM, NE. ¼ sec. 22, T. 54 N., R. 7 E.

	Thickness.		Depth.	
	Feet.	Inches.	Feet.	Inches.
Pleistocene:				
Clay, glacial drift	13	.....	13	.....
Pennsylvanian Series:				
Shale	7	.....	20	.....
Shale	4	6	24	6
Limestone	1	6	26	.....
Shale	7	.....	33	.....
Shale, black	6	4	39	4
Coal	2	2	41	6
Clay	3	6	45	.....
Limestone	1	6	46	6
Shale, black	1	6	48	.....
Coal	1	.....	49	.....
Clay, dark gray, slightly sandy, fire clay	16	.....	65	.....

Field work in the area would indicate thicker beds of limestone than those shown in the above record. Fifteen feet of limestone were reported in the shaft of the Boudinier coal mine in the SE. ¼ SE. ¼ sec. 23, T. 54 N., R. 7 E., and a thick bed of limestone was also reported in several wells drilled in this part of the state.

The area studied lies well down on the west flank of the Cap au Gres fold, the dominant structural feature of northeast Missouri. The local structure is comparatively simple, being marked by low folds. In two localities south of Perry, the Burlington limestone has been brought to the surface as the result of folding. Pennsylvanian rocks are found in the syncline between the two, the local coal bearing area on Gallaher Branch apparently being confined to this part of the structure. The presence of a fault striking northwest and marking the eastern limits of the coal bearing areas has been suggested by the field work. Local slips, faults and folds were noted at several localities.

Clay Resources—The clay resources in this part of the state are practically undeveloped. A few years ago some drilling was done in the SW. ¼ sec. 3, T. 53 N., R. 7 E., and a small tonnage of plastic fire clay was mined from an outcrop on Galla-

her Branch near the center of the south line of the SW. ¼ of the section mentioned. The clay was considerably stained by iron oxide, but the fusion point was reported to be sufficiently high to classify the material as fire clay. However, the presence of impurities, chiefly iron, resulted in unsatisfactory fire brick. A study of the exposure showed iron-stained clay, marked by an astringent taste due to the presence of soluble sulphates.

The Cheltenham clay in this area, as well as in east central Missouri in general, rests upon an uneven chert conglomerate, and locally sandstone, floor. Consequently it varies in thickness from a few to possibly 25 feet, but on the average will be about twelve feet. "Rolls" or ridges in the conglomerate result in thinning of the clay, but in the accompanying basins a greater thickness is usually found. A notable example of a "roll" in the conglomerate in this area occurs on the English farm, in the NE. ¼ sec. 9, T. 53 N., R. 7 W.

As shown by outcrops the plastic fire clay is usually light gray in color, with local masses tinged a bluish gray to blue. It is often stained red from iron oxide and the weathered portions of the clay are soft and very plastic. Some grit, chiefly sand, was noted in several exposures, particularly in the lower part of the clay bed. The clay from unweathered portions of the bed is light gray in color, and has a waxy luster. It is hard, when dry, fine-grained, and when immersed in water slacks rapidly into fine particles. An examination of drill cores shows some sand in the lower part of the clay in a few holes. Pyrite is very common, and forms the chief impurity. However, it does not occur in any greater quantity than generally noted in the Cheltenham clay in other parts of east central Missouri. As in other parts of the area, the upper part of the Cheltenham seam at Perry contains dark bluish gray low refractory clay. This material known as "dry mill clay" has a thickness of at least three feet.

Outcrops of non-plastic flint fire clay were noted in two places in the area. As in other parts of the district, it appears to be confined chiefly to the deeper depressions between the "rolls" in the conglomerate floor. The most accessible outcrop noted was on the Richards farm, near the center of sec. 27. T. 54 N., R. 7. W., where the clay outcrops for a short distance on the north side of a small valley. Soft plastic clay and chert conglomerate outcrop a short distance south. The local geology indicates a basin-like depression in this locality and a diamond

core drill hole was put down. White clay was reported at a shallow depth beneath the glacial clay overburden, and the hole was reported to have penetrated 26 feet of fire clay before the conglomerate was reached. Unfortunately no cores of the clay were recovered for testing. The outcrops show light colored flint clay on the surface, slightly stained with iron. The iron stain appears to be confined to the surface, as material from a shallow test pit showed light colored clay of good quality. A firing behavior test of this material bonded with plastic fire clay is given on a following page. A chemical analysis is also given.

The other observed exposure of this clay occurs on the Powell farm, in the NW. ¼ SW. ¼ sec. 29, T. 54 N., R. 7 W., where the clay outcrops near the base of a low bluff. Two and one-half to three feet of heavily iron-stained clay is exposed. This material would probably not be satisfactory for the manufacture of fire brick, but higher grade material might reasonably be expected back in the hill.

Flint fire clay was also cored in a hole drilled on the Willard farm, in the SE. ¼ sec. 22, T. 54 N., R. 7 E. The clay was found between the depths of 50 and 54 feet. It was overlain and underlain by more plastic clay, the total thickness of the clay reported being 15 feet.

A diamond drill hole on the Alford farm, in the NE. ¼ sec. 27, T. 54 N., R. 7 E., was reported by the drillers as ending in two feet of slate. An examination of the core however showed hard, very dark flint fire clay. Unfortunately, the thickness of this clay was not determined. It was overlain by gray plastic fire clay having a reported thickness of 13 feet. The top of the clay was found at a depth of 25 feet, as shown by the record of the hole given below:

RECORD OF DIAMOND DRILL HOLE, No. 11, ALFORD FARM, NE. ¼ sec. 27, T. 54 N., R. 7 E.

	Thickness.			Depth.
	Feet.	—Inches.	Feet.	— Inches.
Pleistocene:				
Surface clay (glacial)	5	6	5	6
Pennsylvanian Series:				
Slate	6	6	12	.....
Coal	1	4	13	4
Mining dirt	1	2	14	6
Clay, green	6	.....	20	6
Coal	1	.....	21	6
Clay, gray, sandy	3	6	25	.....
Fire clay	13	.....	38	.....
Flint clay, dark	2	.....	40	.....

A study of the core indicates the presence of at least three feet of dark blue, slightly sandy "dry mill" clay in the upper part. The lower part of the seam was darker colored and appeared to become higher grade material with increasing depth. Pyrite was noticeable in the clay. Complete core recovery was not obtained from this hole, but a sufficient amount was obtained to make firing behavior tests.

The results of the tests made on this plastic fire clay are given in the table below. They were determined by the clay testing laboratories of the Missouri School of Mines.

DRYING BEHAVIOR.

Working properties: Clay molds readily and is quite plastic.
Water of plasticity: 22.2%
Per cent drying shrinkage volume (dry basis): 22.60.
Per cent drying shrinkage linear (dry basis): 7.03.
Drying behavior: Clay dries easily and free from all cracks.

FIRING BEHAVIOR.

Temperature.	Cone.	% Porosity.	% Volume change.	Color.
1060 deg. C....	02	23.10	12.90	Light gray—white.
1092 deg. C....	2	17.60	18.12	Light gray—white.
1112 deg. C....	4	14.98	18.75	Light gray—white.
1150 deg. C....	6	14.14	19.00	Light gray—white.
1188 deg. C....	8	13.62	19.15	Color darkens with temp. rise.
1245 deg. C....	10	11.35	20.21	Light gray—white.
1296 deg. C....	12	7.29	21.96	Light gray—white.
1311 deg. C....	14	2.86	22.42	Iron spots increase in size.
1414 deg. C....	16	4.05	17.59	Iron spots increase in size.
1445 deg. C....	18	6.44	12.46	Iron spots increase in size.
1494 deg. C....	20	6.74	8.20	Iron spots increase in size.

Overburning temperature cone 16 (1450° C. or 2642° F.).

Best apparent burning range cone 6 to cone 14 (1250° C. or 2282° F. to 1410° C. or 2570° F.).

Gradual porosity and volume changes over a large range terminating in an abrupt change at cone 15.

Long firing range of about 8 cones. A body of excellent strength and structure was developed.

Possibilities: High heat duty refractories.

A test consisting of a mixture of 80 per cent flint fire clay from the S½ NE ¼ sec. 27, T. 54 N., R 7 E., and 20 per cent plastic fire clay from drill hole No. 11, located in the SW ¼ NE ¼ sec. 27, T. 54 N., R 7 E., was made to determine the possibilities of manufacturing a high grade fire brick. The results obtained by the clay testing laboratories are given below.

DRYING BEHAVIOR.

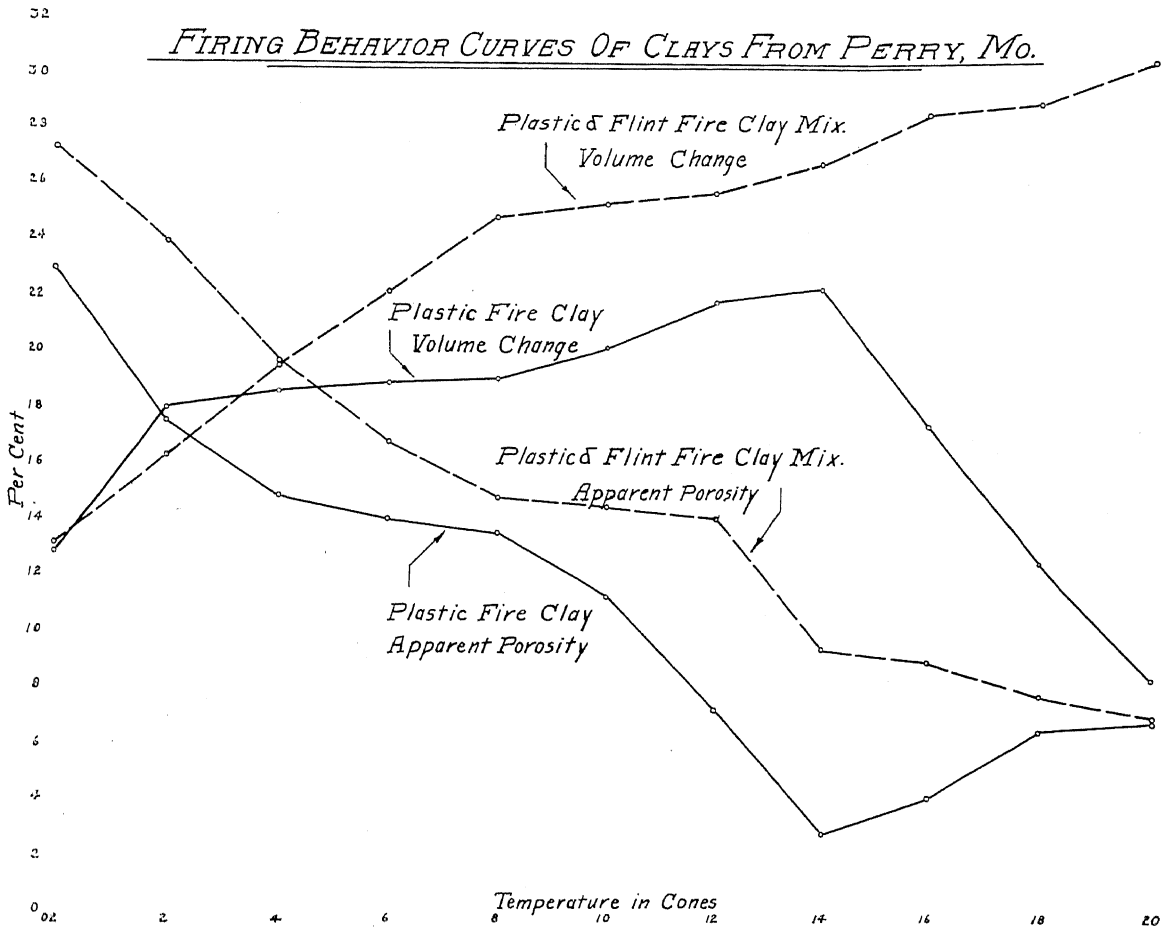
Water of Plasticity: 15.90%.

Per cent drying shrinkage, volume, dry basis: 9.44.

Per cent drying shrinkage, linear, dry basis: 3.25.

Observations: Mixture dries readily without the development of cracks or other defects.

Missouri Bureau of Geology and Mines, Biennial Report, 1927-1928, Plate VI.



FIRING BEHAVIOR.

Temperature.	Cone.	% Porosity.	% Volume change.	Color.
1125 deg. C....	01	26.30	13.92	Light gray—white.
1148 deg. C....	2	24.06	16.35	Light gray—white, steel hard.
1180 deg. C....	4	19.77	19.75	Light gray—white, steel hard.
1200 deg. C....	6	16.80	22.29	Light gray—white, steel hard.
1220 deg. C....	8	14.87	24.90	Light gray—white, steel hard.
1238 deg. C....	10	14.56	25.42	Light gray—white, steel hard.
1254 deg. C....	12	14.20	25.88	Light gray—white, steel hard.
1344 deg. C....	14	9.43	26.85	Dark gray—Iron speckled.
1430 deg. C....	16	8.82	28.75	Dark gray—Iron speckled.
1455 deg. C....	18	7.68	29.15	Dark gray—Iron speckled.
1497 deg. C....	20	6.81	30.50	Dark gray—Iron speckled.

Possibilities: No. 1 flint fire clay refractories.

The results of this test indicate that the clays of this mixture are suitable for No. 1 flint fire clay refractories. The mixture will withstand a more severe heat treatment than cone 20 (1530°C. 2786°F.). When used alone the plastic fire clay is overfired at Cone 14 (1410°C, 2570°F.), but when mixed with the flint fire clay is satisfactory as a bond, and gives a workable mixture. Iron splotches, noted in the plastic clay alone, are not as prominent in the ware made from this mixture. The test shows a comparatively short firing range, but this is not considered serious as there is not a great change in porosity and shrinkage between cones 6 and 12, (1250°C. 2282°F., and 1370°C. 2498°F.). The pyrometric cone equivalents (fusion point) of the plastic and flint fire clay samples used in this test were cones 31-32 (1760° centigrade, 3200° Fahrenheit) and cone 33, (1790° centigrade, 3245° Fahrenheit.) A sample of plastic fire clay from a cistern dug in the town of Perry had a pyrometric cone equivalent value between cones 30 and 31, 1670°—1685°C, 3038°—3065°F.

The chemical analyses given below indicate the clays in the Perry area are comparable to those from other parts of the district, except perhaps the sample from the cistern dug in the town which is slightly higher in silica than the average. It was overlain by glacial clay and there may have been some mixing of the two.

The sample obtained by core drilling and given below as No. 2, shows considerable iron, due to the presence of pyrite. This impurity is common to the Cheltenham seam, and locally

is often found in considerable amounts, or again in very small amounts.

Chemical analyses of samples of the flint and plastic fire clay were made with the following results:

	1	2	3
Silica (SiO_2)	56.08	53.42	44.20
Alumina (Al_2O_3)	29.18	28.55	37.62
Iron (Fe_2O_3)	1.06	3.15	1.40
Lime (CaO)	0.34	None.	None.
Magnesia (MgO)	0.12	None.	None.
Titania (TiO_2)	2.04	1.50	2.72
Potassium (K_2O)	N. D.	1.03	.28
Sodium (Na_2O)	N. D.	.36	.08
Ignition loss	10.87	11.88	14.11
Sulphur (S)	0.37	N. D.	N. D.
Sulphur tri-oxide	0.18	N. D.	N. D.
Totals	100.24	99.89	100.41

N. D. Not determined.

1. Analysis of plastic fire clay collected from cistern dug near the center of the town of Perry. Sample from near the surface, slightly iron-stained.

2. Analysis of plastic fire clay, from diamond drill hole No. 11, depth 29-38 feet. NE. ¼ sec. 27, T. 54 N., R. 7 E.

3. Analysis of flint fire clay, from outcrop, S. ½ NE. ¼ sec. 27, T. 54 N., R. 7 E.

Coal Resources—The coal resources of the area while not fully developed have probably received the greatest attention, and a number of shaft and slope mines have been in operation for a number of years. The distribution of the coal appears to be confined to three distinct areas. The first, a basin lying east and northeast of Parry; second a small area south of Perry on Gallaher Branch, and third, the area west and north of Perry on the west side of Lick Creek. The coal-bearing areas appear to be affected by structural features, and those on the east side of Lick Creek appear to be confined to shallow synclinal basins, resulting from low folding and possibly faulting.

The approximate boundary of the main coal bed is shown on the geological map. However, it was not accurately determined in certain parts of these basins, because of the nature of the country, the lack of outcrops, and accurate and reliable drill records. The vein worked in this field is normally 22 to 26 inches thick, exclusive of a thin clay parting from one-half to one inch in thickness. In the Boudinier mine, northeast of

Perry in the SE. ¼ SE. ¼ sec. 23, T. 54 N., R. 7. W., the coal is 22 to 26 inches thick, with a clay parting (the 'snubbing band' of the miners) 4 to 6 inches above the base.

The coal above the 'snubbing band" is jet black in color, fairly hard and comparatively clean. It contains some pyrite and gypsum (white scale) along plane surfaces. Below the clay parting or snubbing band the coal is softer and slacks into dust upon exposure to the air. The coal as observed on the outcrop in various parts of the area has a rusty color due to the presence of iron which coats the white scale.

The demand for coal from this field is greater than the present production. The coal producing areas as outlined cover some 18 square miles, and the coal available is estimated at several million tons of which only a small part has been mined. While the vein is not exceptionally thick, it furnishes coal of good quality and could be developed on a larger scale than at present. The vein underlies over 3 square miles east of Perry, and a large tonnage is available from this part of the field. It is well located with respect to transportation facilities, and should become a more important shipping and local producer. The coal in this part of the field would have to be mined from shafts, due to the thickness of the overburden which amounts to 60 to 70 feet, or from slopes along the belt of outcrop.

The possibilities of stripping in this area are local and limited to places along the outcrop bordering the valley in the west half sec. 23, T. 54 N., R. 7 W., the S. ½ sec. 15, T. 54 N., R. 7 W., and the NW. ¼ sec 14, T. 54 N., R. 7 W. Some local stripping has been done on the Alexander farm in the SW. ¼ NW. ¼ sec. 23 and the NW. ¼ SW. ¼ of sec. 23. However, the thickness of the coal is not sufficient to handle the rock overburden over large areas. Plans are now being made for strip mining operations in the first locality mentioned.

The basin south of Perry, adjacent to and lying in Gallaher Branch, offers possibilities for slope and shaft mining. This part of the field is 2 miles or more from the railroad and shipping mines would require a railroad spur of that length. The coal is of good quality and this area could very easily become a more important producer.

West of Perry, on the west bank of Lick Creek, the coal outcrops extensively along the "breaks," and appears to be more widespread. Many drifts have been driven in the 22-26 inch bed for the production of local coal. The rock overburden appears

to be of too great a thickness over most of this part of the field to offer more than local areas for stripping, the extent of which would not justify any great outlay for this type of mining. Local stripping has been done on the Parks farm in the SE. ¼ sec. 18, T. 54 N., R. 8 W., Monroe County.

A second bed of coal was noted during the investigation. It lies about 10 feet below the bed mined, and will average 10 to 12 inches in thickness. It is not of sufficient thickness to be of commercial importance, and appears to be absent locally. It outcrops generally on the west side of the basin east of Perry, and in the field on the west side of Lick Creek.

Analyses of the coal from the 22-26 inch seam are given below. Unfortunately the analyses available were not made on a moisture or moisture free basis. The coals compare favorably with other coals from the state, and there is no reason why they should not fill the demands of the northeast Missouri markets.

PARTIAL ANALYSES OF COAL SAMPLES FROM PERRY, MISSOURI.

	Sample No. 1	Sample No. 2
Moisture	1.60	1.44
Volatile matter	43.62	45.31
Fixed carbon	44.84	44.98
Ash	9.94	8.27
Sulphur	4.68	5.09
British Thermal Units	12,812	13,208

Sample No. 1: From face in Foster Slope Mine, SW. ¼ SE. ¼ sec. 20, T. 54 N., R. 7 W.

Sample No. 2: From face in Boudinier Coal Co. Mine, SE. ¼ SE. ¼ sec. 23, T. 54 N., R. 7 W.

The field work and subsequent core drilling have indicated an area capable of producing flint and plastic fire clay, suitable for the manufacture of high grade fire brick. A bed of coal of workable thickness is also available. The results of core drilling and a study of the shaft and slope coal mines indicate that the strata overlying the clay and coal are of sufficient strength to afford a satisfactory roof for underground mining. No great amount of water should be expected in the deeper mines. The results of this investigation are such as to indicate considerable development in this part of the state during the next few years.