MISSOURI BUREAU OF GEOLOGY AND MINES.

E. R. BUCKLEY, Ph. D., Director and State Geologist.

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THE

Geology of Moniteau County

BY

F. B. VAN HORN

WITH AN INTRODUCTION BY

E. R. BUCKLEY.

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MISSOURI BUREAU OF GEOLOGY AND MINES

E. R. BUCKLEY, Ph. D., DIRECTOR AND STATE GEOLOGIST.

GEOLOGICAL MAP

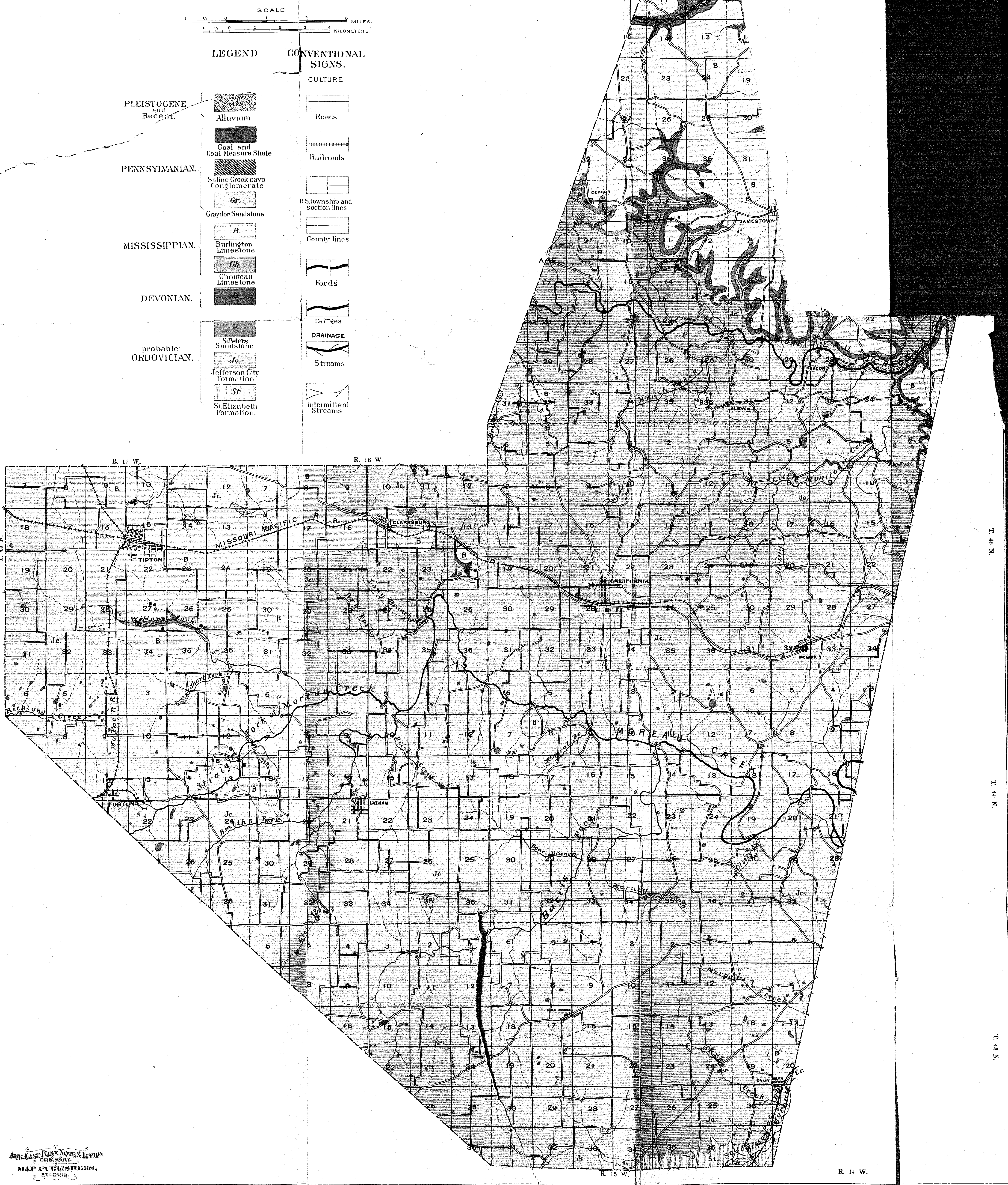
OF

MONITEAU COUNTY,

MISSOURI.

BY

F. B. VAN HORN.



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BUREAU OF GEOLOGY AND MINES,
ROLLA, MO., June 1, 1905.

To the President, Governor Joseph W. Folk, and the Members of the Board of Managers of the Bureau of Geology and Mines:

Gentlemen—I have the honor and pleasure to transmit to you a report on the Geology of Moniteau county.

The field work for this report was begun in the summer of 1902 by Sydney H. Ball. During the month of June Mr. Ball mapped the east half of township 43, R. 14 W. and the southeast half of T. 43, R. 15 W. During the same summer Francis B. Laney mapped parts of T. 45, R. 15 W.; T. 44, R. 15 W.; and T. 45, R. 16 W. Carl Smith mapped all or parts of T. 45, R. 15 W.; T. 44, R. 15 W.; T. 44, R. 16 W.; T. 43, R. 15 W.; T. 43, R. 16 W.; and T. 43, R. 14 W. In the summer of 1903 that portion of the country remaining unsurveyed was mapped by Frank B. Van Horn and Edward B. Hall. The report was written in the office by Frank B. Van Horn and revised by myself. The work in the field and in the office has at all times been under my immediate supervision.

The topographic map of this area, made by the U. S. Geological Survey a number of years ago, is so very much generalized that it could not be used in the field work or as a basis for the geologic mapping. The work is, therefore, based chiefly on elevations taken from the surveys of the Missouri Pacific railroad. All elevations, beginning with a known elevation, were determined with aneroid barometers. Elevations were determined at many places along the different contacts between the formations; at nearly all road and stream crossings; and at mines, prospects, quarries and other places of economic interest.

The mapping was done by traversing on foot or horseback. The distances were determined by pacing and directions by using a Gurley "Geologist's Compass." All locations were made with reference to section corners, quarter posts or some other known point upon which the work could be checked. In the hilly country the locations are naturally not as accurate as on the prairie.

Owing to the fact that the contacts between the formations follow very closely, a horizontal line between the tops of the hills and the bottoms of the valleys, the ravines and valleys were everywhere traversed from head to mouth. Where a contact follows close to the top of a ridge, the ridge itself was traversed in order to locate definitely the contacts.

In this manner the outcrops of rock, the quarries, mines, prospects, soils and clays on every section of land were examined. All the occurrences of minerals and ores were recorded in field notebooks. Special attention has been given to the mines and prospects, and careful, accurate descriptions of these were made.

I remain, very respectfully,

Your obedient sir,

E. R. BUCKLEY,

Director and State Geologist.

ACKNOWLEDGMENTS.

To all those interested in mining in this county, and especially to Mr. A. D. Hatten, superintendent of the Gundling Mine, our thanks are due. We also desire to acknowledge our indebtedness to Dr. E. M. Shepard, who has read the manuscript of this report very carefully and offered helpful suggestions, and to Dr. E. O. Ulrich of the United States Geological survey for assistance in determining the age of the various Devonian and sub-Carboniferous beds. Our thanks are also extended to the Missouri Pacific railroad for co-operation in carrying on this work.

The Bureau has had the hearty co-operation of every citizen in the county and to all these we desire to express our indebtedness.

INTRODUCTION.

This is the second of the county geological reports prepared and published under the present administration. At the time the field work was begun in 1902, there were 49 counties for which reports and maps had never been issued; 49 counties for which general reconnoissance reports had been published; one for which a complete and 20 for which partial detailed reports had been published. During the last three years, Miller, Morgan and Moniteau counties have been surveyed in detail. A report has been published covering the work in Miller county; this report is the result of the work in Moniteau county; and the results of the work in Morgan county are still in manuscript form. Also, during this period, portions of St. Francois and Newton counties have been surveyed. It is intended to survey and publish reports on the different counties which remain unsurveyed, as rapidly as possible. It is the plan to survey these counties in sufficient detail to make them valuable aids to both the miner and prospector.

GENERAL PLAN FOR COUNTY REPORTS.

In the publication of State Geological reports, the county must be recognized as the unit. The people do not consider the location with reference to the degrees of longitude and latitude, but rather with reference to the political subdivisions. It is believed that county reports serve the public better than sheet reports, and for this reason they have been adopted by this Bureau.

TEXT OF THE REPORT.

Moniteau is one of the most centrally located of the counties in the State, and geologically it is especially important in so much as it contains excellent exposures of rock representing the geological formations from the Cambro-Ordovician to the Pennsylvanian.

In the first and second annual reports of the Geological Survey of Missouri, by G. C. Swallow, published in 1855, there is a short report on the Geology of Moniteau county by F. B. Meek. In this report the author recognized and described most of the different formations, including the Burlington limestone, Coal Measure shale, Chouteau limestone, Devonian limestone and sandstone, Saccharoidal sandstone and Second Magnesian limestone. The general relations which the different formations bear to one another were clearly recognized by Mr. Meek, although all the different exposures were not examined or mapped in detail.

The oldest formation recognized in this county, is that which has been designated by Ball and Smith, in their report on "The Geology of Miller County," as the St. Elizabeth. Beds of dolomite and chert belonging to this formation, outcrop in the southern part of the county. Above this formation and conformable with it is exposed the Jefferson City or First Magnesian limestone. This formation is separated from the St. Peters or First sandstone above by an unconformity. The St. Peters sandstone in turn is unconformably below the Devonian, which is represented by thin beds of limestone and sandstone. Above the Devonian occur the Chouteau and Burlington limestones belonging to the Mississippian series. Unconformably above the Burlington limestone occur isolated areas of shale, sandstone and coal belonging to the Pennsylvanian series. The shale and coal probably belong to the Des Moines stage (Lower Coal Measures).

The southern part of the county is chiefly underlain with limestone belonging to the Jefferson City formation, while the northern part is underlain chiefly with Burlington limestone. Scattered over the entire surface of the county, are isolated areas of sandstone, coal and shale. The coal and shale occur more abundantly in the northern than in the southern part of the county, and are unquestionably of Carboniferous age. The sandstone, on the other hand, is thought to belong chiefly to the St. Peters formation. A part of the sandstone may belong to the Pennsylvanian, but the fact that not over one-tenth as much sandstone to each square mile occurs over the area underlain with Carboniferous limestone as over the area underlain with Jefferson City limestone, is very conclusive evidence that the sandstone is mainly of pre-Carboniferous age.

It was not possible in mapping this area to separate the Burlington into an upper and lower member. For this reason the limestone above the Chouteau is all mapped as Burlington.

The differentiation of the formations in this county has been based upon both structural and paleontological evidences. The fossils, examined in the field by Dr. E. O. Ulrich, of the United States Geological Survey, and the stratigraphic relations have been the basis of the separation of the strata into the different formations as outlined on the accompanying map.

In the preparation of this report, some attention has been given to the origin of the chert. From the examination made it is quite clear that a great part of the chert is secondary, having been formed through the replacement of the limestone by silica. Some of the chert nodules occurring in the Burlington limestone may be original, but of this there is very little evidence.

The chapter on the mineral resources, is a careful and concise description of the valuable rocks and minerals occurring in the county. The attempt has been to make these descriptions clear, concise and accurate and it is thought that if anyone cares to investigate the quarries or mines herein described, they will find the conditions as set forth in this report.

The mines in the Fortuna district have not been as productive as it was hoped they might be when first opened up. The Standard and Gundling mines which were practically the only producers in the district, are located on a single ore body which might be called a circle. It consists essentially of an area of broken or brecciated limestone and flint, roughly circular in form and resembling in outline a sink hole. It was chiefly within the cavities of this brecciated limestone and flint that the galena and blende were deposited. The mineral does not occur as a replacement product of either the limestone or flint, but has crystallized out of the solutions in the same manner as calcite frequently crystallizes out of water filling caverns within the rocks.

Deposits similar to this one are not necessarily connected with others in the same district. They are frequently isolated and it would be difficult to determine the location of similar deposits except by extensive drilling. The cost of locating other and similar ore bodies, in this manner, would probably be very great. Following the discovery of lead and zinc at this place, hundreds of drill holes were sunk, without finding another ore body sufficiently extensive to warrant development.

OBSERVATIONS ON THE NOMENCLATURE OF THE CAMBRO-ORDOVICIAN FORMATIONS IN MISSOURI.

There seems to have been very little if any confusion in use of the name Joachim as applied to the dolomitic formation occurring above the known St. Peters sandstone at Crystal City and Pacific. It is true that this name has been applied to dolomite which has, later, been proven to be older, but to the known Joachim only one other name has been given. Keyes in a paper published in 1898 called this formation the "Folley," but the name did not meet with general acceptance.

To the St. Peters* sandstone, which is immediately beneath the Joachim, various other names have been applied viz.: First Sandstone, Saccharoidal Sandstone, Cap au Gres, Crystal City, Pacific, Key and Roubidoux. The earlier geologists suspected that this sandstone might be the equivalent of the St. Peters of Wisconsin, Iowa and Illinois but not until recent years has this fact been well established. At this time there is very little doubt that the sandstone which outcrops at Pacific, Crystal City, Klondike and other places is the St. Peters. It is our intention hereafter to use this same name in preference to all others.

Beneath the St. Peters there is a succession of thick, pitted beds of arenaceous dolomite alternating with thin beds of argillaceous, arenaceous dolomite (cotton rock). These beds make up what is known as the Jefferson City formation. This name was applied to the formation by Winslow in 1892. By the earlier geologists this formation was known as the 2nd Magnesian limestone, while others have attached to it certain local names such as Finley and Winfield.

Beneath the Jefferson City formation occurs a complex formation consisting of dolomite, chert and sandstone. The lower limit of this formation is represented in some places by a conglomeritic bed of sandstone and everywhere by an abrupt change in sedimentation. That such a complex existed beneath the Jefferson City formation was recognized by Nason and other geologists. It is believed that Nason intended to apply the name Gasconade to that part of the complex underneath his Roubidoux sandstone and including the beds to which we now apply the term Gasconade, which outcrop along the Piney, Gasconade and Current rivers. He evidently did not examine the outcrops along either the Niangua or Osage rivers where the underlying Gunter sandstone is exposed. Nason's Gasconade evidently included most of the St. Elizabeth of Ball and Smith, and most of the formation known as the Gasconade which is between the St. Elizabeth formation and the Gunter sandstone. I think it is clear from reading both Nason and Winslow that the name Roubidoux was applied to the uppermost sandstone member of the St. Elizabeth and that Gasconade was applied to the remaining portion of the St. Elizabeth and the underlying beds which we have seen fit to distinguish as the Gasconade.

Some have objected to the use of the name St. Elizabeth, preferring the name Roubidoux and claiming for it priority. The name

*This is also spelled St. Peter's and St. Peter. The name is taken from the name of a river. Owen was the first to apply this name to the sandstone, and in his report it is spelled St. Peter's. It is, therefore, wrong to drop the s, although the apostrophy may be omitted without question.

Roubidoux was first used by F. L. Nason in his report on the "Iron Ores of Missouri." It is evident, however, from this report that the name was not applied to a complex, consisting of sandstone, dolomite, quartzite and chert, but to the upper sandstone member alone. Since Nason's time it has been used by C. F. Marbut in this sense. Nason also applied the name Roubidoux to the St. Peters sandstone believing that the sandstone which outcrops conspicuously at Pacific, Klondike, Crystal City and other places was a continuation of the sandstone of the interior Ozark region named Roubidoux by him. Later Winslow (1894) in his report on "Lead and Zinc Deposits," accepted the term Roubidoux as the equivalent of the Crystal City, Pacific or St. Peters sandstone. If one should examine the provisional table on page 331 of Vol. VI of the reports of this Bureau he would find that Winslow, avowedly following Nason, clearly, did *not* include as a part of the Roubidoux the complex which we include under the St. Elizabeth. In support of this fact we read on page 378 of this report of Winslow, "Work conducted by Mr. Frank L. Nason during 1892, over the Ozark area, led him to the conclusion that the so-called First, Second and Third sandstones do not exist as persistent beds, and are not of the stratigraphic value which the old classification gave them. He divides the series, so far as his observations went, into an overlying stratum, called Roubidoux sandstone (probably the equivalent of what we have called the Crystal City sandstone), and an underlying series of Magnesian limestones, including some thin beds of sandstone, to which he applies the name of Gasconade limestone."

Nason in his report on "Iron Ores," page 110, says: "Another fact supporting the existence of the *continuous bed of sandstone,* already referred to, is the persistent occurrence of a distinct fossil stratum always occurring in the same well recognized relation to the sandstone." He also says, pp. 114 and 115: "In view of the facts above pointed out it is suggested that the name Roubidoux sandstone be applied to the rock above described as overspreading the Ozark region from Cabool to Gasconade City and from Salem to Doniphan. This embraces much, if not all, of what has been called Second sandstone, and will undoubtedly include the areas of so-called First sandstone as well. Further, it is proposed that the name Gasconade limestone be applied to the great series of limestone beds, interstratified with thin beds of sandstone, which underlie the Roubidoux sandstone." Evidently Nason believed that there was a continuous bed of sandstone overlying a complex of sandstone, dolomite and chert, and underlying a limestone formation (Joachim), to which *sandstone* formation he applied the name Roubidoux. He clearly included under the term Gasconade the Gasconade limestone and that portion of the St. Elizabeth formation below the Bolin creek sandstone, as defined in the Miller county report. The formation which we know as the Jefferson City, occurring as it always does above the sandstone called, by Nason, Roubidoux, must have been thought by him to be Joachim.

The term Gasconade was never, as far as I can learn, applied by Nason to any succession of beds which included either the Gunter sandstone or the Proctor limestone. In the descriptions of his canoe trips he says nothing of having visited those portions of the State where these formations are exposed. A greater part of the rocks to which he applied the name Gasconade are those which we now recognize under that name. To the formation which we now know as the Gasconade and a part of the St. Elizabeth, Winslow applied the name Osage. This name was applied at an earlier date to a different formation and should therefore be abandoned.

Directly beneath the Gasconade there is a sandstone bed varying from four to thirty feet in thickness, which has been variously known as the "Third," "Cole Camp" or "Gunter" sandstone. The sandstone at Cole Camp, from which locality Winslow took the name of this sandstone, is not at the same horizon as the Gunter, but near the top of the St. Elizabeth formation. It is believed that the sandstone which outcrops at Cole Camp does not belong to the Third sandstone. For this reason the name Cole Camp has been abandoned and Gunter substituted in its place. At Gunter, (Ha-ha-ton-ka) Springs the sandstone at the base of the Gasconade formation is typically and best exposed.

The Gunter sandstone is separated from the underlying dolomite by a well defined unconformity. Wherever the Gunter sandstone has been observed it overlies, unconformably, the dolomite. We believe that our present knowledge of these formations warrants us in separating this dolomite from the Gunter sandstone, and also in applying to it a distinct formational name. In conformity with these ideas we have adopted the name Proctor which was applied to it by Winslow.

There is very little known of the formations, of the Central Ozark region, which occur beneath the Proctor limestone. Indeed, only the upper part of this formation is exposed. Drill holes in the neighborhood of Decaturville and Ha-ha-ton-ka are reported to have passed through two additional sandstone beds beneath the Gunter, but to my knowledge they are nowhere exposed at the surface.

Other formational names have been applied to the Cambro-Ordovician series in the southeastern part of the State. For example, there are exposed three distinctly different formations in St. Francois county which have been called La Motte sandstone, Bonne Terre or St. Joseph limestone and Potosi limestone. These three names were intended by Winslow to include all the various limestone, sandstone and shale beds between the Crystal City (St. Peters) sandstone above and the Iron Mountain Conglomerate or pre-Cambrian below. These formations are in a large part equivalent to the formations of the Central Ozark region. In discussing Winslow's observations, it must be borne in mind that he believed the St. Peters and Second sandstone formations to be one and the same. Believing this, he also must have considered the Jefferson City (Second) limestone and the Joachim (First) to be one and the same, and to be above the St. Peters sandstone. From this we are forced to conclude that Winslow intended to apply the name Potosi to that part of the complex formation in the central district (known as the St. Elizabeth) which lies underneath the so-called Second sandstone and the Gasconade. In the light of present observations made in Reynolds, St. Francois, Washington and other counties I am forced to believe that the Potosi, as we know it. is the equivalent of the St. Elizabeth and the Gasconade; that the shale horizon called the Elvins formation by Dr. Ulrich, corresponds to the Gunter sandstone; that the Bonne Terre limestone is the equivalent of the Proctor, and that the La Motte sandstone is the equivalent of some formation not exposed in the Central district.

The above conclusions are not final and are published only that those interested may have the results of our latest efforts to correlate the Cambro-Ordovician stratigraphy of the different sections of the Ozark region.

THE SILURIAN, DEVONIAN AND CARBONIFEROUS.

The line of separation between the Cambrian and Ordovician has not been determined, depending as it does chiefly upon the fossil content of the rocks.

The remainder of the geologic section in Missouri, consisting of Silurian, Devonian and Carboniferous, is better defined and offers less serious obstacles to separation into formations.

The Devonian in this State is represented by a relatively thin horizon of shale, limestone and sandstone. Its areal distribution, thickness and relations to the overlying and underlying formations have not been fully determined.

Dr. E. O. Ulrich has been working on this problem in the eastern part of the State, but up to the present time the results of his investigations have not been published. The investigations which have been carried on by this Bureau in the Ozark region have given no evidence that the Devonian ever covered that portion of the State. If Devonian strata ever existed over that portion of Missouri they have long since been removed.

On the other hand the Carboniferous strata evidently overspread the entire Ozark region, as shown by the small, scattered patches of limestone, shale, sandstone, and coal that occur on the flanks and summit of the plateau. Small areas of typical Chouteau and Burlington limestones, belonging to the Mississippian or lower division of the Carboniferous, are of frequent occurrence. Small areas of shale, sandstone and coal belonging to the Pennsylvanian or upper division of the Carboniferous are also common. Whether these strata belong to the Missourian* (Upper Coal Measures) or Des Moines (Lower Coal Measures) has not been determined positively. It is believed, however, that they belong to the Des Moines.

The Mississippian limestone was laid down on an eroded land surface. This is also true of the Pennsylvanian strata. Everywhere we find the rocks belonging to these formations occupying depressions in the underlying formations. In some places the pockets of Pennsylvanian shale and sandstone are so deep and the enclosing walls so steep that the unconformity is mistaken for a fault.

It is thought that the shale and coal of the Pennsylvanian has had a far reaching influence on the deposition of the lead and zinc minerals of the Central and Southwestern districts. They have evidently affected the location of the ore bodies, (1) by influencing the circulation of underground waters and, (2) by providing sulphur compounds and organic matter, both of which have been thought to serve as precipitating agents.

It is also believed that the processes of weathering which were active during the erosion intervals between Cambro-Ordovician and Mississippian and between Mississippian and Pennsylvanian times were important agents in preparing the rocks of these formations for the reception of the solutions from which the lead and zinc ores were deposited.

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*Attention is here called to the names Missourian and DesMoines, in the use of of which there is evidently some confusion. In the earlier reports of the Iowa and Missouri Geological surveys the term Missourian has been applied to the Upper Coal Measures and the term DesMoines to the Lower Coal Measures. In the late reports of the United States Geological Survey, (22nd Annual Report, Part III, Pl. XXII, and p. 341), their use has been reversed, the term Missourian being applied to the Lower Coal Measures and the term DesMoines to the Upper Coal Measures. These names were first applied in the Missouri reports during the Keyes administration, and there appears to be no good reason for reversing their application.

Detailed discussions of the ore deposits have been planned in the preparation of reports on the more important mining districts of the southwestern and southeastern parts of the State. In the publication of later reports it is hoped that we may be able to correlate more positively the formations of the Ozark region with those of the southeastern disseminated lead district.

E. R. BUCKLEY,
State Geologist.

CHAPTER I.

GEOLOGY OF MONITEAU COUNTY.

PHYSIOGRAPHY.

Moniteau county lies in the central part of the State, and is bounded on the north by Cooper county, on the east by the Missouri river and Cole county, on the south by Miller and Morgan counties and on the west by Morgan and Cooper counties.

It has an area of approximately 410 square miles, the greater portion of which is situated in the northwestern part of the Salem Plateau, of the Ozark Uplift. The extreme northwestern part of the county is included in the Springfield Structural Plain of the Barton Platform.*

In structure Moniteau county is comparatively simple, being a region of practically flat lying rocks, with a general dip of about 1° to the northeast. The rocks are chiefly limestone and dolomite, belonging to three different formations.

The streams which traverse Moniteau county, exclusive of the Missouri river which forms the northeast boundary, are: (1) Moreau creek, (2) Moniteau creek, (3) Factory creek, (4) Little Splice creek, (5) Big Splice creek and (6) Petite Saline creek. The latter, however, barely crosses the northeast corner of the county before emptying into the Missouri river. These streams, with their tributaries, have been the chief agents of mechanical erosion, from which have resulted the present physiographic features of this county. The physiographic features are divided into (1) Alluvial Plains, (2) Hilly Area, and (3) the Table-land.

ALLUVIAL PLAINS.

The alluvial plains consist principally of the flood plain of the Missouri river, together with narrow strips of land adjacent to the larger streams. The latter are very unimportant, owing to the diminutive size of the creeks which are scarcely large enough to form alluvial plains, except near their mouths.

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*Physiographic Features of Missouri, by C. F. Marbut; Mo. Geol. Sur., Vol. X, 1896, pp. 56, 60.

The bottom lands or alluvial plains of Moniteau county are not very extensive, including about fifteen square miles of territory. As stated above, practically all this land is along the Missouri river, the tributary streams adding to the area only where they have cut their way through the bluffs to the river.

The Missouri river is constantly shifting its channel, carrying away bottom land in one place and building it up in another. Hence the alluvial bottom land of one season may be the bed of the river the next. An example of this may be observed southeast of Lupus, in sec. 14, T. 47, R. 14 W. Here a wagon road which was formerly laid out in the bottom land, ends at the river. The stream bed has shifted until it now occupies the land over which the wagon road formerly passed. A longer and hillier route now replaces the former level road of the valley.

The depth of the alluvium of the Missouri river is unknown. The following is a section of a well at the pumping station of the Missouri Pacific Railway at Lupus:

(1) 12 ft. Mixed sandy soil.
(2) 2 ft. Coarse sand.
(3) 3 ft. (Gumbo) sand (?)
(4) 10 ft. Quicksand.
(5) 4 ft. Coarse gravel.
(6) 15 ft. Mixed coarse and fine sand.
(7) 2 ft. Boulders.
(8) 14 ft. 10 in. Sand, bearing water.

The boring ceased at 63 feet, at which depth a sufficient flow of water was obtained for the use of the railroad. Up to this depth solid rock was not reached.

The flood plain of Factory creek extends a mile and a half from its mouth. Moniteau creek has a somewhat wider flood plain than that of Factory creek, the back water extending, during flood times, about three miles from the mouth.

THE HILLY AREA.

The areas of hilly land occur in the eastern and northeastern portions of the county, adjacent to the Missouri Pacific Railroad and between the principal drainage streams in their lower reaches.

The hills in the northeastern part along the railroad track have an elevation of from 600 to 790 feet above sea level, which is from 40 to 230 feet above the normal level of the Missouri river. Toward the southwest the hills become gradually higher until they merge into the plateau land, at an elevation of 900 to 1,000 feet above sea level.

In the northeastern part of the county along the Missouri river, the hills end abruptly in almost vertical cliffs. The Missouri Pacific railroad has a branch line between Jefferson City and Kansas City which, in Moniteau county, is built close to the river bluffs, at an elevation of from 15 to 20 feet above the water level of the river. It was necessary in building this road to blast away the rock from some of the cliffs, and these afford an excellent opportunity for the study of the formations from the tops of the bluffs to the railroad track.

In places the bluffs end in sheer cliffs presenting a massive wall of rock 100 feet in height with a steep talus slope to the railroad track below.

The hilly area comprises approximately two-fifths of Moniteau county, and is separated into two distinct areas. The larger one includes all of that part of the county north of township 45 which is drained by Moniteau creek and the Missouri river. The second and smaller area is a narrow strip of land one-half to three-fourths of a mile wide, along Moreau creek, extending from the east line of the county to within three or four miles of Fortuna.

The northern hilly area may be subdivided into three parts, the northernmost being drained by Petite-Saline and Big Splice creeks, the middle by Big Splice and Factory creeks, and the southern by Factory and Moniteau creeks.

These three ridges in Moniteau county are finger-like projections of the Barton platform. They gradually spread out into a plateau or upland area west of the county. The northern and middle hilly areas merge into the Barton platform in Cooper county near the Moniteau county line, while the southern unites with that plateau within the county.

The topography of these three areas is essentially the same. North of the creeks the country slopes rather gently to the ridges, which are from 750 to 850 feet A. T., and have an altitude of 190 to 290 feet above the Missouri river. These ridges and large parts of the southern slopes are cultivated quite extensively. To the north the ridges end in rather abrupt escarpments. They are too steep to be easily cultivated, and are generally covered with a fairly heavy growth of scrub oak and hickory.

The valley of Moniteau creek is of the U-shaped type throughout its entire course in this county, while those of Big Splice and Factory creeks are U-shaped only in their lower reaches, merging insensibly into the V-shaped type as their sources are approached. The tributaries of all these streams lie in V-shaped valleys, and each sends out branches at right angles breaking up the land less and less until finally the flat country at the tops of the ridges is reached.

Since the rocks in this county are horizontal or nearly so, it is evident that this land was once a nearly level plain, the present hills and valleys having been formed by weathering, erosion and underground solution.

In the northern part, where the surface is underlain by Burlington limestone, the evidences of solution are abundant. Numerous sink holes and caves and undercutting abound. The upper portion of the Burlington limestone frequently stands out in projecting ledges as a result of the solution of the softer, underlying beds. In many places along the Missouri river, blocks have become detached from the main ledge in the bluffs and fallen down the steep slope.

Many of the small tributary streams, which are fed by springs originating between the Burlington and Chouteau limestones have worn away the soil and are now running over solid rock which, in many cases, is exposed nearly the entire length of the stream.

That portion of the county immediately underlain by the Burlington limestone consists of roundish hills having fairly gentle slopes. Where the upper beds of the Chouteau limestone appear, there is an abrupt escarpment of several feet down to the lower hard thin beds. Below this the slope is very gentle, passing imperceptibly into the valley tract.

The second and smaller area of hilly land lies along Moreau creek. It is practically all underlain by the Jefferson City (Second Magnesian) limestone. The south bank of the river is made up chiefly of steep cliffs, while on the north side the land slopes up gently from Moniteau and Moreau creeks to the table-land area.

(3) THE TABLE-LAND.

That part of Moniteau county outside of the already described bottom lands and the hilly areas is table-land. There are two parts to the table-land area; the first extends east from Tipton and Fortuna, and the second, which is south of Moreau creek, gradually merges with the first about three or four miles east of Fortuna, and includes the balance of the western part of the county.

These two areas are similar in character, both being underlain mainly with Jefferson City limestone. A strip north of the Willow Fork of the Moreau, extending from a short distance west of Tipton to about a mile east of Clarksburg, is underlain with Burlington limestone. This part of the table-land has a good soil for farming, but the soil on most of that underlain by the Jefferson City formation is very thin and poor, being fit mainly for pasture.

The elevation of the table-land varies from 960 feet at Fortuna to 890 feet north and east of California. The land has been trenched by the tributaries of Moreau and Moniteau creeks, which start on the gentle slopes of the prairie as mere ditches, gradually deepening and widening until they reach the hilly area where the gradient increases rapidly.

SINKS AND CAVES.

Sinks.—The sink holes of Moniteau county occur principally in the region underlain by Burlington limestone. At the top of the ridge between Moniteau and Factory creeks, on the road between Jamestown and Bacon, there are a number of sinks. North of Lupus, where they are best developed they are from seventy-five to two hundred and ten feet in diameter, and from ten to twenty-five feet in depth. Some are filled with water while others are dry. The latter probably have some connection with an underground channel through which the water is removed. When a farmer wishes to make a pond out of a sink hole, he feeds hogs in it, as a result of which the outlets are packed with clay, making the bottom impervious.

Sink holes result from the work of underground waters. Part of the water, which falls as rain, soaks into the ground and travels along the cracks and crevices in the rocks dissolving the stone walls. At places, where solution has been very active, under-ground caverns form. The roof to one of these caverns may finally become too thin to support itself, when it will fall in, forming a sink hole.

Plate II, Figs. 1 and 2, illustrate typical sink holes, located in sec. 36, T. 48 N., R. 15 W. One is filled with water and the other is empty.

Caves.—All the caves observed in this county occur in the Burlington limestone area. In the E. ½ of the N. E. ¼ of sec. 7, T. 46 N., R. 14 W., there is a spring, called "Cave" spring, issuing from a very small cavern in the Burlington limestone. In the middle of the S. W. ¼ of sec. 28, T. 47 N., R. 11 W., a cave occurs at the contact of the Burlington and Chouteau limestones. This cave has an opening about 10 feet wide and 5 feet high and extends into the hill about 150 feet. It gradually narrows until not large enough to admit a man. A spring issues from the mouth of the cave. A cheese factory was at one time located near the cave which furnished an excellent cold storage place for the product.

Bruce's cave, located in the center of the N. E. ¼ of sec. 36, T. 48 N., R. 15 W., is the largest in the county. It occurs at the contact between the Burlington and Chouteau limestones, and has an opening 30 feet wide and 15 feet high. A small spring issues from its mouth. During periods of heavy rain fall, the water issuing from the opening forms a fair sized stream.

This cave was carefully and fully explored. Its length, including all its chambers, is about a half a mile. It follows a winding course

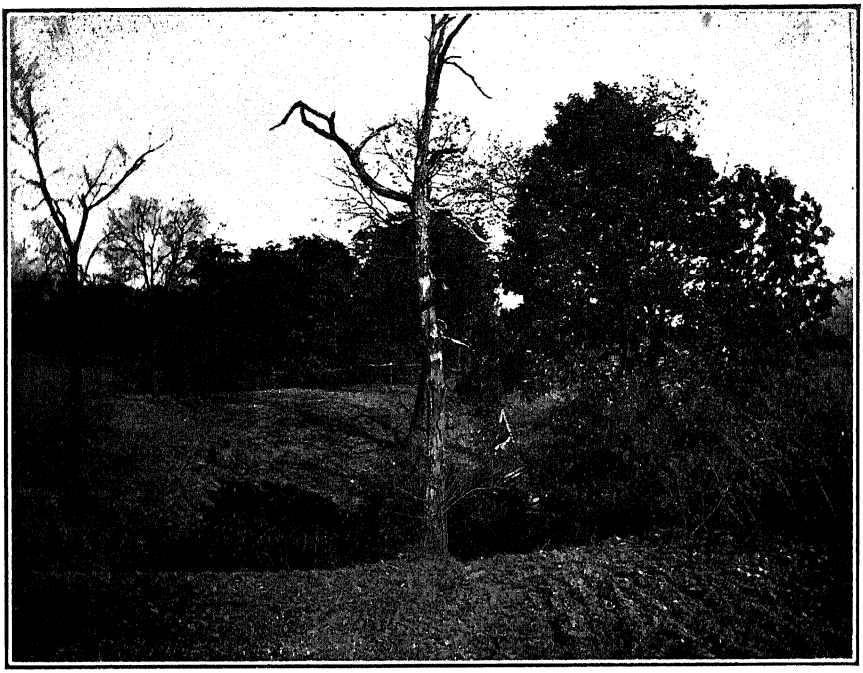

FIGURE 1.

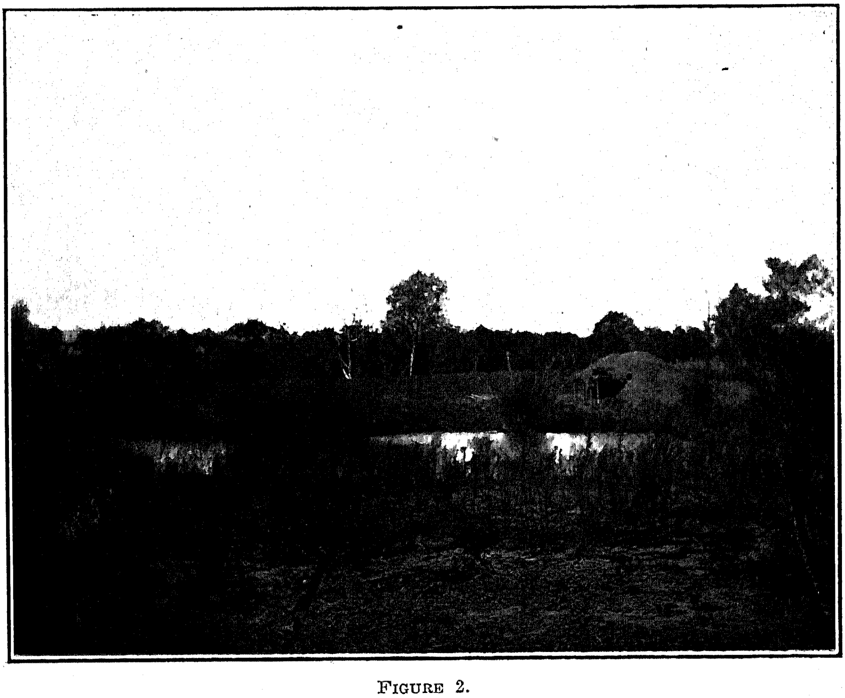

FIGURE 2.

SINK HOLES IN THE BURLINGTON FORMATION NORTH OF LUPUS.

Fig. 1. With underground drainage.
Fig. 2. Without drainage. Filled with water.

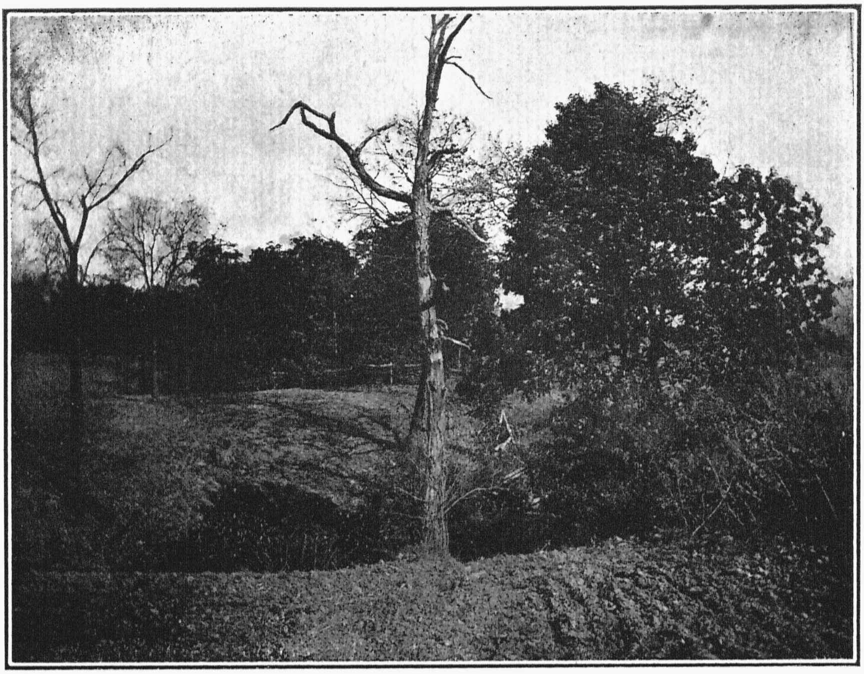

FIGURE 1.

FIGURE 2.

SINK HOLES IN THE BURLINGTON FORMATION NORTH OF LUPUS.

Fig. 1. With underground drainage.
Fig. 2. Without drainage. Filled with water.

into the hill, but no trace was found of the "bottomless" pool which the cave was reported to contain. It consists of a series of chambers connected by narrow passageways through which one must, in places, crawl on hands and knees. At the end there is a chamber which has no branches, but which is connected by a small opening with one of the numerous sink holes in this part of the county.

The cave is lined with stalactites and stalagmites varying in size from a quarter of an inch to a foot in diameter, some round and others flat. At several places there are pillars of onyx of considerable size. The bottom of the cave, over which a stream of water flows, is covered to an unknown depth with yellow clay mixed with sand.

TABLE OF ELEVATIONS.

The only elevations in Moniteau county which have been established by leveling are as follows:

Name.	Authority.	Elevation in feet above sea level.
Sandy Hook landing B. M. in Wm. Geutsch's yard	Missouri river Com.	581
Lupus (formerly Wolf Point) B. M. at Musick & Redford's store	" " "	605
B. M. in sec. 5, T. 47 N., R. 14 W. (formerly Mt. Vernon)	" " "	381
California	Mo. Pac. R. R.	889
Clarksburg (formerly Moniteau)	"	898
Tipton	"	925
Fortuna	"	960
Enon	"	691
B. M. at High Point	U. S. G. S.	904

RIVER SYSTEMS.

INTRODUCTION.

Moniteau county is drained by the Missouri river, which flows for about nine miles along the northeast boundary of the county, and its tributaries. The drainage is accomplished chiefly by the South Moreau, Moreau, Moniteau, Factory, Little and Big Splice and Petite Saline creeks, all of which are tributaries of the Missouri river.

THE MISSOURI RIVER.

The Missouri river, flowing in a southeasterly direction, forms the northeastern boundary of the county for a distance of about nine miles. It flows through an alluvial plain, about ten square miles of which is southwest of the river, in Moniteau county. In this county the alluvial plain ends abruptly against high bluffs through which, at irregular intervals, the tributary streams have cut channels.

THE SOUTH MOREAU.

The South Moreau, with its tributaries, Burke and Morgan creeks, drains approximately 35 square miles in the southeastern part of the county. It rises in Miller county and enters Moniteau in sec. 32, T. 43 N., R. 15 W., flows two miles east, parallel to the county line, re-entering Miller county and returning to Moniteau in sec. 36, T. 43 N., R. 15 W. From this place it flows in a northeasterly direction, entering Cole county at the north line between secs. 20 and 29, T. 43 N., R. 14 W. The South Moreau has very little fall in Moniteau county.

The tributaries, Burke and Morgan creeks, are each about three and one-half miles long and practically the same size. Each drains an area of about four square miles.

MOREAU CREEK.

This stream has its source in Morgan county and is formed by the union of Straight Fork, flowing northeast, and Willow Fork, flowing southeast. These branches unite in sec 5, T. 44 N., R. 16 W., Moniteau county, forming the main creek, which flows in a southeasterly direction. It leaves the county in sec. 28, T. 44 N., R. 14 W., re-enters and finally passes into Cole county in sec. 16, T. 44 N., R. 14 W.

In Moniteau county, Moreau creek, with its tributaries, drains an area of about 200 square miles, embracing that part lying south of the Missouri Pacific railroad, with the exception of the southeastern portion, which is drained by the South Moreau.

The fall of the Moreau, from the junction of its two forks to the place where it leaves the county is 160 feet, or 8 feet per mile. Where it leaves the county, it is about 40 yards wide, and has a rather swift current. The south bank of the Moreau is usually bordered by a high bluff of Jefferson City limestone, while on the north side the land slopes gently up to the divide.

Willow Fork of Moreau creek rises in the table-land area, in sec. 19, T. 45 N., R. 17 W., and flows southeast for seven miles where it joins the Straight Fork to form Moreau creek. This branch drains an area of about 20 square miles and has a fall of 10 feet per mile.

Straight Fork rises in Morgan county and flows northeast to where it joins Willow Fork. It flows for a distance of six miles in Moniteau county and drains approximately fifteen square miles. Its fall is somewhat less than that of Willow Fork, being about eight feet per mile.

These two forks may be forded at nearly all seasons, although at times in the spring they are dangerous for one who is unfamiliar with the fords.

The tributaries of the Moreau are not important streams, Smith and Burris Forks being the largest. Smith Fork rises in Morgan county a short distance from the Moniteau county line, and flows northeast, emptying into Moreau creek in sec. 3, T. 44 N., R. 16 W. In Moniteau county it is seven and one-half miles long, and with its minor branch streams drains about twenty-seven square miles of the county.

Burris Fork rises in Moniteau county and flows northeast parallel with Smith's Fork, emptying into Moreau creek in sec. 11, T. 44 N., R. 15 W. It is twelve miles long and drains an area of fifty square miles. It has numerous branches, none of which is of sufficient importance to receive a name.

MONITEAU CREEK.

Moniteau creek rises in Cooper county, enters Moniteau in sec. 20, T. 46 N., R. 15 W., follows a crooked course in a general southeast direction, and flows into Cole county in sec. 24, T. 46 N., R. 14 W. Its length, including its windings, in Moniteau county is sixteen miles. It drains approximately 135 square miles. It is a sluggish stream except during times of high water, when the current is quite swift. The fall from its entrance into the county to its exit is about four feet per mile. It is about thirty yards wide where it leaves the county. During periods of flood the back-water extends up the creek four and a half miles, forming a small flood plain on the north side.

The topography of the country bordering Moniteau creek is similar to that adjacent to the Moreau. Rather steep bluffs of Jefferson City limestone occur on the south side, while the land on the north side slopes gently up to the ridge.

The main tributaries of Moniteau creek, all of which rise in Moniteau county, are as follows, named from west to east: Howard's creek, Brush creek, Little Moniteau creek and Tanyard branch.

Howard's Creek.—Howard's creek rises in sec. 33, T. 47 N., R. 15 W., flows east two miles, and then due south, emptying into Moniteau creek in sec. 23, T. 46 N., R. 15 W. It is about twenty-five feet wide at its mouth. It is eight miles long, and the area drained is sixteen square miles. The fall is considerable, amounting to twenty feet per mile.

Brush Creek.—Brush creek rises in sec. 16, T. 45 N., R. 15 W., flows two miles north and then northeast, emptying into Moniteau creek in sec. 19, T. 46 N., R. 14 W. Its length is eight miles and it drains twenty square miles of land. The fall is 20 feet per mile.

Little Moniteau Creek.—This creek rises in sec. 23, T. 45 N., R.

15 W., a mile northeast of California, and follows a general northeast course, emptying into Moniteau creek at the line between secs. 26 and 27, T. 46 N., R. 14 W. The creek bed is about fifteen yards wide at its mouth, but only during times of exceptionally high water is the bed filled. At such times the back-water extends up the Little Moniteau for a mile and a half. The fall of the creek, from source to mouth, is thirty feet per mile. The drainage area of the Little Moniteau is the greatest of any of the tributaries of the Moniteau, being approximately 30 square miles.

Tanyard Branch.—Tanyard branch is a small stream flowing into Moniteau creek from the north. It rises in sec. 6, T. 46 N., R. 14 W., flows two miles east, then southeast, joining the Moniteau in sec. 26, T. 46 N., R. 14 W. This branch is six miles in length, and drains 8 square miles.

FACTORY CREEK.

Factory creek is a small stream, six miles long, which rises in sec. 32, T. 47 N., R. 14 W., flows one mile northeast, then southeast, and empties into the Missouri river in sec. 2, T. 46 N., R. 14 W. It is usually only a few feet wide at its mouth, but during high water it is often thirty feet wide. The back-water extends a mile and a half from the mouth. The creek is fed by numerous springs issuing from between the Burlington and Chouteau limestones.

The drainage area of Factory creek is twelve square miles, and the fall is ten feet per mile. It has no tributaries of any importance.

LITTLE SPLICE CREEK.

This creek rises in sec. 24, T. 47 N., R. 15 W., and flows northeast, five miles, to the Missouri river. It drains about five miles of territory.

BIG SPLICE CREEK.

Big Splice creek rises in Cooper county, enters Moniteau in sec. 15, T. 47 N., R. 15 W., flows five miles northeast and then two miles southeast, emptying into the Missouri river in sec. 9, T. 47 N., R. 14 W. It is seven miles long and drains twelve square miles of territory in Moniteau county. The fall of this creek is not great, and the volume of water is small, except during rainy seasons.

PETITE SALINE CREEK.

The Petite Saline rises in Cooper county, enters Moniteau in sec. 24, T. 48 N., R. 15 W., and flows southeast three miles emptying into the Missouri river in sec. 31, T. 47 N., R. 14 W. There is no appreciable fall to this creek in Moniteau county, as it flows entirely in the bottom land. It is a large stream, about fifty yards wide at its mouth, but it drains only three square miles in this county.

DIVIDES.

There is only one main divide in Moniteau county and that is between Moreau and Moniteau creeks. This divide extends from the county line on the east, in a slightly northwest direction, to the county line on the west. In height it ranges from 890 feet on the east to 960 feet on the west.

The Missouri Pacific railroad follows along this divide, and the important towns of the county, California, Clarksburg and Tipton, are located upon it.

This divide, which forms the watershed between Moreau and Moniteau creeks, has numerous arms, which separate the main tributaries of these streams from each other. The divide proper is a broad, flat-topped ridge, one to four miles wide. In the vicinity of California and Clarksburg it is narrowest. At these places, the heads of several tributaries of the Moreau and Moniteau approach to within a half or three-quarters of a mile of each other.

The surface rock, in the eastern part of the ridge, belongs to the Jefferson City formation, while that in the western part belongs to the Burlington. The greater part of this divide belongs to the table-land area already described under that heading.

The ridges between Moniteau and Splice creeks and that between Splice and Petite Saline creeks, can hardly be classed as divides, since they are of such small importance. However, they may be called divides in the sense that they are ridges between drainage streams. They are so badly trenched by small tributary streams that they have been included in the hilly area already described.

THE RELATIONS OF PHYSIOGRAPHY TO INDUSTRIAL AND SOCIAL CONDITIONS.

The relations of Physiography to industrial and social conditions are obvious. The early settlers as a rule located along the stream valleys and on the bottom lands. Some, however, who were more hunters than farmers, built their cabins beside springs on the hillsides, clearing a few acres, at a favorable place for raising corn and potatoes for their own use.

In the early days the settlers did not appreciate, as they do today, the value of the upland areas for agricultural purposes. As a result their crops were often flooded with the high water during the spring.

Later, however, when all the desirable bottom land had been taken possesion of, they gradually took possession of the best of the hilly and table-land areas, clearing and cultivating them with much success. In the northern and western parts of the county, where the underlying rock is the Burlington limestone, it was soon discovered that the soil was excellent for farming.

The hilly country, exclusive of the cultivated ridges, is covered with timber, and furnishes wood for fuel and railroad ties. The tie industry in the county is not very important.

Stock raising is increasing, especially in the southern and central parts of the county, where the prairie land affords good pasture.

Farming is the main industry, good crops of wheat, corn and oats being raised annually, particularly in those portions of the county underlain by Burlington limestone. The farming industry is the chief factor in the concentration of the people, governing the location of the towns and villages. California, Clarksburg, Jamestown and Tipton are in the table-land areas, and those of Lupus and Sandy Hook in the river bottoms. All owe their location to physiography.

Transportation facilities both on the upland and bottom land areas are good. The main line of the Missouri Pacific railroad crosses the county on the divide between Moreau and Moniteau creeks, running in a slightly northwest-southeast direction. The branch line from Jefferson City to Kansas City follows the Missouri river along the northeast side of the county. In the early days the steamboats on the Missouri river were the principal means of transportation, but at present they are seldom used for shipments from Moniteau county.

In the northern and western parts of the county the price of farm land varies from $20 per acre for that which is rough and hilly to $60 and $75 per acre for the bottom land along the Missouri river. The average price of land is from $35 to $40 per acre. The farms in the area underlain with Jefferson City limestone are not so valuable, the price ranging from $15 to $25 per acre.

CHAPTER II.

CAMBRO-ORDOVICIAN.

(A) ST. ELIZABETH FORMATION.

(Second Sandstone and Third Limestone in part, of Swallow.)

AREAL DISTRIBUTION.

The St. Elizabeth formation, which is typically developed near the town of St. Elizabeth in Miller county, Missouri, outcrops in Moniteau county along the South Moreau, in sec. 33, 34, 35 and 36, T. 43 N., R. 15 W., and in secs. 31 and 32, T. 43 N., R. 14 W. It outcrops over only about two and one-half square miles of land.

THICKNESS.

The average thickness of this formation for the north half of Miller county is given by Ball and Smith* as 120 feet. Probably this thickness would hold for Moniteau county, but the area is so small and the exposures so few that no accurate measurements could be made. The thickest exposure observed was forty-six feet.

TOPOGRAPHY.

The area underlain by the St. Elizabeth formation is level prairie with very few outcrops of rock.

COMPOSITION.

The upper part of the St. Elizabeth formation consists of a cellular, porous, cherty sandstone. The cellular structure is caused by the leaching out of fragments, probably pebbles, in the sandstone. Below this sandstone there are about 30 feet of fine to coarse grained pink to brown dolomite, containing nodules of oölitic chert. In the lower dolomite beds there are a few layers of sandstone.

The following section gives a description of the beds belonging to this formation, occurring along Moreau creek. The beds in the upper ten feet belong to the Jefferson City formation.

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*The Geology of Miller county, by Ball and Smith; Mo. Bureau Geol. & Mines, Vol. I, 2nd Series, 1903, p. 52.

Section No. 1.

(From top to bottom.)

Sec. 33, T. 43 N., R. 15 W.

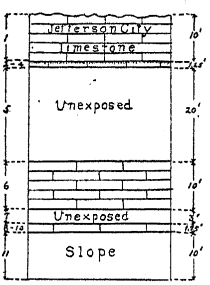


FIG. 1.

No.	Elev.	
1	46-56	Jefferson City limestone contact.
2	45 11-12-46	1 inch CELLULAR CONGLOMERITIC SANDSTONE.
3	45¾-45 11-12	2 inches fine grained, compact brown DOLOMITE. Poorly exposed.
4	44¾-45¾	1 foot poorly exposed, arenaceous DOLOMITE.
5	24¾-44¾	20 feet unexposed, except one foot of brown coarse grained DOLOMITE with considerable flint.
6	14¾-24¾	10 feet DOLOMITE. Upper part coarse grained, pink to white, containing nodules of oölitic flint: lower part fine grained, with crescent shaped cavities parallel to bedding.
7	11¾-14¾	3 feet UNEXPOSED.
8	10¾-11¾	1 foot brown DOLOMITE, containing nodules of oölitic flint and some sandstone.
9	10¼-10¾	6 inches fine grained brown DOLOMITE.
10	10-10¼	3 inches red, coarse grained DOLOMITE.
11	0-10	10 feet slope to creek.

WEATHERING.

The conglomerate is made up of pebbles of limestone and chert, some of which have weathered out, giving it a cellular structure. The weathered surface of the beds of cherty dolomite is very rough and hackly, owing to the difference in the rate of weathering of the chert and dolomite.

STRUCTURE.

On account of the very few scattered outcrops and the limited areal extent of the St. Elizabeth formation in this county, very little can be said concerning its structural features. Ball and Smith* found that the St. Elizabeth formation in the extreme northern part of Miller county extended into Moniteau county along Moreau creek. This area is surrounded on all sides by the Jefferson City formation, and it appears that the St. Elizabeth formation, at this place, occurs in the shape of a dome, along the axis of which the Jefferson City limestone has been eroded away.

RELATIONS TO OTHER FORMATIONS.

In Moniteau county the contact between the Jefferson City and St. Elizabeth formations is abrupt, the cotton rock of the former resting upon a thin bed of conglomeritic sandstone. In Miller cocnty, where the St. Elizabeth is typically developed, Ball and Smith** found in some places a complete gradation between the two formations, while in other places the cotton rock was in sharp contact with the conglomerate. They decided, however, that the two are practically conformable.

*Geol. of Miller county by Ball and Smith, Mo. Geol. Survey, Vol. I, 2nd Series, 1903. (See Geol. Map.)

**Ibid. pp. 59-60 and 75.

ECONOMIC.

The St. Elizabeth formation is of no economic importance in Moniteau county.

RÉSUMÉ.

From the fact that this formation consists of alternating thin beds of sandstone and dolomite, it would appear that it was laid down in shallow water, and under conditions which changed frequently. These conditions were practically the same as those under which the beds of the Jefferson City formation were deposited.

(B) JEFFERSON CITY FORMATION.

(Second Magnesian Limestone of Swallow.)

AREAL DISTRIBUTION.

The Jefferson City formation, named by Winslow from its typical exposure at Jefferson City, Missouri, underlies by far the larger portion of Moniteau county. By reference to the map it will be seen that this is the surface formation over all the county south of Moreau creek, except the extreme southern part, where the St. Elizabeth formation and a few small areas of Burlington limestone are exposed. It is also the surface rock south of Moniteau creek, with the exception of a small area just south of the creek and another east and south of Tipton which are underlain with stone belonging to the Burlington and Chouteau formations. The Jefferson City formation also outcrops along the lower reaches of the main streams north of Moniteau creek. Altogether this formation is the surface rock over at least three-fourths of the county.

THICKNESS.

Ball and Smith*, in their report on Miller county, give the average thickness of this formation, north of the Osage river, as 60 feet, "although near Eldon it is 104 feet." South of the Osage river it has a known thickness of 200 feet.

Meek** states that "owing to the fact that it is very difficult to identify the same beds at different localities, it is almost impossible to form any very correct estimate of the thickness of a formation like this, where no connected sections of all the beds are to be seen. Exposures seen in Cooper county, however, sem to indicate a thickness of from 160 to 170 to 200 feet for this rock in this region."

*Ball and Smith, Geology of Miller county.

**Meek's Report Geol. Surv. of Missouri I and II Reports, p. 107.

In sec. 17, T. 45 N., R. 14 W., are two artesian wells, one of which is 265 feet and the other 182 feet deep. From the records of these wells, which are in the possession of Mr. E. B. Faulkes, of California, Missouri, it would seem that the bottom of the Jefferson City formation was not reached.

The bottom beds of the Jefferson City formation are exposed in the southern part of the county, in sec. 33, T. 43 N., R. 15 W., overlying the St. Elizabeth formation at an elevation of 780 A. T. At this place the thickness is ten feet. However, it increases toward the north, being exposed at an altitude of 925 A. T. on the divide between Moreau and Moniteau creeks.

In the valley of Moniteau creek it is exposed at an altitude of 575 feet. The bluffs south of Moniteau creek rise to a height of from 50 to 100 feet above the valley, and consist entirely of Jefferson City limestone.

Judging from the different elevations at which the Jefferson City limestone occurs, it will be seen that, if the formation were horizontal, it would have a thickness of at least 350 feet. However, the beds have a gentle northeast dip, which when taken into consideration would probably reduce this estimate of the maximum thickness of this formation in Moniteau county to 250 or 300 feet.

TOPOGRAPHY.

The topography of the area underlain by the Jefferson City formation represents the types already described as table-land and hilly land. The table-land consists of the gently rolling prairies south of Moreau creek and between Moreau and Moniteau creeks. As these creeks are approached, the topography gradually becomes rougher and hillier. The ridges underlain by the Jefferson City formation are steeper on one side than on the other. On the south side of Moreau and Moniteau creeks the land rises in precipitous cliffs, while on the north it slopes gradually from the creek banks.

In places the topography is step-like, although this feature is not prominent. Ball and Smith* noted this step-like topography in Miller county, and ascribe it to "the ease with which the thin beds of this formation flake off." However, the usual tendency is to form rather steep cliffs from fifty to one hundred feet in height.

COMPOSITION.

The Jefferson City formation is composed of "cotton rock," thickly bedded dolomite, sandstone, shale and chert.

*Geology of Miller county by Ball and Smith, Mo. Geol. Survey, Vol. I, 2nd Series, p. 70.

"Cotton Rock."—This is a siliceous, argillaceous, fine grained, soft dolomite having a light brown to a yellow or buff color. It occurs chiefly in beds, ranging from a few inches to two feet in thickness. In places the beds are several feet in thickness. This stone usually shows many dendritic markings.

The cotton rock occurs very persistently at the top of the Jefferson City formation. It is found in thin, much broken beds at nearly every place where the Jefferson City formation and the Chouteau limestone are exposed together. The aggregate thickness of these thin beds is not great at this horizon, varying from two to ten feet. In some places the beds are rather massive, rarely, however, exceeding three or four feet in thickness.

This is the only persistent horizon in this formation, in Moniteau county, although scarcely an exposure of any size can be found which does not have some cotton rock.

Pitted dolomite.—The typical part of the Jefferson City formation consists of thick, massive beds of pitted dolomite. It is usually buff colored, but sometimes has a reddish, purple color. The beds are from two to four feet in thickness.

In places the rock has a great many blotches or streaks of a soft white, powdery silica which are parallel to the bedding planes, giving the rock a mottled appearance. These blotches are more frequent in the gray or buff colored stone than in the purplish phase. Numerous cavities filled or lined with crystals of quartz occur in the dolomite. The rock usually contains varying amounts of chert, both nodules and layers, although in places it is entirely absent. The pitted surface of the rock is due to the removal of siliceous nodules and powder.

Small nodules of pyrite and limonite are contained in the dolomite. The rock has a hackly fracture.

Sandstone.—The sandstone in this formation is soft, has a white to buff or brown color and occurs in beds from one inch to three or four feet in thickness. It occurs at no definite horizons, although in the exposures along the Missouri Pacific railroad, it is fairly persistent in the upper part of the formation. Here it occurs in a bed which varies in thickness from one inch to four inches. At some places it is difficult to determine whether it is siliceous limestone or a calcareous sandstone, since it consists in part of dolomite and in part of white, rounded quartz grains. In some places the dolomite predominates and in others the quartz sand.

In the N. E. ¼ of sec. 30, T. 44 N., R. 14 W., on the line between secs. 30 and 19, there is a large exposure of Jefferson City limestone, in the middle of which is a six inch layer of sandstone. This sandstone is very hard and partly recrystallized. It has a grayish white color.

In the N. W. ¼ of the N. E. ¼ of sec. 5, T. 43 N., R. 14 W., on the hill-side, there is an outcrop of brownish white, friable sandstone, overlain with a two inch layer of oölitic chert.

Other exposures of intercalated sandstone occur in the S. E. ¼ of sec. 29, T. 44 N., R. 14 W.; the S. E. ¼ of sec. 30, T. 44 N. R., 14 W.; the N. W. ¼ of sec. 12, T. 46 N., R. 14 W.

Chert.—In this formation the chert usually occurs in nodules of various shapes and sizes, although a few thin beds of a bluish black oölitic chert, from one to six inches in thickness, were observed.

The chert occurs most persistently in the upper part of the formation, near the contact with the Chouteau limestone or St. Peters sandstone. At this horizon it is chiefly in the form of nodules, which in some cases form beds, extending for a considerable distance along the outcrop.

At other places, usually at the contact of the dolomite with one of the sandstone layers, masses of brecciated chert were observed. This chert is a bluish black, white, brown or gray, and is sometimes banded, although more often arranged without order as in a breccia. Little cavities filled with quartz crystal occur in the chert at this horizon. This brecciated chert occurs in the S. E. ¼ of sec. 35, T. 46 N., R. 14 W., and in the N. W. ¼ of sec. 24, T. 46 N., R. 15 W.

The beds of bluish black, oölitic chert occur in the N. E. ¼ of sec. 6, T. 43 N., R. 14 W.; in the N. E. ¼ of sec. 30, T. 44 N., R. 14 W. and in a little ravine running north in sec. 21, T. 46 N., R. 15 W., just west of California.

Shale.—The shale occurs in thin beds from one to six inches in thickness usually between beds of dolomite. It has a blue, green, or bluish black color. It almost invariably contains some sand and varies from a shaly sandstone to a sandy shale. In most cases, however, it may be described as a sandy shale.

One of the best places at which to observe this shale is along the Boonville branch of the Missouri Pacific railroad, just north of Sandy Hook, in the E. ½ of the N. E. ¼ of sec. 11, T. 46 N., R. 14 W. At this place five different shale layers are exposed.

WEATHERING.

The weathered surface of the cotton rock is usually smooth and even, while that of the pitted dolomite is very rough. The pitted dolomite has a gray color, and looks very much as if it were soft, until broken with a hammer, when it is found to be very hard. The small hackly cavities are caused by the disintegration and removal of the drusy quartz with which the cavities in the fresh stone are filled. The chert nodules often stand out on the weathered surface of the dolomite as little projections, while the softer dolomite has been removed by the weather. In the case of the chert layers the condition is different. Where the chert layers are exposed to weathering they are the depressed parts of the rock, on account of the ease with which the chert disintegrates. In places the dolomite stands out in projecting ledges as a result of the removal of underlying layers of chert.

Some of the bluish-black chert weathers on the surface to a brownish red color, due to iron staining. Wherever this was observed, it was in the vicinity of a mass of sandstone from which the iron oxide had evidently been derived.

The joints, both in the cotton rock and the pitted dolomite, have in many cases been enlarged by weathering until fissures of considerable size and extent have been formed.

STRUCTURE.

As a whole the Jefferson City formation lies practically flat, although many, gentle, local dips were observed.

Bedding.—The beds of cotton rock are usually from four to six inches thick, although at times they vary greatly from this. Some of the beds are two inches, while others are three feet or more in thickness. The pitted dolomite ordinarily occurs in beds from two to four feet thick. The beds are rarely less, but sometimes more. Beds six feet in thickness were observed.

The beds are frequently separated from each other by thin layers of shale. In places the bedding planes are very wavy. This is particularly well exhibited in the exposures along the railroads. Ball and Smith* note this wavy bedding in the Jefferson City formation in Miller county, and state that "Mr. Bailey Willis has suggested that this discordance in bedding may be the result of ocean scour combined with other conditions existing at the time the sediments were originally deposited."

Folding.—Although the formation as a whole is horizontal, there are numerous gentle folds. These are best exhibited in the exposures along the railroad, particularly near the contact with the Chouteau limestone. Northwest of Sandy Hook in sec. 2, T. 46, R. 14 W., there are a number of outcrops in which the Jefferson City limestone is exposed in a series of flexures the limbs of which vary from forty to one hundred feet in length. These flexures are the result of minor movements of

*Ball and Smith.

the earth's crust and are of very little importance. The dip varies from 2° to 4° in a direction a little east of north, usually about N. 10° E.

Other folds exist in this formation, which strike approximately at right angles to these, but no measurements could be taken. They were recognized by the outcrops at different elevations, and are shown in the east-west section across the county.

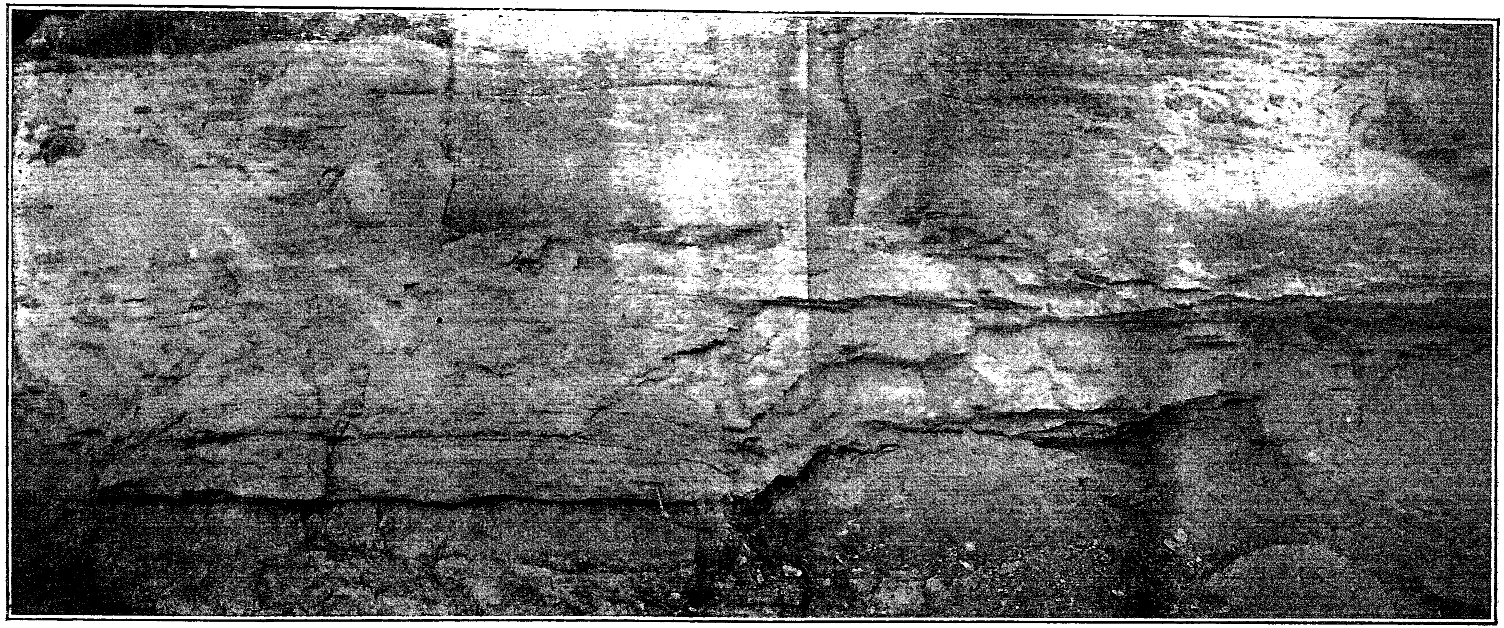
Faulting.—No great faults were observed. In the N. E. ¼ of sec. 31, T. 43 N., R. 14 W., a series of four faults having throws of from fifteen to twenty feet were noted. At this place the north end of the outcrop is Burlington limestone and conglomerate which abuts against the cotton rock of the Jefferson City formation. The beds of cotton rock are horizontal, but only extend ten feet toward the south, where they are apparently faulted. At least this bed ends abruptly along a rather regular line, being replaced by beds of pitted dolomite. Along the contact there is a breccia of hard dolomite and soft cotton rock about two feet thick. The pitted dolomite beds are undisturbed for about thirty feet when they are again displaced. The fault at this place has a throw of about fifteen feet, the fault line being filled with a shaly substance. Twelve feet south there is a third fault having a throw of fifteen feet. Green shale occurs between the walls. It has an approximate dip of 85° S. 35° E. Just south of this there is a fourth fault, the throw of which could not be determined. It is at least twenty feet. The thick pitted dolomite beds abut against a curving mass of sandstone and then disappear. This sandstone is probably Carboniferous filling a fault cavity.

These faults could not be traced beyond the outcrops in which they occur on account of lack of rock exposures.

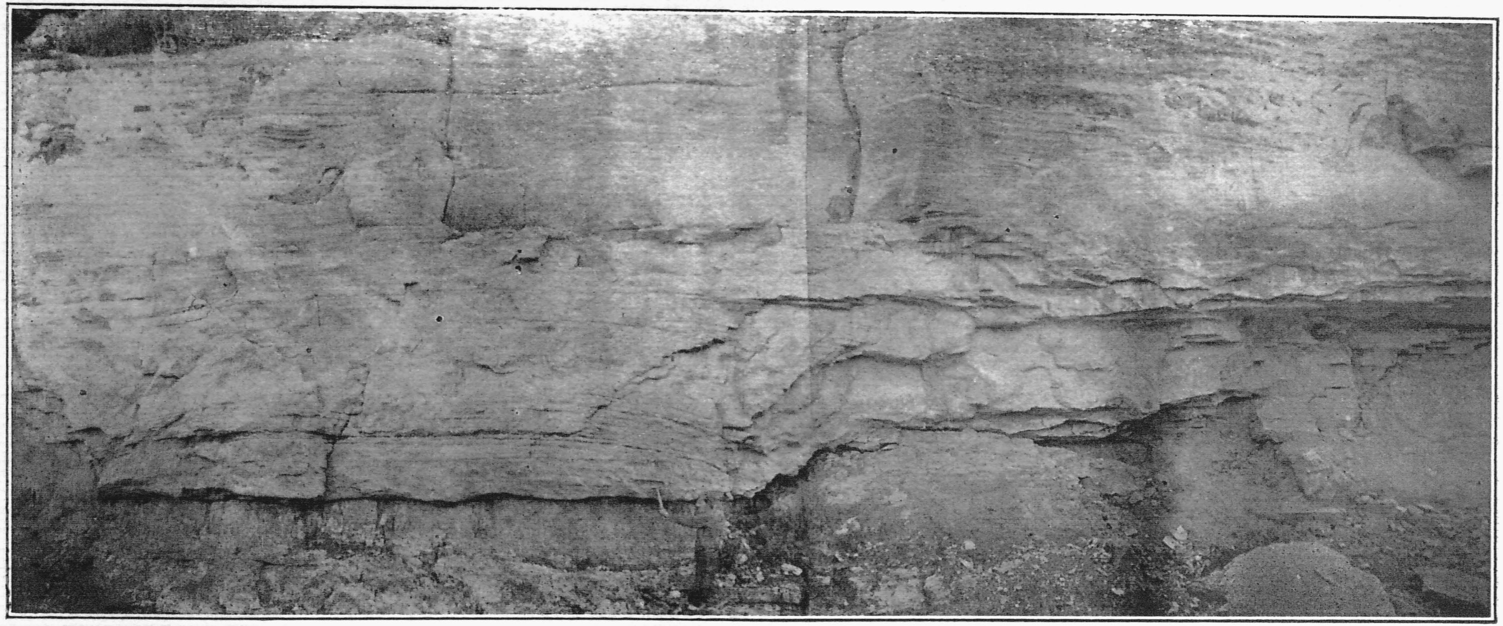
A number of small faults having a throw of from one to five feet were noted elsewhere. In the S. W. ¼ of the N. E. ¼ of sec. 30, T. 44 N., R. 14 W., a ledge of Jefferson City limestone about 200 feet long and 15 to 20 feet high, has been faulted in several places. One of the faults has a throw of four feet and another a throw of one foot. In the N. E. ¼ of sec. 28, T. 44 N., R. 14 W. along Moreau creek, there is a ledge of Jefferson City limestone in which two or three small gravity faults occur.

Faults of this character were noted in many other parts of the county, but they are so obviously unimportant that it is useless to give their location.

Jointing.—The joints in the Jefferson City formation seem to occur with no regularity. They strike in all directions and dip at all angles. From the observations taken, four sets were made out. The major



CONTACT OF JEFFERSON CITY AND ONONDAGA FORMATIONS NORTHWEST OF LUPUS, MO.



CONTACT OF JEFFERSON CITY AND ONONDAGA FORMATIONS NORTHWEST OF LUPUS, MO.

joints strike N. 27° W. and N. 65° E., and the minor joints N. 25° E. and N. 75° W. There is a tendency, both in the cotton rock and in the pitted dolomite, especially in the former, for the joints to be curved. This is not true of the joints in the other formations. Similar curved joints were noted by Ball and Smith in Miller county.

RELATIONS TO OTHER FORMATIONS.

Relation to the St. Elizabeth Formation.—The cellular, conglomeritic sandstone, which in Moniteau county is the uppermost member of the St. Elizabeth formation, is an indication of unconformity between it and the Jefferson City formation. In Miller county Ball and Smith* found complete gradation between the two formations and concluded that they are conformable.

In Moniteau county, both above and below the conglomeritic sandstone, dolomite is exposed. The dolomite above the conglomerate is the usual cotton rock of the Jefferson City formation. The St. Elizabeth dolomite is more quartzose, and contains flint in greater quantity. In general, however, there is very little difference in the character of the two dolomites. The sandstone conglomerate represents a very slight, local unconformity between the two formations in Moniteau county.

Relation to St. Peters Sandstone.—The St. Peters Sandstone everywhere overlies, unconformably, the Jefferson City formation. In some places there is a conglomeritic phase between the cotton rock and the typical saccharoidal sandstone, but usually there is an abrupt change from one to the other.

In the N. W. ¼ of sec. 11, T. 46 N., R. 14 W., along a ravine near the road, there are several patches of Pacific sandstone overlying the uneven surface of the cotton rock of the Jefferson City limestone. The lower part of the sandstone contains pebbles of the Jefferson City limestone, some of which are six inches in diameter. The elevation at this place is 585 feet A. T. Numerous patches of this sandstone were found in the vicinity of California at an elevation of over 900 feet A. T., and at many intermediate elevations. It occurs on the tops and sides of the hills, and in the bottoms of the valleys.

Relation to the Onondaga.—In the few places where they are in contact, the Onondaga limestone is unconformably above the Jefferson City formation. There is a sharp contact between the two, and the upper surface of the Jefferson City formation is uneven. The unconformity is further established by the difference in faunas and the altogether different character of the rocks at the contact.

*Geology of Miller county, Mo. Bureau Geol. and Mines, Vol. I, 2nd Series, 1903, p. 52.

Relation to the Chouteau.—In no place in the county where the Jefferson City and Chouteau formations found in contact. The striking difference in the lithological characteristics and the contrast in the faunas, lead one to believe that they must be unconformable. The occurrence in places of Devonian rocks above the Jefferson City formation and their absence in others, is positive proof of this unconformity.

Relation to the Burlington.—The Burlington is in contact with the Jefferson City formation at a number of places in the southern part of the county, where it occurs as outliers. At these places it overlies, unconformably, the Jefferson City formation.

Relation to the Pennsylvanian.—Where the Pennsylvanian sandstone occurs in contact with the Jefferson City formation, the relations are those of unconformity.

ECONOMIC CONSIDERATIONS.

Soil.—The soil formed by the disintegration of the Jefferson City formation is usually thin, although it is of fair quality. In the valleys it attains a sufficient thickness to make good farming land, but on the table-land and ridges its value lies chiefly in its adaptability for stock raising, it being somewhat thin for agriculture.

Lead and Zinc.—Nearly all the lead and zinc thus far obtained in Moniteau county has come from the Jefferson City formation. It occurs in pockets in the cotton rock and heavy dolomite, as float in the surface clay and disseminated through the rock. The mines in this formation will be discussed in detail in chapter VIII.

Barite.—Barite occurs in all parts of the formation. It is found in many localities coating or filling cavities in the rock.

Iron.—Iron ore is unimportant in Moniteau county. Hematite and limonite occur in the Jefferson City formation in small nodules, principally in sandstone and chert.

Building Stones.—The pitted dolomite is well adapted for chimneys, foundations and heavy masonry. The cotton rock is also used for building purposes. Some of the buildings at Enon are constructed out of pitted dolomite and cotton rock.

RÉSUMÉ.

The Jefferson City formation was deposited in waters which were comparatively shallow, as evidenced by the variety of rocks comprising it. Conglomerate, containing pebbles of chert, cotton rock and dolomite; thin beds of shale and sandstone; and the difference in the character of the dolomite and cotton rock, indicates constantly changing conditions of sedimentation.

After the deposition of the formation there was an elevation above sea level. Then followed a long period of erosion during which the existing surface was deeply trenched. However, the erosion interval was not of sufficient duration to reduce the land area to base level. A period of submergence followed, during which the Pacific sandstone was deposited, filling the valleys and covering the highest elevations.

DETAILED COLUMNAR SECTIONS OF THE JEFFERSON CITY FORMATION.

Section No. 2, Fig. 2.

N. W. ¼, Sec. 5, T. 44 N., R. 15 W.

(From top to bottom.)

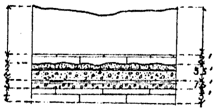


FIG. 2.

No.	Elev.	
1	10-9½	Six inches of decomposed COTTON ROCK, badly broken.
2	9½-8	One and one-half feet of thinly bedded COTTON ROCK.
3	8-6⅔	One and one-third feet of white, somewhat calcareous SANDSTONE. Upper surface uneven. White chert at lower contact.
4	6⅔-4⅔	Two feet of sandy CONGLOMERATE containing chert and dolomite. Decomposed and shattered.
5	4⅔-4	Three to eight inches of banded white and blue SHALE.
6	4-3	One foot of CONGLOMERATE similar to (4), but without the sand.
7	3-0	Three feet of badly shattered COTTON ROCK. Four beds.

Section No. 3, Fig. 3.

N. E. ¼ of the N. E. ¼ of sec. 11, T. 46 N., R. 14 W.

(From top to bottom.)

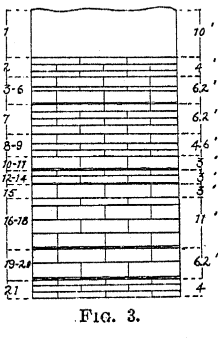


FIG. 3.

No.	Elev.	
1	61-51	Ten feet of SOIL.
2	51-47	Four feet of thinly bedded COTTON ROCK.
3	47-44½	Two feet six inches of cherty PITTED DOLOMITE.
4	44½-43⅔	Ten inches of thinly bedded COTTON ROCK.
5	43⅔-41⅙	Two feet six inches of cherty PITTED DOLOMITE.
6	41⅙-40⅚	Four inches of bluish green sandy SHALE.
7	40⅚-34⅔	Six feet two inches of COTTON ROCK.
8	34⅔-32⅔	Two feet of cherty PITTED DOLOMITE.
9	32⅔-30	Two feet eight inches of COTTON ROCK with thin layer of chert and shale at bottom.
10	30-27⅙	Two feet ten inches of cherty PITTED DOLOMITE.
11	27⅙-27	Two inches of bluish green SHALE.
12	27-25¾	One foot three inches of sandy COTTON ROCK.
13	25¾-24⅓	One foot five inches of reddish DOLOMITE with layer of blackish chert near middle.
14	24⅓-24	Four inches bluish green sandy SHALE.
15	24-21	Three feet PITTED DOLOMITE.
16	21-19½	One foot six inches COTTON ROCK.
17	19½-10½	Nine feet massive PITTED DOLOMITE.
18	10½-10⅙	Four inches bluish green sandy SHALE.
19	10⅙-4⅙	Six feet cherty PITTED DOLOMITE.
20	4⅙-4	Two inches SHALE.
21	4-0	Four feet broken COTTON ROCK.

Section No. 4, Fig. 4.

W. ½ of the N. W. ¼ of sec. 12, T. 46 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	50-40	Ten feet of SOIL.
2	40-35⅚	Four feet two inches of thinly bedded, sandy PITTED DOLOMITE.
3	35⅚-35⅔	Two inches of bluish green, sandy SHALE.
4	35⅔-32⅔	Three feet of PITTED DOLOMITE like No. 2.
5	32⅔-32⅓	Four inches of bluish green SHALE.
6	32⅓-30⅓	Two feet of thinly bedded, broken, grayish white COTTON ROCK, containing chert.
7	30⅓-27⅚	Two and one-half feet of very cherty, PITTED DOLOMITE.
8	27⅚-24⅚	Three feet of grayish white COTTON ROCK.
9	24⅚-24⅙	Eight inches of hard, reddish brown, PITTED DOLOMITE. Contains cavities filled, in some cases, with white chert.
10	24⅙-23½	Eight inch bed of brecciated, reddish DOLOMITE, cemented by greenish shale.
11	23½-15½	Eight feet of hard, reddish brown, DOLOMITE. Contains some intercalated cotton rock and is full of chert nodules.
12	15½-15⅓	Two inches of blue green SHALE.
13	15⅓-12⅓	Three feet of irregularly bedded, very cherty DOLOMITE.
14	12⅓-11⅓	Six to twelve inches of bluish green SHALE.
15	11⅓-10⅓	One foot of pinkish, dendritic COTTON ROCK, with chert concretions.
16	10⅓-6⅓	Four feet of reddish brown DOLOMITE containing chert.
17	6⅓-6	Four inches of bluish green SHALE.
18	6-5	One foot of reddish brown DOLOMITE.
19	5-4	One foot of thinly bedded broken COTTON ROCK.
20	4-3	One foot of DOLOMITE.
21	3-0	UNEXPOSED.

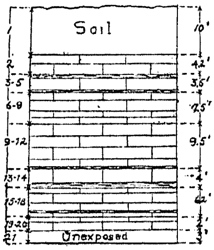


FIG. 4.

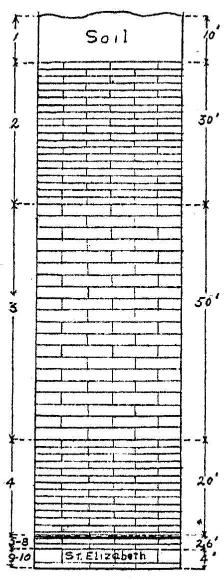


FIG. 5.

Section No. 5, Fig. 5.

Sec. 33, T. 43 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	117-107	Ten feet of SOIL.
2	107-77	Thirty feet of COTTON ROCK.
3	77-27	Fifty feet of PITTED DOLOMITE in heavy beds.
4	27-7	Twenty feet of COTTON ROCK.

Just below are the following beds:

5	½ inch.	Green SHALE.
6	1½ inch.	Gray, striped FLINT, containing apparent sand grains.
7	1¼ feet.	One inch beds of medium to fine grained DOLOMITE with arborescent cavities filled with siliceous material.
8	1¼ feet.	Fine grained, rather distinctly laminated DOLOMITE. Top three inches consist of layers of sand composed of well rounded grains.
9	3 feet.	Hard, argillaceous DOLOMITE having a conchoidal fracture. A hard COTTON ROCK.
10	1 foot 4 inches.	Hard, compact DOLOMITE, containing a few well rounded sand grains.

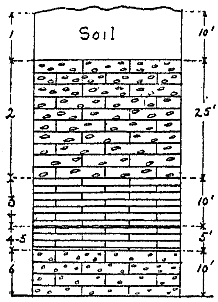


FIG. 6.

Section No. 6, *Fig.* 6.

S. E. ¼ of the S. E. ¼ of sec. 2, T. 46 N., R. 14 W.

No.	Elev.	
1	60-50	Ten feet of SOIL.
2	50-25	Twenty-five feet of cherty PITTED DOLOMITE.
3	25-15	Ten feet COTTON ROCK.
4	15-14½	Six inches of thinly laminated, green SHALE.
5	14½-10	Four feet six inches of fractured COTTON ROCK.
6	10-0	Ten feet of cherty PITTED DOLOMITE, wavy bedding planes.

ST. PETERS (PACIFIC) SANDSTONE.

(1st Sandstone of Swallow.)

In a great number of places in Moniteau county there are exposures of a soft, friable, white to reddish brown, medium to coarse grained sandstone, composed of well rounded grains of quartz, which resembles the St. Peters or First Sandstone of Swallow. This sandstone contains small particles of chert. It occurs in patches overlying the Jefferson City formation and is separated from it by an unconformity, as indicated by the occurrence of the sandstone at different elevations from the tops of the highest hills to the lowest valleys, and also by a conglomerate which, in a few places, occurs at its base.

AREAL DISTRIBUTION.

The areal extent is not very great, although small patches are very numerous, especially in that part of the county underlain with the Jefferson City formation. In the northern part, which is underlain chiefly with Carboniferous rocks, there are also exposures of sandstone similar in all respects to that in the southern part of the county. In the Carboniferous area there are very few outcrops of sandstone, while in the area underlain with the Jefferson City limestone, outcrops of sandstone are abundant. The number of outcrops of sandstone in the two areas is about in the ratio of four to one.

THICKNESS.

The thickness varies from one foot to forty feet, sometimes within a few yards. In two or three places, in the bluffs along the Missouri river, the sandstone underlying the Chouteau limestone is thirty feet thick, while a few yards away in either direction it is absent, or, if present, it occurs in beds not over a few inches in thickness.

Prominently exposed on a bluff, in the S. E. ¼ of the S. E. ¼ of sec. 35, T. 46 N., R. 14 W., there is a block of sandstone thirty feet thick and thirty feet long. Fifty feet to the south, the Jefferson City limestone is exposed at about the same elevation. North of the sandstone there are no outcrops for two hundred and fifty feet, but at this distance the Jefferson City limestone is exposed with no sandstone above it. The sandstone could not be traced in either direction from the large outcrop.

WEATHERING.

The weathered surface of the St. Peters sandstone is usually a dirty gray color, although in some places it is a brownish red, due to the presence of ironoxide. A fresh surface is, as a rule, nearly pure white, varying to light brown in spots.

The well developed joints in the St. Peters sandstone cause it to break into polygonal blocks which stand out prominently on the hillsides. The strike of the joints is not the same in all places, each exposure apparently having its own system.

RELATIONS TO OTHER FORMATIONS.

The relation of the St. Peters sandstone to other formations is always that of unconformity. In the N. W. ¼ of sec. 11, T. 45 N., R. 16 W., northeast of Clarksburg, there is an outcrop of undoubted St. Peters sandstone which is overlain by beds of Chouteau limestone which at this place dip 12° N. 20° W. Between the sandstone and the Chouteau limestone there is a bed of conglomerate from three to four feet in thickness. It consists of chert and limestone fragments embedded in a matrix of sand. It contains thin intercalated seams of clay.

Burlington limestone occurs at the top of the north end of this bluff, while at the southeast end there is another outcrop of sandstone. From the angle of dip of the strata below and north of it, this sandstone is probably St. Peters, although the absence of the conglomerate and clay seams might be taken as evidence of its Carboniferous age. However, from the general field relations, it is thought that this sandstone is St. Peters. Jefferson City limestone, having a dip of 60° N. 20° W., occurs in the ravine on the west side of this bluff south of the lower sandstone.

Fig. 7 is an ideal section drawn through the hill in the direction of the dip, N. 20° W.-S. 20° E., showing the relations existing between the formations in these outcrops.

Section No. 7, Fig. 7.

Sec. 11, T. 45 N., R. 15 W.

(From top to bottom.)

No.	Elev.	
1	115⅓-100⅓	15 feet of friable, white SANDSTONE containing a few greenish shale lenses.
2	100⅓-50⅓	50 feet of BURLINGTON limestone.
3	50⅓-20⅓	30 feet of CHOUTEAU limestone.
4	20⅓-19⅚	6 inches bluish, sandy CLAY.
5	19⅚-17½	2 feet 4 inches of white, sandy CONGLOMERATE. Made up of pebbles of blue, black and white chert and Jefferson City limestone embedded in a sandy matrix.
6	17½-17⅙	4 inches of yellow, clayey, SAND containing rounded pebbles of oölitic limestone.
7	17⅙-15	2 feet 2 inches of SANDSTONE with a few fragments of sandy Jefferson City limestuone.

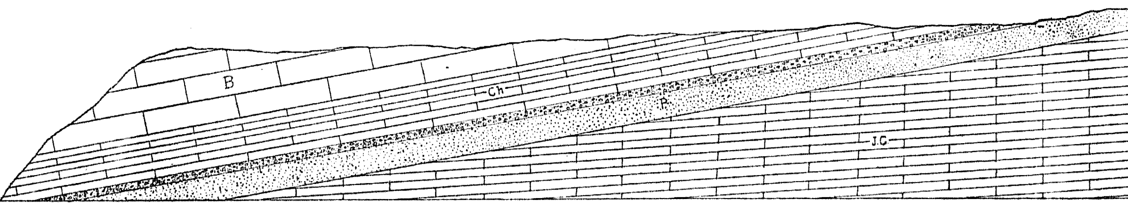


FIG. 7. Ideal cross section through a hill in the N. W. ¼ of Sec. 11, T. 45 N., R. 16 W.

At the base of a bluff in sec. 15, T. 47 N., R. 14 W., three-fourths of a mile southeast of Lupus, there is an exposure of sandstone which is believed to be the top of St. Peters sandstone. Of the four or five feet exposed, the lower three feet is typical, friable, white St. Peters sandstone. Above this is a six-inch bed of sandstone, having a greenish tinge, and immediately on top of this is a twelve to eighteen inch bed of conglomerate composed of pebbles of magnesian limestone, from a half an inch to two inches in diameter, embedded in a soft, shaly matrix. One foot above this the Devonian rocks are exposed.

ECONOMIC CONSIDERATIONS.

Iron.—Nodules of limonite and hematite occur in this sandstone, but not in sufficient quantities to be of value.

Soil.—Where the St. Peters sandstone is the surface rock, the soil is barren. There are many fields in this county which have small, barren areas scattered through them, which are due to the underlying St. Peters sandstone.

Sand.—When disintegrated, this sandstone is used locally for mortar. In some places it is undoubtedly pure enough for making glass, but suitable deposits, near the railroad, are not large enough to be of value.

GENERAL.

Since the St. Peters or First sandstone (Swallow), so closely resembles lithologically the Graydon (Carboniferous) sandstone of Dr. E. M. Shepard, some difficulty has been experienced in distinguishing the two.

Ball and Smith,* in their report on Miller county, refer most of the sandstone similar to that mapped in this county as St. Peters, to the Graydon. From very careful field work in this county it is believed that very little of the sandstone is of Carboniferous age.

At one time the Burlington limestone must have extended over the southern part of Moniteau county, since isolated exposures still persist in that area. The Graydon sandstone, being younger than the Burlington limestone, must have overlain it. The relatively small number of exposures of sandstone in that part of the county underlain with the Burlington limestone compared with the number in that part of the county underlain with Jefferson City limestone is evidence that the sandstone is mainly older than Carboniferous. We find that for an equal area there are about four outcrops of sandstone in the Jefferson City limestone area to one in the Burlington limestone area. If the Burlington were removed before the deposition of the Graydon, the present number of exposures for an equal area should be nearly the same. If the Burlington were not so removed, the exposures of Carboniferous sandstone in the area underlain with Jefferson City limestone, where the Graydon sandstone and Burlington limestone have both been removed, should be far less for a given area than those in the area where the Burlington still remains. Since there are only four exposures of sandstone in the southern part of the county which contain fragments of Burlington limestone and are thus known to be of Carboniferous age, it has been thought best to map the balance of the sandstone as St. Peters.

(D) JOACHIM LIMESTONE.

Winslow,** in describing the Silurian rocks of Missouri, gives a table showing the Lower Silurian of the mining districts. In this table he shows the Joachim limestone capping the Crystal City (St. Peters or Pacific) sandstone in the southeastern district, but not in the central district.

In two places in Moniteau county a dense, shaly magnesian limestone was observed overlying the St. Peters sandstone and beneath the Devonian limestone. At the base of a bluff, in sec. 15, T. 47 N., R. 14 W., three-fourths of a mile southeast of Lupus, a conglomerate twelve to eighteen inches thick consisting of magnesian limestone pebbles in a shaly matrix directly overlies the St. Peters sandstone. The slope above this is covered with talus for four feet, above which the Devonian limestone appears.

*Ball and Smith. Ibid.

**Lead and zinc deposits of Mo., by Arthur Winslow, Mo. Geol. Sur., Vol. VII, p. 331.

At the base of a bluff in sec. 4, T. 47 N., R. 14 W., three-fourths of a mile northwest of Lupus the following section occurs:

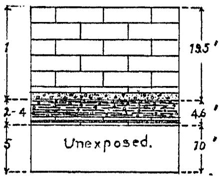


FIG. 8.

Section No. 8, Fig. 8.

1 DEVONIAN.
2 3½ feet CONGLOMERATE. Magnesian limestone pebbles cemented in a soft gray shaly matrix.
3 14 inches very hard, dense gray MAGNESIAN LIMESTONE, in beds two inches thick, with a two-inch layer of soft, friable white SANDSTONE, quartzitic in places, in the middle.
4 6 in. Same as 4.
5 10 feet unexposed.

One hundred feet northwest of this place, along the railroad track, there is an eight-foot bed of typical St. Peters sandstone.

From Winslow's description of the Joachim limestone, it is altogether probable that these thinly bedded, dense, gray limestone layers and shaly conglomerates are remnants of this formation.

CHAPTER III.

DEVONIAN.

The Devonian is represented in Moniteau county by two limestones, one belonging to the Middle and the other to the Upper Devonian. The age and position of these beds were determind by E. O. Ulrich of the United States Geological Survey. Dr. Ulrich's determinations were based upon a study of the fauna.

Meek,* in his description of the geology of Moniteau county, mentions the Onondaga limestone as being met with at only three places in the county. The principal outcrop is in sec. 4, T. 47 N., R. 14 W., near the mouth of Big Splice creek. He says, "At this place it is a calcareous sandstone, whilst at another point, only a short distance along the same outcrop, it passes into layers of arenaceous limestone, containing its usual fossils, and alternating with beds of obliquely laminated sandstone."

AREAL DISTRIBUTION.

In Moniteau county the Devonian outcrops chiefly in the bluffs along the Missouri river. Since the only exposures are in the cliffs, the areal distribution cannot be accurately given. It is, however, very small.

While the Devonian was observed only in the bluffs along the Missouri river, it is possible that it extends to the west under the Chouteau limestone. As already stated, the contact of the Jefferson City and Chouteau limestones was not found in the county, a few feet beneath the two always being covered. This intervening space may be occupied by the Devonian, although no outcrops indicating its presence were observed.

THICKNESS.

The thickness of the Devonian varies from seven to twenty-five feet. The greatest thickness exposed is in sec. 4, T. 47 N., R. 14 W., just north of the mouth of Big Splice creek near Lupus.

COMPOSITION.

The beds consist of a bluish gray or drab, dolomitic limestone; a gray and brown, sub-crystalline, siliceous limestone, containing pure, limpid

*1st and 2nd An. Rept. 1854, p. 105 of Meek's report.

quartz grains; an almost pure quartzose sandstone; and a calcareous, sandstone conglomerate. In places the stone has the appearance of being worked over sandstone. In one place a two-foot bed composed of a mass of broken fossils in a matrix of grayish, shaly limestone was observed. This, however, probably passes into the usual sandy limestone within a short distance, as it could not be followed any distance and was not observed at any other locality.

STRUCTURE.

Bedding.—The sandstone occurs in a single bed from eight to thirteen feet thick. Cross-bedding is common. The upper surface is uneven. The bedding planes in the coral-bearing limestone are from one to three feet apart, while those in the siliceous, limestone conglomerate are two feet apart.

Faulting and Jointing.—No faulting was observed in this limestone, and folding is not prominent. Joints are not frequent, although two sets were made out, the major one striking N. 70° E. and the minor N. and S.

RELATIONS TO OTHER FORMATIONS.

The Devonian is unconformable with the overlying and underlying formations. Where the contact was seen it was sharp and clean cut. The sandy limestone or conglomerate rests either upon the wavy, massive beds of cotton rock of the Jefferson City formation or upon the St. Peters sandstone.

FAUNA.

The fossils collected are nearly all brachiopoda and of the following species, as determined by Dr. E. O. Ulrich:

Newberria missouriensis (Swallow) Hall and Clarke.
Pentamerella, cf. arata (Conrad).
Spirifer macbridei, Calvin.

These Dr. Ulrich believes, without doubt, establish the Devonian age of these beds.

TYPICAL OUTCROPS.

On a bluff, in sec. 41, T. 47 N., R. 14 W., the Devonian is separated from the dense thinly bedded Chouteau limestone by an eight to twelve inch bed of greenish blue, vermicular, sandy shale.

In sec. 13, T. 46 N., R. 14 W. about, three-quarters of a mile southeast of Sandy Hook, the Devonian limestone has a thickness of seven feet. Here it is very sandy, containing pebbles of chert and quartzite. Only a few feet southeast of this outcrop this conglomerate is underlain by beds belonging to the Jefferson City formation and overlain by thin beds of Kinderhook.

For a distance of half a mile southeast, the Devonian, if it exists at all, is covered with talus from the Chouteau and Burlington limestones. Near the county line, in the same bluff, there is a twelve-foot bed of typcial St. Peters sandstone with white quartzite pebbles at the top. Resting immediately upon the uneven surface of this sandstone is a seven-foot ledge of siliceous, brown, fossiliferous Devonian limestone, which grades at the top into two feet of brownish dolomite. Above this and up to the thin beds of Chouteau limestone there is a talus slope.

In a bluff near the railroad track, in sec. 22, T. 47 N., R. 14 W., two miles southeast of Lupus, there is an exposure of calcareous sandstone, ten feet in thickness, resting upon a two-foot bed made up almost entirely of badly mashed fossils in a matrix of white or grayish shaly limestone. Below this there is a three-foot bed of fine grained dolomitic, coral-bearing, limestone, underlain by eight inches of grayish, siliceous limestone. This rests upon the uneven surface of the Jefferson City limestone. Above the sandstone are thin beds of Chouteau limestone. A few hundred feet northwest, the St. Peters sandstone appears on a level with the railroad track, or fifteen feet below the bottom of the Devonian in the outcrop just described.

A half a mile northwest of this exposure the Devonian outcrops ten feet above the upper beds of St. Peters sandstone. Between the two there are no exposures. At this place there is a four-foot ledge of siliceous gray limestone, upon the uneven surface of which rests an eight-foot ledge of dolomitic, coral-bearing limestone in two beds. The upper bed probably represents the fossiliferous bed mentioned as occurring southeast of this place. The slope above this is unexposed, but the contact with the Chouteau is probably within two or three feet of the top of the Devonian outcrop.

Half a mile northwest of Lupus, just beyond the mouth of Big Splice creek, the Devonian is exposed in its greatest thickness. At the top there is a thirteen-foot bed of nearly pure quartzose sandstone, showing cross-bedding. Under this, and grading into it, there is a soft, sandy, brown limestone containing middle Devonian fossils.

Only a few feet northwest, the brown limestone passes into a gray, arenaceous phase, four feet of which is exposed. Underneath this there are thin, broken beds of cotton rock belonging to the Jefferson City formation. The cotton rock is absent at the south end but comes in at the north, thickening quite rapidly until it is six feet thick. The contact of the Devonian and Jefferson City at this place is shown in Plate III.

A quarter of a mile northwest of this outcrop the Devonian again appears as shown in the following section:

Sec. No. 9, Fig. 9.

Sec. 4, T. 47 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	71½-21½	50 feet of CARBONIFEROUS.
2	21½-12	Nine and a half feet of hard, medium grained, grayish dolomitic, coral-bearing LIMESTONE, altered in spots to black chert. This rock also contains a few spirifers. Stratification planes very well marked.
3	12-4	Eight feet of sandy, brown LIMESTONE, the upper surface of which is wavy and uneven. These beds probably represent the sandstone which outcrops farther south. Beds two to three feet in thickness.
4	4-2½	One and a half feet of SANDSTONE, full of black, gray and bluish chert pebbles. The sandstone is of a green color and quite calcareous.
5	2½-0	Two and a half feet of CONGLOMERATE consisting of pebbles of magnesian limestone and chert. The matrix is a gray to buff, argillaceous, sandy limestone. This conglomeritic mass rests upon a little anticline four feet across consisting of sixteen inches of hard, gray, thinly bedded, fine grained MAGNESIAN LIMESTONE, with a one-inch layer of soft friable white sandstone, quartzitic in places in the middle.

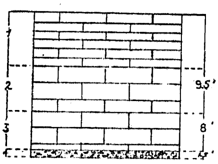


FIG. 9.

One hundred feet northwest of this place is an eight-foot bed of typical St. Peters sandstone.

Dr. E. O. Ulrich examined the rocks in this exposure, and, from the fossil content, pronounced the upper 9½ fee to be Upper Devonian and the remainder, down to the shaly conglomerate, Middle Devonian.

These Devonian beds have a slight dip to the northeast, and one mile northwest of Lupus they disappear underneath the Chouteau limestone.

GENERAL.

Meek referred these Devonian beds to the Onondaga limestone, basing his correlation on the similarity of the fossils with those of the Onondaga of New York. Dr. E. O. Ulrich, who made a hasty examination of these beds and the fossil content in the field, did not care to attempt a correlation without a more detailed study of the fossils.

Since such detailed study is impracticable during the present field season, the correlation of these beds must be reserved for future publication. Dr. Ulrich, however, inclines to the belief that the lower arenaceous beds are Middle, and the coral-bearing beds Upper Devonian, an unconformity being indicated by the uneven upper surface of the arenaceous limestone.

RÉSUMÉ.

The fact that the Devonian rocks in Moniteau county, consist of alternating beds of conglomerate, arenaceous and dolomite limestone and nearly pure sandstone, indicate that they were off-shore deposits, formed under constantly changing conditions.

The Devonian is absent in the central, southern and western portions of the county, all of the exposures being found along or near the Missouri river.

South of Sandy Hook the Devonian is seven or eight feet thick, occurs at an elevation of 570 feet and is overlain with the Chouteau limestone. A mile northwest, just north of Sandy Hook, the Jefferson City formation appears at an elevation 20 feet higher, with no Devonian above it. The Devonian is absent for several miles, when it again appears with a thickness of about 10 feet. Here it dips north, and it can be traced a mile northwest of Lupus, where it disappears beneath the Chouteau limestone. In both cases the St. Peters sandstone is found underlying it.

These exposures may be remnants left after the erosion of the Devonian in pre-Carboniferous times. However, the entire absence of Devonian in the central and western parts of the county leads one to think that it never covered this portion of the county. Taking into consideration this fact, Dr. Ulrich's suggestion that the Devonian rocks in this county were laid down in little embayments or extensions of the Devonian seas into the surrounding Silurian land area, seems to be a plausible explanation of the disconnected condition of these beds.

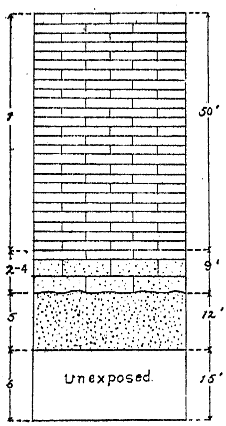


FIG. 10.

DETAILED COLUMNAR SECTIONS.

Section No. 10, *Fig.* 10.

Sec. 13, T. 46 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	86-36	Fifty feet of slope with exposures of CHOUTEAU LIMESTONE.
		DEVONIAN.
2	36-34	Two feet of brownish sandy DOLOMITE.
3	34-27	Seven feet of brown, sandy, fossiliferous LIMESTONE.
		SILURIAN.
4	27-15	Twelve feet of soft SANDSTONE with quartzite pebbles at top.
5	15-0	Fifteen feet UNEXPOSED.

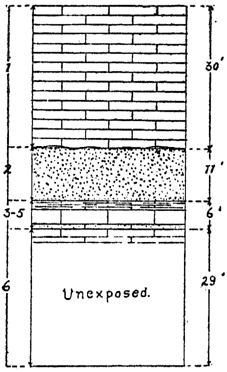


FIG. 11.

Section 11, *Fig.* 11.

Sec. 22, T. 47 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	68-38	Thirty feet of CHOUTEAU LIMESTONE.
		DEVONIAN.
2	38-35	Eleven feet of calcareous SANDSTONE.
3	35-33	Two feet of badly shattered fossils in shaly gray matrix.
4	33-30	Three feet of fine grained, brownish gray, dolomitic, coral-bearing LIMESTONE.
5	30-29	Six inches to one foot of gray arenaceous LIMESTONE.
6	39-0	JEFFERSON CITY LIMESTONE and unexposed slope.

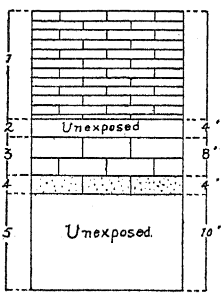


FIG. 12.

Section No. 12, *Fig.* 12.

Sec. 15, T. 47 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	93-26	Sixty-seven feet of CHOUTEAU LIMESTONE.
2	26-22	Four feet UNEXPOSED.
		DEVONIAN.
3	22-14	Eight feet of gray dolomitic, coral-bearing, LIMESTONE in two beds.
4	14-10	Four feet of gray arenaceous LIMESTONE.
5	10-0	Ten feet UNEXPOSED.

CHAPTER IV.

MISSISSIPPIAN (LOWER CARBONIFEROUS.)

The Mississippian or Lower Carboniferous is the surface rock over a large part of Moniteau county north of Moniteau creek, comprising an area of 60 square miles. The beds are mainly horizontal, although a gentle general dip to the northeast was observed.

In this county, the Mississippian is represented by two clearly defined members, the Chouteau and the Burlington. There is also possibly a third, the Hannibal.

(A) CHOUTEAU LIMESTONE.

AREAL DISTRIBUTION.

The Chouteau is exposed as a fringe beneath the Burlington limestone in the northern part of the county and in small isolated outcrops at a few localities south of Moniteau and Moreau creeks.

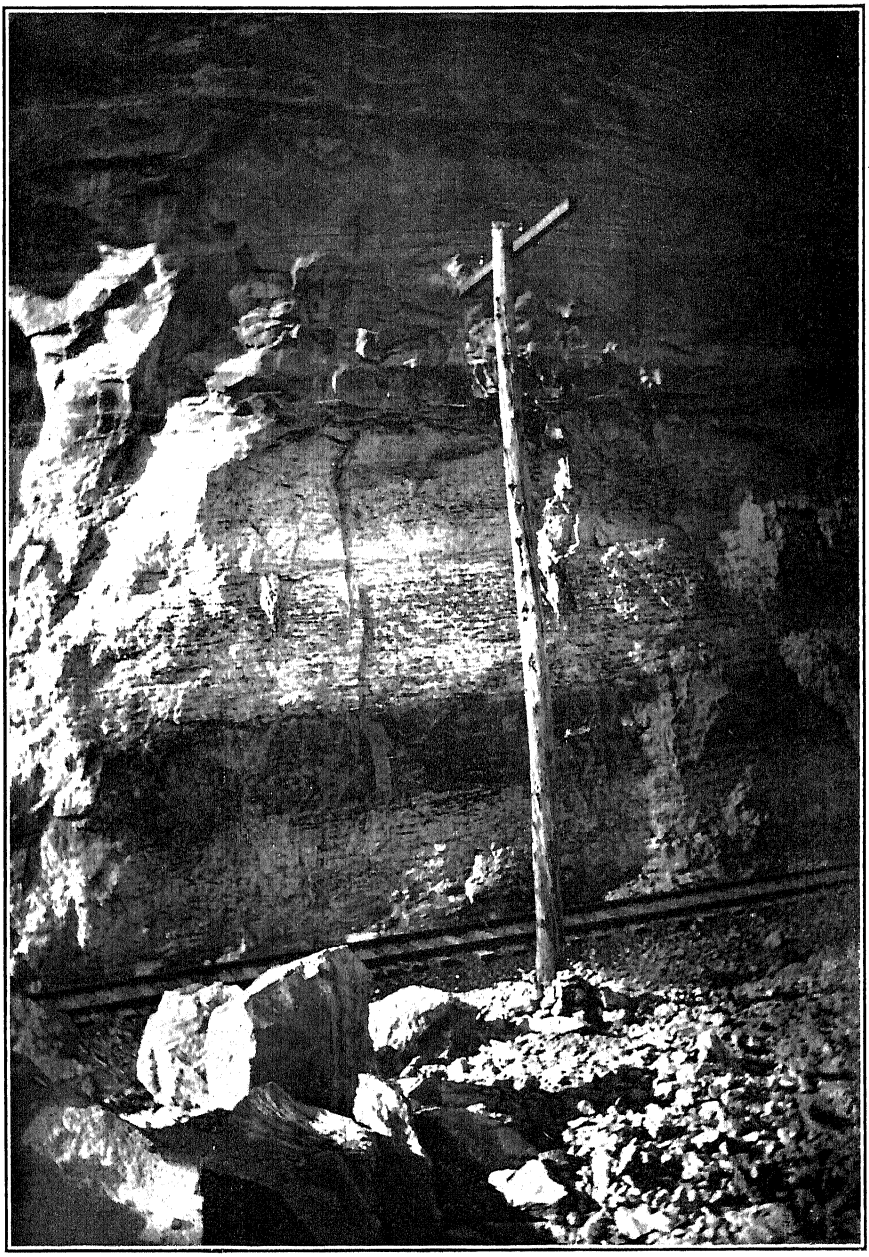
THICKNESS.

The thickness of the Chouteau in this county is variable, ranging from two to three feet in the southern part to sixty feet in the northern. It is two to three feet thick where it outcrops in the bed of Willow fork in sec. 27, T. 45 N., R. 17 W. It is sixty feet thick in the bluffs along the Boonville branch of the Missouri Pacific railroad, in sec. 32, T. 47 N., R. 14 W. At this place there is a sheer cliff 135 feet high consisting of 75 feet of Burlington limestone at the top and 60 feet of Chouteau limestone underneath. The contact of the Burlington and Chouteau formations is well exhibited at this place. Plate IV is a photograph of this exposure.

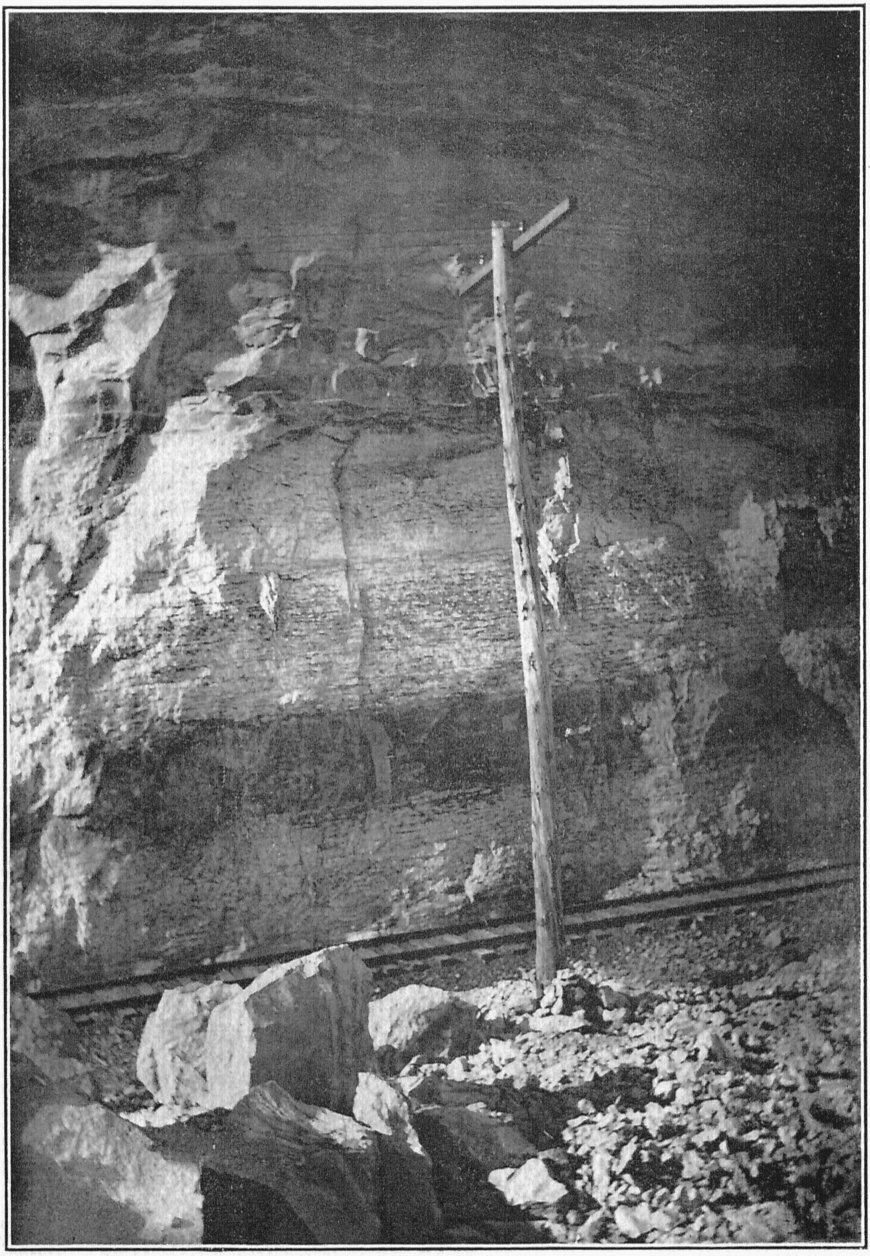
South from this locality the thickness of the Chouteau gradually decreases to forty feet just north of Moniteau creek. South of this stream it occurs only as outliers.

TOPOGRAPHY.

The Chouteau limestone is exposed chiefly on the hillside, and from its contact with the underlying formations to the thick beds of Burlington limestone above, it forms a gentle slope. The upper beds are softer than those below and yield more readily to erosion. These often form a some-



SHOWING CONTACT OF CHOUTEAU AND BURLINGTON LIMESTONES.



SHOWING CONTACT OF CHOUTEAU AND BURLINGTON LIMESTONES.

what steep declivity, underneath which the harder beds produce a gentle slope to the Jefferson City limestone below. Thus the Chouteau limestone wherever it occurs in Moniteau county, is marked by a gentle slope.

COMPOSITION.

The Chouteau limestone in this county may be conveniently divided into two parts; an upper portion consisting of a silico-magnesian limestone, which usually contains a considerable amount of disseminated calcite; and a lower portion consisting of thin beds of hard, bluish gray to drab colored limestone separated by thin shaly partings. The rock in the upper portion is rather soft when in place, but becomes much harder after exposure to the weather. It resembles, very closely, the cotton rock of the Jefferson City formation, although it does not ordinarily have the dendritic markings of the cotton rock. In one place in the uppermost part of the Chouteau, a large number of Bryozoans were collected. Dr. Ulrich of the United States Geological Survey expects to name and describe these for future publication.

The upper beds are massive, being usually ten and sometimes twenty feet in thickness. The lower beds are from two inches to two feet in thickness, the majority being about two inches. In some places, thin beds alternate with the more massive silico-magnesian beds at the top of the formation. This alternation is well exhibited in the last railroad cut northwest of Lupus. The exposure at that place beginning at the bottom, consists of twelve feet of thin beds; eight feet of silico-magnesian limestone; and twenty feet of thin beds grading into silico-magnesian limestone above.

The hard, bluish drab beds contain many fossil crinoid stems. These show as small circular or oval pieces of calcite scattered promiscuously through the rock. The fossils are not well marked in the fresh stone, but the weathered surface, in many cases, is literally covered with fragments of crinoids.

Plate V. shows the typical lower and upper beds of the Chouteau grading into the Burlington limestone above.

At different horizons in the Chouteau there are layers of chert nodules which are usually grayish white on the weathered surface, and drab to bluish black when fresh. These nodules or concretions have various shapes, but are usually oval and range in size from two to twelve inches long by one to six inches wide.

WEATHERING.

The upper portion of the Chouteau weathers to a buff or tan color. A fresh surface of the rock is ordinarily a drab or bluish gray. The weathered surface of the lower hard beds has a white color, while the fresh surface is blue or drab. Where the beds of soft and hard limestone in the lower part of the formation alternate, they form step like terraces which end abruptly against the upper beds, which form nearly vertical cliffs.

STRUCTURE.

Like the other formations in this county, the Chouteau is practically flat lying, having, however a gentle dip to the northeast.

Bedding.—The bedding planes in the upper and lower parts of the formation are very different. In the upper silico-magnesian division the bedding planes are usually five or six feet apart, although in some places they are only two or three feet apart. The bedding planes in the hard blue or drab limestone are two to four inches apart and are usually marked by thin layers of black shale a sixteenth of an inch in thickness.

Folding.—The folds in this formation are very gentle, consisting of flexures having an amplitude of only a few feet. Many gentle flexures of this character were observed along the railroad track where the rocks are well exposed.

Faulting.—No faulting was observed in this formation.

Jointing.—Four sets of vertical or nearly vertical joints were observed. The strike of the major joints is N. 24° W. and N. 64° E., and that of the minor N. 19° E. and N. 70° W.

TYPICAL EXPOSURES.

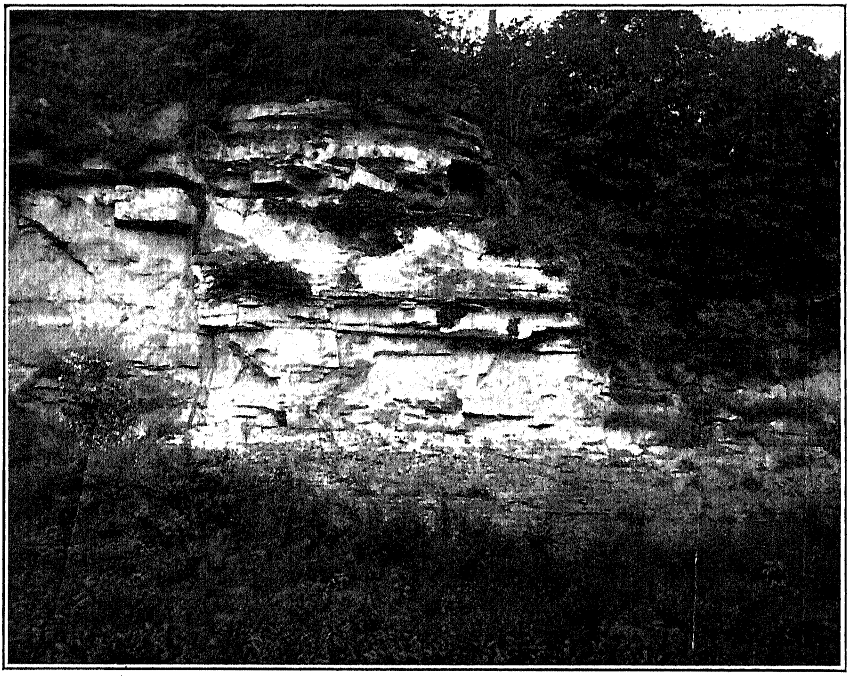
The best exposure of the Chouteau observed is along the railroad in sec. 4, T. 47 N., R. 14 W. At this place, the upper silico-magnesian beds are mostly covered with soil, but the lower beds are well exposed. The thin layers of hard, bluish drab limestone and silico-magnesian limestone alternate at intervals of a few feet. The surfaces of some of the more massive hard beds show peculiar bluish blotches which are evidently a part of the rock. These are probably due to organic matter.

The rock also contains crinoid stems which show as white flecks on the fresh surface.

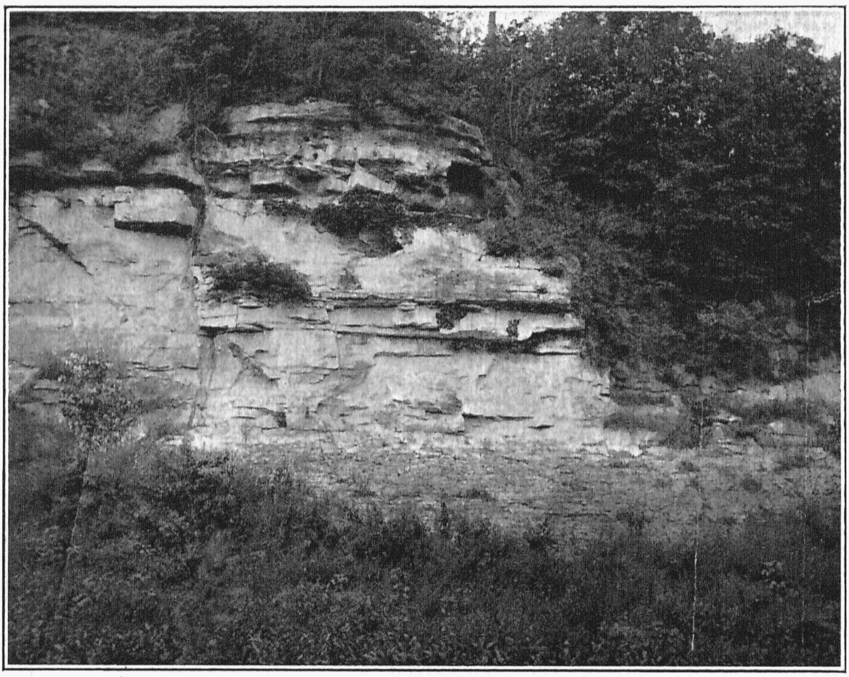
This outcrop shows a one foot bed of green, vermicular, sandy shale, which, in places, is quite soft. This shale has the appearance of having been worm eaten and possibly represents what is known as the Vermicular sandstone.

This outcrop is one of the best in the county at which to collect Chouteau fossils.

In sec. 13, T. 46 N., R. 14 W., three-fourths of a mile southeast of Sandy Hook, in a bluff three hundred feet west of the railroad track,



LOWER AND UPPER BEDS OF CHOUTEAU GRADING INTO BURLINGTON.



LOWER AND UPPER BEDS OF CHOUTEAU GRADING INTO BURLINGTON.

there is an interesting exposure. At this place there is a bluff, at the base of which the Jefferson City limestone outcrops. Above the Jefferson City the Devonian and Kinderhook are well exposed. The following section shows the relations between these formations at this place.

Section No. 13, *Fig.* 13.

Sec. 13, T. 46 N., R. 14 W.

(From top to bottom.)

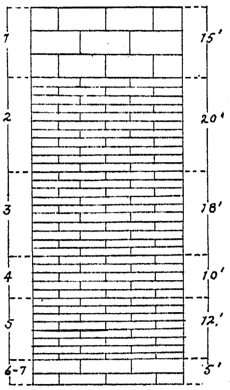


FIG. 13.

No.	Elev.	
1	80-65	Fifteen feet of BURLINGTON LIMESTONE.
2	65-45	Twenty feet of brown to buff colored fine grained SILICO-MAGNESIAN LIMESTONE. Non-fossiliferous, but contains masses of calcite.
3	45-27	Eighteen feet of thinly bedded, dense, hard blue to drab LIMESTONE, breaking with conchoidal fracture, and containing numerous lenticular masses of gray knife edge chert. Numerous fossils, fairly well preserved.
4	27-17	Ten feet of thinly bedded, nodular, gray LIMESTONE with a shaly structure, containing small nodules of marcasite. Thin shale seams separate the beds. The stone is fairly fossiliferous. The caudagalli, or "rooster tail" markings are very prominent. (Hannibal shales?)
5	17-5	Twelve feet of massive fine grained buff colored SILICO-MAGNESIAN LIMESTONE, in beds from six to ten inches in thickness. Very few fossils. (Louisiana limestone?)
		DEVONIAN.
6	5-2	Three feet of calcareous SANDSTONE containing water worn pebbles of chert and quartzite. To the north this passes into a seven foot bed of subcrystalline, fossiliferous, siliceous LIMESTONE, containing water worn pebbles of chert and quartzite.
		SILURIAN.
7	2-0	Two feet of pitted JEFFERSON CITY DOLOMITE.

The twenty feet of silico-magnesian limestone underlying the Burlington is the upper part of the Chouteau limestone; the next eighteen feet of alternating, hard, thinly bedded, blue limestone and silico-magnesian limestone is the lower Chouteau.

The twenty-two feet of argillaceous limestone above the Devonian is in some doubt. It is certainly Kinderhook, but whether it is the Louisiana limestone, a phase of the Hannibal shales, or part of the Chouteau, cannot be positively stated until a careful examination is made of the few fossils collected. It is unfortunate that this cannot be done before the publication of this report.

Dr. E. O. Ulrich of the U. S. Geological Survey, visited the locality, but he is unable to make the necessary determinations in time for this report.

RELATIONS TO OTHER FORMATIONS.

The Chouteau and Jefferson City formations were nowhere found in contact, but the fact that the Devonian limestone occurs between the two at a number of places as well as the lithological differences, are evidence that the two are unconformable.

The Chouteau limestone and the Devonian are unconformable. In sec. 13, T. 46 N., R. 14 W., there is an exposure of very siliceous subcrystalline limestone, containing water worn pebbles belonging to the Onondaga. Resting on top of this, with no gradation between the two are thin beds of Chouteau. In sec. 4, T. 47 N., R. 14 W., the unconformity between the Chouteau and Devonian is represented by a one-foot bed of green, vermicular, sandy shale.

From the field relations it is difficult to say how much, if any, unconformity exists between the Chouteau and the Burlington. In the S. E. ¼ of sec. 26, T. 47 N., R. 14 W., in a railroad cut, there is an outcrop showing a perfect gradation between the Chouteau and the Burlington, with apparently no break.

In a railroad cut in sec. 4, T. 47 N., R. 14 W., there is a bed of bluish green, sandy shale from 6 to 10 inches in thickness between the Chouteau and Burlington. This shale occurs between the two formations in a number of places, but in as many places there is a complete gradation.

The scarcity of fossils in the upper beds of the Chouteau and the very great abundance of fossils in the Burlington, are evidences of a considerable difference in the conditions of sedimentation at the time the two limestones were deposited.

ECONOMIC CONSIDERATIONS.

Soils.—The small surficial distribution of the Chouteau renders it of very little importance as a soil producer.

Minerals.—An occasional concretion of limonite and pyrite and crystals of zinc blende are the only metallic minerals observed in this formation. Barite is not common.

Building Stone.—The resistance which the upper beds of the Chouteau offer to erosion and their occurrence in beds which can easily be quarried are evidence that this stone is very suitable for buildings. The lower beds are used to some extent for foundations. The abutments to the bridge over Little Moniteau creek, in sec. 35, T. 46 N., R. 14 W., are built out of this rock, quarried from a nearby hill.

Cement.—The upper beds of the Chouteau might be used for the manufacture of hydraulic cement, although analyses show too high a percentage of magnesium.

RÉSUMÉ.

The Chouteau limestone is the lowest member of the Mississippian, or Lower Carboniferous, in Moniteau county. It consists of two parts, very different lithologically. This difference has led some of the earlier geologists to separate these beds into two formations.

During the earlier stages of deposition the sea was probably of considerable depth, and the conditions of sedimentation were such as to preserve the forms of life existing at the time. Later the water, gradually, became shallower and the silico-magnesian deposits were laid down under conditions unfavorable to marine life.

After the Chouteau was deposited, there was a period of elevation and erosion with subsequent depression, during which the Burlington with its abundant fauna was deposited. It is not possible to estimate the length of the time interval between the deposition of these formations, but it was probably considerable.

DETAILED COLUMNAR SECTIONS.

Section No. 14, *Fig.* 14.

Sec. 49, T. 47 N., R. 14 W.

(From top to bottom.)

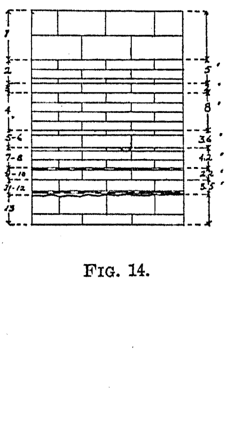


FIG. 14.

No.	Elev.	
1		BURLINGTON LIMESTONE.
2	28½-23½	Five feet grayish white, earthy silico-magnesian LIMESTONE.
3	23½-21½	Two feet of hard, blue to drab, thinly bedded compact LIMESTONE.
4	21½-13½	Eight feet of blue to drab LIMESTONE. Same as No. 1.
5	13½-12½	One foot. Same as No. 2.
6	12½-$9\frac{5}{6}$	Two and two-thirds feet of hard, blue drab, fine grained LIMESTONE, in beds eight to ten inches thick. Crinoid stems on weathered surface.
7	$9\frac{5}{6}$-$9\frac{1}{6}$	Eight inches. Same as No. 1. Contains a few reddish streaks, and has thin shaly partings between beds.
8	$9\frac{1}{6}$-$5\frac{2}{3}$	Three and one-half feet of hard, earthy, silico-magnesian LIMESTONE, with peculiar blue markings, probably organic matter. Beds six to ten inches thick with thin, black, shaly partings.
9	$5\frac{2}{3}$-5½	Two inches of gray SHALE.
10	5½-3½	Two feet of thinly bedded, hard, bluish brown, compact LIMESTONE, containing calcite.
11	3½-1	Two and one-half feet. Same as No. 1.
12	1-0	One foot of green, sandy SHALE. Quite soft in place, but detached pieces are hard on exposed surface. Peculiar ropy weathered surface.

Section No. 15, *Fig.* 15.

Sec. 4, T. 47 N., R. 14 W.

(From top to bottom.)

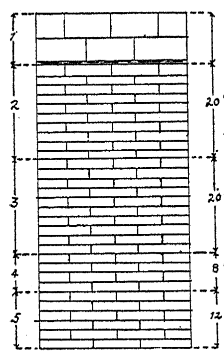


FIG. 15.

No.	Elev.	
2	60-40	Twenty feet dark blue to buff, earthy, silico-magnesian LIMESTONE, containing calcite masses and bluish streaks.
3	40-20	Twenty feet alternating beds of hard, compact, blue to gray, thinly bedded LIMESTONE, and softer beds like No. 1, separated by thin, black, shaly layers. Contains chert nodules.
4	20-12	Eight feet. Same as No. 1. Massive beds.
5	12-0	Twelve feet, alternating hard and soft beds. Same as No. 2. Contains chert nodules.

Between 3 and 4 is a persistent horizon of white to brown chert nodules, from two to six inches in thickness.

(B) BURLINGTON LIMESTONE.

(Encrinital of Swallow.)

AREAL DISTRIBUTION.

The Burlington limestone is the surface rock over practically all the county north of Moniteau creek, and also of the ridge between Moniteau and Moreau creeks west of Clarksburg to the Morgan county line. Two or three outliers also occur south of Moreau creek.

The northern part of the county is hilly and for this reason the rocks of this formation are well exposed. On the table-land area, in the western part, the exposures are small, few in number and scattered, making it difficult to accurately map the formation. Along some of the branches of Moniteau creek, north of Tipton, in the table-land area and along the Willow Fork of Moreau creek, southeast of Tipton, there are a number of outcrops of Burlington associated with Chouteau limestone. Excepting along these streams there are no outcrops over the entire table-land area, but in a number of places boulders of undoubted Burlington chert are scattered over the surface. In addition to this Mr. Martin Dueber of Tipton, who owns several well drilling outfits, states that a few feet of Burlington limestone are always passed through near the surface whereever he has drilled in that area. It is thought that the evidence warrants mapping this table-land area as underlain with Burlington limestone.

THICKNESS.

Over the table-land area in the western part of the county the Burlington is probably not over fifteen feet thick. In the northern part of the county, north of Moniteau creek, the formation thickens quite rapidly until, in the high bluffs along the Missouri river, it attains a thickness of one hundred and thirty feet. Keyes* estimates the average thickness of the Burlington in Missouri at sixty feet. Its average thickness in Moniteau county is about seventy-five feet.

In the bluffs along the Missouri river, which rise almost vertically two or three hundred feet, almost the entire thickness of the Burlington formation in this county is exposed.

TOPOGRAPHY.

Most of the area underlain with the Burlington limestone, with the exception of that adjacent to the Missouri river, is gently rolling prairie.

*Keyes, Mo. Geol. Survey, Vol. IV, p. 30.

The level character of the table-land is everywhere interrupted by sink-holes which are abundant throughout the area underlain by Burlington limestone.

The hills along the Missouri river are rounded at the top, but layers of chert occur in the formation near the top, and as a result of these cherty beds the hillsides are steep.

COMPOSITION.

The Burlington limestone in this county is nearly pure calcium carbonate and has a white to brownish color. It is composed of a great mass of fossils, chiefly crinoid stems, which are cemented together with calcium carbonate. A. H. Worthen* describes this formation in its typical locality in Illinois, as follows:

"The upper portion of the mass is the most calcareous, and consists of light gray and brown crinoidal limestone, composed almost entirely of the remains of crinoids, cemented together by calcareous matter. The cleavage of the rock is generally through the joints and plates of the crinoids, and this gives to the freshly broken surface a semi-crystalline appearance * * * * * *. At Burlington, Iowa, the typical locality where this limestone was first studied and its peculiar lithological characters determined, the mass is easily separated, either by its fossil contents or lithological characters, into two beds. The upper bed is a light gray or nearly white limestone. with some brown layers interstratified, and when free from chert, is a nearly pure carbonate of lime.

The lower bed is usually a brown magnesian limestone, locally arenaceous—sometimes so much so as to become pulverulent—and this renders the rock worthless for building purposes. Chert and hornstone are abundant, both in this and the upper bed, and occur both in seams and nodules."

Dr. E. M. Shepard** divides the Burlington limestone into the Upper and Lower Burlington and again sub-divides the Upper Burlington into three horizons.

"1. A heavy bedded chert, or thin, alternating beds of shaly lime and chert, which vary from a few feet to about 40 feet in thickness.

2. The limestone underneath, rather coarse grained, crystalline, soft and grayish in color, usually having white, rather soft, lenticular masses of chert, from a few inches to a foot or two in diameter, though the chert is occasionally absent. The so-called suture joint structure is also characteristic.

3. The lower beds are decidedly shaly in structure, though much

*A. H. Worthen, Geol. Survey of Illinois, Vol. I, 1866, pp. 102-103.

**Mo. Geol. Survey, Vol. XII, 1898, p. 49.

harder than the upper ones, and, where exposed, form shelving ledges, giving a rugged and barren appearance to the country."

In Moniteau county the Burlington approaches more nearly the rock described by Worthen than that described by Shepard. The upper beds are pure white and very fossiliferous and make up the entire formation down to within a few feet of the contact with the Chouteau, where the rock becomes softer and the color changes to a buff and brown.

Below this, in places, there is found a soft, yellow to brown, calcitic, magnesian limestone, from two to ten feet in thickness. This has a pinkish tinge on the weathered surface. The calcite cleavage faces are probably the broken ends of crinoid stems, although this rock is not as fossiliferous as the overlying beds.

Chert, both nodular and bedded, occurs at different horizons. The chert layers are from two to eighteen inches thick, and exhibit all stages of alteration from limestone to chert. It is ordinarily white to brown on the weathered surface, and contains fossils which are beautifully preserved. It is usually rather compact and dense and breaks with a splintery fracture.

In a stream bed in the S. W. ¼ of sec. 4, T. 44 N., R. 17 W., there is an outcrop of Burlington limestone containing an interesting development of chert. Part of the limestone has been completely altered to chert at the surface, while underneath there is every gradation into perfectly fresh limestone. In places the layer of chert is not over 3-16 of an inch thick, but it serves as a protecting mantle, causing the bed to weather unevenly, forming a bouldery surface.

The hillsides in the vicinity of these chert horizons are strewn with chert boulders, some of which are badly decomposed, consisting of a mass of silicified shells and crinoid stems.

The metamorphism of the limestone into chert is nowhere complete, some limestone always remaining. The solution of this limestone, which has been in progress since Carboniferous times, accounts for the porous condition of this formation.

WEATHERING.

The composition, coarse grain and porosity of the Burlington limestone render it an easy prey to the weathering agents. Where it occurs on a hillside the slope is more or less gentle resulting from the wearing away of the rock into steps and ledges from four to six inches in thickness. The exposed surfaces of the upper beds are rough, as a result of the differential weathering of the fossils and matrix. The color also changes from a white to a gray. Where chert is abundant the slope is much steeper than where it is absent.

That this limestone is taken into solution with comparative ease is shown by the numerous sink-holes which occur wherever it is the surface rock. These sink-holes are usually connected with underground channels, which have also been formed through solution. The water which flows into the sink-holes usually re-appears in springs, along the Burlington-Chouteau contact.

The caves and cavities in the limestone in the bluffs along the Missouri river are the results of solution. In places great triangular blocks of Burlington limestone project from the face of the cliffs, giving them a somewhat turreted appearance. These are caused by weathering along the north and south and east and west systems of joints.

STRUCTURE.

Bedding.—In this formation the bedding planes usually occur from six inches to two feet apart, although in some of the vertical cliffs they are six feet apart.

Folding.—Folds in the Burlington limestone in this county are very local. The formation has a slight, general, northeast dip, which is not noticeable in individual outcrops except in the extreme northeastern part of the county, where it is quite steep.

The beds comprising a number of the outliers south of Moreau and Moniteau creeks have very steep dips. In some places the beds are nearly on edge. There is no uniformity in the direction in which these outliers dip. At the foot of a hill, in sec. 18, T. 45 N., R. 14 W., a dip of 60° S. was noted. About 350 feet above this, on the hillside, the Chouteau is exposed, and directly north of this a dip of 50° N., 40° E. was noted. On the side of a hill in the N. E. ¼ of sec. 10, T. 45 N., R. 14 W., the beds dip 80° W.

In sec. 5, 6, 7 and 8, T. 44 N., R. 15 W., there is a small area of Burlington limestone, surrounded on all sides, at the same elevation, by the Jefferson City formation. Everywhere the Burlington limestone dips toward the center of the area, and the men, who are quarrying at this place, say that the dip is steeper in the lower beds.

These dips are probably due to the gradual settling of the beds into caverns formed by underground water which has taken the limestone into solution. It is thought improbable that they are due either to original deposition or subsequent folding through compressive stresses.

Faulting.—No faulting of any consequence was observed in this formation. The only faults noted were gravity or tension faults having a throw of a few inches.

Jointing.—The joints in this formation are sharp and well defined. The major joints strike N. 25° W. and N 60° E. Minor sets strike N.-S. and E.-W. Stylolites, or suture joints, are common.

RELATIONS TO OTHER FORMATIONS.

This formation unconformably overlies the Jefferson City formation and the Chouteau limestone. In the N. E. ¼ of sec. 31, T. 43 N., R. 14 W., along the Missouri Pacific railroad, there is an outcrop of Burlington limestone in contact with the Jefferson City formation. At the base of the limestone there is a conglomerate made up of oölitic chert, sandstone and cotton rock boulders embedded in a limestone matrix. Some of the boulders are several feet in diameter. The conglomerate in places grades into the overlying Burlington limestone, but in other places it is sharply separated from it. The conglomerate and Burlington limestone occupy the north end of the exposure. Near the middle, the conglomerate is in contact with the cotton rock of the Jefferson City formation. It fills a crevice in the cotton rock, and there is sufficient evidence to warrant the supposition that it was deposited in an erosion channel. There may have been faulting at this place but none could be made out.

In sec. 2, T. 44 N., R. 17 W., on the south side of a creek, there is an exposure of Burlington limestone three feet thick and one hundred and twenty-five feet long. Underlying this limestone there is one foot of yellowish white, sometimes arenaceous, clay, representing a bed of shale, in which are embedded roundish flint boulders. On the opposite side of the creek, and in contact with the shale, there are some slightly disturbed beds of Jefferson City limestone.

At some places in the county the Chouteau and Burlington grade into each other, while at other places the contract between the two is sharp. Occasionally a thin bed of bluish green, sandy shale, from six to ten inches thick, separates them.

The transition is well shown in a railroad cut in sec. 26, T. 47 N., R. 14 W. At this place the upper, soft, massive beds of the Chouteau gradually grade into the Burlington. In a railroad cut in sec. 32, T. 48 N., R. 14 W., the Burlington and Chouteau are separated by a layer of green, sandy shale.

ECONOMIC CONSIDERATIONS.

Soils.—The decomposition of the Burlington limestone forms a light, calcareous, clayey soil, of a reddish brown color. In places the soil is thickly studded with chert fragments, which render it difficult to cultivate. In general, this soil is the best adapted for agricultural purposes of any in Moniteau county. Even the stony ground is remarkably fertile, and is very suitable for fruit growing. Near the Missouri river the steepness of some of the slopes renders cultivation impracticable, but on the prairie in the western and northern parts of the county there is very little land which cannot be profitably tilled.

Minerals.—So far as known, lead, zinc and iron, in commercial quantities, have not been found in the Burlington in this county. Barite occurs in several places, having been mined in the S. W. ¼ of sec. 25, T. 47 N., R. 15 W. Here it occurs in a small ravine, on one side of which there is a deposit of Carboniferous sandstone, through which a large quantity of barite is scattered.

Quicklime.—The principal value of this formation is in the limestone, which is well adapted to the manufacture of quicklime. There are four kilns in the county, located respectively in sec. 5, T. 44 N., R. 15 W.; sec. 13, T. 44 N., R. 17 W.; the N. W. ¼, sec. 17, T. 43 N., R. 14 W., and the N. E. ¼ sec. 13, T. 14 N., R. 17 W. The lime manufactured at the first, second and fourth is used exclusively for local consumption. The last mentioned is located on land owned by Mr. Charles P. Keller, and has been operated for about six years. The third mentioned kiln is located on land owned by Mr. Joseph Bartsch, and in 1899 the lime was shipped to Russelville, a distance of three and one-half miles. The cost of haulage was too great and the plant was abandoned.

The lime produced at all of these kilns is of good quality.

Building Stone.—Some of the stone of this formation is well adapted for buildings. It has a permanent grayish white color, is quite uniform in texture, and takes a fair polish. Altogether it is one of the most durable building stones in the county. It is used for retaining walls and foundations and is well adapted for other heavy masonry work.

RÉSUMÉ.

The highly fossiliferous character of this stone indicates that it was formed at a moderate depth, under conditions of comparative quiet, and in a sea, teeming with animal life. The somewhat clayey and sandy composition of the lower beds, together with the comparatively few fossils, lead to the conclusion that they were deposited near the shore. The uniform composition of the upper beds indicates that the conditions of sedimentation remained undisturbed throughout a greater part of the period.

After this formation had been deposited the land was elevated above the sea and there followed an erosion interval, which was of sufficient duration to remove a part of the formation from the southern portion of the county. This is shown by the occurrence of sandstones and shale of Pennsylvanian age, resting upon the Burlington and Jefferson City formations, both on the hill tops and in the valleys.

DETAILED COLUMNAR SECTIONS.

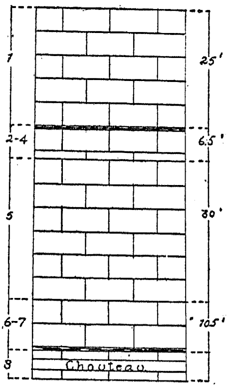


FIG. 16.

Section No. 16, *Fig.* 16.

Sec. 4, T. 47 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	132-107	Twenty-five feet of coarse grained, grayish white, crinoidal LIMESTONE, in beds six to eight inches thick.
2	107-106½	Six inches of cherty LIMESTONE. The white limestone of the Burlington is altering to the porous, white fossiliferous chert.
3	106½-102	Four and one-half feet of soft brown MAGNESIAN LIMESTONE, containing very few fossils.
4	102-100½	One and one-half feet of bluish white, dense, fine grained CHERT, showing a few crinoid stems on the weathered surface.
5	100½-70½	Thirty feet of brown and buff colored, earthy, crinoidal LIMESTONE, soft and very fossiliferous.
6	70½-60½	Ten feet. Same as No. 5. Only of a darker brown color and more loosely cemented.
7	60½-60	Six inches of bluish green, sandy SHALE.
8	60-0	CHOUTEAU LIMESTONE.

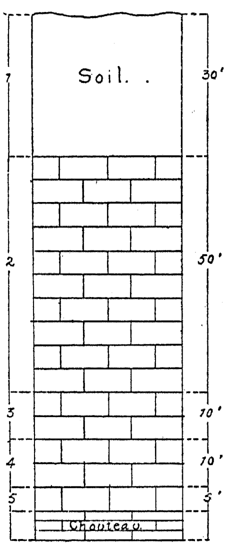


FIG. 17.

Section No. 17, *Fig.* 17.

Sec. 23, T. 47 N., R. 14 W.

(From top to bottom.)

No.	Elev.	
1	120-90	Thirty feet UNEXPOSED.
2	90-40	Fifty feet of coarse grained, grayish white, thinly bedded, crinoidal LIMESTONE.
3	40-30	Ten feet of brown, crystalline MAGNESIAN LIMESTONE, with veinlets of calcite.
4	30-20	Ten feet same as No. 2. Grades into crinoidal limestone underneath.
5	20-15	Five feet of soft, brown, loosely cemented, crinoidal LIMESTONE.
6	15-0	CHOUTEAU LIMESTONE.

GENERAL.

Dr. E. M. Shepard divides the Burlington limestone of Greene county into two members, the Upper Burlington and Lower Burlington. He describes the Lower Burlington as follows:

"The upper beds of the Lower Burlington are made up of from 5 to 20 feet of yellowish-white, very hard chert, which breaks with a conchoidal or splintery fracture, some fragments being as sharp as a knife blade. This chert is apparently non-fossiliferous. It sometimes has a bluish cast, but is more usually pure white with an external yellow tinge due to iron. The amount of chert increases toward the south from Springfield."

"In a low bluff on the east side of the James river, south of the Gibson ford, alternating beds of limestone from 6 to 18 inches in thickness outcrops in ledges which lithologically resemble Chouteau. The upper layers of these beds are a light brownish yellow, the lower being darker, more Chouteau-like, and carrying minute particles of calcite. There are 20 feet of the Chouteau-like beds of this shaly, nodular chert, with softer crinoid layers and the typical hard blue limestone. It was somewhat difficult, for want of paleontological evidence, to decide whether this represented the Chouteau-like layer of the Upper Burlington, resting on the Lower Burlington, or whether it was a distinct bed of similar characteristics belonging to the latter. Evidence obtained from the outcroppings above and below this point on the river rendered the latter view more probable. This same peculiar structure has been noted at several other places. As far as investigated, this layer increases toward the south, and it is quite probable that it may be the northern equivalent, in the Lower Burlington, of the marble beds which underlie the massive chert deposits of that formation in the northern part of Arkansas, and in the southern tier of counties in Missouri."

"The basal portion of the Lower Burlington is made up of a heavily bedded, bluish or slate colored, fine grained, very hard limestone which is often interspersed with lenticular masses of chert in the north, and which, toward the south, as seen in the little bluff just north of Ozark, becomes mixed with the lime in the most extraordinary manner. The chert has the appearance of having been squeezed, laterally, in great rolls into the thin layers of limestone."

In Moniteau county all the exposed Burlington limestone corresponds with Shepard's Upper Burlington. The Lower Burlington is not present, but the Chouteau limestone nearly corresponds with the Lower Burlington, and was, at first, taken for that formation. Shepard in his report speaks of the similarity of the middle part of the Lower Burlington to the Chouteau.

The Chouteau limestone, as exposed at Chouteau Springs, in Cooper county, is described by Swallow* as follows:

"1st. At the top, immediately under the Encrinital Limestone, we find some forty or fifty feet of brownish gray, earthy, silico-magnesian

*Mo. Geol. Survey, Vol. XII, pp. 103-105.

limestone in thick beds, which contains disseminated masses of white or limpid calcareous spar. This rock is very uniform in character, and contains but few fossils. Reticulated corrals, and Fucoidal markings like the Cauda-galli, are most abundant."

"In the quarry it is quite soft, but becomes very hard on exposure, and forms a very firm and durable building rock. * * *"

"The rock ranges through the western part of Boone and Moniteau and is very common on the La Mine, in Cooper, and in Polk and Greene counties."

"2nd. The upper division passes down into a fine compact blue, or drab thin-bedded limestone, whose strata are quite irregular and broken. Its fracture is conchoidal, and its structure somewhat concretionary." * *

A thickness of sixty feet of these rocks was observed in a vertical cliff along a railroad cut on the Boonville branch of the Missouri Pacific railroad, in sec. 4, T. 47 N., R. 14 W. At this place the lower beds are thin and consist of hard, compact, bluish gray limestone containing lenticular masses of chert, described by Meek as typical of the basal beds of the Chouteau, and by Shepard as typical of the Lower Burlington. These grade into and alternate with thin beds of the silico-magnesian limestone containing calcite. The uppermost twenty feet consists entirely of this latter rock, which is separated from the Burlington by a thin layer of greenish blue shale. The old town of Mount Vernon, where Meek collected his typical Chouteau fossils, is located just north of this place.

Numerous fossils were collected from the Chouteau in Moniteau county, and sent to Dr. E. O. Ulrich, Paleontologist of the United States Geological Survey, who referred them to the Chouteau. Later Dr. Ulrich, in company with the writer, visited Moniteau county and examined and collected fossils from these localities. He recognized the fossils as typical of the Chouteau and identified the beds positively as Chouteau.

*Mo. Geol. Survey Ann. Rept. I & II, pp. 101-102.

CHAPTER V.

PENNSYLVANIAN (UPPER CARBONIFEROUS.)

The Coal Measure formations consist of the Saline creek cave-conglomerate, the Graydon sandstone and Coal Measure shale. The Saline creek cave-conglomerate is found filling depressions in the Jefferson City formation, but not in the Burlington limestone. The evidence in this county shows it to be altogether of post-Ordovician age. Ball and Smith, however, found boulders of Burlington limestone in the conglomerate and referred it to the Coal Measures. For this reason it is considered in this report as a Coal Measure formation. The sandstone corresponds with Shepard's* Graydon in lithologic characters and in position. The shale occurs in depressions in the Burlington and Jefferson City formations, and for want of more detailed information it is simply referred to the Coal Measures.

(A) SALINE CREEK CAVE-CONGLOMERATE.

This formation, so named from its typical occurrence along Saline creek in Miller county, outcrops in a few places in Moniteau county. The largest and best exposure is along the Missouri Pacific railroad, a mile and half northwest of Sandy Hook, in sec. 2, T. 46 N., R. 14 W. At both ends of the outcrop bedded cotton rock, underlain by cherty, pitted dolomite, is exposed. These beds are horizontal up to within a few feet of the conglomerate, when they dip, gradually at first and then steeply, toward the conglomerate. The exposure is two hundred and seventy feet long, seventy-five to one hundred feet of which is conglomerate. Fig. 18 represents this exposure of conglomerate.

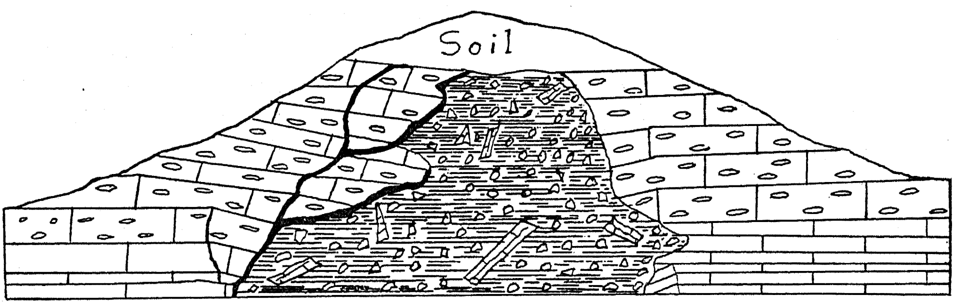


FIG. 18.
Exposure of Saline Creek Cave-Conglomerate near Sandy Hook.

*Mo. Geol. Survey, Vol. XII, p. 124.

THICKNESS.

The thickness at this place is twenty-five feet. However, this is not to be taken as the thickness of the formation as a whole, since this varies with each exposure.

LITHOLOGIC CHARACTERS.

The conglomerate is made up of cotton rock and cherty, reddish colored Jefferson City limestone. The boulders are roundish and angular, and some have a diameter of three or four feet. The cotton rock boulders are the largest, and slabs of this rock two to four feet long and eight to ten inches thick are common. The matrix is a grayish white dolomitic limestone which is not readily soluble in hydrochloric acid. No Burlington or Chouteau boulders were observed, although some of the fragments resemble the more crystalline phase of the Choureau.

Another exposure of this conglomerate occurs in sec. 21, T. 46 N., R. 15 W., near the line between secs. 21 and 28. The underlying formation is Jefferson City limestone, the beds of which are horizontal, except at the very edge of the conglomerate, toward which they dip at both ends of the outcrop. The boulders are similar to those in the above described exposure, and consist of massive dolomite and cotton rock of the Jefferson City formation, embedded in a sandy limestone matrix. The conglomerate is twenty feet thick.

In the S. W. ¼ of sec. 3, T. 45 N., R. 14 W., this conglomerate overlies the Jefferson City formation, under the same conditions as at the other exposures. The beds of Jefferson City limestone dip toward the conglomerate, which is composed of pebbles, boulders and slabs of cotton rock and dolomite. This exposure is fifteen feet thick.

AGE.

Ball and Smith* observed this cave-conglomerate in Miller county, where it contained fragments of Burlington limestone and chert. For this reason they considered it to be of post-Burlington age. In Moniteau county no Burlington limestone or chert was found in the formation. For this reason it is regarded as post-Ordovician. It may have been formed either before the Burlington was laid down, or after it had been removed by erosion.

ORIGIN.

The dipping of the beds of Jefferson City limestone toward the conglomerate points to a sink-hole or cave origin. The boulders consist of

*Ball and Smith, Geol. of Miller County, p. 92.

cotton rock and pitted dolomite, some rounded and others angular. Slabs of both kinds of rock are present and the whole formation has the appearance of having resulted from the action of surface waters draining into a sink-hole.

RELATIONS TO OTHER FORMATIONS.

This formation was found in contact only with the Jefferson City formation, which it overlies unconformably.

(B) GRAYDON SANDSTONE.

AREAL DISTRIBUTION.

The known exposures of the Graydon sandstone are confined entirely to isolated outcrops in that part of the county which is underlain by Burlington and Chouteau limestones, and to a few exposures in the southern part of the county in which are found fragments of Burlington limestone and chert.

LITHOLOGIC CHARACTERS.

This sandstone is made up, usually, of fine quartz grains, although in places the individuals are medium to coarse grained. In color it varies from an almost pure white to a reddish brown, depending upon the amount of iron oxide present. In a few places there is a conglomerate at the base which carries pebbles of Burlington limestone and chert. This conglomerate occurs in the N. E. ¼ of sec. 31, T. 43 N., R. 14 W.; the N. E. ¼ of the S. W. ¼ of sec. 18, T. 43 N., R. 14 W., and sec. 9, T. 44 N., R. 17 W.

THICKNESS.

The thickness varies with each exposure, ranging from two feet in the N. E. ¼ of the S. W. ¼ of sec. 18, T. 43 N., R. 14 W. to seventy feet at the Brady diggings, in the S. W. ¼ of the S. W. ¼ of sec. 7, T. 44 N., R. 15 W. At the last locality there is a shaft that, when examined, had gone through forty-five feet. Since then the shaft has been sunk to a depth of seventy feet, and it is reported to be still in sandstone.

WEATHERING.

This sandstone always weathers to a reddish brown color, due to the iron content. The outcrops usually take the form of irregular or roundish domes slightly above the general level of the country.

STRUCTURES.

No well developed system of joints could be made out, although, in places, polygonal blocks occur at the surface.

No cross-bedding, as described by Shepard,* was observed in this sandstone, nor is the formation distinctly bedded.

Faulting was not observed.

ECONOMIC.

The soft, friable character of this sandstone makes it well adapted for mortar, for which it is used locally. It contains too much iron to make it a valuable glass sand.

RELATIONS TO OTHER FORMATIONS.

The Graydon sandstons overlies, unconformably, the Burlington and Chouteau limestones, and, at least at one place, the Coal Measure shales. Undoubtedly some of the Graydon is unconformably above the Jefferson City formation, but it is impossible to distinguish it from the St. Peters sandstone in the absence of fossils or fragments of Burlington limestone.

TYPICAL EXPOSURES.

In the N. E. ¼ of sec. 31, T. 43 N., R. 14 W., there is a mass of Graydon sandstone which apparently overlies the Burlington limestone. The contact was not seen, but the sandstone contains boulders of rounded Burlington flint.

In the N. E. ¼ of the S. W. ¼ of sec. 18, T. 43 N., R. 14 W., on Mr. A. B. Hunsacker's land, there is an exposure of sandstone which rises two feet above the field. It evidently is about fifty feet in diameter, as shown by the sandy character of the surface soil. One piece of Burlington flint was found in this sandstone, while Burlington flint and sand are intermingled in the soil near the outcrop. One well developed vertical joint striking N. 55° E. was noted.

Another interesting exposure of Graydon sandstone occurs in the S. E. ¼ of the N. W. ¼ of sec. 18, T. 43 N., R. 13 W., in the bed of a stream. At the south end beds of red ferruginous sandstone from six inches to one foot in thickness are interstratified with six inch layers of arenaceous greenish and white shale which pass gradually into sandstone. A short distance north and underlying the sandstone, there is a conglomerate containing chert fragments. In one place it grades into a shale, which in turn passes into sandstone which makes up a greater part of the exposure. This sandstone abuts against Carboniferous shale in which was found a pebble of Burlington flint and crystals of marcasite. The actual contact is occupied by a one-half inch layer of iron pyrite having the structure of the sandstone. There may be a fault at this place, al-

*Geol. of Greene county, Mo. Geol. Surv., Vol. XII, p. 128.

though, at one place, near the contact, the shale is arenaceous. This shale continues for about four feet and then abuts against a yellowish, very fine grained, arenaceous shale, the relations to which could not be made out. It is much jointed and the thickness could not be determined. Along the contact with the Carboniferous shale are nodules of iron pyrite having their longest axes parallel to the contact plane. The shale is much slickensided, indicating that there may be a fault. The pyrite nodules have no definite outlines.

In the north center of sec. 9, T. 44 N., R. 17 W., there is an exposure of Carboniferous shale, overlain with Carboniferous sandstone. This sandstone contains fragments of the shale. The contact between the two is sharp, although in one place there was some clay in the matrix of the sandstone. This, however, might be due to the subsequent action of percolating waters.

GENERAL.

The field work tends to the belief that much, if not the greater part, of the sandstone which occurs in isolated outcrops over the county belongs to the St. Peters, rather than to the Graydon formation. The areal distribution of the sandstone supports this belief. The northern and western parts of the county, comprising about eighty square miles, or one-fifth the total area, are entirely underlain by Carboniferous rocks. Over this area only sixteen exposures of sandstone were noted, while over the remaining three hundred and thirty square miles of the county, underlain by Jefferson City limestone, three hundred and sixty exposures were mapped. In other words, the area underlain by Carboniferous rocks, one-fifth of the county, contains about five per cent of the exposures of sandstone, as compared with ninety-five per cent for the other four-fifths of the county underlain chiefly with Jefferson City limestone. Per unit of area there are four exposures in the Jefferson City limestone area to one in the Carboniferous.

(C) COAL MEASURE SHALE AND COAL.

AREAL DISTRIBUTION.

About fifty distinct and separate areas of Coal Measure shale and coal occur in this county. The greater number are in the southern and western parts, and nearly all of them are closely associated with the Burlington limestone. A few areas were observed which were distant from any known outcrop of Burlington limestone. The shale areas are all small, and occur at different elevations, having no regard for the topography.

TOPOGRAPHY.

Occurring as they do, these small isolated areas of shale have very little effect upon the topography of the country.

THICKNESS.

The thickest known deposit of shale in the county is the one in which the shaft of the Newkirk Mining Company, in sec. 12, T. 44 N., R. 17 W., is located. This shale, as shown by the shaft, is one hundred and ten feet thick. The cribbing in the shaft prevented an examination, but it is reported that the shale continues from the surface of the ground to a depth of one hundred and ten feet.

A shaft on land owned by the Monarch Coal and Mineral Company passes through eighty feet of shale.

The pockety nature of the Coal Measure shale in this county and the isolated character of the deposits make it impossible to estimate, even approximately, the original thickness of the formation.

WEATHERING.

The black shales, upon exposure to the atmosphere, weather to a dark brownish color, and quickly disintegrate. The light colored shales take on a greenish white tint.

LITHOLOGIC CHARACTERS.

The Coal Measure shale varies from a grayish colored impure kaolin to one in which there is sufficient carbonaceous matter to constitute a fairly good cannel coal. In some places the shale is quite arenaceous, grading into sandstone, while in other places it is very calcareous. The color of the shale ranges from a light gray, through dark green, to black, several different tints often occurring in the same exposure.

In places the shale is conglomeritic, containing pebbles of the underlying formations. At the bottom of the Newkirk shaft the shale contains pebbles from the Jefferson City formation, as well as from the Chouteau and Burlington limestones.

At numerous places the shale is sufficiently carbonaceous to be considered a cannel coal. At several localities this cannel coal is now being mined.

STRUCTURE.

Bedding.—The bedding in the Coal Measure shale is sometimes well developed and at other times it cannot be made out. Stratification planes are fairly well developed in the outcrop along the railroad track in sec.

31, T. 43 N., R. 14 W. In sec. 24, T. 43 N., R. 15 W., beds of striped drab and white shale occur.

Folding and Faulting.—This shale has undoubtedly been folded and faulted in many places. Steep dips are frequent and where it is lying against the rock of another formation, it is often very much slickensided. In the cannel coal pockets slickensides are very common. However, the amount of movement could, in no case, be determined.

ECONOMIC.

Coal.—Where the carbonaceous material has been present in sufficient quantity, a fair quality of cannel coal has been formed. Several deposits of this coal are being worked, the output being used for local consumption.

Lead and Zinc.—Galena and zinc blende are always present in and near the coal pockets, chiefly in sheets along the bedding and jointing planes. In some cases these minerals occur in sufficient quantity to pay the expenses of mining the coal.

Barite and Iron Pyrite are both of common occurrence, but neither has been found in commercial quantities.

RELATIONS TO OTHER FORMATIONS.

The Coal Measure shale unconformably overlies the Jefferson City formation, the Mississippian limestone and the Graydon sandstone.

From the fact that the shale occurs in pockets and that the other formations occur at the same level and usually dipping toward the shale, it is thought that the shale pockets are cave or sink hole deposits.

TYPICAL EXPOSURES.

Newkirk Mine.—This mine is located in the N. W. ¼ of the S. E. ¼ of sec. 12, T. 44 N., R. 17 W. The deposit is completely enclosed in Jefferson City limestone, beds of which occur at the surface. The strata passed through in sinking the shaft could not be examined on account of the cribbing, but Mr. W. M. Kope, Superintendent of the mine, says that coal was first encountered at a depth of 45 feet. At 110 feet two drifts have been cut out, one to the north and another to the south. From these a thickness of thirty feet of coal has been mined. The coal pitches in all directions and is well jointed. Slickensided surfaces are common.

Just north of the bottom of the shaft there are seven feet of bluish shale which forms an anticline in the coal. This could not be traced to the east and pinches out to the north and south, within a few feet. Pockets of bluish drab shale from one to eight feet in diameter are plentiful in the coal. At the bottom of the shaft the shale is conglomeritic, and contains pebbles of Chouteau and Burlington limestone and Jefferson City cotton rock and chert.

On the surface, about one hundred and seventy-five feet northeast of the shaft, the Jefferson City formation is exposed in the creek bank. On the east side the beds are practically horizontal, but on the west side they dip rather sharply west at an angle of 10°. Just west of this exposure a drill hole penetrated coal at a depth of forty-five feet. One hundred and ten feet southeast of the shaft another drill hole entered coal at a depth of forty-five feet. A third hole, two hundred feet east of the shaft and across the creek, did not penetrate the coal.

This deposit of coal is probably about two hundred and eighty-five feet long by one hundred feet wide. The coal is all of the cannel variety. It is of fair quality, although it has a considerable percentage of ash.

Plate VI is a photograph of the Newkirk mine. The following is a section of the shaft at this property as given by Mr. Kope:

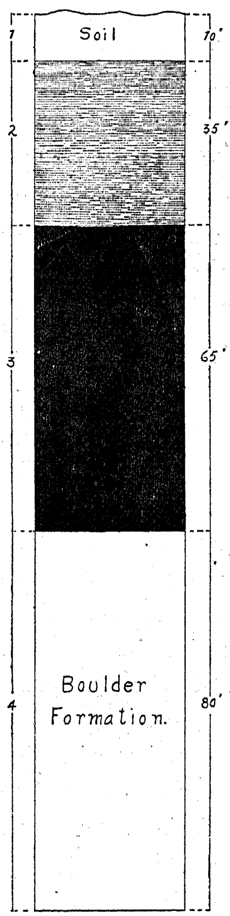


FIG. 19.

Section No. 18, Fig. 19.

No.	Elev.	
1	0-10	Ten feet of SOIL.
2	10-45	Thirty-five feet of variously colored SHALE and argillaceous limestone.
3	45-110	Sixty-five feet of CANNEL COAL.
4	110-190	Eighty feet of SHALE with boulders of limestone.

THE NEWKIRK MINE, NEAR FORTUNA, MO.

THE NEWKIRK MINE, NEAR FORTUNA, MO.

Monarch Coal & Mineral Company's Mine.—The pocket of shale and coal, in which this mine occurs, is located a little southwest of the center of sec. 15, T. 43 N., R. 16 W. The coal has been mined by the strip pit method. The coal in the open cut dips 45° S. 22° E. Mr. T. L. Hite, Superintendent of the property, reports that in a tunnel driven south one hundred and forty feet from a ninety foot shaft at the east end of the open cut, the coal becomes flat lying. He says that this tunnel is all in coal.

The north slope of open cut is covered mainly with talus, only a few beds of the Jefferson City limestone, dipping gently toward the coal, being observed. At the east end of the cut there is an outcrop of Burlington limestone dipping 45° N 80° E. A short distance north of this, however, horizontally bedded Jefferson City limestone occurs.

This shale pocket is probably three hundred feet long by two hundred feet in width. Most of the coal is of the cannel variety, there being only five feet of poor quality bituminous coal at the top.

Plate VII is a photograph of the open cut.

The following is a section showing the beds at this place:

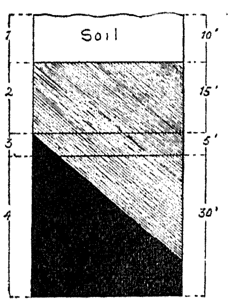


FIG. 20.

Section No. 19, Fig. 20.

No.	Elev.	
1	0-10	Ten feet of SOIL.
2	10-25	Fifteen feet of blue and black SHALE.
3	25-30	Five feet poor grade BITUMINOUS COAL.
4	30-60	Thirty feet CANNEL COAL.

Mr. Hite says that the shaft at the east end of the open cut is ninety feet deep, and that the bottom is in coal. This being the case, the shale pocket must be at least ninety feet thick.

Kellar's prospect.—About three-quarters of a mile S. 20°E. from the Newkirk property, in the N. E. ¼ of sec. 22, T. 43 N., R. 16 W., there is a shale and coal pocket through which Mr. Charles P. Kellar has sunk two shafts. One shaft which is eighty feet deep, is just east of a large Burlington limestone bluff. In this shaft boulders of Burlington limestone and some bituminous shale were found. The second shaft, which is just northeast of the first, is sixty feet deep. The uppermost twenty feet passed through soil containing boulders of Burlington flint and limestone. Underneath this the shaft passed through a six-foot bed of bituminous coal, dipping 40° N. 80° E.; twenty-four feet of alternating thin beds of bituminous shale and coal; and seven and one-half feet of coal pitching in the same direction as the bed of bituminous coal above.

This shale pocket is probably two hundred feet in diameter.

Rohrbach-Bowlin Mining Company's prospect.—This prospect is located in the S. ½ of the S. E. ¼ of sec. 23, T. 45 N., R. 15 W. A shaft fifty feet deep has been sunk into Coal Measure shale. The following is a section from top to bottom:

Section No. 20.

1. 15 feet blue clay.
2. 10 feet bituminous shale.
3. 10-15 feet cannel coal.
4. 10 feet poor grade bituminous coal.
5. Bottom of sandy limestone with thin veins of lead.

The coal in this deposit air slacks badly and has a high percentage of ash.

This pocket is about one hundred and twenty-five feet long, eighty feet wide, and fifty feet in thickness.

RÉSUMÉ.

The Coal Measure rocks were deposited on the uneven surface of the pre-Coal Measure formations. After the deposition of the Mississippian or Lower Carboniferous, the region was elevated above the sea, and a period of erosion was inaugurated. This erosion interval was probably of long duration, since the Mississippian rocks during this period were almost completely removed from the south half of the county. At least it was of sufficient duration for the formation of sink holes and caves in which the Coal Measures were deposited.

Finally, however, the land was gradually submerged. Ball and Smith* believe that at this time "Miller county seems to have been on the coast, being alternately above and below the sea," and that at this time boulders from the Burlington and Jefferson City formations were washed into sink holes in the rocks, thus forming the Saline creek cave-conglomerate. The conditions which held for Miller county would obtain equally well for Moniteau, its northern neighbor. The occurrence of the conglomerate seems to substantiate this theory.

After the entire submergence of the land area, the Graydon sandstone and the other Coal Measure formations were laid down.

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*Geology of Miller county, by Ball and Smith, Mo. Geol. Surv., Vol. I, 2nd Ser., p. 116.

MONARCH COAL AND MINERAL COMPANY'S COAL BANK.

MONARCH COAL AND MINERAL COMPANY'S COAL BANK.

CHAPTER VI.

MESOZOIC AND CENOZOIC.

Rocks of Mesozoic age do not occur in Moniteau county. During Cenozoic time we have evidences of deposition only during the glacial period known as the Pleistocene and the Recent period.

(A) PLEISTOCENE.

Glacial Age.—Glacial boulders were found at nine different localities in the valleys tributary to the Missouri river. These are all igneous rocks, consisting of coarse and fine grained granite, granite gneiss and diorite. The following are the localities at which these boulders occur:

In the N. W. ¼ of the N. W. ¼ of sec. 9, T. 47 N., R. 14 W., there is a large granite boulder, partly buried in the soil. The owner of the land on which this occurs states that he has seen seven feet of the granite exposed. This boulder is about forty feet above low water level of the Missouri river.

Two well rounded, water-worn granite boulders were observed in sec. 19, T. 46 N., R. 14 W. Each of these is about twelve inches in diameter. One is forty and the other fifty feet above low water level of the Missouri river.

In sec. 21, T. 46 N., R. 14 W., there is a small water worn boulder twelve inches in diameter. It is fifty feet above low water level of the Missouri river.

Another granite boulder 2½x2½x1 feet occurs in the N. E. ¼ of sec. 21, T. 46 N., R. 15 W. This boulder is sub-angular in shape and slightly polished. It is fifty feet above low water level of the Missouri river.

A boulder of granite occurs in the S. W. ¼ and another in the N. W. ¼ of sec. 27, T. 46 N., R. 14 W. These measure about 2′ x 1′ x 1′ They are forty and fifty feet, respectively, above low water level of the Missouri river.

Another granite boulder was found in the S. W. ¼ of the N. W. ¼ of sec. 25, T. 46 N., R. 15 W.

In the S. E. ¼ of the N. W. ¼ of sec 13, T. 46 N., R. 14 W., a pebble of diorite, six inches in diameter, was found.

None of the boulders are at a higher elevation than fifty feet above low water level of the Missouri river. There are no outcrops of igneous rocks in the drainage area of the streams along which these boulders occur, and the natural conclusion is that they must have reached their present location by transportation from the north at the time of one of the glacial epochs. The nearest outcrops of igneous rocks, of the various kinds represented by these boulders, occur in Minnesota and Wisconsin. There are igneous rocks in southeastern Missouri, but one cannot find the varieties represented by these boulders. The ice sheets of the glacial epochs did not reach as far south as Moniteau county, and it is highly probable that these erratics were carried on floating ice, by the backwater, up the estuaries of the streams tributary to the Missouri river and there deposited. The Missouri river must have been much higher at that time than at present, in order to account for the present elevation at which the boulders are found.

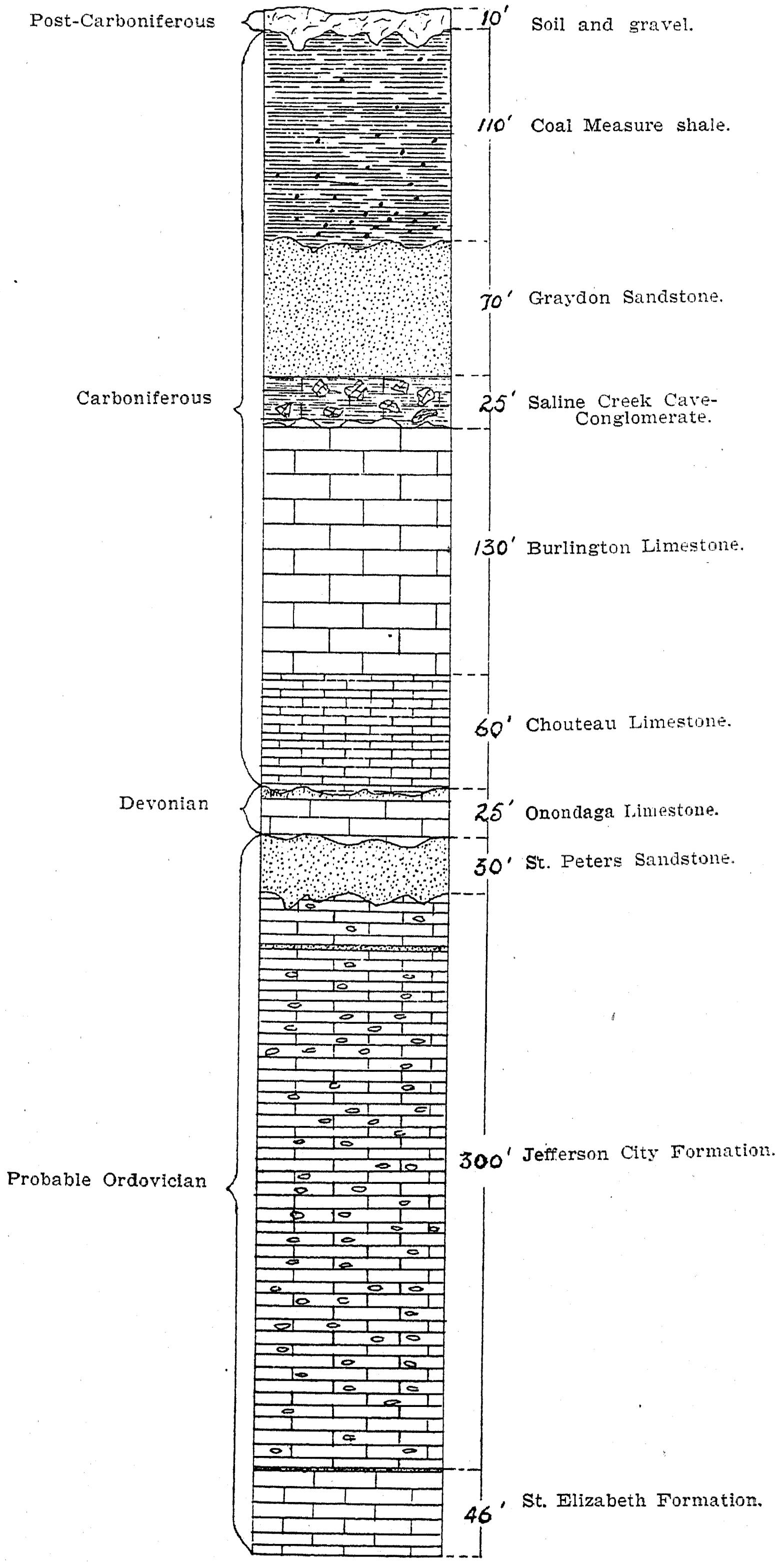
(B) RECENT.

The river alluvium is confined to the Missouri river and the lower reaches of its larger tributaries. The bottom land of the Missouri river is composed of a sandy, clayey soil of considerable depth. Away from the river, along the tributary valleys the soil is a very rich, dark loam, well adapted to agriculture.

TRAVERTINE.

Deposits of travertine occur wherever under-ground water issues from the bluffs along the Missouri river. Stalactites and stalagmites are abundant in the caves of the region. Bruce's cave, in the N. E. ¼ of sec. 36, T. 48 N., R. 15 W., is lined with travertine, and stalactites and stalagmites of large size are numerous.

GENERALIZED SECTION OF THE FORMATIONS IN MONITEAU COUNTY.



CHAPTER VII.

STRUCTURE.

Folding.—Moniteau county is located on the northern slope of the great qua-quaversal dome of southeastern Missouri. The general dip of the strata is toward the northeast. Just over the Moniteau-Morgan county line, in Morgan county, the Jefferson City formation has a gentle dip to the west or southwest, while the same formation in Moniteau county dips in the opposite direction. The Burlington limestone, which is the surface rock, dips to the northeast.

Numerous gentle folds and flexures are superimposed upon the northeastward dipping strata. However, these folds are so very gentle that the dips of the limbs cannot be accurately measured. Except along the Missouri river bluffs, where the exposures are sufficiently extensive to permit of actual measurement, the minor folds can be made out only by comparing the elevations of the different outcrops.

Cross folds occur at right angles. The limbs are approximately of the same length and usually dip at about the same angle.

Faulting.—The faults in this county are small. Those which were noted are all gravity or tension faults.

In the N. E. ¼ of sec. 31, T. 43 N., R. 14 W., along the railroad track, northeast of Enon, four faults having a throw of fifteen to twenty feet were observed. However, they could not be followed on account of the absence of exposures. They are described on a following page. page.

In the S. E. ¼ of sec. 26, T. 47 N., R. 14 W., a block of Burlington limestone has been faulted about twenty feet into the Chouteau.

At several localities series of step faults of small size were observed. These occur chiefly in the Jefferson City limestone.

Jointing.—The joints in the different formations are all practically vertical, with the exception of those in the cotton rock of the Jefferson City formation. In many places the joints are curved, causing the rock to weather with roundish surfaces.

The average strike of the joints in the different formations, determined from a great number of observations, is as follows:

The St. Elizabeth.—This formation is not exposed over a sufficient area to enable one to determine any system of joints.

Jefferson City.—Four sets of joints are common to this formation. The major sets strike N. 27° W. and N. 65° E., and the minor ones N. 25° E. and N. 75° W.

St. Peters Sandstone.—Each exposure of the St. Peters sandstone has its own system of joints. The strike of these joints varies in the different outcrops.

Onondaga.—The few readings taken seem to indicate two sets of joints, one striking N. and S. and the other N. 70° E.

Chouteau Limestone.—A large number of observations show four sets of joints, the major set striking N. 24° W. and N. 64° E. and the minor N. 19° E. and N. 70° W.

Burlington.—Four sets of joints were noted in this formation. The major joints strike N. 25° W. and N. 60° E., and the minor N. and S. and E. and W.

Unconformities.—There are distinct unconformities between the St. Peters sandstone and the Jefferson City formation; between the Onondaga limestone and the St. Peters sandstone and Jefferson City formation; between the Chouteau limestone and the Onondaga limestone, St. Peters sandstone and Jefferson City formation; between the Burlington limestone and the Chouteau limestone and Jefferson City formation; between the Saline creek cave-conglomerate and the Jefferson City formation; between the Coal Measure shale and the Burlington limestone and Jefferson City formation; and between the Graydon sandstone and the Burlington limestone and Jefferson City formation.

St. Peters sandstone-Jefferson City formation unconformity.—The chief evidences of the unconformity between these formations are (1) the occurrence of the sandstone at different elevations overlying the limestone, and (2) the conglomerate at its base. In a ravine near the road, in the N. W. ¼ of sec. 11, T. 46 N., R. 14 W., there are several exposures of St. Peters sandstone overlying the uneven surface of the Jefferson City formation. Some of this sandstone contains fragments of the limestone. The elevation at this place is 585 feet A. T. In secs. 21, 23 and 24, T. 45 N., R. 15 W., the same sandstone occurs at an elevation of over 900 feet. Since this difference in elevation cannot be accounted for by folding subsequent to deposition, we must conclude that the sandstone was laid down upon a very uneven floor.

Onondaga limestone-St Peters sandstone and Jefferson City formation unconformity.—The unconformity between these formations is shown (1) by the difference in the faunas, (2) by a conglomerate at the base of the Onondaga, and (3) by the fact that the Onondaga overlies both the Jefferson City formation and the St. Peters sandstone.

On a hillside, in the S. E. ¼ of sec. 13, T. 46 N., R. 14 W., a twelve-foot ledge of soft, white friable St. Peters sandstone is exposed.

From the base of this sandstone to the bottom of the valley the slope is covered with talus. In sharp contact with this sandstone, and overlying it, is a ten-foot ledge of Onondaga limestone. There is no gradation between these formations.

In at least one place the Onondaga grades into an almost pure quartzose sandstone, but the gradation at this point is horizontal. The fact that in the former place the limestone overlies the sandstone, without gradation, leads to the belief that the underlying formation is the St. Peters sandstone.

In the N. E. ¼ of the same section, about seven feet of Onondaga limestone is exposed at the surface. The bottom two feet is conglomeritic, containing roundish pebbles of Jefferson City chert and limestone.

Chouteau limestone, Onondaga limestone, St. Peters sandstone and Jefferson City formation, unconformity.—The Chouteau limestone occurs in direct contract with the Onondaga limestone and St. Peters sandstone. The unconformity is shown by (1) a basal conglomerate, (2) fossils and (3) general field relations.

In sec. 11, T. 45 N., R. 15 W., the St. Peters sandstone is exposed underneath the Chouteau limestone. The top four feet of the sandstone contains pebbles of Jefferson City chert and limestone and may be said to be conglomeritic. Above this occur the thin beds of Chouteau limestone. Evidently, at this place, during the Ordovician-Carboniferous erosion interval, the sandstone was protected, while the surrounding rocks were eroded away. When the land was again submerged, pebbles from the Jefferson City formation were washed in and deposited above the sandstone.

The exact contact of the Chouteau with the Jefferson City formation was not observed, but beds belonging to each occur within two or three feet of each other.

Burlington-Chouteau limestone and Jefferson City formation unconformity.—This unconformity is indicated by fossils and general field relations. The Burlington everywhere overlies the Jefferson City formation and dips toward it at all angles. In places, in the northern part of the county, there is a perfect gradation between the Burlington and Chouteau limestones, while at other places the two are separated by a layer of sandy shale from six to twelve inches in thickness. The gradation is well shown in sec. 26, T. 47 N., R. 14 W. (See plate V.) The layer of sandy shale is best exhibited in sec. 31, T. 48 N., R. 14 W. (See plate IV.) The chief evidence of unconformity is in the fossil content.

Saline Creek cave-conglomerate-Jefferson City formation unconformity.—The Saline Creek cave-conglomerate occurs filling sink holes or caves in the Jefferson City formation.

Coal Measure shale-Burlington and Jefferson City formations unconformity.—The evidences of this unconformity are (1) the conglomerate at the base of the Coal Measures, (2) discordance in bedding, (3) fossils and (4) general field relations.

The bottom of the shaft of the Newkirk mine is in a conglomerate made up of boulders of Chouteau and Jefferson City limestone, embedded in a matrix of shale. Near the shaft, at the surface, the Jefferson City limestone is exposed in approximately horizontal beds.

The Coal Measure shale usually dips steeply in many directions, while the surrounding rocks are practically horizontal.

Graydon sandstone-Burlington limestone and Jefferson City formation unconformity.—This unconformity is shown by a basal conglomerate containing pebbles of the Burlington limestone and chert, and by the general field relations. Pebbles of Burlington limestone occur in the sandstone in the N. E. ¼ of sec. 31, T. 43 N., R. 14 W.; in the N. E. ¼ of the S. E. ¼ of sec. 18, T. 43 N., R. 14 W., and in sec. 9, T. 44 N., R. 17 W. In sec. 31, R. 14 W., the sandstone fills crevices in the Jefferson City and Burlington limestones.

CHAPTER VIII.

ECONOMIC CONSIDERATIONS.

The mineral resources of Moniteau county are: Barite, building stone, clay, coal, quicklime, lead, zinc and sand. Iron ore occurs in places, but not in large enough bodies to be of commercial value.

BARITE ("Tiff" or "ball tiff").

Very little barite has been mined in this county. It occurs in the surface clay and in crevices and cavities in the Graydon sandstone, Burlington limestone and Jefferson City limestone.

It is usually associated with galena, blende and calcite, although in some cases these minerals are absent. Pyrite, limonite and occasionally chalcopyrite are also associated with the barite.

In the N. W. ¼ of sec. 33, T. 43 N., R. 15 W., in the Jefferson City formation, there is a prospect from which 1,000 pounds of barite has been mined. At this place the barite is associated with blende, calcite and chalcopyrite. Some of the barite occurs in crystals coating the calcite. The barite carries inclusions of crystallized blende and contains cavities from which blende apparently has been leached.

From land owned by J. C. Monroe, near a branch in the S. W. ¼ of sec. 17, T. 43 N., R. 14 W., some barite has been mined. This barite is colored with limonite, an alteration product of pyrite, and occurs in the residual clay of the Jefferson City formation.

In the N. E. ¼ of the N. E. ¼ of sec. 35, T. 46 N., R. 15 W., there is a bank of residual clay containing barite. It is reported that one hundred cars have been shipped from this place. The mining is carried on intermittently by the farmers, chiefly during the winter months.

BUILDING STONE.

There are a number of small quarries in this county from which building stone is obtained. Stone, suitable for foundations and other rough masonry constructions, is easily obtainable. The Jefferson City formation contains two good stones for building purposes—cotton rock, a rather soft cream colored stone, which is easily quarried, and pitted dolomite, a rough hackly stone, which is more difficult to work. The beds of cotton rock are usually from six to ten inches in thickness, and the joints are close enough to make quarrying easy.

The pitted dolomite is very well suited for heavy masonry, and is used locally for foundations and culverts.

The stone from the upper, buff colored beds of the Chouteau gives every evidence of being very durable. It is moderately soft when first quarried, but becomes harder upon exposure to the atmosphere. It with stands weathering remarkably well. This stone has been quarried to a very limited extent, having been used only locally for foundations.

The Burlington limestone is a strong, durable stone and is considered the most desirable for buildings of any in the county. There is a great thickness of this formation in the northern part of the county, from which an almost inexhaustible supply of good building stone might be obtained. The thickness of the formation, the ease with which it may be quarried, and its comparative freedom from chert make it worthy of more extensive exploitation.

CEMENT.

Cement is not manufactured in Moniteau county. The Jefferson City and Chouteau limestones contain too high a percentage of magnesium for the manufacture of hydraulic cement. The Burlington limestone is sufficiently pure to furnish the calcium carbonate required in the manufacture of Portland cement, but it is valueless for this purpose because there is no suitable deposit of shale in close proximity.

CLAY.

The clays in this county are mainly residual, chiefly from the Jefferson City formation and the Coal Measure shale.

The clay resulting from the decomposition of the Jefferson City formation usually has a red, yellowish or buff color and is used for making brick. In some places it has a bluish color and is quite plastic.

A half a mile northwest of High Point a shaft has been sunk through 40 feet of grayish white shale which has a considerable degree of plasticity.

In sec. 13, T. 44 N., R. 17 W., there is a deposit of very pure white plastic clay, which might be used for pottery.

Near the Monarch Coal and Mineral Company's coal bank there is a bluish white plastic clay.

COAL.

The coal in Moniteau county occurs in pockets, and not in the form of regular seams underlying any considerable portion of the area. It is thought that none of these pockets are large enough to warrant either the building of spurs from the railroads or the installation of modern machinery. There is an abundance of coal for local use for a number of years, but not enough to ship extensively.

Meek,* writing in 1855, cautioned the people against over-estimating the extent of these coal pockets. He says: "This highly important mineral has been found in various parts of the county, and, doubtless, exists in sufficient quantities for the supply of all ordinary home consumption for a long time to come. It is, nevertheless, a matter of some importance to the people of the county that the nature of the coal beds so frequently met with here, and their relations to the other formations of the county, should be rightly understood; as every one must know, over-estimates of the value and extent of mineral deposits have been more frequently the cause of loss to those interested than anything else connected with mining operations.

Most observing persons who have frequented coal regions are aware of the fact that beds of coal which crop out in valleys, and along slopes, where there are no considerable disturbances of the strata, usually extend horizontally beneath large areas of country. As general, however, as this law is, it is by no means applicable to the district under consideration; for instead of being spread out in continuous beds as is usually the case, the coal of this county is found in widely separated masses, which, although often of great thickness, are always very limited in their horizontal extent, being in every instance confined to shallow depressions in the lower Carboniferous, and even lower Silurian rocks. It is manifest these depressions must have been worn in the older rocks previous to the deposition of the Coal Measures; though, in many instances, they appear to have been subsequently widened and deepened, in such a manner as to partly undermine the coal, and cause it to fall or slide from its original horizontal position."

The Monarch Coal and Mineral Company.—This company owns and operates a coal mine in sec. 15, T. 43 N., R. 16 W. This mine is located on what was formerly known as the "Simpson Coal Bank." It was discovered by Mrs. Simpson in 1860, and was worked by farmers in that neighborhood until purchased by the present company. The company is planning to build a railroad spur seven and three-fourths

*Mo. Geol. Surv., Ann. Repts., I and II, p. 112.

miles long to connect with the Chicago, Rock Island and Pacific railroad.

The Newkirk Mining Co.—The mine operated by this company is located in sec. 12, T. 44 N., R. 17 W. It was discovered in 1902. It is being worked at present chiefly to supply the Gundling mine and other local consumers with coal. When visited the stock pile contained about one thousand tons of cannel coal.

The Rohrbach-Bowlin Mining Company.—This company is working a coal pocket in the S ½ of the S. E. ¼ of sec. 23, T. 45 N., R. 15 W.

The coal is mostly the cannel variety, although some is a poor quality of bituminous. The pocket is 125 to 150 feet long, 80 feet wide and 40 feet thick.

Miscellaneous.—In sec. 1, T. 46 N., R. 15 W., there is a coal pocket which has been mined since before the war. It is located in a small ravine near a branch of Howard's creek, and is underlain with Burlington limestone. The structure of this pocket could not be determined. It is a fair quality of bituminous coal, but the pocket has been nearly worked out. Meek* describes this coal deposit as being about eight feet thick and dipping into the side of the hill. He says "There can be no doubt that this coal is an outlier that has slidden down from a higher position, in consequence of some undermining process, connected with the denudation of the country." The coal has been used by the local blacksmiths and farmers.

Other coal deposits are located as follows:

S. W. ¼ of sec. 6, T. 44 N., R. 14 W.
S. W. ¼ of sec. 14, T. 45 N., R. 14 W.
S. W. ¼ of sec. 8, T. 45 N., R. 15 W.
S. E. ¼ of sec. 11, T. 45 N., R. 15 W.
On line between N. E. ¼ and S. E. ¼ of sec. 31, T. 46 N., R. 15 W.
S. W. ¼ of sec. 5, T. 43 N., R. 16 W.
On line between N. E. ¼ and S. E. ¼ of sec. 15, T. 43 N., R. 16 W.
On line between N. E. ¼ and N. W. ¼ of sec. 24, T. 43 N., R. 16 W.
S. E. ¼ of S. W. ¼ of sec. 1, T. 44 N., R. 17 W.
S. W. ¼ of S. E. ¼ of sec. 12, T. 44 N., R. 17 W.
S. E. ¼ of sec. 26, T. 45 N., R. 17 W., along Willow Fork of the Moreau.

All these deposits have been nearly, if not quite, worked out. In most cases a very much decomposed dump pile is all that remains.

Most of the coal in this county is of the cannel variety and is usually associated with a poor grade of bituminous coal. In all of the mines the coal is very much jointed, and for this reason it usually breaks into small pieces when mined. Most of it air slacks considerably.

Although usually forming considerable ash when burned, it is a good steam coal and is used at many of the mines.

*Mo. Geol. Survey, Ann. Repts., I and II, p. 112.

GOLD AND SILVER.

Thus far gold and silver have not been discovered in any form in this county and the presumption is strongly against their occurrence. Often people are deceived by iron pyrites, taking it to be gold ore on account of its yellow color.

IRON.

No workable deposits of iron ore were noted. The only iron ore observed was limonite, which occurs on the surface of the St. Peters and Carboniferous sandstones, and pyrite which is associated with the lead and zinc ores and the coal deposits.

QUICKLIME.

The Burlington limestone in the northern half of the county is very suitable for the manufacture of quicklime. It burns to a good white color and is strong. At almost every exposure of this limestone in the southern part of the county a rude kiln has been built by the farmers to burn lime for local use.

Along the Boonville branch of the Missouri Pacific railroad, northwest from sec. 26, T. 47 N., R. 14 W., this limestone is exposed in a thickness ranging from 10 to 130 feet. It is comparatively free from chert.

The pure character of the limestone, and its proximity to the railroad, should make this part of the county a good locality for the erection of a modern plant for the manufacture of quicklime. Such a plant, however, would have to compete with the lime manufacturers of Boonville, twenty miles from Moniteau county.

LEAD AND ZINC.

Monteau county is in the northern part of what is known as the Central Lead and Zinc Mining District of Missouri. The principal mines are in the southwestern part of the county, in the vicinity of Fortuna, from which town the area has derived its name. The Fortuna area includes portions of Moniteau and Morgan counties. Mines and prospects occur in other parts of the county, but this area, although new, has been the greatest producer.

History.—The first lead discovered and mined in this county was at High Point, in sec. 17, T. 43 N., R. 15 W. A mine was opened at this place in 1841. In 1855 Meek* describes lead diggings or mines in sec. 24, T. 47 N., R. 15 W., near a small branch of Howard's creek; in sec.

*Meek, 1st and 2nd Am. Repts., 1855, pp. 116-119.

24, T. 46 N., R. 15 W.; in sec. 5, T. 45 N., R. 14 W.; in sec. 17, T. 45 N., R. 14 W.; in sec. 10, T. 45 N., R. 15 W., (Mineral Point diggings); in sec. 33, T. 44 N., R. 15 W., near Burrows Fork of the Moreau; in sec. 12, T. 44 N., R. 17 W., in the bed of Straight Fork of the Moreau; in sec. 3, T. 43 N., R. 16 W., on a small branch of Burrows Fork; and at High Point.

During the war, mining operations in Moniteau county were evidently suspended, but in 1872 the Eanes diggings, in sec. 32, T. 44 N., R. 14 W., were discovered, and in 1873 the Mineral Point diggings were reopened. Shortly after this the Baty diggings, in sec. 4, T. 45 N., R. 15 W., were discovered, and in 1874 the Reed diggings, in sec. 12, T. 45 N., R. 15 W., were opened up. From that time until 1901 mining operations were conducted on a very small scale. The shafts were not deep and the lead was obtained chiefly from residual clay at or near the surface.

In 1901 a new impetus was given the mining industry in this county by the discovery of a rich body of lead and zinc ore near Fortuna. Since that time most of the prospecting work has been near this place.

Smelting.—The first and only lead smelter in Moniteau county was erected by Judge W. H. Eanes, of Russelville and Clark and Berry, in 1872, close to the Eanes diggings, in sec. 32, T. 44 N., R. 14 W. According to Broadhead,* this smelter made three charges of 1,200 pounds of Galena in 24 hours. The pigs weigh 72 to 80 pounds, and are branded thus: "Moniteau Co. Furnace." At the present time there is nothing to indicate that a smelter ever existed at that place.

Production of Lead and Zinc.—The following is a table showing the total production of lead and zinc for Moniteau county as given by Winslow** in a report published in 1894:

Period.	Lead.				Zinc.			
	Ores.		Metal.		Ores.		Metal.	
	Tons.	Values.	Tons.	Values.	Tons.	Values.	Tons.	Values.
1840-1849	1,200	$48,000	780	$70,200	....	....	....	....
1850-1859	500	20,000	350	37,800	....	....	....	....
1860-1869	150	9,000	105	17,850	....	....	....	....
1870-1879	500	25,000	350	41,300	....	....	....	....
1880-1893	150	6,450	105	8,600	500	$11,000	215	$21,500
Totals	2,500	$108,450	1,690	$175,750	500	$11,000	215	$21,500

There is no record of any ore being shipped from Moniteau county from 1893 until 1901. In 1901 the Fortuna mine (now the Standard)

*Broadhead, Geol. Survey of Mo., 1873-74, p. 558.
**Winslow, Mo. Geol. Survey, Vol. VII, p. 526.

produced 548 tons of galena and 231 tons of zinc blende for which they received $35,140.00. The total shipments of ore from Moniteau county from 1901 to June 1904, have been as follows:

Name of mine.	Galena.		Zinc blende.	
	Tons.	Value.	Tons.	Value.
Gundling	915	$49,000	820	$30,420
Standard	698	35,600	456	14,136
Brady	80	4,240	....	....
Total	1,693	$88,840	1,276	$44,556

CHARACTER OF THE ORES.

The lead occurs in the form of galena, and the zinc as sphalerite, known commonly as jack or blende. Both are very pure. Some cerussite, lead carbonate, occurs, but not in sufficient quantity to be mined.

ASSOCIATED MINERALS.

The minerals associated with the lead and zinc ores are chiefly barite, gypsum, calcite, crystallized dolomite, pyrite, chalcopyrite and marcasite. Of these, barite is the most abundant, while calcite, pyrite, chalcopyrite, marcasite and gypsum occur in smaller quantities.

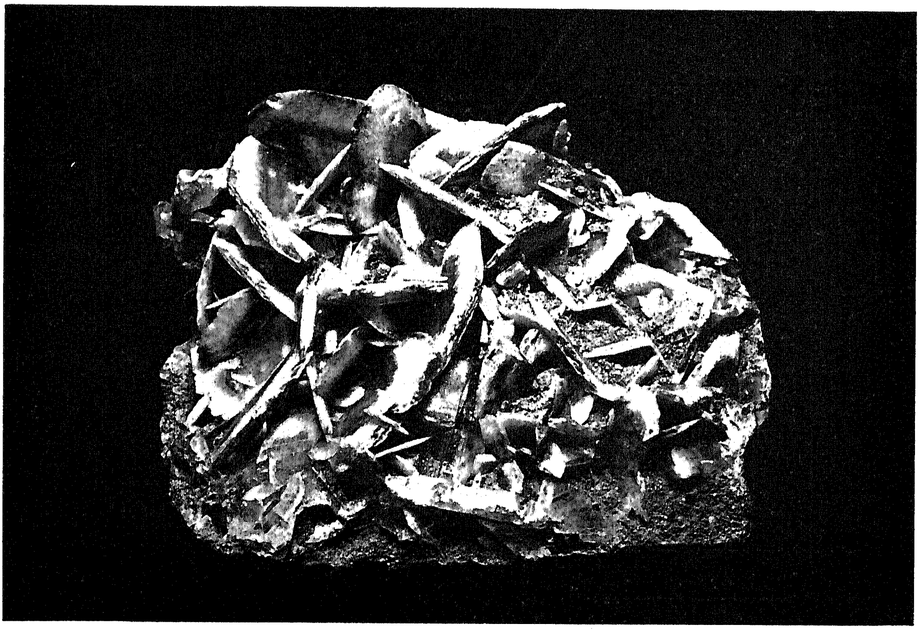
The barite occurs chiefly in clay pockets, and is older than the minerals with which it is associated. At Stark's mine in sec. 30, T. 43 N., R. 14 W., part of the galena consists of small, irregularly shaped fragments imbedded in a matrix of decomposed chert, known as "chalk tiff." At the Gundling mine beautiful crystals of gypsum were observed covering the wall rock, the galena and blende. Azurite and malachite, which are the decomposition products of chalcopyrite, are associated with the galena and blende at the Brady diggings. Plate IX shows gypsum crystals coating the wall rock in the Gundling mine.

METHODS OF OCCURRENCE.

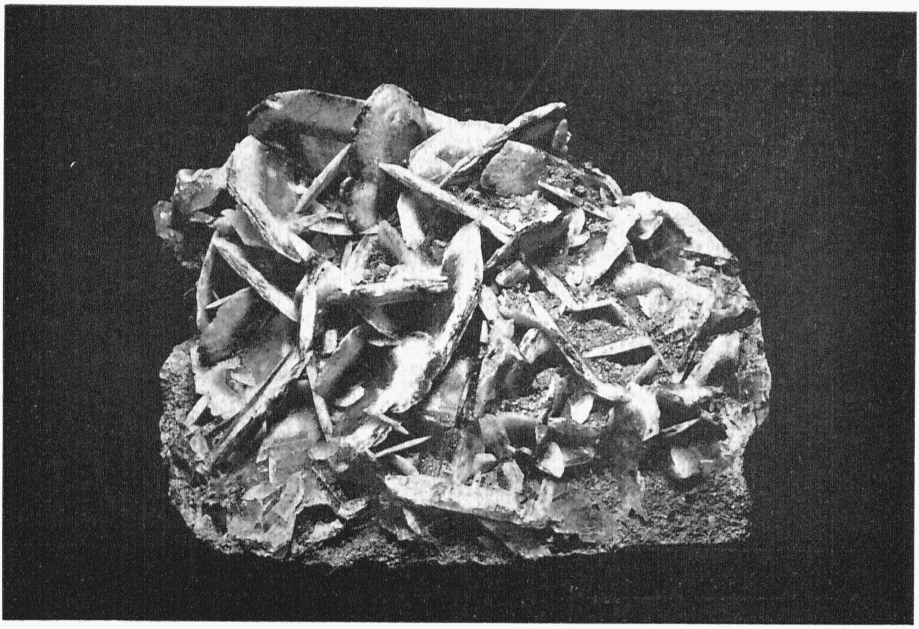
The usual methods of occurrence of the lead and zinc ores in Moniteau county are: (1) sheets, (2) circles and (3) residual. The sheets occur principally in the Coal Measure shales, although vertical sheets also occur in the Jefferson City formation. The circles are characteristic of the latter formation, while the residual ores occur in the clay overlying that formation.

Sheets.—Both horizontal and vertical sheets of galena and blende occur in the coal, and in some of the mines it is claimed that a sufficient quantity is obtained to pay the expense of mining the coal.

Vertical sheets also occur in crevices in the Jefferson City formation. These crevices, which are joints that have been enlarged by solu-



GYPSUM CRYSTALS FROM GUNDLING MINE.



GYPSUM CRYSTALS FROM GUNDLING MINE.

tion are frequently several hundred feet long. They are usually partly filled with clay formed by the decomposition of the adjacent wall rock or washed in from the surface. The minerals are usually embedded in this clay.

Circles.—Winslow* describes circular deposits as "fillings of caves which had vertical openings leading to the surface." He gives, in evidence, a cross section of Marble Cave in Stone county, which is here reproduced from his report. (Fig. 22.) He says: "The cross section of the

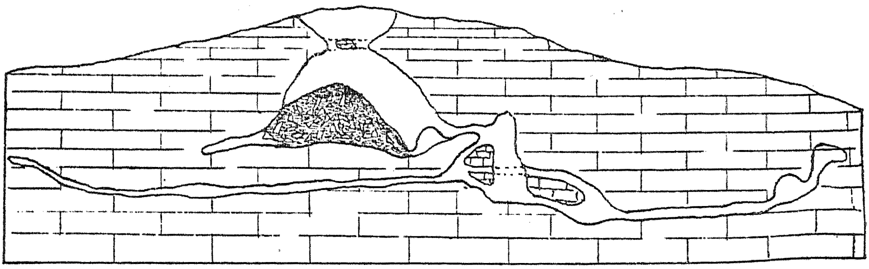


FIG. 22. Projection of Marble Cave, Stone county (after Winslow). Scale 1″=300′.

main cavern shows that its shape is closely that of the later described circular deposits. We have the same conical shape with widening of the walls downward. In the center is a conical mass of debris, consisting of rock derived from the roof and surface. Around this is an annular space. If now, the outlet downward from this cave were closed, and waters carrying surface materials were introduced at the top, the whole space would become filled as are the circle deposits. The annular clays about the central cone of debris would be, subsequently, the most ready course for solutions carrying metalliferous and other minerals. Thence, they would penetrate inward into the core of the breccia, and outward into the crevices of the wall rock. Hence we should expect the greatest concentration of these minerals in the annular space, as is the case with the circle deposits. At the bottom of the cavity is the floor of the cave, beyond which the ore would not extend, excepting along crevices. Such a floor is also found in the circle deposits where exploitation has proceeded far enough."

There are several "circle deposits" in Moniteau county, chief among which is the old High Point lead mine, from which 2,000,000 pounds of lead ore have been taken. The diggings of the Crown Company, operated by Mr. Fehr, is also a good illustration of the circle deposit.

*Lead and zinc deposits of Missouri, by Arthur Winslow, Mo. Geol. Survey, Vol. VII, p. 467.

Residual Ores.—The residual ores are found in clay near the surface and are scattered all over the county. At one time the galena in the clay probably occupied crevices or irregular cavities in the rock. Percolating waters removed the more soluble limestone, leaving the clay and galena as a residuum. With these are usually associated barite, calcite and chert.

RELATION OF THE ORE DEPOSITS TO STRUCTURE.

There seems to be no relation between the position of the ores and the faulting or folding of the rocks. Brecciation is quite frequent, but it has probably resulted from solution and not faulting. It is in and around these solution breccias that the ore chiefly occurs.

GEOLOGICAL DISTRIBUTION OF PROSPECTS.

Burlington Limestone.—In only one case has lead or zinc ore been found in the Burlington limestone. In sec. 24, T. 47 N., R. 15 W., Meek* describes the ore as being "found amongst loose chert, on a slope some seventy feet below the summit of the county." As strata of Encrinital limestone crop out of the slope below the openings, the lead must have been originally derived from that or some of the newer rocks. No vein was discovered; and the probability is that only loose fragments of "Float mineral exist here." The lead has all been removed, since none could be found at that place during the present survey of the county.

Jefferson City Formation.—Most of the prospects and mines in Moniteau county are located in this formation. No very large deposits of ore have been discovered, and such as have been worked occur in circles, breccias, and in the residual clay resulting from the decomposition of the limestone.

Coal Measure Shale.—The ores in the Coal Measure shale and coal occur as sheets along the bedding planes and in vertical joints. Blende is the preponderant ore, although galena exists in considerable quantities in the Jefferson City formation.

DESCRIPTIONS OF MINES AND PROSPECTS.

Howard's Mine.—This prospect, located in the south half of sec. 19, T. 43 N., R. 14 W., is in the Jefferson City limestone. The shaft is 80 feet deep, but is now abandoned and filled with water. The lead occurs in joint crevices and in pockets. It is reported that before the present shaft was sunk, this mine produced from shallow diggings about 10,000 pounds of lead.

Stark's Mine.—Stark's mine is near the center of sec. 30, T. 43 N., R. 14 W. The heavy beds of the dolomite in which the lead occurs, do

*1st and 2nd An. Repts. Mo. Geol. Survey, p. 115.

not seem from the dump to be much brecciated. However, there is some brecciation, which may be but slight breaking resulting from solution and recementation along the joints. The ore occurs in crevices and the order of crustification is (1) country rock; (2) chalk tiff; (3) lead, and (4) crystallized barite.

High Point Diggings.—These diggings, located in the N. E. ¼ of sec. 17, T. 43 N., R. 15 W., were first opened in 1841 and worked until 1845, producing 2,000,000 pounds of lead. In 1845 the mine was reopened by Harrison, Berthoud & Co. of St. Louis, and worked until 1857.

This is a circle deposit, and is described as follows, by Meek*:

"The explorations here have been prosecuted in such a manner as to form a circular pit, about three hundred and thirty feet in circumference at the upper part, and eight feet in depth, which widens out gradually in every direction, from the top downwards. The middle of this excavation is occupied by an immense mass of rock, left by the miners, in the form of a depressed cone, the apex of which rises nearly to the top of the mine. The space thus worked out, I was informed by Mr. Prewitt, was occupied by masses of broken-up magnesian limestone of several varieties, confusedly mingled together in a softer material, apparently of the same composition as the masses themselves. Much of the lead ore was found embedded directly in this softer substance, but the larger bodies were found occupying cavities in it, such as miners term "pockets" where it was directly enveloped in a tough brownish red clay. To what depth this kind of mingling of materials may extend, is unknown, as no essential change was observed as far down as explorations were continued.

Not only that portion of the mine to which the attention of the miners was mainly directed, presents the peculiarities above mentioned, but the whole of the central conical mass has the same structure and composition to an unknown depth, excepting that it appears not to be so rich in lead ore. It has, however, been perforated by the miners in various directions, and has yielded much ore, and is even supposed to contain enough to pay for working it entirely out.

Much of the mingled materials within the circumference of the mine is so incoherent as to be worked out without blasting, while the surrounding wall is quite hard, and contains little or no ore. The richest nests of ore were found near the wall-rock, where the miners say it was usually found in a succession of bodies, forming almost continuous belts entirely around the mine; the belts being separated by a few feet of other materials.

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*1st and 2nd An. Repts. Mo. Geol. Surv., pp. 117-118.

When this mine was examined, it was still filled with water to within sixteen or eighteen feet of the top, as far down as the wall-rock could be seen; however, with the exception of a thin bed of sandstone around the top, it consists of "Cotton Rock;" though I was informed by one of the old miners, that, lower down, it is composed of a gray, porous rock, which is, doubtless, correct, as much of the broken-up materials in the center of the mine is composed of that variety of magnesian limestone, and beds of that nature are known to occur beneath the "Cotton Rock" in this region. The wall-rock, though comparatively undisturbed, is, in places, fractured, and so traversed by cleavage-joints as to partially obscure the planes of stratification; but, as far as could be ascertained, there is no perceptible dip in any direction. It appears probable, however, from exposures seen in the surrounding country, that there is a slight general dip of the strata in almost every direction, from a point somewhere near the mine."

Figure 23, copied from Meek's report, is a cross section of this circle illustrating the relation of the ore to the surrounding rock. The mine has long been abandoned, and is now filled with water.

Mineral Point Diggings.—This prospect, located in the S. E. ¼ of the N. E. ¼ of sec. 10, T. 45 N., R. 15 W., is now abandoned. The shafts are partly filled, and very little could be learned from the dump.

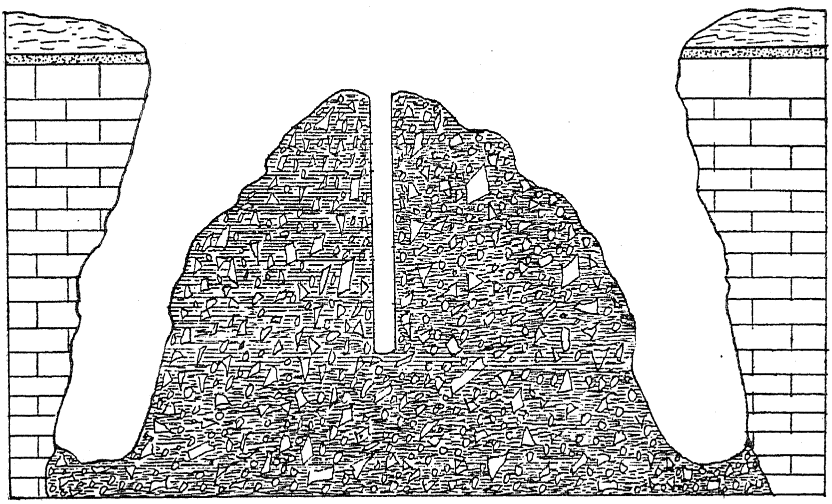


FIG. 23. High Point Lead Mine. (After Meek, 1854).

It is evident, however, that the galena occurred in a fissure. Galena still occurs in the fissure, and is mingled with fragments of cotton rock. There is some brecciation along the seam. This deposit was discovered in the early fifties and worked for a short time. In 1873 it was reopened, and Broadhead* gives the total production as 15,000 pounds.

Eanes Diggings.—These are located in the N. ½ of sec. 32, T. 44 N., R. 14 W. They were discovered in 1873 and have produced 200,000 pounds of galena. The galena occurs mainly in residual clay, ten to twenty feet deep, although seams and pockets were found in the rock beneath.

Reed Diggings.—This prospect, located in the N. E. ¼ of the S. E. ¼ of sec. 12, T. 45 N., R. 15 W., was discovered in 1874, and in that year 7,000 pounds of galena were taken out. According to Broadhead* a shaft 120 feet deep passed through:

Section No. 21.

"(1) 15 feet clay, in which one chunk of galena was found loose.
(2) 15 feet broken masses of soft yellow Magnesian limestone.
(3) 30 feet the same, with large pockets of galena, also with pockets filled with Barytes and with clay.
(4) 30 feet the same, with smaller pockets of galena.
(5) 30 feet the same, with only occasional traces of galena."

Crown Mine.—This mine, located in the N. E. ¼ of the S. E. ¼ of sec. 23, T. 45 N., R. 15 W., is being prospected by Mr. F. C. Fehr. Formerly, while in the state of a diggings, this property produced considerable galena. Mr. Fehr is working in the old shaft of the Crown Company, which is eighty feet deep and cribbed most of the way. The bottom of the shaft is in brecciated cotton rock, in which there was a drift twelve feet long at the time the property was visited. The galena and blende occur in the interstices of the breccia. At the end of the drift the brecciated zone is becoming thinner, being replaced by unbroken beds of cotton rock.

This mine is a circle in which galena and blende occur in clay pockets and brecciated limestone. On the surface the circle is outlined by diggings from each of which it is reported that considerable galena was taken. At the surface the circle is about 125 feet long and 100 feet wide. The galena is always accompanied by barite, and in many places chalcopyrite and its decomposition products are found.

It is the intention to work the richest portion of the circle and not attempt to go deeper.

King Jack Mine.—This property, which is owned by Ham and Ham, of California, Missouri, is located in the N. W. ¼ of the N. E. ¼ of sec. 13, T. 45 N., R. 16 W. On the two acres surrounding this mine twelve drill holes have been put down, eight of which showed shines of lead and jack. A shaft is down 106 feet deep and at a depth of 40

*Mo. Geol. Sur., 1873, p. 556.

feet considerable drifting has been done. Mr. Ham says that the ore is from 28 to 35 feet from the surface. A new shaft, a little southeast of the old one, is in ore at this depth. The ore occurs in crevices and in soft clay pockets, but evidently not in very large quantities. Mr. E. S. Lovejoy of St. Louis, has leased the mine and expects to operate it.

FORTUNA DISTRICT.

The Fortuna district, as ordinarily defined, lies in the southwestern part of Moniteau county and the northeastern part of Morgan county, along the northwest-southeast line dividing the counties. The district comprises an area of about twelve square miles in T. 44 N., R. 17 W. It has been thoroughly prospected with hundreds of drill holes, to a depth of from 150 to 200 feet. There are in the neighborhood of thirty shafts, all in the Jefferson City formation. Of this number only two have been proven to be in paying ore bodies—the "Gundling" and Standard."

The Gundling Mine.—This mine is owned by the Gundling Mining Company, which is incorporated and capitalized for $150,000. The property is situated on a small branch of Moreau creek in the N. W. ¼ of the N. E. ¼ of sec. 22, T. 44 N., R. 17 W. In 1870 Messrs. Peter Sously and Nathan Allen recovered 150 pounds of lead from the surface clay on this property. They sunk a shaft eight feet deep, but discontinued work because it was thought they had better prospects in Morgan county. From that time nothing was done on this property until the present company began operations in June, 1902. Since 1902 five shafts have been sunk, one 140 feet, another 145 feet, two 160 feet, and one 202 feet deep. All are in the Jefferson City formation. In one of the 160-foot shafts, at a depth of 100 feet, drifts were run sixty feet to the east and west. In the west drift galena and blende were found in veins and crevices. No well developed crustification was observed, but blende, associated with galena, was found in places next to the wall. These veins and crevices do not occur according to any system, and vary greatly in width. They are open for short distances and have a tendency to end abruptly. Sometimes the blende occupies, completely, the openings, there being no associated galena, and at other times both occur together in sharp contact. Fig. 24 shows the relation between the ores and wall rock in this drift.

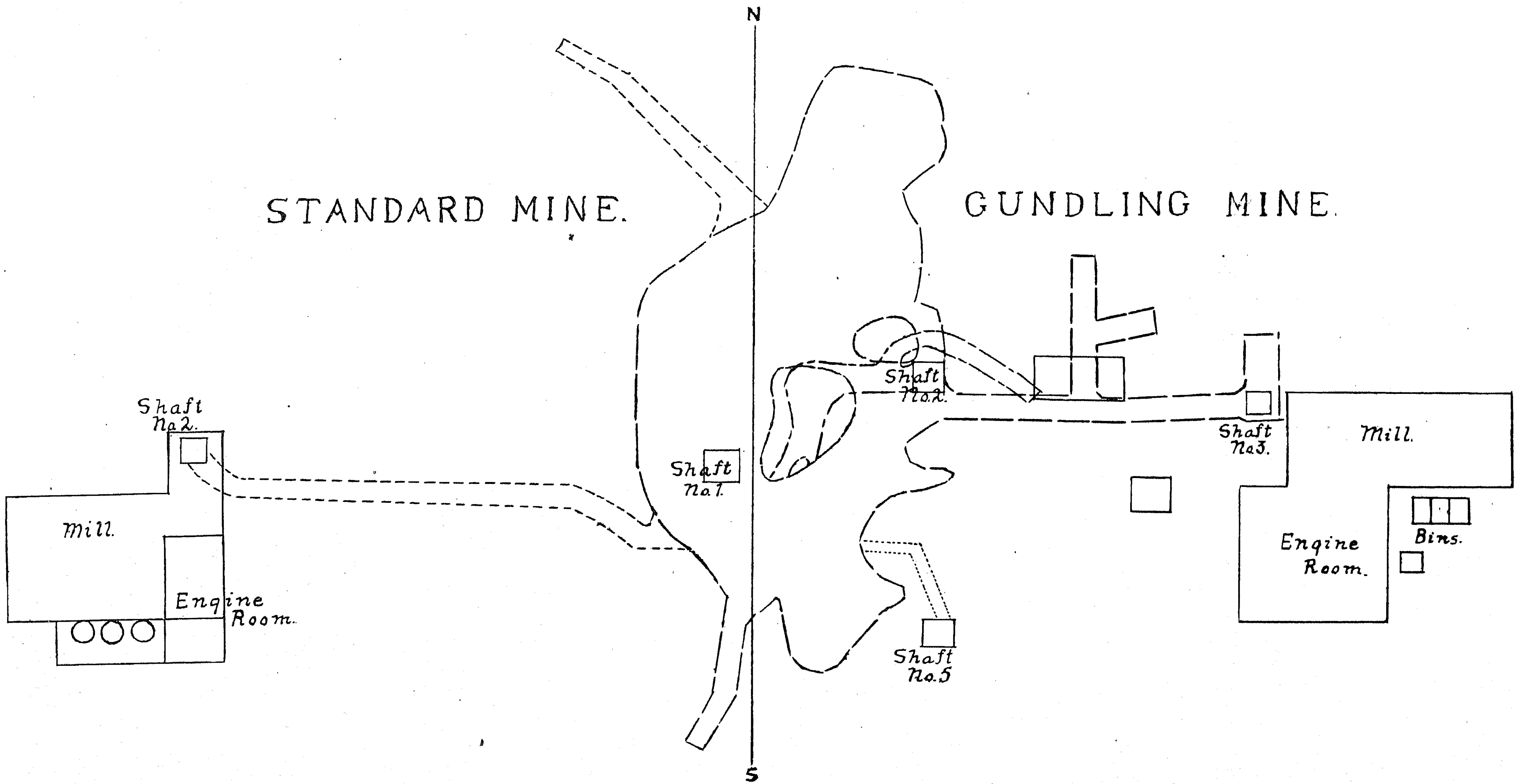
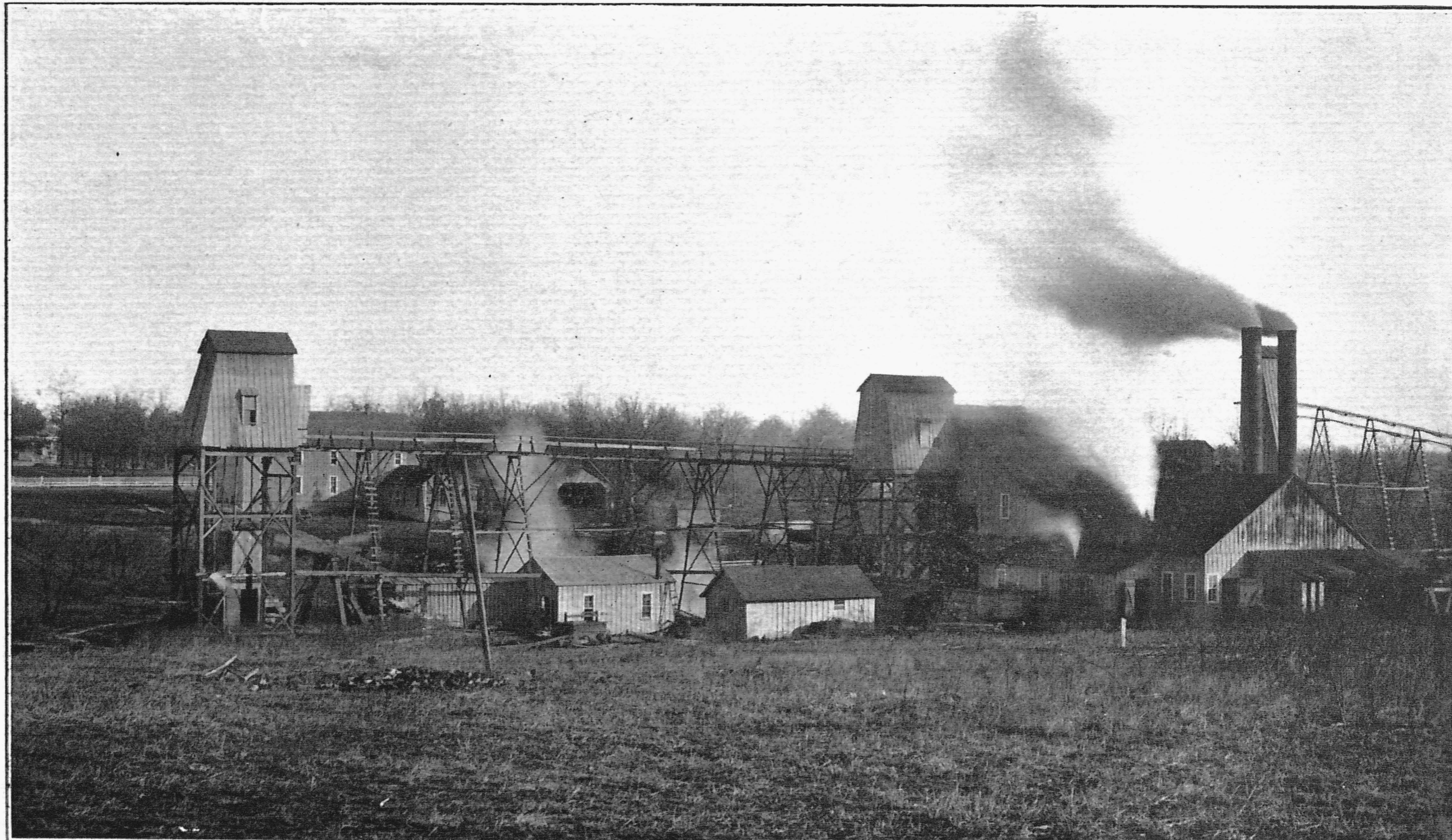


FIG. 25. Map showing surface and underground workings of the Standard and Gundling Mines, Fortuna Mo.

THE GUNDLING MINE AND MILL, FORTUNA, MO.



THE GUNDLING MINE AND MILL, FORTUNA, MO.

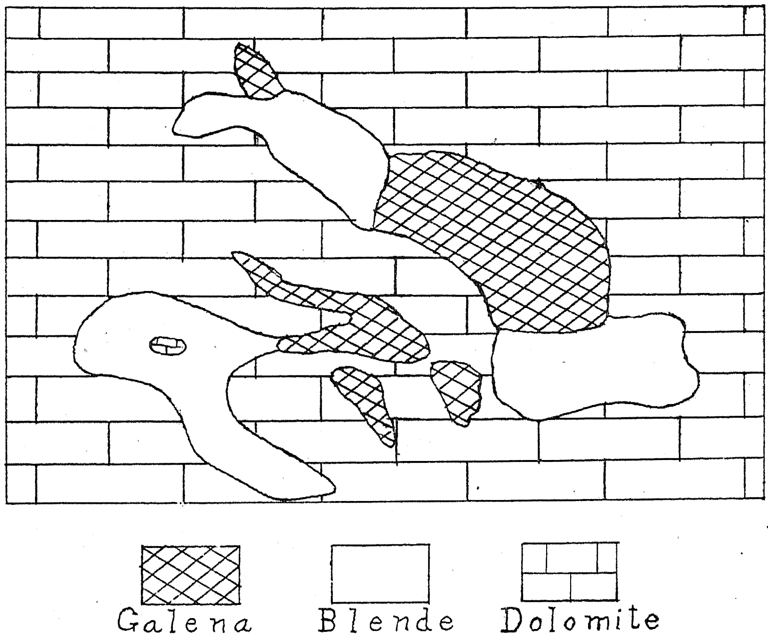


FIG 24. Galena, blende and dolomite as observed in the Gundling Mine, Fortuna, Mo.

The ore in the east drift is mainly galena, which occurs in a crevice striking N. 30° E. There are no well defined walls, the ore occurring irregularly in the horizontal beds which show very little brecciation. The proportion of galena and blende obtained from this level, as indicated by the mill reports, was about two to one.

The 160-foot level, from which most of the ore mined has been taken, covers a considerable area. West of the shaft which reaches this level, the beds dip 50° west and are very much brecciated. The zone of brecciation is about 75 feet wide, and galena and blende, in about equal proportions, occur in the breccia and in joints striking N. 70° E. and N. 30° E. The blende usually occurs in brecciated chert. The ore-bearing crevices in the wall rock strike N.-S. and E.-W. The ore also occurs in clay pockets which vary in size from those four to five feet wide by six to seven feet long, down to those six inches wide by three feet long. Small cracks filled with galena radiate from the pockets. The pockets in which galena is found consist chiefly of dolomitic mud, which has resulted from the decomposition of the walls to which the galena was at one time attached. The galena and blende in these pockets are in the ratio of about four of galena to one of blende. However, the mill reports for the ore from the entire level show the proportion of galena and blende to have been about equal. The last time this mine was examined a drift was being run northwest on the 202-foot level. At the head of this drift intersecting N.-S. and E.-W. crevices, about six inches in width, were encountered out of which heavy streams of water were issuing. This strong flow of water compelled the company to abandon work to await the arrival of a new pump having a capacity sufficient to handle the water. A pump having a capacity of 1,000 gallons per minute was installed, but for some reason it was insufficient and this level was allowed to fill with water.

The mill at the Gundling mine has a capacity of 150 tons per shift of ten hours. It is equipped with a 15-inch crusher, three sets of rolls, five plunger rotary and six plunger cleaning jigs and a hoist for each shaft. The combined boiler capacity is 450 horsepower.

The company employs fifteen men on the surface and in the mill, and ten men underground. The wages average $2.25 per day.

The first car of ore was shipped on June 16, 1902, and during that year the shipments amounted to 719,645 pounds of blende and 1,134,170 pounds of galena, at an average price of $35.86 per ton for the blende, and $50.40 per ton for the galena. During 1903 the shipments amounted to 921,774 pounds of blende and 694,440 pounds of galena, at an average price of $37,90 for the blende and $56.70 for the galena.

Figure 25 is a map of the surface and of the underground workings of the Gundling and Standard mines, which are on adjacent properties. Plate X is a photograph of the Gundling mine and mill.

Standard Mine.—The Standard mine, adjoins the Gundling on the west, and has two shafts 160 feet deep. A drift connects the two shafts, the one at the 160-foot level having been worked up to the line on both sides.

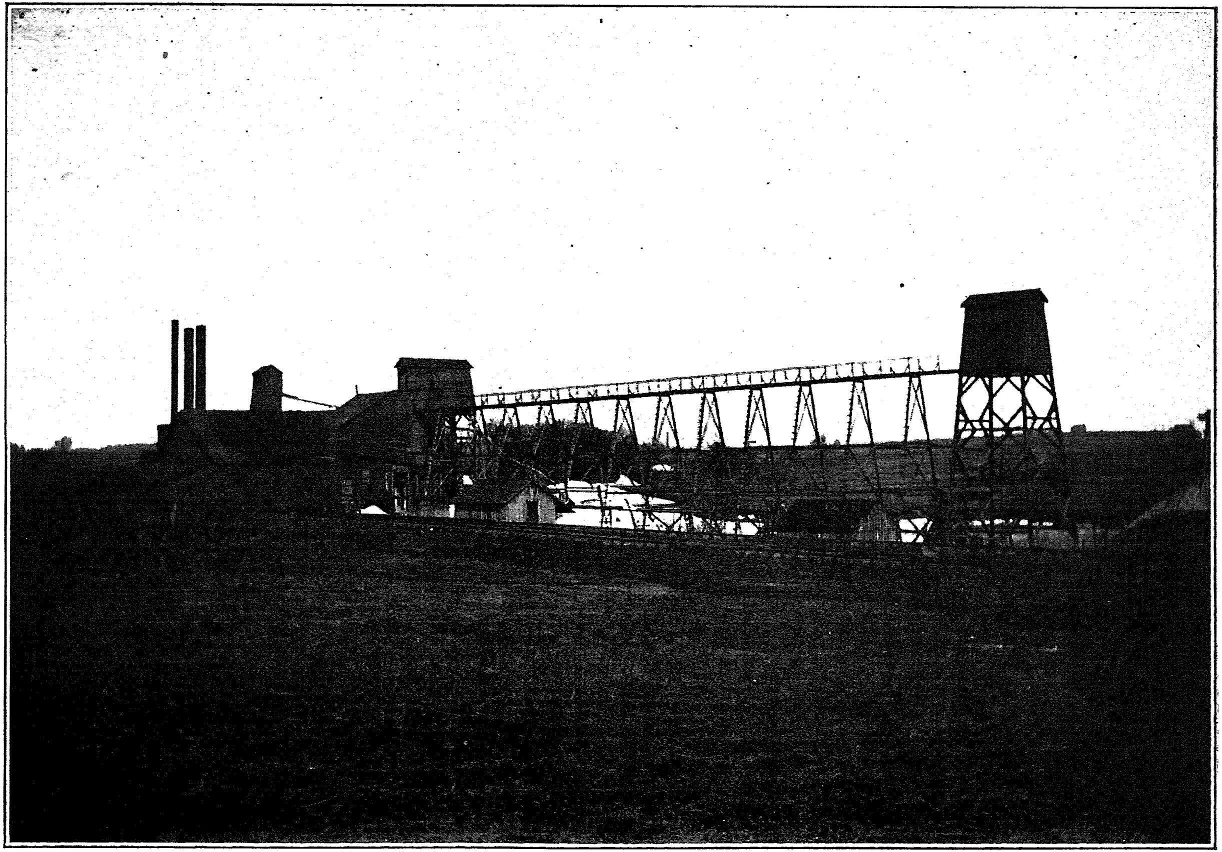
The ore, as in the Gundling, occurs in crevices, openings and pockets, some of which have resulted from brecciation. The Standard company was formerly capitalized at $1,500,000. The ownership has recently changed hands. At the time the district was visited the mine was idle although it was reported that the company expected to soon resume operations.

The total shipments from this mine have been 1,396,000 pounds of galena and 912,000 pounds of blende.

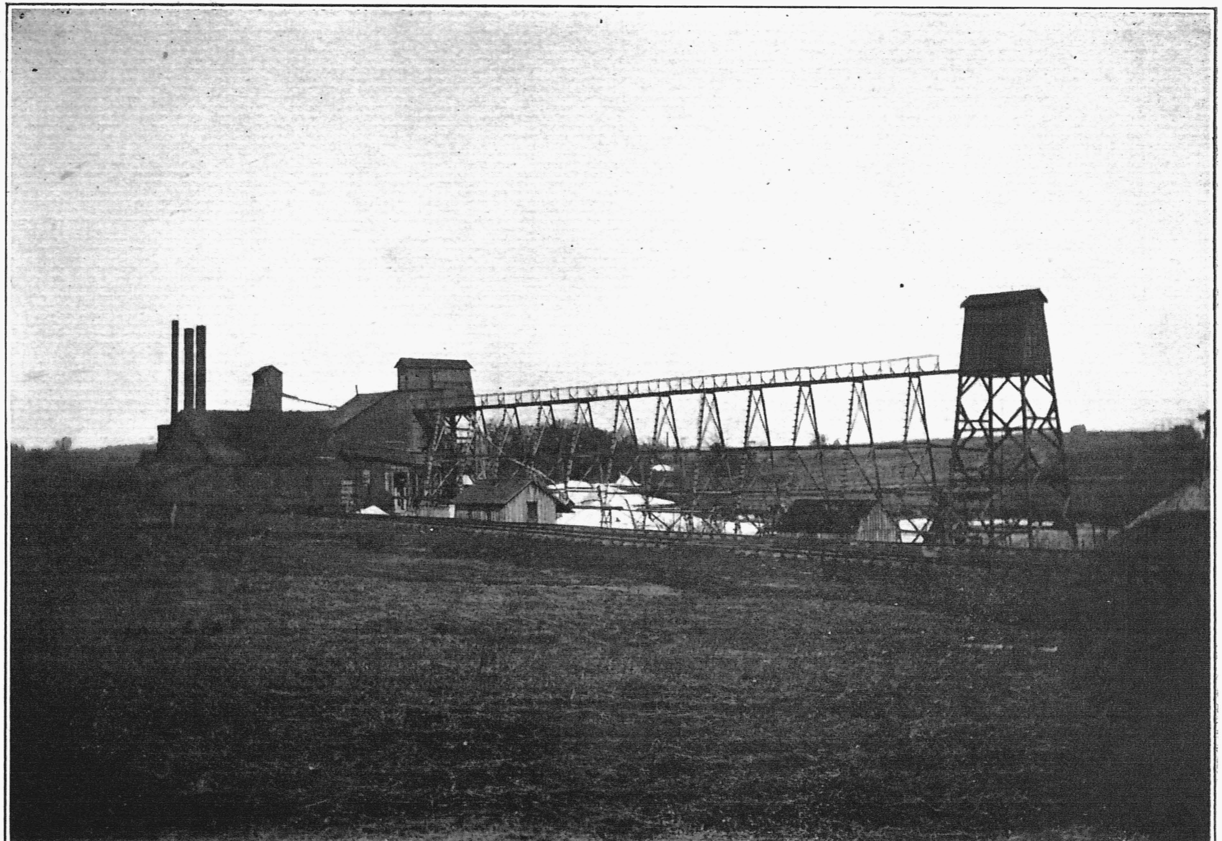
Plate XI is a view of the Standard mine and mill.

The Penn Mine.—The Penn Lead and Zinc Mining Company have leased land owned by the Gundling Mining Company, just east of the Gundling mine. When visited they were sinking a shaft which was down

NOTE—None of the mines so-called, in the Fortuna district, with the exception of the Standard and Gundling, have been producers. They are all prospects.



THE STANDARD MINE AND MILL, FORTUNA, MO.



THE STANDARD MINE AND MILL, FORTUNA, MO.

125 feet. At a depth of 115 feet a brecciated anticlinal fold, striking east and west, occurs in the rock. From this the water pours out in a heavy stream. The drill record of a hole 25 feet east of the shaft, shows that this breccia was penetrated at a depth of 123 feet. It is reported that ore was struck at 128 feet. The company intends to sink the shaft a little deeper and then run a drift in this brecciated zone. No ore has been taken out up to the present time.

Hot Springs Mine.—This mine is located in the N. E. ¼ of the S. E. ¼ of sec. 21, T. 44 N., R. 17 W. A shaft has been sunk 120 feet deep, and at the 95-foot level drifts have been cut north and east into limestone and flint. In the east drift ore occurs in solution joints in the limestone. It is usually accompanied by brecciation. At the same level in the north drift the rock is much more cherty, and towards the head of the drift it is almost entirely chert, which is considerably brecciated. Lead and zinc ores occur in the interstices of the breccia, galena being much more abundant than blende. The ground around the flint is usually very soft. Pockets containing some galena and blende are frequent. This prospect has never produced any galena or blende, and has been abandoned.

East Liverpool Mine.—This mine is located in the N. W. ¼ of the S. E. ¼ of the S. W. ¼ of sec. 15, T. 44 N., R. 17 W. A shaft has been sunk to a depth of 100 feet. Ore is reported to have been passed through in drill holes at a depth of 140 feet, but work on the shaft had been suspended at the time the property was visited. It is reported that work will be resumed.

Shelley Mine.—The Shelley property joins the East Liverpool on the east. The mine was not being worked at the time the property was visited and therefore could not be examined. The shaft is said to be 140 feet deep, and it is reported to have been in ore at the time it was closed down.

Geneva Mine.—This property which is located a little east of the Shelley, in sec. 15, T. 44 N., R. 17 W., has been drilled and abandoned. Shines were reported in the drill holes at a depth of 120 feet and ore at 140 feet.

New Discovery Mine.—This mine, which is located in the S. E. ¼ of sec. 15, T. 44 N., R. 17 W., has been abandoned and the shaft is filled with water. There is some shale on the dump which has the appearance of being Carboniferous. Thin knife edge seams of galena in the spaces along the stylolitic partings were the only evidence of ore.

Youngstown Mine.—The Youngstown Lead and Zinc Company own the N. W. 40 of sec. 22, T. 44 N., R. 17 W. The company, according to Mr. W. C. Oliver, superintendent of the mine, is capitalized for $400,-000, 400,000 shares with par value of $1.00. Mr. Oliver reports that the shaft is 140 feet deep and that thin runs of ore in crevices were passed through down to the 58-foot level. At a depth of from 59 to 65 feet the rock is soft and brecciated. This he calls "mill dirt," with blende as the chief mineral. From 125 to 135 feet shines of galena were obtained, but it does not occur in paying quantity. The bottom of the shaft is in hard, dark limestone. Mr. Oliver says that the company ceased operations March 17, 1904, because of a scarcity of coal. He reports that they expect to resume work soon, and will then drift in the open ground at the level between 58 and 65 feet. At the time the property was visited no work was being done and the shaft could not be examined.

Woodyard Mine.—This mine, formerly called the Parkersburg, is located in the S. E. ¼ of the S. W. ¼ of sec 22, T. 44 N., R. 17 W. It was filled with water and could not be examined when visited. The shaft is reported to be 146 feet deep, with good ore at the 60, 103 and 140-foot levels. No shipments have been made, and there is no ore at the mine.

Schreck Mine.—This property is located in sec. 3, T. 44 N., R. 17 W. Mr. Hatten, of the Gundling, says that the shaft on this property is 35 feet deep, and that it passes through very good galena and blende ore. He considers it a favorable prospect.

Clarke and Blair Mine.—This property is in the S. E. ¼ of the N. E. ¼ and the N. E. ¼ of the S. E. ¼ of sec 17, T. 44 N., R. 17 W. The shaft is about 100 feet deep and it is reported that good lead ore was passed through at a depth of 84 feet. The mine was not being operated at the time the property was visited.

Superior Mine.—The Superior Lead and Zinc Company, of Pittsburg, owns 40 acres in the S. E. ¼ of the N. E. ¼ of sec. 21, T. 44 N., R. 17 W., which is reported to have cost $150 to $200 per acre. A shaft on this property is down 130 feet and is connected with about 100 feet of drifts. Ore in paying quantity has not been found. The mine was shut down in December, 1903.

Belmont Mine.—This mine is in the S. E. ¼ of the S. W. ¼ of sec. 22, T. 44 N., R. 17 W. A shaft, which is said to be 65 feet deep, was filled with water when the property was examined. Little or no ore was found.

Missouri Pacific Mine.—This mine is located in the W. ½ of the N. W. ¼ of the S. E. ¼ of sec. 22, T. 44 N., R. 17 W. It was not being worked when visited, but Mr. Oliver, of the Youngstown company, says that the shaft is 110 feet deep and that the best run of lead that he has seen in the district was struck at a depth of 90 feet. At this level a drift was run 55 feet a little west of south into the ore. The ore occurs in clay pockets and brecciated dolomite.

Mr. Oliver says that work was stopped because the Standard Development company, which promoted it, had done all they agreed to. The company is capitalized at $750,000, $1.00 par value per share, and in the neighborhood of 400,000 shares have been sold. The stock has been turned over to the stock-holders who may develop the property. No ore has been shipped from this mine.

Pittsburg Mine.—This mine, which is located in the N. E. ¼ of the S. E. ¼ of sec. 12, T. 44 N., R. 17 W., was shut down when visited and could not be examined. The following information was obtained from a man who had worked in the mine.

The shaft is 140 feet deep, with 150 feet of drifts at the 80-foot level. Most of the ore is galena, there being two veins varying in thickness from four inches to mere threads. No shipments have been made.

Herschey Mine.—The Herschey mine is located in the S. E. ¼ of the N. E. ¼ and the N. E. ¼ of the S. E. ¼ of sec. 15, T. 44 N., R. 17 W. A shaft 130 feet deep, with 40 feet of drifts, has been sunk on this property. The mine was not being operated at the time it was visited and could not be examined. Thin knife-edge seams of galena, usually along modified stylolitic partings, were observed on the dump Blende is also reported as occurring in clay and in flint boulders embedded in clay. Pink and white crystals of dolomite associated with flint were observed.

When the mine was being worked 100 gallons of water per minute was pumped. The first 40 feet of the shaft is said to be in shale. No shipments have been made and there is no ore in stock.

Rose Mine.—The Rose Company own the south half of the S. E. ¼ of sec. 15, T. 44 N., R. 17 W. In company with most of the other mines in this area, they have suspended operations. A shaft has been sunk 153 feet deep. At a depth of 43 feet some drifting has been done. In a drift at the bottom of the shaft there is reported to be a one-foot layer of dark gray, fine grained Carbonaceous shale, much slickensided. This shale pitches to the north 1½ feet in 5 feet, while the limestone, in which it occurs, is horizontal. Blende is reported as occurring in nuggets in this shale. At the 153-foot level a drift has been run northeast 140 feet in undisturbed layers of flint and dolomitic limestone. The flint contains some pockets carrying blende. These pockets are from 4 inches to 1½ feet long, and 3 to 6 inches wide. Blende is the preponderant mineral, although thin seams of galena occur nearer the shaft, in joints which strike N. 15° E. and N. 78° E. A second drift running 130 feet south is in flint and limestone, the flint being secondary after the limestone.

Joslyn Mine.—This mine is located in the N. W. ¼ of the S. W. ¼ of sec. 13, T. 44 N., R. 17 W. The ore, both galena and blende, occurs in brecciated dolomite and flint. The galena evidently replaces, metasomatically, the oölitic flint, sometimes being impressed by oölitic grains. The mine is not working.

Mary M. Mine.—This mine is located in the N. W. ¼ of the S. E. ¼ of sec. 21, T. 44 N., R. 17 W., in Morgan county. The mine was shut down at the time it was visited. It is reported that the shaft is 202 feet deep, and that drifts have been cut at the 160, 180 and 202-foot levels. The drift at the 180-foot level is said to contain the most ore, although galena and blendé are reported to have been found in all of them.

Leroy Lead and Zinc Company's Mine.—The land owned by this company is located just south of the Mary M. mine, and consists of the S. E. ¼ of the S. W. ¼ of sec. 21, T. 44 N., R. 17 W. A shaft 30 feet deep has been sunk, but at the time the property was examined it was filled with water. A single shine of jack was noted on the dump. Work at this place has been suspended.

Brady Diggings.—This prospect, which was formerly known as the Merrill mines, is located in the S. W. ¼ of the S. W. ¼ of sec 7, T. 44 N., R. 15 W. No work was being done when the property was visited.

There are four shafts on this property, three in Jefferson City limestone, and one in Carboniferous sandstone. Most of the galena has been taken from the shaft in the sandstone. It occurs in crevices and crystal aggregates varying in size from small pieces up to those weighing one hundred or more pounds are found. The shaft is 70 feet deep. A drift has been run northeast from the bottom connecting with another shaft, which is 150 feet deep and in Jefferson City limestone. This second shaft has forty feet of drifts at the 57-foot level, from which considerable galena is said to have been taken.

The easternmost shaft is 160 feet deep, and is said to have passed through several rich stringers of blende. At a depth of 70 feet a drift was run in this ore, but it pinched out within a very short distance.

The fourth shaft is shallow and galena has been taken from the clay through which it passes.

Five cars of galena have been shipped from this property, and there is a stock pile at the mine which is said to contain about $2,500 worth of galena.

Merrill Mine.—This property, which is located in the N. E. ¼ of the S. W. ¼ of sec 10, T. 45 N., R. 15 W., has a shaft 100 feet deep in Jefferson City limestone. Mr. Merrill, who owns the property, reports that the shaft was in ore when he was compelled to shut down on account of a shortage of coal. Considerable galena has been mined from shallow diggings on this property.

GALENA AND BLENDE IN COAL.

Both galena and blende occur in the cannel and bituminous coal in the different deposits in the county, along the bedding plane and joints either as sheets or lenses one to two inches in thickness and two or three feet in diameter. The galena and blende in the coal are always associated with iron sulphide.

It is reported that enough blende and galena are obtained in mining the coal at the bank operated by the Monarch Coal and Mineral Company to pay the expense of mining the coal.

The Newkirk Mining Company have four or five tons of galena and about twenty tons of blende which has been separated from the coal which they have mined. This company has six hand jigs, and expects to put in a magnetic separator for separating the pyrite.

Galena and blende also occur, to some extent, disseminated in crystals through the shale accompanying the coal. No prospects have as yet been opened in the shale.

DISPOSITION OF THE ORES.

The fact that lead and zinc ores occur in the dolomite of the Cambro-Ordovician formations throughout the Ozark region is indisputable evidence that mineral-bearing solutions have permeated these formations and deposited their burdens wherever conditions were favorable to deposition. The places favorable for such deposition are in openings formed by joints, breccias, faults and folds and in solution cavities.

In Moniteau county, galena and blende occur in all of these different openings, but the most favorable places for a concentration of the ores have been sink holes, known commonly as circles. Some of these sink holes, as at the Gundling and Standard mines, contain deposits of commercial value, but many of them are too small to be worked with profit.

The ores are of two kinds (1) those which have been concentrated mechanically, and (2) those which have been concentrated chemically.

(1) The mechanically concentrated ores are those mined from the residual deposits of clay and chert and are chiefly galena. These ores

were first chemically precipitated from mineral-bearing solutions in joints or crevices.*

As erosion progressed the openings in which these minerals were deposited were brought near the surface and the wall rock to which they were attached was taken into solution leaving the galena free. The new openings formed near the surface were filled with clay washed from the surface.

(2) The ores of chemical concentration are illustrated by the sink hole deposits. The free circulation afforded by these sink holes, and the consequent convergence of mineral-bearing waters in them caused a mingling of the solutions and deposition of the ores.

Van Hise** believes the ores of the Central district of Missouri to be due to a first concentration by ascending waters and a secondary enrichment by descending waters. In Moniteau county the evidence of a first concentration by ascending waters is lacking, the only workable deposits being in sink holes. However, the vertical distribution of the ores in the Gundlng mine corresponds to that of ores enriched by descending waters, as explained by Van Hise, that is, mechanically concentrated lead ore above ground water level; a zone of rich galena and subordinate blende just below the level of ground water; a zone of combined lead and zinc sulphides lower down; and finally a zone of rich blende and subordinate galena.

Of the three sulphides, galena, sphalerite and pyrite, the galena is the one upon which the oxidizing waters have the least effect. The sulphides of zinc and iron being comparatively easily oxidized are more readily taken into solution and transported downward until precipitated by organic material or other reducing agents. A very small proportion of the galena is oxidized, but when this comes into contact with the existing iron and zinc sulphides the lead is reprecipitated as sulphide, and the iron and zinc again taken into solution as sulphates and carried further downward. Zinc, since it holds sulphur more strongly than does iron, will be reprecipitated first, the iron continuing its downward course until it in turn is precipitated as the sulphide.

The Gundling mine has been worked at the 100 foot and the 160 foot levels. A drift has been run out at the 202 foot level, which is now being worked. In the 100 foot level the ore occurred in the proportion of about two of galena to one of blende. In the 160 foot level the two seem to have occurred in about equal quantities. The total output from the first

*They were not metasomatic replacements of the rock but crystallized from solutions in openings in the rocks. Buckley.

**Lead and zinc deposits of the Ozark Region, pp. 43-46.

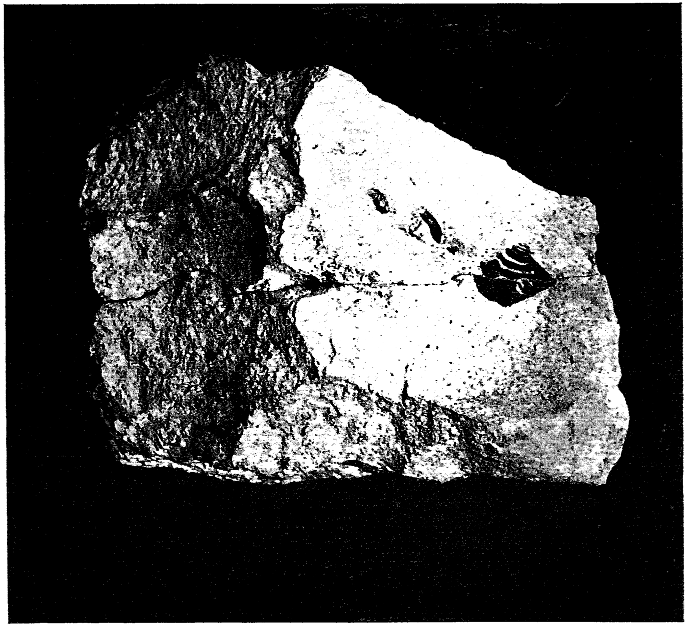


FIG. 1.

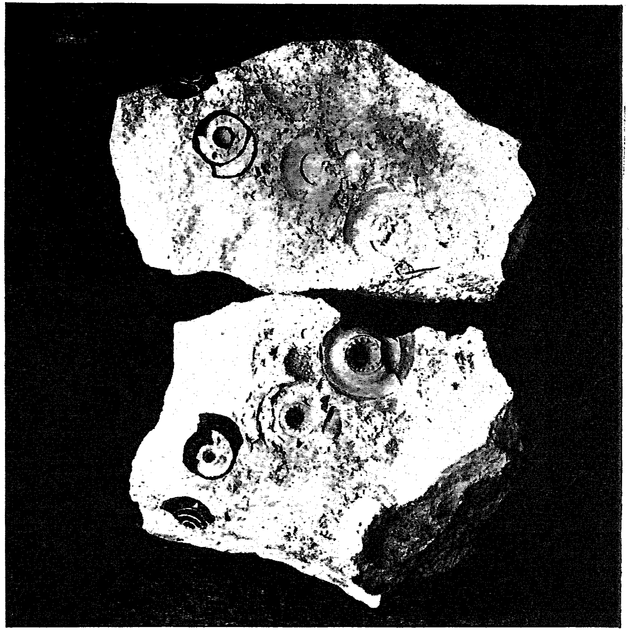


FIG. 2.

GALENA OCCUPYING GASTEROPOD IMPRESSIONS.

(The black areas are galena.)

Fig. 1. Before breaking specimen.

Fig. 2. After breaking specimen.

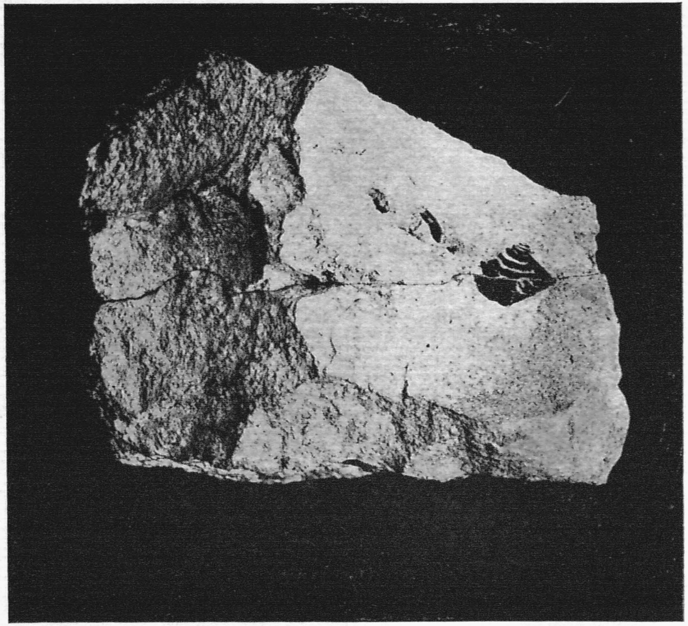


FIG. 1.

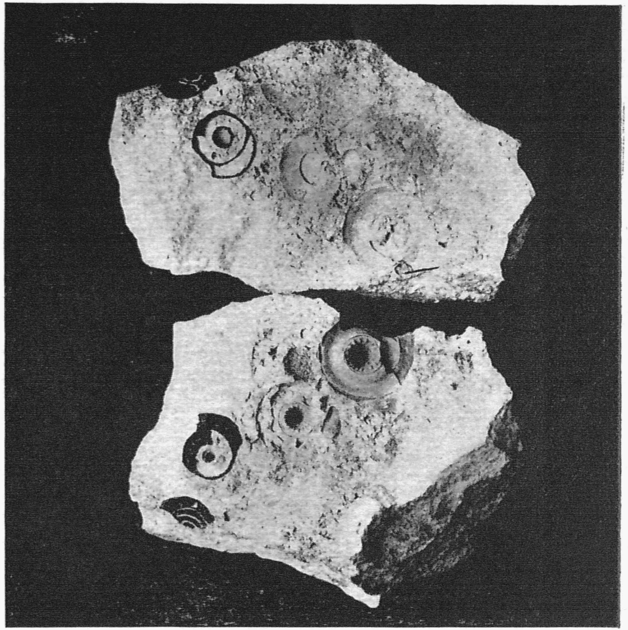


FIG. 2.

GALENA OCCUPYING GASTEROPOD IMPRESSIONS.

(The black areas are galena.)

Fig. 1. Before breaking specimen.

Fig. 2. After breaking specimen.

two levels shows a little more lead than zinc, thus indicating an increase of zinc with depth. Very little iron sulphide occurs in the upper levels. Mr. Hatten, Superintendent of the property, advises that in the 202 foot level the blende predominates over the galena in the proportion of two to one. The comparative absence of iron sulphide in any of these zones can be explained only on the supposition that there is pyrite below the present lowest level; or that the precipitation of the lead and zinc sulphides has been mainly brought about by contact with organic matter and the reaction of the lead bearing solutions on the blende, in the absence of pyrites.

An interesting illustration of the deposition of the ore in openings in the rock is shown in the accompanying photographs. Plate XII., Fig. 1, shows what appears to be a crystal of galena embedded in the Jefferson City limestone. On breaking the rock open the fracture took place along a zone formerly occupied by a gasterapod, only the impression of which remains. The lead bearing solutions have evidently followed this open space in the rock, depositing lead in the gasteropod cast. Plate XII, Fig. 2 shows the two halves of two of these impressions which have been only partially filled with galena, when, for some reason or other, deposition ceased.

ROADS AND ROAD MATERIALS.

In the southern and western parts of the county, which are chiefly prairie land, the wagon roads, as a rule, follow the section lines. In the remainder of the county most of the main roads follow the ridges, their location being controlled by the topography. These roads are usually good and therefore the most traveled. The valley roads are dusty during dry weather, and very muddy during wet weather. The ridge roads, however, are surfaced with a mixture of clay and gravel, as a result of which they are easily passable during the most unfavorable weather.

The roads are given very little attention. At irregular intervals the citizens pay their poll tax by working the road with plow, shovel and scraper, throwing the dirt from the sides to the center of the road and removing the larger boulders.

The pitted dolomite of the Jefferson City formation affords a good material for macadam. It is a hard, dense stone, will wear better than most limestones, and is easily rolled into a hard, smooth surface. This stone underlies a greater part of the county and hundreds of outcrops make the stone easily accessible. All of the larger creek beds contain an abundance of excellent gravel, which could be used to advantage in improving the roads. The tops and slopes of many of the ridges are covered with a mixture of clay and flint, which, when properly used, makes a hard, smooth and durable road bed.

The roads to be surfaced should first be graded and thoroughly rolled. All stumps and large boulders should be removed. Surface and underground drainage should be provided. The crushed rock or gravel should be spread in three inch layers over the road, the coarse pieces at the bottom and the fine on top. Each layer should be packed with a street roller.

The first cost of macadamizing the roads would be considerable, but the cost of keeping them up would be less than it costs at present to keep them in a barely passable condition.

SAND.

The sand from the Missouri river bottoms is used quite extensively for mortar in the northern part of the county. The grains, however, are not sufficiently sharp and angular to impart the greatest strength to the mortar.

The Graydon and St. Peters sandstones, which occur in masses scattered over the county, afford a good sand for mortar. As a rule the sandstone is soft and friable and can be easily crushed. In many places it can be dug with a shovel, crushing being unnecessary.

All of the sandstone in this county contains too much iron to permit its use in the manufacture of clear glass.

SOILS.

The soils in this county may for convenience be classified as residual and transported, (or alluvial). The transported soils cover only a limited area bordering the Missouri river and its main tributaries. The soil along the streams tributary to the Missouri river consists usually of a rich brown or black sandy loam derived from the Jefferson City, Chouteau and Burlington limestones and the St. Peters and Graydon sandstones. These soils vary in depth from one to ten feet.

The alluvial soil of the Missouri River Valley contains more sand than that of the tributary streams, and is much deeper.

Residual Soils.

St. Elizabeth Formation.—The decomposition of the St. Elizabeth formation affords a sandy, clayey soil. It is cultivated to a small extent.

Jefferson City Formation.—The soil, resulting from the decomposition of the Jefferson City formation, is a reddish brown, loamy soil, containing some quartz sand. Its thickness varies from one foot on the up-lands to eight or ten feet in the valleys. It usually contains numerous flint fragments.

Chouteau Limestone.—The area underlain by the Chouteau limestone is so small that the soils formed through its decomposition are not worthy of note.

Burlington Limestone.—The soil resulting from the decomposition of this limestone is the most fertile of any in Moniteau county. It is a light, calcareous, clayey soil of a reddish brown color. On the high ridges it is thin and contains considerable residual chert, but on the slopes and plateaus it is deep and less cherty.

Soils and Industries.

The principal crops raised in Moniteau county are corn and wheat. Apples and grapes are cultivated to some extent and, some seasons, the yield of peaches is large. However, the severity of the winters and the possibility of heavy frosts in the spring has a tendency to discourage the cultivation of peaches.

The Jefferson City limestone soil is scarcely deep enough for raising cereals, but it is sufficient for grass. Cattle, sheep and hog raising are fast becoming the leading industries among the farmers, and will doubtless receive more attention in the future.

WATER SUPPLY.

The water supply of this county is derived from (1) springs, (2) streams, (3) wells and (4) artificial ponds.

Springs.—Springs are abundant in the Jefferson City formation, and at the contact between the Chouteau and Burlington limestones. The largest springs are at the latter horizon.

In sec. 28, T. 47 N., R. 14 W., about two miles north of Jamestown, a large spring issues from the side of a bluff and forms a stream about six feet wide. This is the source of Factory creek. This spring is at the contact of the Chouteau and Burlington, and has formed a cave extending into the bluff for a considerable distance.

In sec. 8, T. 46 N., R. 14 W., a spring, forming a stream three or four feet in width, issues from the contact between the Burlington and Chouteau limestones. This is known as Cave Spring.

In sec. 35, T. 46 N., R. 14 W., at the foot of a hill is a spring containing sulphur water. This is situated at the contact of the St. Peters sandstone and Jefferson City limestone.

Wells.—The wells are divided into (1) rock penetrating wells, (2) cisterns and dug wells, and (3) flowing wells.

Most of the rock penetrating wells are on the plateaus and high ridges where the distance from springs is great. The intercalated sandstone layers in the Jefferson City formation are water bearing horizons, and it is from these that the water is chiefly obtained. The first water bearing horizon occurs from 30 to 50 feet from the top of this formation.

At Jamestown a well has been sunk 64 feet into the Burlington limestone. Water was obtained at 40 feet.

Cisterns and Dug Wells.—Most of the people on the upland areas obtain their water supply from cisterns. In the bottom lands, shallow wells, dug in the alluvium, are the prevailing source of supply.

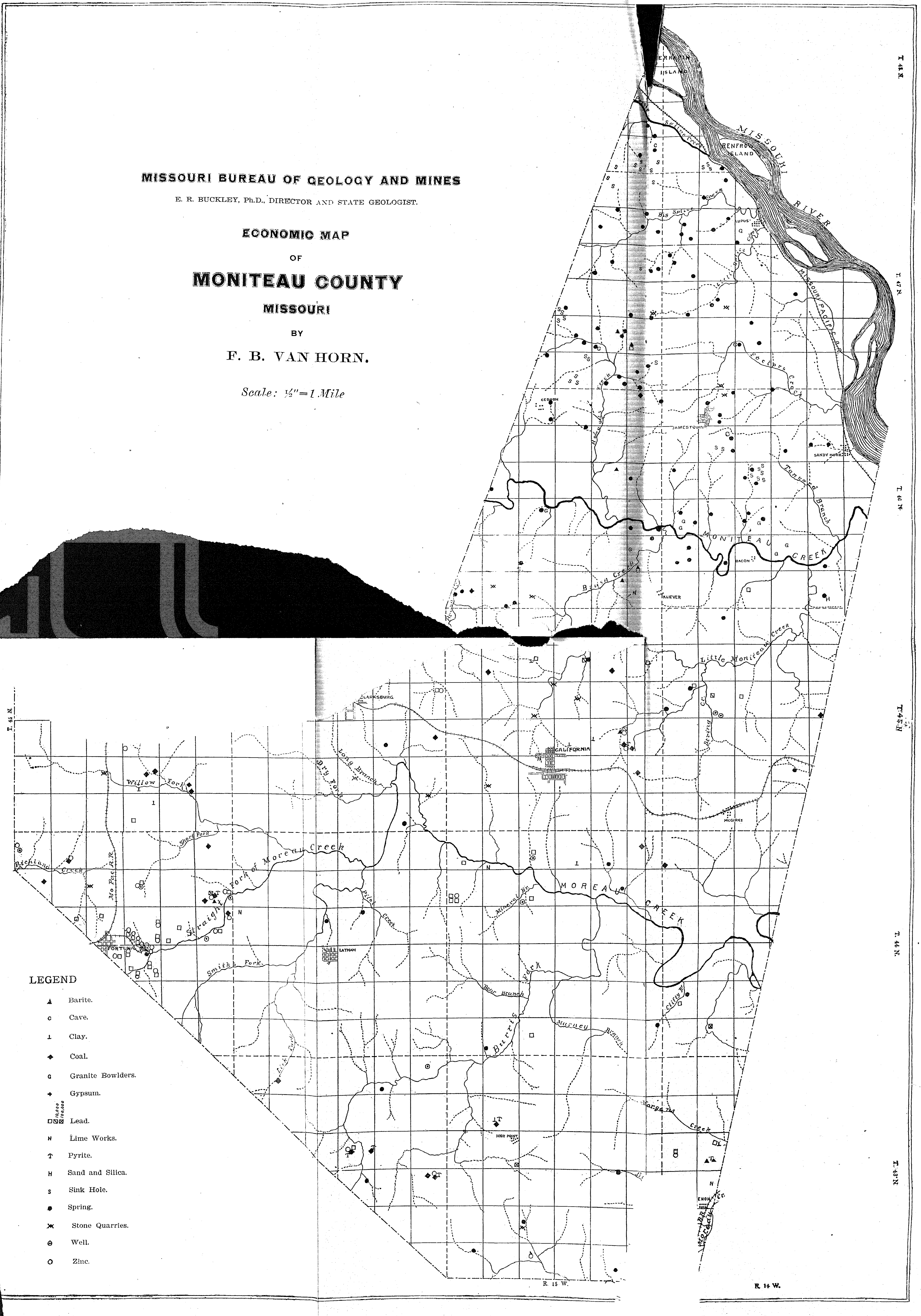
Flowing Wells.—In sec. 17, T. 45 N., R. 14 W., on land owned by Mr. Karl Messerle, there are two flowing wells in the Jefferson City formation. The first, which is east of Mr. Messerle's house, passed through a layer of sandstone at a depth of 128 to 136 feet, then through lime and flint down to 265 feet, at which depth a strong stream of water flowed out of the pipe at the surface.

The other hole was 182 feet deep and at 65 feet entered a broken lime and flint formation, from which the water ran over the top of the pipe. Six inch casing pipe was attached so that it stood twelve feet above the surface of the ground and the water flowed over this. Several other flowing wells exist in different parts of the county.

Artifiicial Ponds.—The sink-holes are utilized by the farmers for ponds for watering their stock. Hogs are fed in the holes and the openings in the bottom are thus packed with the clay in the sink. The surface waters drain into the sink-holes, and, being unable to escape through the impervious clay, form ponds. Where sink-holes are not available, reservoirs are constructed in the clay by building dams. These are filled by surface water during the wet season.

WATER POWER.

The Moreau and Moniteau creeks have a sufficient volume of water and the necessary fall to afford water power for small mills, but they have not been used for this purpose, at least in recent years.


MISSOURI BUREAU OF GEOLOGY AND MINES
E. R. BUCKLEY, Ph.D., DIRECTOR AND STATE GEOLOGIST.
ECONOMIC MAP
OF
MONITEAU COUNTY
MISSOURI
BY
F. B. VAN HORN.
Scale: ½"=1 Mile
LEGEND
Barite.
Cave.
Clay.
Coal.
Granite Bowlders.
Gypsum.
Lead.
Lime Works.
Pyrite.
Sand and Silica.
Sink Hole.
Spring.
Stone Quarries.
Well.
Zinc.
MISSOURI RIVER
RENFROW ISLAND
MISSOURI PACIFIC R.R.
JAMESTOWN
SANDY HOOK
MONITEAU CREEK
Little Moniteau Creek
CALIFORNIA
CLARKSBURG
McGIRKS
MOREAU CREEK
Straight Fork of Moreau Creek
Willow Fork
Smiths Fork
Long Branch
Dry Fork
FORTUNA
LATHAM
HIGH POINT
Burris Fork
Bear Branch
Harney Branch
Richland Creek
Mo Pac R.R.
Tabo Creek
KLIEVER
R. 15 W.
R. 14 W.
T. 48 N.
T. 47 N.
T. 46 N.
T. 45 N.
T. 44 N.
T. 43 N.

INDEX.