GEOLOGICAL SURVEY OF MISSOURI.

ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN No. 1.

CONTENTS:

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GEOLOGICAL SURVEY

OF MISSOURI.

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CONTENTS.

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STATE GEOLOGIST.

ARTHUR WINSLOW . . . . . JEFFERSON CITY.

ASSISTANTS.

G. HAMBACH, palæontologist.

G. E. LADD, asst. geologist.
Specialty: Building Stones, Clays, Etc.

A. E. WOODWARD, asst. geologist.
Specialty: Mineralogy and Chemistry.

JAMES D. ROBERTSON, assistant in the Zinc and Lead Regions.

LEO GLUCK, assistant in the Coal Fields.

ELSTON H. LONSDALE, aid.

C. F. MARBUT, aid.

JOHN C. HALLIGAN, clerk.

NOTICE.

This publication is the first of a series of bulletins which it is the purpose of the Geological Survey to issue at intervals. They are not intended to embody final results, nor are they to be taken as reports of progress to date. The material in them will represent such portion of the results of the work of the Survey, as can be provisionally and briefly presented in a serviceable form; the aim will be to make the matter such as the demand is most urgent for. But it must be distinctly understood that no such publication, or series of publications, represents the total product of the Survey's expenditure of money or labor, as is more fully explained in the following administrative report. In the present instance, in addition to what is here presented, a large amount of work, the short time considered, has been done on the zinc and lead deposits of the State, some of the results of which, it is the intention, shall appear in the next bulletin; further, a large part of Lafayette county has been examined and mapped in detail, and similarly portions of Iron and adjoining counties, and work has been done and facts have been collected relating to the geology of Jackson and Johnson counties. A general inspection has been made of the quarry industry of the State, preliminary to future work, and considerable progress has also been made in the examination of the clays in the vicinity of St. Louis. In addition to this a large amount of work has been done in the office in draughting and correspondence, and in the laboratory in the examination and arrangement of specimens.

ARTHUR WINSLOW,
State geologist.

BULLETIN NO. 1,

OF THE

GEOLOGICAL SURVEY OF MISSOURI.

ADMINISTRATIVE REPORT.

By ARTHUR WINSLOW, State geologist.

CONTENTS.

THE ORGANIZATION AND PLAN OF THE SURVEY.

Survey established May 13th, 1889.

The act establishing the Bureau of Geology and Mines was approved May 13th, 1889. The State geologist was elected by the Board of Managers on August 29th, 1889, and entered upon the duties of his office September 20th, 1889.

The location of the Survey headquarters was not decided upon until the beginning of October. This question settled, the State geologist started at once to organize the Survey.

Operations to cover the whole State.

In planning the work it was, from the start, evident that it would not be just nor practicable to examine and report only upon those subjects and areas which had not been reported upon by previous surveys of the State. Fifteen years have now elapsed since such work was done. New developments have been made. Interests which at that date were insignificant are now of great importance. Work of a character sufficient for the needs of that time, is now inadequate. The only rational plan for the Survey to follow was one which would satisfy all existing demands and requirements, as far as the means at disposal would allow.

With this idea in mind the following works are in progress, or will be in progress in the near future:—

THE WORK IN PROGRESS.

Subjects of work.

1. An examination of the zinc and lead deposits.
2. An examination of the coal fields.
3. An examination of the building stones, clays, sands and cements.
4. An examination of the mineral waters.

Ultimate objects.

The ultimate objects of these, and of similar examinations to be made by the Survey in the future, will be to determine, first the origin or mode of formation, second the distribution or horizontal and vertical extent, and third the character and adaptabilities of the substances studied.

THE ASSISTANTS.

Names and titles of assistants.

To carry on the work outlined, the following assistants have been appointed: —

G. Hambach, palæontologist.

G. E. Ladd, assistant geologist in charge of Building Stones, Clays, Sands and Cements.

Amos E. Woodward, assistant geologist in Mineralogy and Chemistry.

Leo Gluck, assistant in the Coal Fields.

James D. Robertson, assistant in the Zinc and Lead Region.

Elston H. Lonsdale, aid.

GILMER MERIWETHER, aid. (Resigned February 10th.)

C. F. MARBUT, aid.

JOHN C. HALLIGAN, clerk.

Special work on the Clays.

Professor H. A. Wheeler, mining engineer, of St. Louis, has been engaged as a special assistant in connection with the study of the clays of the State. He will have special charge of the experimental work, and is working in conjunction with Mr. Ladd.

Zinc and Lead Work of the U. S. Survey.

In addition to this regular force of the State Survey, Mr. Walter P. Jenney has been detailed by the United States Geological Survey, to make an examination of the zinc and lead deposits of this and adjacent States. He is working in co-operation with the State Survey and the results reached by him will be published by the State. Further, the following persons are working in co-operation with the Survey as local and volunteer assistants: —

Local and volunteer assistants.

JAMES A. MERRILL, assistant professor in natural sciences, State Normal School, Warrensburg.

E. M. SHEPARD, professor of natural sciences, Drury College, Springfield, Mo.

E. W. NEWTON, Bolivar, Polk Co., Mo.

During the coming summer it is probable that at least three additional volunteer assistants will be at work in the State, in various parts of it and on different subjects.

THE PROGRESS OF THE WORK.

Operations to date.

Much of the time during the past six months has necessarily been spent upon work incidental to the organization of the Survey. Assistants had to be found and their credentials examined; office furniture, supplies and field instruments had to be provided. Forms for office records had to be prepared; details of field and office work had to be systematized and described, and assistants had to be instructed in them. A large amount of correspondence has also been carried on, in answer to applications and inquiries of all kinds. Arrangements have been made for an exchange of publications with various scientific bureaus and associations, and, as a result, the nucleus of a valuable reference library for the Survey has already been collected. The State geologist has given a large part of his time to these matters of organization, to editorial work and to ordinary administrative duties,

Exchanges and Library.

such time as could be spared from these duties being spent in the field with the assistants, over all of whose work he is obliged to keep a general supervision, and over part of which he assumes immediate direction.

THE WORK ON THE ZINC AND LEAD DEPOSITS.

Corps engaged in the work in the Zinc and Lead Regions.

Mr. Walter P. Jenney is in immediate charge of this work and with him is associated Mr. James D. Robertson. Mr. Jenney is the geologist of the United States Survey, assigned to this work here. Mr. Jenney's many years of experience in various mining districts of this country, added to a thorough scientific training, should admirably fit him for the study of the important subject which he is now in charge of. There is every reason to expect that immediate and valuable results will flow from his work, when it is made public. Mr. Robertson, a graduate of Washington University, is an assistant of the State Survey, detailed by the State geologist to assist Mr. Jenney. He was appointed an assistant and entered upon the discharge of his duties October 1st, 1889.

Operations to date and ultimate results.

Mr. Jenney came to the State during the latter part of September. Early in October, he and Mr. Robertson started work in Jasper county and have since been busy examining mines in that and adjoining counties. They have also made brief studies in Greene, Christian, Lawrence and Polk counties, and also in Madison, St. Francois and other eastern counties. The objects of this inspection and study have been to obtain a clearer insight, than previous work has made possible, into the origin and mode of formation of the ore, and to acquire definite information as to its distribution. All of their work so far is, however, merely preliminary to the systematic and detailed investigation which these important deposits deserve, and for which it is the sincere hope of the State geologist that ample provisions will be made in the future, either by the national or State government.

THE WORK IN THE COAL FIELDS.

Corps engaged in the work in the Coal Fields.

This work is under the immediate direction of the State geologist. With him are associated Mr. Leo Gluck as assistant and

Mr. C. F. Marbut, who has succeeded Mr. Gilmer Meriwether, as aid. Mr. Gluck is a graduate of Washington University, St. Louis, and came to the Survey directly from Mine La Motte, where he was employed as chemist. He began work on October 23d, and after some three weeks of office work, started into the field about the middle of November. He has since been intermittently engaged in field and office work. Mr. Meriwether is a graduate of Vanderbilt University, Tennessee, and during the past year or two has been a resident of Kansas City, Missouri. He began work with the Survey on November 11th, and proceeded into the field with Mr. Gluck soon after. He resigned from the Survey early in February and his place was filled by Mr. C. F. Marbut, a graduate of the State University.

Operations to date and ultimate results.

The regular work in the coal fields has thus far been confined to Lafayette county, but a large part of this county has already been covered, and a great amount of valuable material has been collected. It is the aim of the State geologist in this work to systematically collect such detailed facts as will enable him to illustrate and define, as closely as possible, by maps, sections and reports, the area underlain by individual coal beds, their probable depth beneath the surface at any point within such area, their probable thicknesses at such points, and the adaptabilities of the various kinds of coal. With these objects in view, every coal opening is visited, examined, and located on the map, every drill hole record is hunted up, copied for future use, and the position of the hole located on the map. Through this work every land owner will ultimately be placed in possession of the best attainable information concerning what underlies his land.

THE WORK ON THE BUILDING STONES, CLAYS, ETC.

Corps engaged in the work on the Building Stones and Clays.

Mr. G. E. Ladd, assistant geologist, is in immediate charge of the work. Mr. Elston H. Lonsdale, a graduate of the State University of Missouri, is his assistant. Mr. Ladd entered upon his duties here on December 1st, coming directly from Texas, where he was connected with the geological survey as an assistant geologist. Mr. Ladd is a graduate of Harvard College and

has done geological work in the East, under Professor N. S. Shaler, for the United States Geological Survey.

The work on the clays of the State is to be a joint work, in which Professor H. A. Wheeler, of St. Louis, will be associated with Mr. Ladd; the former having especial charge of the experimental part of the investigations.

Operations to date, and in the future.

The past winter months have been spent by Mr. Ladd and Mr. Lonsdale in the field, in Iron, St. Francois and Madison counties. Their attention has been chiefly given to a preliminary examination of the building stones of that section. Mr. Ladd's report, in this bulletin, contains some of the results of this examination. Work has now been begun by Mr. Ladd and Professor Wheeler upon the important subject of the clays of the St. Louis district. Along with this, however, the detailed work in the southeastern counties still continues under Mr. Ladd's supervision and part of his time is spent there, while Mr. Lonsdale will be continuously occupied in the systematic mapping.

Importance of the work on the Building Stones and Clays.

Very little available to the public has been done on the subjects of this division of the work, and, thus, very little is known about them. The work in progress has for its objects, first a description of the quarries, clay pits and other workings, accompanied by suitable maps and illustrations; second a determination of the areas underlain or covered by these materials, and thirdly a determination of their qualities. This latter is an important part of the work, but can not be taken up at once. It will include the determination of such questions as the resistance to compression, to attrition, to frost, to heat, to water etc., of the building stones, the readiness with which they are dressed or polished, etc. A thorough study of the clays gives promise of most fruitful results. The clay and dependent industries of the State are already of great magnitude. The demand for the products is not only increasing with the population, but new uses for the material are constantly being found. A determination of the distribution, the amount and the nature of the raw materials will result in benefits to both the land owner and the manufacturer.

THE WORK ON THE MINERAL WATERS.

Assistant engaged in the work on the Mineral Waters.

An examination of the mineral waters of the State has been begun by Mr. A. E. Woodward, assistant geologist in charge of the mineralogical and chemical work of the Survey. Mr. Woodward was recently assistant in geology at the Massachusetts Institute of Technology. He was appointed to his position on the Survey in December last, and reported for work early in January.

Operations to date.

During the past months he has made examinations in the field and has collected samples for analysis of the mineral waters of Saline county. Since this time he has superintended the outfitting of the laboratory of the Survey, has made analyses of the mineral waters and of other samples, and has attended to miscellaneous duties connected with the collections of the Survey.

THE WORK OF THE PALÆONTOLOGIST.

The palæontologist.

Dr. G. Hambach, adjunct professor of geology at Washington University, St. Louis, has been appointed palæontologist. He assumed the duties of his position October 20th. He gives to work of the Survey only part of his time.

Operations to date.

During the past six months, in addition to preparing the list of fossils published in this bulletin, he has been occupied in examining and preparing for study a large amount of palæontological material which has been inherited from previous surveys of the State. He has also made several trips to examine collections already made by the Survey. His paper in this bulletin, prepared at the suggestion of the State geologist, is a valuable statement of the condition of our knowledge of the palæontology of the State and will be of great use to all field geologists.

THE WORK OF VOLUNTEER AND LOCAL ASSISTANTS.

Persons acting as volunteer and local assistants.

Professor J. A. Merrill, of Warrensburg, has volunteered his services to the Survey. The subject of his work, for the present, will be the geology of Johnson county, especially that part in the vicinity of Warrensburg. Professor Shepard, of Springfield, and Major Newton, of Bolivar, have already made a con-

siderable study of the geology of their respective counties, and have their notes recorded in an available form. This material is placed at the disposal of the Survey and additions will be made through future field work. The work of these gentlemen will be only such as they can find time for, outside of their regular occupations. At present this amounts to only an occasional day, but, during the summer, several months' time will probably be given. Their work will be of great assistance to the Survey as supplementary to the systematic work in the various counties.

Work in Jackson County.

Mr. Edwin Walters, of Kansas City, was in the employ of the Survey, as a temporary assistant, during the month of November. He was engaged in collecting drill hole data and other facts relating to the geology of Jackson county.

THE WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

Work of the U. S. Geological Survey previous to 1889.

Previous to the year 1889 the United States Geological Survey had confined its operations in this State almost entirely to topographic work. As a result of this there is now about one-half of the area of the State mapped, on a scale of about 2 miles to the inch and with a contour interval of 50 feet. Further, Mr. W. J. McGee, United States geologist, made in 1887 a special survey of a portion of Macon county.

Work contemplated in the immediate future.

The State geologist has now the assurance of the Director of the United States Geological Survey that the topographic work will be resumed here this year. In addition a special assistant will be sent here this Spring to work on the palæontology of the State, under the direction of the State geologist, and with the advice of Professor H. S. Williams, of Cornell, who will report upon the collections.

The continuance of the work in the Zinc and Lead Regions.

The continuance of the work on the zinc and lead deposits, by the National Survey, is provided for up to the end of June, 1890. In what manner it will be continued after that date is not decided. It is to be hoped, however, that this will be with much more ample means and on a scale proportional to the importance of the subject.

THE WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY.

Work of the U. S. Coast and Geodetic Survey to date.

Up to the present date the United States Coast and Geodetic Survey has carried a chain of primary triangles from the Mississippi river across the State to Kansas City, and has further run a line of precise levels up the Missouri river valley as far as Jefferson City. These levels are of value in the prosecution of geologic work, are indispensable for the construction of correct topographic maps, and will be valuable in the future for engineering projects of all kinds. It is desirable that the line to Jefferson City be extended up the Missouri valley to Kansas City, and thence southwards to the Arkansas line and the probability is that the work will be done this year.

FUTURE PROGRESS AND ULTIMATE RESULT OF THE SURVEY.

The nature of the work of the State Geological Survey.

The ultimate result to be obtained by the geological survey of the State is a complete knowledge of its natural features and products. The work will not be one of startling discoveries, but rather of simple descriptions based upon facts patiently accumulated. The object will not be to bring disproportionately into prominence any one mining enterprise or district; but rather to give, in a nearly uniform manner, an exact description of every subject or area studied. Such descriptions are sought after by the property owner, by the miner, by the investor, by the home-seeker and by the professional man. They should be accessible to all in such a form as to be plainly intelligible, and in such detail as to be of immediate use in practice. The information which the maps and reports will contain will be, in part, such as the native of long residence may be familiar with, but which is news and information of value to the stranger; and it will be, in part, such as the resident property owner is probably not familiar with and concerning which he may have only the wildest hypothesis to guide him. These two classes of facts grade into each other, of course, insensibly, and they are both, properly, parts of a complete description.

Simple and exact descriptions. The objects.

Final results cannot be attained quickly.

The material for such description must be collected systematically and patiently on the ground, and too rapid progress must not be expected. Too much must not be expected in a short

time, nor must work be looked for in too many places at the same time. The Survey force is small and the area to be covered is great. Good work demands time.

Partial and provisional results to be published in bulletin articles.

But, though detailed and accurate work is necessary for results of permanent value, so much time has elapsed since any description of the geology of the State or of its mineral industries has been made, that no recent and reliable information concerning these subjects is to be had. To supply this want, it is the intention of the Survey to push forward, as rapidly as possible, a reconnoissance along the various lines of study which are taken up, at the same time that the detailed work is in progress in special localities. The results of this reconnoissance work will be published in bulletin articles, such as are herewith presented, while the results of the detailed work will make up the matter of the monographs and of a series of uniform, detailed maps.

PUBLICATIONS OF THE SURVEY.

The nature of the bulletins.

The results of Survey work will be published in bulletins and in monographs or systematic reports upon special subjects or areas. The bulletins will be issued as nearly periodically as possible, probably every three months, and it is the object to publish in them short papers which are complete in themselves, and such partial results as admit of, or demand immediate publication. A part of the value of some results lies largely in their being made immediately known, and these bulletins furnish thus a convenient means for making such information public.

The nature of the monograph.

The monograph will be the result of comprehensive and exhaustive study; in it will be collected all that is known of the subject or area under consideration; it will be subdivided into topics and these will be systematically discussed; it will be illustrated by maps, diagrams and plates, and will be a volume of permanent value for reference. Disconnected material already published in bulletins, may reappear in a more complete form in a monograph as parts of a systematic discussion of topics.

CABINET, COLLECTIONS AND LIBRARY OF THE SURVEY.

A collection for a State Cabinet is begun.

The act creating the Survey makes special reference to collections and the formation of a State Cabinet by the Survey.

With this object in view a part of one of the rooms occupied by the Survey in the Capitol building has been fitted with specimen cases and shelves. A collection to be put in these cases is already started, and it is thought that, by next Autumn, enough material will be on hand to make the beginning of an instructive exhibit.

The value of a State Museum.

The value of such an exhibit, when carefully arranged with a view to illustrating definite occurrences or processes, and when accompanied by all necessary charts and diagrams, can hardly be overestimated. But to make such a collection valuable it *must be carefully arranged*. The specimens must be nicely prepared, must be plainly labeled and must be assorted and grouped with patient thought and study. There should be no restriction in space. Such a collection, when prepared, represents a great outlay of time and money. When once prepared its perpetuation and healthy growth should be assured for all time. The collections made by previous surveys of the State are now either scattered and largely lost to public use, or are buried in boxes and cases, dust covered and without labels, of little more value than so much rock from a dump pile. Every State should have, located at its center of industry and intellectual activity, a well equipped museum, under active management and responsive to the needs of the times. There, should be exhibited and explained the natural features and the products of the State, and there, should be systematically collected, recorded and preserved from injury and loss, all that mass of facts which constitutes the basis of complete knowledge.

The Museum should be permanent.

RELATIONS OF THE SURVEY TO LOCAL AND PRIVATE WORK.

Reasons why it is impracticable to visit localities on application.

The State geologist receives many applications to visit and to examine different localities in the interests of individuals or of certain sections. Inasmuch as the Survey force is small, and as the whole force is engaged in prosecuting the work systematically in the study of specified districts or subjects, it is impossible to meet these applications in the manner anticipated. A mere inspection by the State geologist, or an assistant, in answer to such application, would, in most cases, serve no useful purpose. An area must be studied systematically and in detail for conclusions of value to be reached. The State geologist is, however,

glad to receive, from any part of the State, notice of discoveries and records and information of all kinds. Especially is it desirable that copies of records of all deep drill holes be sent him. Such communications will be held as confidential if desired. With the light of all the facts accumulated by the Survey, the geologist may be able to draw conclusions from such records which the driller might be far from suspecting. Further, the Survey office is the best possible place for recording such results. They are attained at too great a cost to be allowed to go to waste. The facts ascertained by such drilling are of value for all future. Even if only of negative value, a carefully kept record will often prevent repetition of useless work; while, on the other hand, results which, at the time, may have no economic value, may, with later developments, have most important bearings. When such drilling is in prospect, the State geologist, if advised, will be glad to give suggestions as to the proper method of sampling and preserving record of the drillings of such holes.

Drill Hole records desired.

Information sent should be definite.

It is particularly important that all information sent should be as definite as possible and that the exact location of any occurrence of interest be given by township, range, section, quarter section and fraction. Such information will then be duly recorded and filed, and when the survey reaches that section, in the progress of its regular work, the locality will be examined and reported upon with all due care.

Directions for sending specimens.

With regard to specimens sent to the State geologist the following rules should be observed:—

1. Packages should be addressed to the State geologist, Jefferson City, Mo.

2. Specimens sent, whether by mail or express, should be fully prepaid.

3. The name and address of the sender should accompany the package, and the township, range, section, and quarter from which it comes should be given. If the matter is of importance, it will be regarded as confidential, if desired.

Much of the material sent in is, upon its face, valueless, while in other cases there is doubt which can only be determined by chemical examination. In cases where no critical examination is required, the State geologist will give his opinion regarding

Limits of examination.

the specimens, and, where an assay or analysis is necessary, he will, if desired, make suggestions as to the advisability of having assays or analyses made.

Assays and Analyses not made; — reasons why.

It should be borne in mind, however, that the State Survey is not at liberty to make these assays or analyses gratuitously or for a consideration. Inasmuch as many persons fail to understand why the Survey cannot do such work, some of the reasons are here given.

First. The Survey cannot know where the specimens come from that are sent in by others than its own members, and can therefore never draw trustworthy conclusions from them.

Second. In many cases material is sent in of which it would be a waste of time to make a detailed examination, and in other cases alloys and artificial products are sent which would require more time than the cases warrant.

Third. If the Survey were at liberty to do private work, it would be possible for a single individual or company to take up the entire time of the chemist in doing his or its private work to the exclusion of all others. A person having interest outside of the State might hand in an immense amount of material for examination, and the State of Missouri would thus be conducting a chemical laboratory for his exclusive benefit.

Fourth. The chemical work absolutely essential to the successful operation of the Survey, occupies the full time of the chemist.

NOTES ON THE

COAL BEDS OF LAFAYETTE COUNTY.

By Arthur Winslow, State geologist.

CONTENTS.

Previous geologic work in Lafayette county.

The geology of Lafayette county has not been connectedly studied nor described even to the extent that other counties of the State have received treatment by the earlier geological surveys. About all that has been published is contained in the report of the Geology of Northwestern Missouri by G. C. Broadhead, in Part II. of the Report on Iron Ores and Coal Fields of 1872; some fourteen pages, in the first part of this report, refer to the geology of Lafayette county, and matter relating to it is also found in a dozen or more other pages, scattered through the report. The information thus given is, further, neither connected nor complete, but consists largely of descriptions of outcrops, sections and records found at various localities and derived from various sources.

Scope of present work.

The systematic work which is now in progress in the county aims to give an exhaustive description of its geology in a report illustrated by detailed maps and sections. The progress of such work is, however, necessarily slow and, pending its completion and pursuant to the general plan of work described in the preceding administrative report, this brief

A SKETCH MAP OF

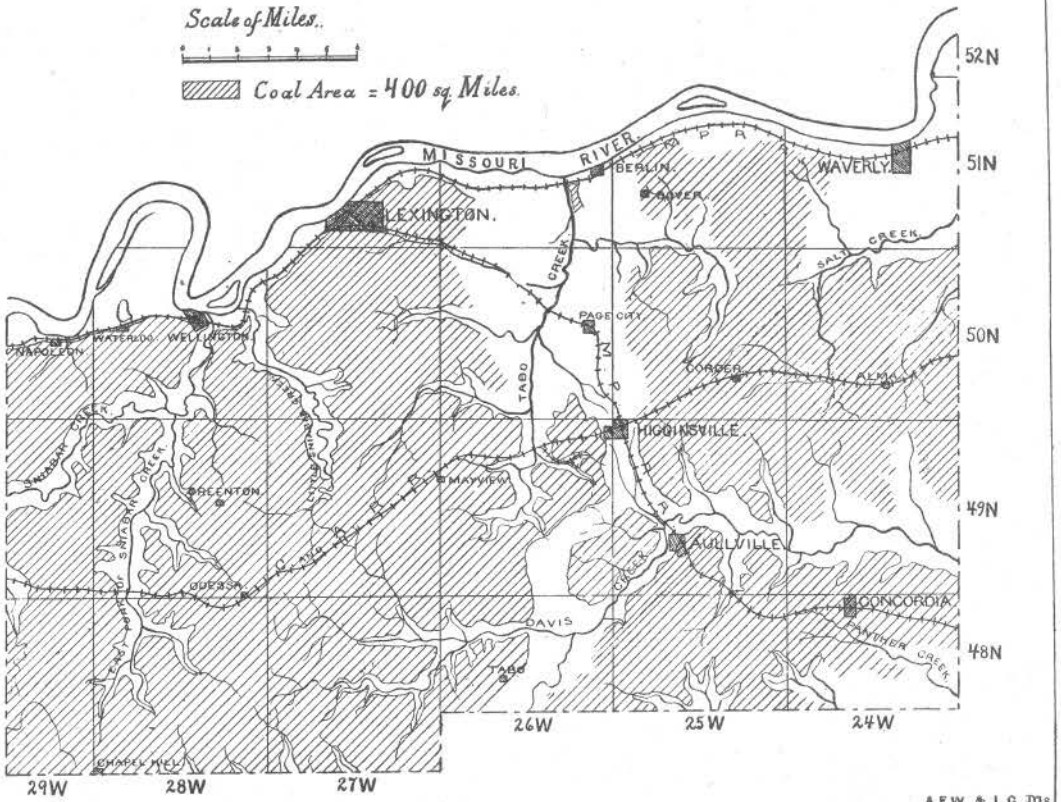
LAFAYETTE COUNTY

SHOWING THE APPROXIMATE

COAL AREA

INCLUDED WITHIN
THE LIMITS OF THE
MULKY AND LEXINGTON BEDS
AS PROVISIONALLY
OUTLINED.

A TYPICAL SECTION OF
THE LEXINGTON COAL BED
AND ASSOCIATED ROCKS.



article is prepared, relating to what is at present the most important mineral product of the county.

Results here expressed are provisional.

It is to be distinctly understood, however, that the conclusions here expressed are not final, and are subject to the modifications which the results of detailed work may hereafter call for. The descriptions and the deductions are almost entirely such as result from a reconnoissance and are presented, merely, to answer immediate calls for information, while the detailed work is in progress.

Rocks belong to the Middle Coal Measures.

The Rocks of Lafayette County, with the exception of a few patches in the western portion, have been referred, by the geologists of the earlier surveys, to the Middle Coal Measures. They consist of alternations of limestones, shales, sandstones, clays and coal beds, the whole aggregating several hundred feet in thickness.

The Coal Beds of Lafayette county.

In this column of rocks several coal beds occur. Of these, what is known as the Lexington Coal Bed is at present of greatest industrial importance. In the southeastern portion of the county, however, in the vicinity of Concordia and Aullville, another underlying bed, known as the Mulky coal, is worked and is there of chief importance. Outcroppings of other beds occur at numerous localities where the coal is too thin to be profitably worked; at some places, notably above Waverly, such coal is reported to have been dug into of considerable thickness, but the developments are not sufficient for one to predict the extent of the bed. Again, at other localities, deep drill holes have been put down in which thick coal beds are reported to have been struck; but the results from such deep drillings at different places are conflicting, and it will take a closer study than this article purports to be the result of, a more careful sifting of facts, before the reported results of such drillings can be reliably judged of.

Position of the Lexington Coal Bed.

The Lexington Coal Bed is situated geologically in the neighborhood of 230 feet below the top of the Middle Coal Measures. Geographically it is included within the shaded area of the page plate map accompanying this article, and west of Aullville the outlines of this shaded area represent approximately the outcrop line of this bed, as provisionally defined. East of Aullville it rises

higher above water level and is found only near the hill tops in comparatively limited patches. Hypsometrically it is in such a position that its outcrop is almost always above the adjacent water level. It lies in a gently undulating sheet, with a slight north westerly dip, which crops out along a sinuous line on each side of the main drainage channels. The thickness of this bed is not very variable, and a fair average of its sections is shown in the plat on the accompanying plate. In the vicinity of Lexington it exceeds the average by two or three inches and in a few localities reaches a thickness of two feet. West of Lexington, along the river about Wellington and Napoleon, the coal is about eighteen inches thick; in the vicinity of Higginsville and Corder it is from seventeen to twenty inches thick, and in the vicinity of Odessa it is from fifteen to sixteen inches thick.

Thickness of the Lexington Coal Bed.

The Mulky Coal Bed is situated, as far as we can judge from present knowledge, at a very variable distance below the Lexington bed. In the vicinity of Mulky creek, two and a half miles southeast of Aullville, the interval between the two beds is in the neighborhood of fifty feet. About a mile southeast of this point, it is apparently nearer seventy feet; while, in the vicinity of Aullville, concordant results of two drill holes show the existence of a bed below the Lexington coal at a depth of about one hundred and fifty feet, which coal, is the only one in this section which could be considered the equivalent of the Mulky bed.

The position of the Mulky Coal Bed.

The existence and the distribution of the Mulky coal is best determined in the vicinity of Aullville and the outline of the shaded area east and northeast of that place approximately defines its limits, as far as has been determined by reconnoissance. West of this, drill hole records or other results of deep explorations are too scarce, and the country has not, as yet, been sufficiently studied for one to attempt to define the distribution of this coal, or even to assert its existence or absence over this area. The thickness of the Mulky bed, where opened upon, is seen to be very nearly the same as that of the Lexington bed. At three different openings, a few miles west of Concordia, the thicknesses measured were respectively: nineteen inches, twenty-two inches, and twenty inches; at the Elling shaft, nearly four miles west of Concordia, the thickness is reported to be between twenty-two and twenty-four inches.

The distribution of this bed uncertain.

Thickness of the Mulky coal.

Breaks in the continuity of the Coal area due to two causes.

The Coal Area. A study of the accompanying map will show that the continuity of the coal area is very much broken.* This is due to two causes. One is a cause at present in action and, though extending back far into geologic time, is yet posterior to the deposition of all the Carboniferous rocks in the county; namely, the process of erosion along the lines of flow of the now existing streams. But, in addition to what may thus be called the erosion area of these streams, a sinuous strip of country, destitute of coal, can be traced on the map from the south line of the county, near Tabo post-office, northwards through Higginsville and Page City to the river. In this strip, which in the vicinity of Higginsville is between one and two miles broad, no Lexington coal bed is found. On the contrary, deep drill holes have been put down hundreds of feet into the ground here and have struck nothing but sandstone and shales. It is in this strip that the McCauslan farm drill hole, reported to be eight hundred feet deep, is located, which is referred to on page 42 of Part II of the report of 1872. This sandstone is considered in the report of 1872, above referred to, to be the upper sandstone of the Lower Coal Measures, and its position has been explained by considering it a protuberance of these lower rocks. Recent drillings and other developments, however, furnish reasons for a modification of this view, and the writer is inclined to assign a *later* age to these sandstones than to the adjacent coals and limestones. The strip above outlined has all the appearances of being the site of an ancient river channel, eroded during some brief period of elevation and afterwards filled by deposits of sand and finer material, during a subsequent period of submergence. Studies now in progress in Johnson county, in the extension of this line, go to confirm this interpretation, but sufficient facts have not yet been accumulated for it to have been accepted as final, nor for the age of such erosion to have been determined. It is presented merely as a promising working hypothesis, and criticism of it will be very welcome.

The sandstone belt.

Age of the sandstone.

*The limits of this coal area, it will be noticed, are not marked in places by definite lines. This, in some cases, is because data have not been obtainable for accurate definition, while elsewhere, especially in the eastern and northeastern portion of the county, the work of the Survey has not yet progressed far enough for closer delineation to be attempted.

The Coal Tonnage. The total coal area of Lafayette county, as shown on the map, is approximately four hundred square miles. From this figure an approximate estimate can he made of the coal tonnage of the county. For this purpose we will neglect those areas of the Lexington coal which are known to overlie the Mulky coal east of Aullville, and will throw out of the consideration any portion of the Mulky coal bed which may underlie the area west of Aullville. Thus the estimate will be on the assumption of only one coal bed over the entire coal area. Should the presence of the Mulky bed west of the vicinity of Aullville be demonstrated later, a very great increment to this estimate of the coal tonnage of the county will be made. For the purposes of this estimate, we will further assume eighteen inches as an average thickness of the coal over this area. On this basis, the total amount of coal in the county would be 669,000,000 tons or about 2,600 tons per acre. With the present methods of mining it is probable that nearly 80 per cent. of the coal in the ground is excavated and shipped; but assuming it to be even as low as 60 per cent., the gross value of the product from the above total tonnage, at present market prices, would be about $670,000,000. Allowing a net profit of twenty-five cents per ton (about one cent per bushel), the total net profit on this amount of coal would be in the neighborhood of $100,000,000. On the same assumption, the gross value per acre of the contained coal would be in the neighborhood of $2,500, while the net value would be about $400.00 per acre.

The Coal Area of Lafayette county.

Total amount of coal.

Total value of the coal.

The value of the coal contents of such land, based upon the present market prices of the same substance, is thus many times what the land is valued at for farming purposes. Coal, however, is a possession which is not convertible until excavated and transported to market, and, until this is done, it represents just so much capital lying idle in the ground. Moreover, the coal of any one tract cannot be opened upon, excavated and thus converted into ready money in a short time; but the work will proceed slowly and the returns will come in gradually from year to year. Thus, if a man own a property of forty acres, of which, according to our calculation, the net value of the coal is $16,000, and if he does not receive any of this $16,000 until the expira-

Difficulties in the way of fixing exact values.

tion of fifteen years, then the present value of his land is a sum, which, at compound interest at current rates, will amount to $16,000 in fifteen years; this at 6 per cent. interest will be about $6,700. The exact time when a man may receive the full net value of the coal contents of his land depends upon many indefinite factors, such as the growth of facilities of transportation, the demand for the product, etc. It is thus impossible to give any one value per acre which will apply to all coal lands, even though their coal contents and the conditions under which it occurs be similar.

Prospects of the Coal Industry.

The Coal Industry. For Lafayette county, however, there is every prospect that the coal industry will increase largely in the near future, and the developments will probably be most active along and adjacent to the railway lines at present constructed. This county stands already second in the State in the amount of its annual production, and the product for the year ending June 30th, 1889, was over 320,000 tons, with an average value at the mine of nearly $537,000. This product is about 14 per cent. of the total for the State during the same period.

The extensive working of so thin a bed is remarkable.

The fact that, in this county, a coal bed is worked, on a large commercial scale, and at considerable profit, which, at the most, is very little over two feet in thickness, and which is generally considerably less than this, will be to many a surprising fact. In this country coal less than two feet in thickness has been ignored in tonnage estimates, and when less than three feet in thickness has been considered of value only when above water level and otherwise favorably located for cheap mining. In the present case, not only is the bed less than two feet in thickness, but it is mined in places by shafts nearly one hundred feet deep, out of which all water has to be pumped. In England coal seams less than two feet in thickness are considered workable on large scales, and official estimates of the workable coal of the United Kingdom have included all beds above one foot thick, within a depth of 4,000 feet. That this country will, before many years, approach England in industrial activity cannot be doubted. The practicability of working these coal beds of Lafayette county under present conditions is a demonstrated fact; with further in-

Limits assigned in England.

dustrial growth we can, therefore, confidently look forward to a much greater development of its coal interests.

Conditions favoring mining in Lafayette county.

The reasons which have permitted the mining of this coal so far will apply equally to its development in the future. Briefly stated these are, first that it is generally above water level and can be opened by drifts or shallow shafts, can be drained by natural flow or with siphons. This condition of the bed is well seen along the river bluffs where the coal crops out, generally above the level of the railway, continuously for miles. Towards the interior, the general northwesterly dip of the bed, and consequent southerly rise, tends to maintain this relation between the position of the beds and the traversing drainage channels, so that the coal crops out at frequent intervals along the hill sides bordering the streams. Further, among the conditions favoring the mining of this coal, is the presence of an excellent roof which overlies it, and the fact that the proportions and divisions of slate, between the coal and the limestone head rock, are such as to permit of mining by a method similar to the long-wall, by which almost all of the coal is excavated. With future developments and enlargements of the industry, it is probable that coal will be produced at a considerably lower cost than at present. Mining is still carried on here, on what would be considered elsewhere a small scale; cutting of the coal is done by hand and hauling in the mines either by man or mule power. With the introduction of suitable coal cutters and wire rope haulage the cost of production will be considerably reduced.

Enlargement of works will cheapen cost.

The Composition of the Coal. No analyses or other tests of these coals of this county have been made by this Survey. In Part I of the Report of 1872, already cited, analyses of six of these coals are given which show the following ranges of composition: —

Analyses of the coal.

Water	5.55	to 8.85	per cent.
Volatile matter	34.05	" 42.95	" "
Fixed carbon	39.66	" 50.04	" "
Ash	5.14	" 18.17	" "

They are, thus, decidedly bituminous coals, somewhat high in water and in ash. Just what their capabilities are for the purpose of coking, gas production, or any other of the uses to which coal is put, cannot be stated without further examination.

NOTES ON THE

BUILDING STONES, CLAYS AND SANDS OF IRON, ST. FRANCOIS AND MADISON COUNTIES, MISSOURI.*

By G. E. Ladd, assistant geologist.

CONTENTS.

* These notes relate to an area where detailed work is in progress upon the various geological problems presented. Chemical and physical tests, and microscopic studies of the specimens selected in the field, are necessarily reserved for the future, and this paper is, therefore, chiefly descriptive of localities, and contains only such results and generalizations as a brief field inspection will warrant.

PREFATORY REMARKS.

The following paper, on the building materials of three of the southeastern counties of the State, is the product of about two months' time spent in the field; and though, by no means exhaustive, it will be found a useful description of an, as yet, almost untouched subject, and its preparation reflects great credit upon the energies and discernment of its author. This article, like others of the bulletin, is a partial result; it is a provisional publication and may be taken as a sample of what will be produced in the future from that general reconnoissance along the various lines of work, to be carried on simultaneously with the systematic and detailed work, as outlined in the preceding administrative report. The questions relating to the origin, distribution and properties of the substances here treated of, are numerous and intricate, and can only be solved by critical and comprehensive study. But the importance of these questions demands just such study as this. The very incomplete figures which the Survey has so far been able to collect are yet sufficient to show that the value of the total product of stone quarries of the State reaches many millions of dollars, and the value of the annual product must be now several millions. Stone is destined to be used more and more in the future for building and other purposes, and this not merely in the ratio of the increase of population, but further because permanent construction is destined to succeed the temporary construction which has been largely the practice heretofore. This change is already taking place in the East, and, as a notable illustration, may be cited the case of the Pennsylvania Railway, where iron bridges and other structures are being almost entirely replaced by stone ones. Though no definite figures relating to the clay products are at hand, their value cannot be second to those of the stone quarries, and the tile and brick industry of the State is recognized to be among the most important in the country. Its future growth cannot be doubted. With the recognized importance of these substances in the industrial world, the

time is certainly past when we should be comparatively in the dark, not only as to their distribution and as to the best localities for obtaining them, but also as to their capabilities and adaptabilities, when found. Enterprises must fail if they have not this fore-knowledge. Scientific experimentation should always precede an industrial venture, and this experimentation should be exhaustive and on a scale proportional to the interests involved. The increase in the number of laboratories and testing works during recent years is an indication that this need is beginning to be felt, and it is with an appreciation of this need that the Survey contemplates, as part of its work, an investigation into the properties of the materials herein treated of.

ARTHUR WINSLOW, State geologist.

GENERAL GEOLOGY.

Presumable age of the rocks.

Iron, St. Francois and Madison counties, situated in Southeastern Missouri, include the most important part of what is known as the Missouri Archæan district. With the recognized Archæan rocks, however, Lower Silurian rocks are associated; the Archæan rocks rising in hills of dome-like shape through the Lower Silurian strata, which surround and rest upon them. The hills vary in height from less than one hundred feet to about seven hundred feet. The rocks which have been determined as composing the Archæan, are the crystalline siliceous rocks and the porphyry conglomerates, given in the following classification. The Lower Silurian strata consist of what is possibly

Nature of the rocks.

Potsdam Sandstone, and of the Second Sandstone and of the Third Magnesian Limestone of Swallow. The latter formation consists of thick beds of limestone, which are often magnesian, and also of beds of marble; the latter are, however, of much more limited distribution than the former.

Classification of the rocks.

For convenience of discussion the following provisional classification of the rocks of this region is adopted. It is a classification adopted with reference to the industrial uses of the rocks. It cannot be considered in any way final until a detailed study into the origin and composition of the various rocks is made.

1. CRYSTALLINE SILICEOUS ROCKS.
   a. Granite.
   b. Syenite.

c. Porphyry and Felsite.
d. Diabase and Diorite.

2. CARBONATES.
a. Limestone.
b. Marble.

3. FRAGMENTAL ROCKS.
a. Sandstone.
b. Conglomerates and Breccias.

Clays and sands.

The clays of commercial value, so far as discovered, are not wide-spread, and are practically undeveloped. The clays which have been worked are classed locally as brick and pottery clays, and will be discussed under these headings. The sands and gravels are recent Quarternary deposits.

BUILDING STONES.

The building stones are the most important materials of construction to be considered here; they will be discussed in the order of the classification given.

CRYSTALLINE SILICEOUS ROCKS.

Distribution of the granites.

Granites. — Of this group the granites afford the most valuable structural materials. Their most important occurrences are in the southern part of St. Francois county, the northeastern part of Iron and the northwestern part of Madison counties.

Qualities.

These rocks have many qualities to recommend them, which are apparent on cursory observation. The colors are excellent, varying from red and pink to gray, while often a contrast between the colors of the constituent minerals yields very beautiful effects. They take a brilliant polish, are very strong and are reasonably durable.

Conditions of occurrence.

Other considerations which make these granites valuable lie in the conditions under which they occur, and these conditions probably hold over extensive areas. The first of these is, that the joint planes, or open seams in the rock, are in number and arrangement so happily adjusted as to make the quarrying of the rock easy and economical. The second, is that very little "stripping" has to be removed before stone quarrying may be carried on. Further, the stones are easily split by the quarryman, and are easily dressed by the stone cutter.

Demand and market for granites.

The localities where the granite is workable, although not immediately accessible to the railway, can be reached in most cases by switches or tramways. The demand for these granites for building purposes and for paving blocks seems to be constantly growing. The principal markets are St. Louis and Chicago, but the stone has found its way to many distant parts of the United States.

Distribution and qualities of the syenites.

Syenites. The syenites are wide-spread, but have been quarried only in St. Francois county. They take a good polish and are very handsome. Their colors are dark pink, and light and dark grays, which are mottled with red feldspars and with black crystals of hornblende. These rocks, when quarried, are now used entirely for paving purposes. Only one attempt has been made to quarry them for dimension stone, and this proved a failure because of the easy fracturing of the rocks along numerous, almost imperceptible seams.

Uses.

"Motions" and "motion work."

Near Knob Lick the syenite is worked extensively in "motions," the name motion being given in this region to a class of work confined to boulders, which either lie already loose upon the surface, or are excavated from the decayed rock by pick and shovel. These boulders in the syenite lie *in situ* to a depth of twenty or more feet. The decay of the rock mass has progressed from a net work of joint planes, the amount of decay diminishing away from these planes until, near the center of the meshes, the boulders are still fresh and ready to be split and worked. Many are thus able to make paving blocks who could not assume the expense of opening a quarry. A "motion" man, assisted by a boy to drill and split boulders, will probably produce from this rock an average of seventy paving blocks a day. Motions are occasionally developed until bed-rock is reached, when derricks are put in use and small quarries opened.

Distribution and qualities of the porphyries and felsites.

Porphyries and Felsites. The porphyries and felsites are widely distributed and make up the greater part of the Archæan rocks. They take a high polish, and are of widely varying colors, such as red, purple, green, black and brown of many shades. The porphyries are especially handsome, containing, as they do, crystals varying from mere specks to those several inches long, which contrast beautifully in color with the matrix of the rock

They are exceedingly hard and break with a sub-concoidal fracture. Their specific gravity is very high. For dimension work these rocks will probably never be extensively quarried, principally because the joint planes which intersect them are so numerous as to make it impossible, or at least extremely difficult, to obtain large enough blocks; and also because the rock is so very hard that, worked by present methods, it cannot be dressed without too great an expense. However, they split easily and are widely worked by small companies for paving blocks; and for these they have the recommendation of being very durable, but have the defect that, unlike the granites which wear to a very rough surface, they become very smooth and slippery with use. Uses limited.

Diabases and Diorites. These rocks are found most extensively in Madison county. They are commonly called green stones, and are intrusive in the granites, but have not been observed in the prophyries by the writer. They are mostly dark gray in color, and are as readily polished and dressed as the granites. Such attempts as have been made to quarry them for dimension stone have failed completely on account of the large number of seams and joint planes. They make good paving stone and are easily quarried and split. Distribution of diabases and diorites. Qualities.

CARBONATES.

Limestones. The limestones exist in these counties in inexhaustible supplies. They are, as a rule, easily quarried, and some of them dress very readily. Their best color is a soft buff, although they are also of a dark gray and an almost white color. They seem to be very durable. No attempt has been made to quarry them for any commercial purposes. Locally they are used extensively for foundations, bridges, walls, tiling, etc., and a few very handsome dwelling houses have been constructed of them. Distribution and qualities of limestones. Uses.

Marbles. The marbles are confined in these counties, so far as is known, to Iron and Madison counties. In Iron county their distribution is confined to the territory drained by Marble creek and the head waters of Stout's creek. In Madison county they are confined practically to the townships of ranges five and six east, Distribution of marbles.

and, in these, to the territory south of the Little St. Francois river.

Mode of occurrence.

The marbles occur, in places, with a total thickness of probably thirty or more feet, and some strata may be found which are two feet or more thick.

Qualities.

Their colors are beautiful, varying from light gray to dark red and chocolate, sometimes exquisitely combined in variegation. They are capable of taking a brilliant polish.

The development of the marbles.

No well directed effort has been made to develop these marbles, but several partially successful efforts have been made. The chief reasons for their discontinuance have been: the distance from railways, thinness of strata, frequent seams and blotches of green and brown ferruginous clays which weather out on exposure, and a tendency of the stone to "pluck," in a damaging way, under the tools of the stone cutter. In spite of these numerous drawbacks there are, however, many places where well conducted quarrying may be profitably carried on, and the marbles made a source of considerable wealth.

FRAGMENTAL ROCKS.

Distribution of the sandstones.

Sandstone. The Second Standstone is found in many localities capping the Magnesian Limestones or resting upon the Archæan rocks. In St. Francois and Madison counties the beds sometimes reach a thickness of one hundred feet or more.

Qualities.

They are often sacharoidal, but are mostly stained red or yellow with ferric oxide. They disintegrate most easily and are unfit for building material, although they have been used by the railway company in constructing bridge abutments, and locally for door and window sills.

Distribution of conglomerates.

Conglomerates and Breccias. Several varieties of these rocks are found, most of which are not now in their proper geological horizon, but exist only as boulders scattered over the hill slopes. The contained pebbles are usually limestone, while the cementing material varies, being in different localities, lime, silica and limonite respectively. On Pilot knob and Shepherd mountain, Iron county, there occurs a porphyry conglomerate in which the

Porphyry conglomerate.

pebbles (often large enough to be called boulders) are porphyry, as is also the cementing matrix. This rock was quarried locally at Ironton, but was found to be not durable, disintegrating very rapidly. Extensive and thick beds of porphyry conglomerate

are found in the northwestern part of Madison county and in the eastern part of Iron county. In the western part of Iron county is a conglomerate consisting of light green crystalline limestone, or marble, containing small, well rounded pebbles of a darker green sub-crystalline limestone. It makes a very handsome ornamental stone, but the quantity is probably so limited as to make the occurrence of no commercial value.

CLAYS.

Sedimentary and residual clays.

In the area here discussed no sedimentary clays have been observed excepting such as have resulted from local washings from the hillsides; but, of residual clays, there are very extensive beds, products from local decomposition of the rocks, which vary in thickness from a few inches to seventy feet or more.*

BRICK CLAYS.

Bricks made for local use only.

The only demand for bricks is the local one, which is extremely small; consequently the industry has been carried on only in a desultory way. The material used is a clay, residuary from magnesian limestone, but is fit for use only to a depth of about eighteen inches, where, having been weathered and leached by rain water, it is in a condition to make a fair quality of brick which burn to very dark colors. The clay is sticky and much sand is required in moulding it, which is probably the reason for the failure of several brick making machines which have been tried in Iron and Madison counties.

Production.

In Iron county, brick has been made at Ironton, Iron Mountain, Middlebrook and Arcadia. The total product amounts probably to not over 6,000,000 bricks.

In St. Francois county, bricks have been made at Farmington, Bonne Terre, Doe Run and DeLassus. The product to date amounts to about 15,000,000 bricks.

In Madison county, bricks have been made at Fredericktown and at many small kilns in the country. The total product is probably less than 30,000,000 bricks.

* See Geological Survey, Missouri, 1872, page 13. Raphael Pumpelly.

POTTERY CLAYS.

Distribution of kaolins.

Kaolins are known to exist at several localities. These are in the western part of Iron county, and in the eastern part of Madison county. The clays result from the decomposition, *in situ*, of certain porphyry rocks, and they have probably a wider distribution than that at present observed.

Origin.

Uses.

In both Madison and Iron counties, many years ago, these kaolins were mined, and made into several excellent varieties of stone ware. The discontinuance of these works appears to have been due not in any way to the character of the clay, but rather to lack of cheap transportation facilities, and, possibly, to private reasons of the owners.

Examinations not yet completed.

The writer has not yet had opportunity to properly examine any of these kaolins, because such pits as have been opened into them have become filled with water and debris during a long period of disuse, and the samples taken from the dumps about the pits are not now worthy of analysis or mechanical test. The facts observed by a cursory examination indicate, however, that there are extensive occurrences of a valuable quality of kaolin which is adapted for the production of a high grade of stone ware. In some places it contains a large per cent. of peroxide of iron, and will make a valuable commercial paint. It is the intention of the Survey to make further and more detailed examinations into the extent and character of these clays.

SANDS.

Stream sands.

The many water-courses furnish an abundance of sand and gravels of chert and porphyry. These are easily accessible and are extremely useful as road-making materials. A sandstone which has been assigned to the same geological horizon as that at Crystal City, occurs in some localities, and is soft and saccharoidal and otherwise similar to this stone. Chemical examinations have not yet been made of it.

Sand-rock.

DESCRIPTIVE LIST OF STONE QUARRIES.

IRON COUNTY.

QUARRIES IN GRANITE.

Graniteville. In township 34 north, range 3 east, on the southern half of the line dividing sections 10 and 11, are two quarries which have been operated since 1882 by the "Syenite Granite" company. These quarries are probably the largest in the State. They are admirably located on hill slopes, which location permits of their being drained by syphons. The rock is a red granite, exposed in extensive outcrops, generally with a thin cover, necessitating little stripping. It is very easily quarried, having a good "bedding" plane, and vertical joint planes, in sufficient quantities to assist the quarryman greatly in getting out stones, and yet not so abundant as to prevent the obtaining of very large blocks. The color of this stone is red or dark pink, mottled with gray and black, the red shades being due to feldspar, the others to a more or less smoky quartz. The rock takes a high, lustrous and handsome polish; but on account of excessive hardness, it is very difficult to dress.

Syenite Granite Co.

Character of the rock.

Color.

The plant consists of a switch about three miles long, which connects the quarries with the Iron Mountain & Southern railway, a locomotive and two stationary engines, two steam travellers, a vertical and a lathe polisher, several derricks, steam drills, an office, a store, extensive sheds, work shops, etc.

The plant.

The product since 1882 is about 250,000 cubic feet of dimension stone, about 5,000,000 paving blocks, and a large amount of "rip-rap," which has been used for ballast by the Iron Mountain & Southern railway, and also extensively in the manufacture of granitoid pavement and sidewalk flags.

The product.

Structures containing this granite.

Among the important structures for which these quarries have supplied stone are the following: —

Fagin building,	St. Louis, Mo.	Rialto building,	Chicago, Ill.
Odd Fellows hall,	" "	Northwestern Guarantee Loan	
Mercantile library,	" "	Co. bldg.,	Minneapolis, Minn.
Roe building,	" "	Society for Savings building,	
Singer building,	" "	Cleveland,	Ohio.
Commercial building,	" "	Central Sav. Bk.,	Baltimore, Md.
Ligget & Meyer bldg.	" "	Union Depot building,	Indian-
Rosenheim building,	" "	apolis,	Ind.
Meyer Bros. building,	" "	City Hall bldg.,	Cincinnati, O.
Drummond tobacco		Cincinnati art museum,	" "
factory,	" "	Ætna Bank bldg.,	" "
Merchants bridge,	" "	German Savings Bank,	" "
St. Louis stand pipe		Whitney National Bank,	New
tower,	" "	Orleans,	La.
Boatmen's Bank bldg.,	" "	Morris bldg.,	New Orleans, La.
Rookery building,	Chicago, Ill.	Oriental hotel (now in construc-	
Marshall Field bldg.,	" "	tion),	Dallas, Texas.
Studebaker building,	" "	Paxton building,	Omaha, Neb.
Savory hotel,	Dubuque, Iowa.	Heest bldg.,	Kansas City, Mo.
		Corrigan building,	Kansas City, Mo.

Sizes of blocks produced.

Among the largest pieces of dimension stone which have been quarried here are: The Allen monument in Pittsfield, Mass., which is 42 feet high and $4\frac{1}{2}$ feet square at the base, and weighs about 45 tons; the columns in the front of the Studebaker building, in Chicago, which are ten in number and are each 18 feet high and $4\frac{1}{2}$ feet in diameter, and weigh about 18 tons; and the window sills in a Chicago building, on Adams street, between Fifth avenue and Franklin street, which are each 3 feet square by 17 feet 4 inches long.

Mode of occurrence and character of the rock.

H. A. Sheahan. In township 34 north, range 3 east, a little south of the "Syenite Granite" company's quarry, Mr. Sheahan opened a small quarry, in August, 1889. The manner of occurrence of the rock with reference to quarrying, and the character of the stone is similar to that of the Graniteville quarries. Little work has been done here. No dimension stone has as yet been quarried, and only a few thousand paving blocks have been produced, which were hauled in wagons to Middlebrook for shipment.

Phil. Schneider. In township 34 north, range 3 east, section 10, west half, Mr. Schneider has two granite quarries which were opened in 1885. They are situated on the west slope of a granite ridge where drainage by siphons is possible and quarrying is easily carried on. The characteristics of the outcrop and of the stone are about the same as those at Graniteville, which have been described above. The plant consists of two stationary engines, a steam traveller, six derricks, three polishers (lathe, vertical and pendulum), a short tramway, blacksmith shop, office, boarding houses, sheds, tools, etc. A railway connection, three miles long, with the St. Louis, Iron Mountain & So. ry. is contemplated. The total output to date is about six million paving blocks, in addition to an undetermined amount of dimension stone. Among the important structures for which it has furnished granite are the Lemp building, and the Moline and Merchants bridges, all of St. Louis.

Mode of occurrence of the rock.

Character.

Plant.

Production.

Uses.

Ozark Mountain. About a quarter of a mile south of Graniteville is a quarry which was opened in 1869, and which is the oldest granite quarry in Missouri. It is in the same outcrop as the Graniteville quarry and the stone answers to the same description. The quarry is not now worked, but, when in operation, from five to six hundred men have been employed here at one time. Stone from this quarry was used in the construction of the famous Eads bridge across the Mississippi, of the Illinois and Iowa State houses, of the St. Louis and Cincinnati custom houses, and of the Memphis and Little Rock post-offices. The stone taken out was, however, inferior to what can be obtained, as it was mostly surface rock.

Character of the rock.

Uses.

Pilot Knob Company. In township 34 north, range 3 east, section 22, center of southern half, there is a very small quarry belonging to the Pilot Knob company, from which a few paving blocks have been quarried. The outcrop of granite is very large here, and can probably be quarried advantageously for dimension stone, as the joint planes seem to be so situated as to facilitate quarrying, and yet not to interfere with the production of large blocks. The stone is composed of grains of clear transparent quartz and of crystals of dark pink feldspar, which latter give it a reddish color. It takes an excellent polish.

Conditions of occurrence.

Composition.

QUARRIES IN PORPHYRY.

J. S. Benson. In township 31 north, range 4 east, section 14, east half, about three miles from the railroad, is a small quarry in porphyry, opened in the spring of 1888. About 700,000 paving blocks have been produced to date here, which were shipped to St. Louis and Memphis. The rock is too full of joint planes to permit of its being quarried for dimension stone; but it splits well and is easily made into paving blocks. Its color varies from dark blue to pink.

Product.

Character of the rock.

May and Tow. In township 31 north, range 3 east, at Annapolis, is a quarry at which work has been discontinued, owing to the extreme difficulty with which the rock was worked and also on account of the numerous seams and joint planes which intersect it. The stone is a blue-black porphyry, speckled with crystals of gray feldspar. It has numerous inclusions which resemble bombs in a lava flow. About 10,000 paving blocks is the total product of the quarry.

Character of the rock.

Product.

E. W. Graves. In township 30 north, range 4 east, section 16, northeast quarter, is an outcrop which has been worked in "motions." The stone is a dark, hard and brittle porphyry which splits easily. It is fit only for the production of paving blocks, and only a very few of these have been made.

Character of the rock.

QUARRIES IN LIMESTONE.

Carley and Mann. In township 33 north, range 3 east, section 1, near the center, are several small quarries in the magnesian limestone, which is here covered by about a foot of stripping. The color of the stone is blue in some strata, and yellow in others. The yellow variety dresses easily and makes a handsome building stone, but the blue is less easily worked and is less valuable. The strata vary in thickness from 6 inches to 2 feet. The output from these quarries has been small, and has been used mostly for foundations. They furnished stone for one small dwelling house, and for Dr. Goulding's hospital, both at Ironton, the latter a handsome edifice.

Color of the rock.

Uses.

Hastings. In township 33 north, range 4 east, section 5, southeast quarter, is a small quarry in the magnesian limestone.

It is situated on the west slope of a hill, where the workable stone is covered with a bed of stripping many feet thick. The color of the stone when fresh is a dark green which fades to a gray as the stone dries. The stone is easily dressed. It occurs in strata about 2 feet thick, two or more of which are workable. The output is small, and has been used mostly for foundations. Color and properties of the rock.

Hollman Bros. In township 33 north, range 3 east, section 27, near Hogan, is a quarry in the magnesian limestone, about 70 feet long, 33 feet wide and 10 feet deep. It is on a hillside and is connected with the Iron Mountain and Southern railway by a short switch. The stone occurs in strata varying from one to fourteen inches in thickness. Its color is bluish, streaked here and there with drab or yellow. It does not dress easily. The output has been used entirely by the Iron Mountain & Southern railway, in the construction of bridge abutments and culverts. Conditions of occurrence and color of the rock

Russell. In township 33 north, range 4 east, section 5, northeast quarter, is a small quarry in the magnesian limestone. The bed-rock is covered with about 3 feet of stripping of light red loam. Joint planes seem too numerous to permit the quarrying of blocks of desirable sizes for dimension work. The colors of the stone are gray and yellow, and black in the case of one non-continuous stratum of marble, which has a maximum thickness of 6 inches. The stone is very tough, has numerous veins of calc-spar and, hence, is dressed with difficulty. The product has been used in Ironton and Arcadia for foundation purposes. Conditions of occurrence and character of the rock.

QUARRIES IN MARBLE.

Sarah P. Childers. In township 34 north, range 3 east, section 35, southwest quarter, are two or three very small openings in the out-cropping marble, which were made many years ago, and are not now worked. The marble occurs in a hill which occupies an area of many acres. The hill slope is covered mostly by a thick mantle of residuary products and detrital matter; but at several horizons marble beds crop out, and it is probable that they have a total thickness of many feet. Individual strata 18 inches thick were observed. The stone has a gray color and is mottled and streaked with green and yellow. Some of the Conditions of occurrence and character of the rock.

Uses. mantel-pieces in the Capitol at Washington are said to have been taken from beds here exposed.

QUARRY IN CONGLOMERATE.

Shepherd Mt. On the southern slope of Shepherd Mountain is a small quarry in a porphyry conglomerate which grades into a coarse sandstone. From 2 to 10 feet of stripping of clay and boulders covers the rock. The stone is easily quarried and dressed, but that from this locality disintegrates very rapidly on exposure to the weather, and is practically worthless for building purposes. The output, which has been very small, has gone to Ironton to be used for foundations. Some of the steps of the Iron County court house are of this stone and these are very deeply worn, compared with those of limestone with which they are associated.

Conditions of occurrence of the rock.

Character.

Product.

ST. FRANCOIS COUNTY.

QUARRIES IN GRANITE.

Milne and Gordon. In township 34 north, range 6 east, section 5, near the center, is a granite quarry which was first open in 1870, and reopened in 1876 by the present company. It is situated on the west slope of a low granite ridge and is drainable by siphons. The stripping on the rock varies in thickness from 1 foot to about 10 feet. The distribution of joint planes permits the quarrying of enormous blocks, one solid block having been broken out measuring fifty feet in length and twenty feet in width and depth. The stone is of a soft gray or pink color. Feldspar is the chief coloring mineral, and a milky quartz and black biotite serve to modify its effects. Both the gray and pink varieties take a brilliant polish. The stone is hard but dresses quite easily. It splits to best advantage along the "lift."* The plant of this company consists

Conditions of occurrence of the rock.

Character.

The Plant.

* The "lift," at the quarries described in this paper, is the name given to the plane along which the rock splits, and which is parallel to the bedding plane of the quarry. The bedding plane is the one which is nearest to horizontal in position. The plane nearest perpendicular to the "lift" along which the rock splits is called the "rift." The plane approximately at right angles to the "lift" and to the "rift" is called the "hardway."

of a tramway about a mile and a half long, two stationary engines, of 30 and 10 horse powers respectively, 6 derricks, a polishing room with a circular and a vertical polisher, sheds, tools, etc. The output of this quarry to date amounts to about 60,000 cubic feet of dimension stone and about half a million paving blocks. Among the most important structures for which it has furnished granite, are the J. R. Lionberger and the H. L. Forks buildings of St. Louis; U. S. custom house and post-office, Marquette, Mich.; United States custom house and post-office, Keokuk, Iowa; United States Rock Island arsenal, Rock Island, Ill.; Jackson County court house, Kansas City, Mo. The largest dressed stone produced is a block ten feet square and one foot thick.

The Output.

Important Structures.

"*Syenite.*" In township 34 north, range 6 east, section 5, in the northeast quarter, are two granite quarries which are controlled by the Syenite Granite company. They were opened in 1878. Work at these quarries is now suspended because the company finds it most convenient, at present, to supply the stone for all of its contracts from the Graniteville quarries. Dimension stone can be obtained here in large blocks, and the rock is quite easily dressed, and takes a high polish. The color of the stone, derived from the contained feldspar, is a pale pink, mottled with grains of milky quartz and black specks of biotite. The quarries are connected with the Belmont Branch railway by a switch, a little less than two miles long. Most of the company's working plant is, at present, at the Graniteville quarries.

Syenite Granite company's quarries.

Character of the rock.

Allen and Vieths. In township 35 north, range 5 east, section 36, on Doe Run creek, is a large quarry which was opened a few years ago. It is situated on the east slope of a hill, and is drainable by siphons. It is not now worked, though capable of furnishing excellent dimension stone. The rock outcrop has practically no cover, and is cut by joint planes in an advantageous manner. There are two varieties of stone: a pink, fine grained syenite, and a gray to pale pink and rather coarse grained granite, which in places is handsomely mottled with crystals of a pale green mineral. The former is apparently intrusive in the latter. The quarry has produced about 400,000 paving blocks to date.

Conditions of occurrence of the rock.

Color.

Product.

Motion quarries.

Motions at Syenite. The country for several miles north, west and south of the town of Syenite, in section 5, township 34 north, range 6 east, has extensive outcrops of red granite in which the quarries, already discussed, of Milne and Gordon, Doe Run and Syenite are situated. In addition to what these quarries have produced, stone has been gotten out at a number of other localities from "motions," or other small openings, for the production of paving stone. Such are the Walsh, Ruecking & Co., O'Bannon, Abbot, Turpin, Bougeois, Cartee, Chamberlain, Crawford and the Kansas City company's motions or quarries. These granites do not offer the facilities for motion work that the syenites do, and it is usually necessary to open them by powder blasts. In general they are not intersected by many joint planes, have no great amount of stripping, and are situated so as to favor economic quarrying of dimension stone, on a large scale. They are destined to be worked extensively in the future. The characteristics of the stone, as described above in the notes on the Milne and Gordon and the Syenite quarries, are fairly representative of the stone of this whole area, although it varies locally in depth of color and in texture; the latter being occasionally very coarse. The output of paving blocks from these localities has been, approximately: from the Walsh, 200,000; Ruecking & Co., 100,000; O'Bannon, between 4,000,000 and 5,000,000; Cartee, 10,000; Crawford, 4,000, and others 5,000.

Names of owners.

The Output.

QUARRIES IN SYENITE.

Allen and Company. In township 36 north, range 4 east, section 20, southwest quarter, is a quarry in the syenite, known as the Garrett quarry, which was opened in 1887, by a blast of many tons of powder. It is not now worked. The total output to date is a little less than 100,000 paving blocks. The rock is covered with very little stripping, but joint planes and seams are so abundant that it is impossible to quarry it for dimension stone. It is fine grained, pink in color, and easily dressed.

Output.

Conditions of occurrence of the granite.

Motions at Knob Lick. In the neighborhood of Knob Lick, west of the railroad, "motion work," started some thirteen or fourteen years ago, has been extensively carried on, and there are probably not less than three hundred motions now ex-

300 motions near Knob Lick.

isting, though not all at present worked, within a few miles of the depot. They are most numerous in the syenite outcrops which occur in sections 4 and 9, in township 34 north, range 6 east.

The motions are mostly on the lands of Messrs. Price, McDowell and Simpson to whom the "motion men" pay a royalty for each paving block made. The total product to date of these syenite motions is about 17,000,000 paving blocks. Product.

The syenite is here exposed over an area of perhaps a square mile. On the eastern side of this area it disappears beneath the thick, overlying beds of Second Sandstone, while, on the western side, it rises topographically into a high peak, known as the Knob, the summit of which is composed of a very fine grained, pink, porphyritic felsite. The relation of this felsite to the syenite is not clear. From the summit of the Knob, down the western side, the felsite passes by apparent gradations, into a coarse grained, red or pink granite. On the north and south it is surrounded by sandstone or granite. The syenite is covered with an extraordinary amount of stripping, the surface being strewn with loose boulders, beneath which lie, *in situ*, boulders and decayed rock to a depth, often, of many feet. The stone varies in color from a light to a dark gray, which is locally called blue (the stone being known as "blue granite"). It is fine grained, splits and dresses easily, and is well adapted for the production of paving blocks. It takes an excellent polish, but has not yet been produced as dimension stone. Relations of the felsite to the syenite. Conditions of occurrence. Color.

QUARRIES IN PORPHYRY.

Motions at Knob Lick. In township 34 north, range 6 east, section 9, on what is known as the "Knob," are several motions and very small quarries where a porphyritic felsite is worked into paving blocks. The rock is too hard to be dressed, and is so cut up by joint planes that it will probably never be quarried for dimension stone, although it is very handsome and is remarkably durable and strong. The production of paving blocks from this rock has been small. Character of the rock.

QUARRIES IN LIMESTONE.

St. Joe Lead Co. In township 37 north, range 4 east, section 23, near Bonne Terre, are several small quarries in the limestone.

Conditions of occurrence of the rock.

The stone is easily quarried in open cuts on the hill-sides, where the stripping is very light. The strata vary in thickness from six to eighteen inches, and blocks of large area can be obtained.

Character.

The color of the stone varies from blue to gray, growing lighter as it dries after quarrying. It is dressed with some difficulty, owing to numerous veins of calcspar which it contains. It is used largely in and about Bonne Terre for foundations,

Uses.

edge stones, paving, flagging, etc. The dwelling house of Superintendent Parsons is built of it, and it is there shown to be a very handsome and durable building stone.

P. V. Ashburn. In township 36 north, range 6 east, section 31, southwest quarter, is a limestone quarry, sixty feet square and twelve feet deep. The limestone is covered by about thirty

Conditions of occurrence and character of the rock.

inches of stripping. The strata vary in thickness from three to eight inches. The color of the stone varies, being yellow, gray and blue. The product is used mostly for macadam, and to some extent for foundations and flagging.

J. B. Miller. Mr. Miller has a quarry in limestone similar to Mr. Ashburn's, in the southeast quarter of the same section. The rock, however, is covered by several feet of stripping. It is used for foundations.

A. Parkhurst. In township 35 north, range 5 east, section 2, near the center, is a small quarry in the limestone from which about sixteen hundred cubic feet of stone have been taken, to be used for macadam.

M. P. Cayce. In township 35 north, range 5 east, section 1, southwest quarter, is a limestone quarry which has furnished a small amount of stone, of a poor quality, for foundations in and about Farmington.

J. M. Elvins. In township 36 north, range 4 east, section 12, southwest quarter, is a limestone quarry, in a stone of a yellowish color, which dresses easily. The maximum thickness of any stratum is twelve inches, and blocks of large area are obtainable. The quarry has furnished considerable flagging for Farmington, and also the sills for the Elmwood academy.

Mrs. F. E. Toleman. In township 36 north, range 4 east, section 13, southeast quarter of the southeast quarter, is a limestone quarry. It is an open cut, on a hill-side, about seventy

feet long and twenty feet wide, with an extreme depth of eight feet. The rock is covered by about four feet of stripping. The stone varies in color from yellow to gray, is fine grained, tough and hard, and is dressed with difficulty. The product has been used for foundations only.

Jno. Rothney. In township 35 north, range 3 east, section 5, northeast quarter of northeast quarter, is a limestone quarry, about one hundred yards long, forty feet wide and twenty feet deep. About three feet of stripping covers the rock. The strata vary in thickness from two to fourteen inches and blocks of large surface area are obtainable. The stone is somewhat siliceous, and varies in color from yellow to pink and chocolate. The output has gone almost wholly to the railway company for the construction of bridge abutments and culverts. Conditions of occurrence and character of the rock.

Beals' Quarry. In township 35 north, range 5 east, section 1, northeast quarter, is a quarry in which the limestone is porous, filled with calcite veins and pockets, and unfit for building purposes. The output has been used principally for macadam and foundations.

J. M. Ritters. In township 36 north, range 5 east, section 23, northeast quarter, is a quarry in the limestone where blocks as large as ten feet square by eighteen inches are obtainable. The stone is fine grained, gray to yellow in color, and dresses very easily. The output has been used mostly for monument bases, window sills, etc.

St. Joe Lead Company, North Quarry is in township 38 north, range 4 east, section 35. The strata vary from six inches to two feet in thickness, and large slabs are obtainable. The stone varies in color from gray to yellow, is coarse grained, dendritic, and occasionally blotched with calcite crystals. It does not dress easily. The output has been used for piers and abutments for a railway bridge over the Big river, and for the construction of drains and culverts. It has also been crushed and used largely for ballast in the construction of a railway bed. Character. Uses.

QUARRIES IN SANDSTONE.

Knob Lick Quarries. Close to the railway, about half a mile north of Knob Lick, are several small quarries in the sandstone

Thickness. which are not at present worked. The sandstone has here, probably, an aggregate thickness of one hundred feet only, and consist of strata which vary from one to twenty inches in thickness. Only a few of these strata have any value for building stone and they disintegrate so rapidly that they are scarcely worth quarrying. Stone from the thickest and most compact strata have been used, to a small extent, for foundations at Knob Lick, but the chief use has been by the railway company in the construction of culverts and abutments. An examination of some of the stone in these abutments showed it to be in a badly crumbled condition, and seriously needing replacement by stronger and more durable material.

Uses.

Character.

MADISON COUNTY.

QUARRIES IN GRANITE.

Milne and Gordon. In township 33 north, range 7 east, section 25, northeast quarter, are two small quarries in a granite ledge, which were opened in 1886. The granite here is capable of furnishing large blocks of dimension stone, has very little stripping upon it, and is conveniently near the railroad. The stone has a dark reddish color, due to a prevailing feldspar, and is beautifully mottled with grains of translucent quartz and dark specks of biotite or hornblende. It takes a high lustrous polish and makes a very handsome stone for ornamental purposes. It does not dress very easily, however. The total output of the quarries to date amounts to about five thousand paving blocks and a small amount of dimension stone. These quarries will soon be developed on a large scale by the present owners.

Character of the rock.

Output.

QUARRIES IN DIABASE.

Kansas City Company. About three miles west of Mine La Motte station at Skrainka, are some large quarries in an outcrop of diabase, which is probably an intrusion in the granite. They are not now worked. The rock is covered with from ten to thirty feet of stripping, and has been so violently contorted and broken, that it is impossible to quarry dimension stone from it.

Conditions of occurrence and character of the rock.

It is fine grained, dark gray to almost black in color, splits and dresses easily, and takes an excellent polish. The effects of weathering, as exhibited in the outcrops, would lead one to the conclusion that this is not a durable stone. Efforts made to quarry it for monumental purposes failed on account of the seams above spoken of. About 2,000,000 paving blocks have been produced here to date. Product.

QUARRIES IN MARBLE.

H. L. Gale. About eight miles south of Fredericktown, on the farm of Mr. Gale, a small opening was made in a marble outcrop, about ten years ago. Two strata of marble are exposed here, one being about seven inches thick, and the other about eighteen. The thinner stratum of these has a pale pink color which shades into a lavender, and is relieved by specks and streaks of calcite, arranged in parallel lines, giving the whole stone a subdued but very handsome effect. It takes an excellent polish. The thicker stratum has a pale grayish tint, slightly variegated by green and brown streaks. These marbles are fine grained, and are somewhat "plucky" under the stone cutter's tools. It is probable that there are several strata of good marble here; but the beds of residuary products make it difficult to determine this fact on a cursory examination. Only one car load has been shipped from here, which went to St. Louis. Thickness of the beds. Color of the rock.

Cedar Bottom Quarry. In township 33 north, range 5 east, section 36, northwest quarter, a stratum of dark red variegated marble, which takes an excellent polish, has been opened on. Only a very small amount of stone has been taken out, however, and this mostly for samples. Character of the rock.

L. M. Hebener. In township 32 north, range 5 east, section 17, southwest quarter of the southwest quarter, a small marble quarry was opened some time before the civil war. The best stratum is about eighteen inches thick. The marble is of a light gray color, variegated with streaks of brown and green. It takes an excellent polish, but needs to be dressed with care, owing to its "plucky" qualities. Several car loads were shipped to St. Louis. Thickness of the stratum. Qualities.

Slater Quarry. In township 33 north, range 6 east, section 23, south half, a marble quarry has been worked intermittently for about fifteen years. A heavy stripping was removed over an area of about seventy-five square yards, and a shaft was sunk through about eighteen feet of marble strata. The quarry is now full of water. Blocks lying about show that some of the strata are at least twenty inches in thickness. The marble varies considerably in color, the handsomest variety resembles the thinner stratum in Gale's quarry, described above, but it has a redder shade. These marbles take an excellent polish, but are quite "plucky." A few small shipments have been made.

Developments.

Character of the rock.

Wright's Quarry. About a mile and a half east of Gale's quarry, on the Fredericktown road, a small quarry was opened, in the marble, ten years ago. The thickness of the beds here could not be ascertained. The marble has a dark brown or chocolate color, which is relieved by veins of calcite. It is fine grained, and takes an excellent polish, but is "plucky," like the last described. Two car loads were shipped to Boston and New York.

Character of the rock.

THE

MINERAL WATERS OF SALINE COUNTY.

By A. E. Woodward, assistant geologist.

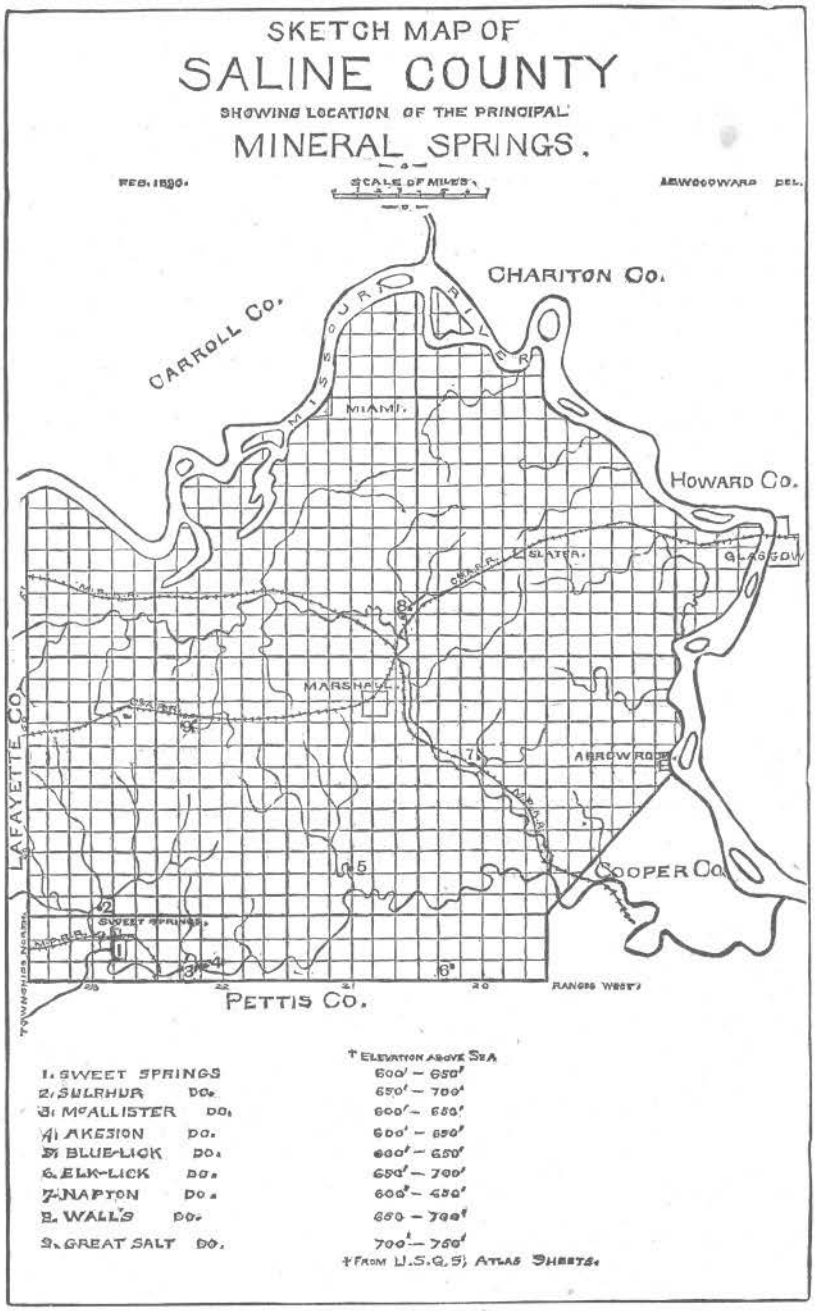
CONTENTS.

PREFATORY REMARKS.

The field work for the following article by Mr. Woodward on the mineral waters of Saline county was done during the month of February, and, despite the inclement weather, occupied only about fourteen days. The beginning of the subsequent laboratory work was delayed until March 22nd, through failure to receive various chemicals and supplies, and it is only by the most unremitting efforts on Mr. Woodward's part that we are now able to present his results.

This paper is one of a series which it is intended to publish on the mineral waters of the State. The examinations will be carried on by counties and the results will be made public, as soon as is possible, in publications similar to this. After all of the important waters of the State have thus received attention successively, a comprehensive report on the mineral waters of the whole State will be issued.

Mr. Woodward has described and indicated the best uses to which the waters of Saline county can be put and their relative values for the various


SKETCH MAP OF
SALINE COUNTY
SHOWING LOCATION OF THE PRINCIPAL
MINERAL SPRINGS.
FEB. 1890.
SCALE OF MILES
A.W. WOODWARD DEL.
CHARITON CO.
CARROLL CO.
MISSOURI RIVER
MIAMI.
HOWARD CO.
SLATER.
MARSHALL.
ARROW ROCK
LAFAYETTE CO.
COOPER CO.
SWEET SPRINGS.
PETTIS CO.
RANGE WEST.
1. SWEET SPRINGS 600' — 650'
2. SULPHUR DO. 650' — 700'
3. McALLISTER DO. 600' — 650'
4. AKESION DO. 600' — 650'
5. BLUELICK DO. 600' — 650'
6. ELK-LICK DO. 650' — 700'
7. NAPTON DO. 600' — 650'
8. WALL'S DO. 650 — 700'
9. GREAT SALT DO. 700' — 750'
† ELEVATION ABOVE SEA
† FROM U.S.G.S. ATLAS SHEETS.

uses can be judged of from the table of analyses. The similarity in composition between some of these waters and those of noted Kentucky springs is interesting and suggestive. Many important questions in connection with these mineral waters, such as their origin, the source of the salt, their geographic extent and geologic horizon, have not been dwelt on here, and cannot be discussed until more detailed field work has been done, and until the investigations have extended over wider areas. Such matter will belong properly in a final report or monograph. ARTHUR WINSLOW, State geologist.

INTRODUCTION.

Location of Saline county.

Saline county, situated in the west central part of Missouri, and having the Missouri river for its northern and eastern boundary, has long been noted for the large number of salt springs within its limits, which facts suggested its name. The majority of these springs are very salty, and would, undoubtedly, be classed as "saline springs." In connection with the salt water many of them give off quantities of hydrogen sulphide gas, and are locally known as "sulphur" springs. The temperatures of all are nearly the same, and the flow remains constant, independent of rain-fall. They are all probably of deep-seated origin, and are not thermal. From the waters of many of the larger ones, salt was manufactured years ago by evaporation over fire. This work has now been abandoned, and the waters are now used extensively as beverages, or for medicinal purposes. The location of the principal springs is shown quite accurately on the accompanying sketch map. Numerous springs exist which are not shown individually on the map; but, of these, many are closely associated with the larger springs, and all are small and do not differ in character from those to be described. Among those not shown on the map are: —

General character of the springs.

Their location.

a. A spring at Arrow Rock, having a good flow, which was formerly a salt-sulphur water, but which is now reported by its owner to be very weak in saline matter.

b. A salt-sulphur spring near Miami, section 35, township 53 north, range 21 west, the property of A. J. Caseboat.

c. A sulphur spring near Shackleford (between Great Salt Springs and Marshall) in section 1, township 50 north, range 22 west, owned by James Prior, and reported to be a weak salt spring.

Springs at Grand Pass.

Some springs of strong flow and clear water also occur along the Missouri bluffs at Grand Pass, but they can hardly be classified as mineral springs. Some are slightly chalybeate and small quantities of oil have been found in connection with them; but the flow of oil has been very weak. Several years ago, on sinking a well at Malta Bend, in section 3, township 51 north, range 22 west, oil was struck; and gas has been reported from the vicinity of Elmwood, section 3, township 49 north, range 23 west.

Most of the salt springs of this county are found in the vicinity of Salt-fork and Black-water branches of the Lamine river, and seem to be limited to the valleys of these streams. An important exception to this is the Elk Lick spring in the Lamine river valley itself.

A DESCRIPTION OF THE SPRINGS.

SWEET SPRING.*

Improvements at Sweet Springs.

Sweet spring is decidedly the best known in Saline County; it is in the southwest corner of the county in the northwest quarter of section 14, township 48 N., range 23 W., about one mile south of the railroad station at Sweet Springs. A hotel, bath house, and other houses have been built here, and the locality is a recognized summer resort. The Sweet spring itself (so called from its lacking any salty or strong mineral taste) issues from a bluff of crinoidal limestone, some twenty-two feet above the low water mark of Black Water. This is the only locality where the water can be seen emerging from the rock so that the exact horizon of its occurrence can be determined. It flows at the rate of about 1100 gallons per hour from a crevice in the limestone of about 50 square inches in area. A remarkable fact

Rate of flow.

* The results of analyses of the water of this, and of other springs hereafter described, will be found in the tables on pages 56 and 57 of this article.

concerning this water, when compared with that of other similar springs in the county, is that, although a deep-seated spring, as evidenced by its regularity of flow, temperature, etc., it contains such an extremely small proportion of saline matter as to be hardly recognized by taste. It is, moreover, destitute of sulphuretted hydrogen and shows a small amount of carbonic acid gas at the spring. Character of the water.

The water flows into a walled basin five feet in diameter and fourteen inches deep, with a cemented porcelain bottom. Thence it is forced into the bottling house, where large quantities are bottled and shipped to various points in the State, and elsewhere. The temperature of the water in the basin was 53.3° F., that of the air being 41.5° F. About twenty feet below the level of Sweet spring, a few feet above Black Water creek, is a "sulphur" spring. It has constant flow, but is covered by the Black-water in times of freshet. Uses of the water. Temperature.

BLACK SULPHUR SPRING.

Two miles north of Sweet Springs, near Davis creek, is a group consisting of six or more sulpho-saline springs. Of these, the largest and best known is the "Black Sulphur" spring, in the southwest quarter of section 34, township 49 N., range 23 W. It issues from the bed of Davis creek and is submerged at times of high water. The water has a very slight saline taste and is very palatable; it is charged with hydrogen sulphide gas, and deposits sulphur where exposed to the air. The other springs of this locality are of the sulpho-saline variety with limited flows and of only local importance. The whole region along Davis creek, and along Blackwater near Sweet Springs, furnishes salt springs, or at least salty seeps, and most of them are sulphuretted. Character of the water. Other springs in this vicinity.

McALLISTER SPRINGS.

These springs are found in the northeast quarter of section 17, township 48 N., range 22 W., about five miles east of Sweet Springs and close to Blackwater creek. The principal springs are three in number, known respectively as the Black Sulphur, White Sulphur, and Salt springs. The Black Sulphur and Salt springs occur near each other and are both saline and sulphuret- Character of the water.

ted; the Salt spring water seems to contain more gas than the other. From the Salt spring is deposited a reddish white precipitate of sulphur, while the Black Sulphur is characterized by a black sediment composed of sulphur and organic matter mixed with clay and find sand. A small amount of the black sulphur water is bottled and shipped away; but most of it, mixed with the "Salt spring" water, flows into the bath houses. The White Sulphur spring is a few hundred feet nearer the Blackwater and is well protected from the weather. It is saline like the other two.

Uses.

Temperatures.

	Water.	Air.
Temperature Black Sulphur springs	57.7° F.,	33° F.
" White " "	52° F.,	33° F.
" Salt " "	58° F.,	33° F.

AKESION AND SALT SPRINGS.

About one mile below this group, on the north side of the Blackwater, in the northwest quarter of section 16, township 48 N., range 22 W., occur the "Akesion" and Salt springs. They are about 300 feet apart, both flowing from the alluvial clays. They are both saline and sulphuretted and appear to flow from a common source. The medicinal properties of the two, it is claimed, however, are quite distinct, the Akesion water being bottled and shipped away, while the salt spring water (together with the Akesion) is pumped over four miles to the Sweet Springs grounds, where it is used in the bath house.

Character of the waters.

Uses.

Both springs deposit sulphur (white and flocculent) along their courses. Their temperatures are as follows:—

Temperatures.

	Water.	Air.
Salt Springs.....	58.8° F.	40° F.
Akesion.....	59.7° F.	35° F.

BLUE LICK SPRINGS.

Passing down Blackwater, on Finney's creek, about one mile from its mouth, we find the group known as "Blue Lick springs," located in the southeast quarter of section 21, township 49 N., range 21 W. Here a number of sulpho-saline springs are scat-

tered along Finney's creek from its junction with the Blackwater; but they culminate at Blue Lick where several such springs occur within a radius of a quarter of a mile. Fresh water springs are common and one, which when visited was flooded with water, is reported to be very bitter or "magnesian" when the surface water is low. As the fresh water springs are somewhat dependent on rainfall, are colder than the sulphur springs, and lack salt, they are probably surface springs and not connected with those from a deep-seated source.

Character and temperature of the water.

The "Blue Lick" spring is the highest of the group and is thus less affected by the floods of Blackwater creek. It is sulpho-saline in character and deposits sulphur. Its temperature is 54.7° F., that of the air being 40° F.

Uses.

At least four or five of the springs here used as beverages could be classed as "black sulphur" or better, as sulpho-saline springs. One of these has been protected by a tile sunk around it and is more generally used than the others of its class. Its temperature is 55.7° F., that of the air being 42° F.

Rate of flow at Gum spring.

The "Gum spring" is the largest of the group and is said to furnish, and apparently flows at a rate of about 3,000 gallons of water per hour. Like the others, the water is sulpho-saline. It is allowed to flow into a large wooden basin 40 feet square and 4 or 5 feet deep, which is used for bathing purposes. On the sides of the basin, sulphur is deposited in very considerable quantities. This sulphur is the so-called "white flocculent precipitate." It is the well known accompaniment of sulphur springs and is derived from the oxidation of the sulphuretted hydrogen gas in the water, of which gas, the sulphur remains in the form of a precipitate. The terms white, black and red sulphur apply to the pure or impure precipitates of sulphur in the springs. The water itself issues from a large "gum" and a great quantity of gas is continually escaping (probably carbonic acid gas). The water is used for bathing purposes entirely. The springs are much frequented during the summer months, and the waters of "Blue Lick" and Black Sulphur springs are also shipped to Marshall in small quantities.

Sulphur deposits.

Gas in water.

Uses.

A short distance south of this group occurs a "sulphur" spring very slightly saline. It is neglected, however, and its true flow could not be seen.

Salt manufacture.

Salt was made from the various springs here several years ago and the lines of ditches where the kettles were placed and the water evaporated can still be seen.

ELK LICK SPRINGS.

On crossing the divide between Blackwater creek and Lamine river, in the southeastern part of the county, we find the Elk Lick springs situated on Heath's creek, in section 17, township 48 N., range 20 W.

Character of water.

Rate of flow.

Uses.

One principal spring here is surrounded by smaller ones. The spring has remarkably clear, palatable water, charged with carbonic acid gas and slightly sulphuretted. It flows at a rate of between 500 and 800 gallons per hour and deposits a very small amount of sediment, mostly of a black color. These springs are occasionally resorted to by excursion parties; but they have little more than a local reputation.

THE CAMP CREEK GROUP.

The first group met on the Salt Fork river occurs near Napton. The Camp Creek group of sulpho-saline springs is located in the southeast quarter of section 28. The various springs flow immediately from alluvial clays, the underlying rock being, probably, limestone. The springs are a dozen or more in number which, flowing together, constitute the "Salt branch" of Camp creek. They are all sulpho-saline. They are included in about five acres of ground, within which area they are reported to be constantly changing their position. Salt was made here quite extensively before the war and the posts can still be seen where evaporation was carried on. In the northwest quarter of section 34 occurs a slightly saline, sulphur spring, the water of which is reported to have medical properties.

Character of water.

Manufacture of salt.

East of Marshall, near the Salt Fork, occur two or three salt seeps which were formerly good sized springs; and about one and a half miles east of town, is a neglected bath house, formerly supplied with water by a sulpho-saline spring. It is now entirely abandoned and the spring partially choked up.

On Cow creek, a tributary of the Salt Fork, in sections 24 and 25, township 51 N., range 21 W., a number of sulpho-saline

springs are found belonging to J. Wall and Martin Zimmerman. They are sulphur springs slightly saline. Those occurring on Wall's land have a local reputation. From this point on, up the Salt Fork, the springs seem to disappear or to assume small proportions.

THE GREAT SALT SPRINGS.

On traveling up the Salt branch, a small tributary of the Salt Fork, we find, about eight and one-half miles west of Marshall, in sections 17 and 20, township 50 N., range 22 W., the group known as "The Great Salt springs." It consists principally of two large springs, but there are numerous other smaller springs and seeps near these two. The largest and at present the most important is a sulpho-saline spring, now known as the "Sulphur spring," in the southeast quarter of section 17, township 50 N., range 22 W., only a short distance south of the Chicago and Alton railway. Sulphur spring.

It is found in a basin five feet below the general level of the alluvium. This basin is nearly circular, about 20 to 25 feet in diameter and 10 to 15 feet deep. The water flows at a rate of at least 10,000 gallons per hour; it is very salty and deposits sulphur for hundreds of feet along its course. This spring is undoubtedly the largest of any in the county, but the area of its basin is gradually being reduced by the wash from the farmed lands around it. Salt was made here formerly in considerable quantities. Improvements. Rate of flow of water, character. Salt manufacture.

The other of these two large springs situated in the northeast quarter of section 20, township 50 N., range 22 W., is a salty spring, with very little if any sulphuretted hydrogen present, distinguished as the "Salt spring." In marked contrast to the Sulphur spring is this one, the flow of which can not exceed 200 gallons per hour, though occupying a basin 25 feet in diameter and 7 feet deep. The temperature of the water of this spring was 36° F., that of the air being 20° F., while at the sulphur spring the thermometer registered 57.2° F., with the air at 14.5° F. Salt spring. Flow. Temperature.

In Meek's report, made twenty years ago, the Salt spring was given a temperature of 59° F., with a flow at least half as strong as that of the Sulphur spring and was also stated to contain sulphuretted

hydrogen in abundance. There can, thus, be little doubt but that this spring has changed in character, and this is probably accounted for by the choking of the spring with mud and silt in times of flood of the "Salt branch."

The groups above described embrace the most important springs in the county and, as will have been noticed, they appear to be confined to the valleys of the Salt Fork and Blackwater creeks. Exceptions to this are, however, a sulpho-saline spring reported to be in the vicinity of Arrow Rock and one in the vicinity of Miami; but the writer was unable to visit them.

Springs not included.

The constancy in temperature, the regularity of flow, the large quantity of salts in solution, all tend to indicate that the waters of these springs have a deep-seated source. From what depth and from what formation the water derives the various substances which it holds in solution is a problem which can only be solved after further observation in other counties and after a more comprehensive comparative study.

Waters probably from a deep source.

TABLE OF ANALYSES OF SALINE COUNTY MINERAL WATERS.*

	Sweet Spring, at Sweet Springs.		Salt Spring, near Akesion.		Akesion.		Black Sulphur Spring, at McAllister's Springs.		Sulphur Spring, at Great Salt Springs.		Salt Spring, at Great Salt Springs.		Elk Lick Spring.		Napton.	
	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.
Sodium Chloride	1.6877	98.79	15.0526	892.26	14.8906	882.57	10.8318	636.63	23.8345	1423.53	23.2564	1387.92	3.0154	176.68	17.4852	1038.90
Potassium Chloride	.0004	.05	.1655	9.81	.0903	5.36	undet.	undet.	undet.	undet.	undet.	undet.	undet.	undet.	.1680	9.81
Calcium Chloride	.1879	11.04	1.8220	108.00	1.4397	85.33	.7578	44.54	2.1205	126.65	1.8136	108.32	.0769	4.51	1.9744	117.31
Calcium Sulphate	.1499	8.80	.9591	56.85	.9426	55.87	.6857	40.30	2.0074	119.90	1.9728	117.73	.3516	20.60	1.7219	102.31
Calcium Carbonate	.2643	15.47	.2944	17.45	.5441	32.25	.6561	38.56	.3680	22.01	.3420	20.41	.2850	16.70	none.	none.
Magnesium Chloride	.3751	21.96	1.4912	88.39	1.5097	89.48	1.0973	64.50	1.9210	114.74	1.7270	103.07	.3894	22.82	1.4096	83.76
Alumnia, with trace of Iron.	.0022	.13	.0018	.11	.0034	.20	.0014	.08	.0018	.11	.0017	.10	.0020	.12	.0030	.18
Silica	.0053	.32	.0048	.28	.0053	.31	.0044	.26	.0086	.50	.0066	.39	.0068	.40	.0080	.47
Total	2.6728	156.56	19.7914	1173.15	19.4257	1151.37	14.0345	824.87	30.2618	1807.44	29.1201	1737.94	4.1271	241.83	22.7701	1352.74
Total Solids	2.8630	167.80	20.3852	1208.30	19.9000	1179.68	14.1090	829.28	30.7120	1834.34	29.8070	1778.86	4.2800	251.12	24.4600	1453.58
Undetermined	.1902	11.24	.5938	35.15	.4743	28.31	.0745	4.41	.4502	26.90	.6869	40.92	.1530	9.29	1.6899	100.84
Specific Gravity at 60° F.	1.0023		1.0150		1.0149		1.0064		1.0227		1.0219		1.0033		1.0174	
Temperature of Water	53.3° F.		58.8° F.		59.7° F.		57.7° F.		57.2° F.		36.0° F.		56.2° F.		55.2° F.	
Temperature of Air	41.5° F.		40.0° F.		35.0° F.		33.0° F.		14.5° F.		20.0° F.		35.0° F.		37.0° F.	
Flow in Gallons per hour	1100		4680		3276		800		10000		200		800		3000	

* All analyses of this table were made in duplicate.

TABLE OF ANALYSES.

	SALINE COUNTY.*						ANALYSES OF MINERAL WATERS OF OTHER STATES.						
	Blue Lick Spring, at Blue Lick.		Black Sulphur Spring, at Blue Lick.		Gum Spring, at Blue Lick.		Upper Blue Lick Spring, Kentucky.	Lower Blue Lick Spring, Kentucky.	Congress Spring, Saratoga, N.Y.	Union Spring, Saratoga, N.Y.	Sea Water.	Marsena Springs, New York.	Paroquet Springs, Kentucky
	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Grs. per Gal.	Pts. per 1000.	Grs. per Gal.	Grs. per Gal.
Sodium Chloride	6.9765	410.32	15.9492	945.68	21.4817	1280.38	516.54	8.3473	434.40	453.30	27.05	76.79	309.60
Potassium Chloride	undet	undet.	undet.	undet.	undet.	undet.	1.80	.0227	Sodium Carbonate 16.00	8.73	.76	.....	.48
Calcium Chloride	.5530	32.56	.7452	44.18	1.7162	102.29	Potassium Sulphate. 12.97	Potassium Sulphate. .1519	.....	Sodium Bicarb. 17.01	trace.	.....	67.71
Calcium Sulphate	.6687	39.33	1.4886	88.27	1.8873	112.49	44.13	.5533	.....	.....	1.41	60.03	2.28
Calcium Carbonate	.3053	17.96	.7665	45.45	.4588	27.35	25.06	.3850	144.00	Calcium Bicarb. 96.70	.04	4.85	2.40
Magnesium Chloride	.7832	46.07	1.5098	89.53	1.9000	113.26	37.72	.5272	Magnes. Bicarb. 32.00	Alumnia. .32	3.66	29.93	48.03
Alumnia (trace of Iron).	.0017	.10	.0011	.06	trace.	trace.	Magnes. Bromide. 3.80	Mag. Brom. & Iod. .0040	.....	Magnes. Bicarb. 109.69	.....	.....	.....
Silica	.0097	.57	.0092	.55	.0070	.41	1.00	.0179	trace.	2.65	.....	.....	3.90
Total	9.2981	546.91	20.4696	1213.72	27.4510	1636.18	.....	.....	.....	.....	.....	.....	.....
Total Solids	9.5100	559.42	20.7500	1230.48	28.6610	1708.31	660.17	10.3000	626.40	696.17	35.23	191.88	.....
Undetermined	.2119	12.51	.2804	16.76	1.2100	72.13	.....	.....	.....	.....	.....	.....	.....
Specific Gravity	1.0071		1.0153		1.0206		.....	.....	.....	.....	1.0276	.....	.....
Temperature Water	54.7° F.		55.7° F.		55.2° F.		60.0° F.	62.0° F.	51.0° F.	48.0° F.	.....	45.0° F.	.....
Temperature Air	40.0° F.		42.0° F.		42.0° F.		.....	.....	.....	.....	.....	.....	.....
Flow Gallons per hour	500		500		3000		1200	300	.....	12.0	.....	700	.....

* All analyses of Saline County Mineral Waters were made in duplicate.

THE ANALYSES.

Mode of collecting samples.

From eleven of these springs, one gallon samples were taken and subjected to analysis. The water was filtered at the springs, so that all foreign matter was eliminated, and the temperatures both of the air and of the spring were noted. The bottles were sealed with paraffine to prevent, as far as possible, access of air to the water.

Nature of results.

An exhaustive analysis was not attempted, but merely such a determination of the principal constitutents as would enable one to ascertain the possible uses to which these waters might be put. The results have been expressed in parts per one thousand, according to recent practice, and in grains per gallon in order to facilitate comparison with older analyses of other waters.

Differences between the mineral waters of the county.

A great difference exists between the compositions of the different mineral waters in the county and this difference is found to be dependent upon the proportion of sodium chloride, or common salt, in solution. To summarize, roughly, the springs may be grouped by their contents of saline matter as follows: —

Salt contents.

a. 1-5 parts saline matter per 1000 — Sweet Springs; Elk Lick Spring.

b. 5-15 " " " " " — Blue Lick Spring; McAllister [Black sulphur].

c. 15-25 " " " " " — Salt Spring near Akesion; Akesion Spring; Springs at Napton; Black Sulphur at Blue Lick.

d. 25-35 " " " " " — Sulphur Springs at Great Salt Springs; Salt " " " " " " Blue Lick. "; Gum Spring " " Blue Lick. "

Comparison with New York and Ohio brines.

If we take the last group, d, as representing the largest proportion of salt, and compare it with the brines of the salt making districts of New York and Ohio, as given in the table below, we find that the strongest salt springs of Saline county have a much lower salt contents than these brines. With the present low price of salt and with the competition of localities possessing much stronger brines and cheap fuels, the making of salt on a commercial scale from these waters can hardly be profitable. The springs of group d are very closely allied to sea water in composition and specific gravity (see following table), and for bath-

Comparison with sea water.

ing purposes would approach such water in their efficacy. As a matter of fact the waters of Gum springs at Blue Lick and the salt and Akesion springs of group c are used for bathing purposes with the beneficial effects of sea water. Value for bathing purposes.

	Sulphur Spring at Great Salt Springs.	Gum Spring at Blue Lick.	Average of Onondago Brines, N. Y.	Average of Brines, Ohio.	Sea Water.
Specific gravity.	1.0227	1.0206	1.1360	1.1996	1.02757
Per cent. salt.....	3.14	2.80	18.55	23.91	3.52
Pounds of salt in one gallon.....	.23	.21	1.755	2.565	.25

The county possesses an abundance of palatable mineral waters which compare favorably with other springs of its class in the United States. The springs all differ from the noted springs of New York by the absence of the large amounts of carbonates and bicarbonates which are in the New York waters. With the springs of Kentucky, however, they are more closely allied, and the resemblance between the waters of the Blue Lick springs of that State and those of Saline county is very striking. The medicinal value of Sweet spring, Akesion spring, McAllister spring and Blue Lick and Sulphur springs at Blue Lick would seem to be sustained by the experience of people using the water for several years. The waters of groups a and c, containing the smaller amounts of saline matter, are more palatable than the saltier waters and consequently will deserve the preference as beverages. And in this connection the close association of these palatable waters with such large quantities of saline waters suitable for bathing purposes, is a happy combination. The waters as beverages. Comparison with Kentucky waters.

A PRELIMINARY CATALOGUE

OF THE

FOSSILS OCCURRING IN MISSOURI.

By G. Hambach, palæontologist.

CONTENTS.

PREFATORY REMARKS.

Fossils are the remains or the casts "of things once alive and flourishing;" things which, like those at present living, bore in their forms the imprint of the times and of heredity. As different plants and animals do now characterize different climates, or different soils, or different waters, so do different fossils characterize the changed conditions represented by the various formations or rock groups of Geology. A man, transported unconsciously to a foreign and strange land, would gain some clue as to his whereabouts by a study of its inhabitants, its animals and plants, and of their customs. So the palæontologist, by a study of the inhabitants of the rocks, helps to determine his location geologically, and assists in assigning to their proper places the rocks which are encountered. Thus, are fossils guides in geologic work, and thus, — contrary statements notwithstanding, — have fossils an almost direct money value; for, the successful determination of the position or geologic age of rocks, leads often to results of great economic value. But, true it is, that, along with this money value of these remnants of ancient life, goes one of such fascinating interest, of such philosophic importance in its relations to the great question of the history and development of life, that the first consideration becomes often so dwarfed as to be entirely overlooked, and the last grows all absorbing, and is often pursued regardless of immediate objects.

The catalogue of fossils, herewith published, is offered as an attempt to present in a definite form a statement of the status of our knowledge of the palæontology of the State at the present time. Were such a catalogue the result of exhaustive work, and did it express final results, then, an *ultima thule* in palæontologic inquiry would have been reached; at least so far as relates to its economic applications. But such a work this catalogue cannot pretend to be; it is to a great extent a compilation; the fossils given have been collected and determined by different men and on different occasions, while engaged on different works. Stratigraphic work has not been prosecuted along with the collecting, and the details of the stratigraphy of the State have not been sufficiently defined for the horizon of any outcrop, in which specimens may have been found, to be asserted without doubt. And as there is, thus, a certain indefiniteness concerning this local rock column and concerning the distribution of its members, so is there likewise doubt concerning the correlation of the formations of this State with those of others. Thus the adoption, in this catalogue, of the classification of Shumard, based upon the New York section, must not be interpreted

as an expression of results reached, or of opinions held by this Survey. It is hardly to be expected that all of the conclusion of early past work, much of which was mere reconnoissance, could stand as final. What detailed work may develop cannot be stated here.

Thus, this publication is offered as a purely provisional one; as a working list for reference in field and office; to be criticised, to be fought over, to be amended, to be improved, that later it may reappear in maturer form, unassailable, a guide for the strong, a support for the weak.

ARTHUR WINSLOW, State geologist.

INTRODUCTION.

The following catalogue of fossils contains, so far as is known, the names of all species occurring in Missouri, excepting such as are new and undescribed. All insufficiently known species have been omitted, and for a number of others the old generic names have been retained, in order not to increase the number of synonyms; especially in such cases where their propriety is doubtful.

The classification is a zoological and botanical one and, at the head of each sub-kingdom, is a table giving the classes, orders, families, and genera included in it. The species of each class are arranged in alphabetical order. The number in front of the names of the species refer to corresponding numbers in front of the family names to which the species belong. The supposed geological horizon is indicated by a dash in the appropriate columns, and the locality where each species has been obtained is also given. It is not to be understood, however, from this catalogue, that the localities given are the only localities in which the particular species may be found; on the contrary, future discoveries may bring to light others and even better localities than those mentioned in the list.

ANIMAL KINGDOM.

Sub-Kingdom Protista.

1. Class — Rhizapoda.

2. Class — Porifera.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
1 Fusulina cylindrica, Fischer	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	▬	Jackson Co. Andrew Co.
2 Ptylostylus heterocostalis, Gurley	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
2 " subtumidus, "	....	....	....	....	....	....	....	▬	▬	▬	....	....	....	....	....	Pike Co.
2 Palæacis, Haime 1860	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
2 Sphenopoterium compressus, M. & W.	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	Clark Co.
" cuneatus, M. & W.	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	Central Mo.
1 Receptaculites Oweni, Hall	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	Jefferson Co. St. Louis Co.

Sub-Kingdom Radiata.

1. Class — Polypi.

A. order zoantharia.

1 Family Cyathophyllidæ.— Acervularia, Campophyllum, Cyathophyllum, Lithostrotion, Streptelasma, Zaphrentis, Chonophyllum.

2 Family Cyathaxonidæ.— Cyathaxonia.

3 Family Favositidæ.— Alveolites, Chetetes, Favosites, Michelinia.

4 Family Halysitidæ.— Syringopora.

B. order alcyonaria.

5 Family Alcyonidæ.— Aulopora.

6 Family Graptolitidæ.— Plumalina.

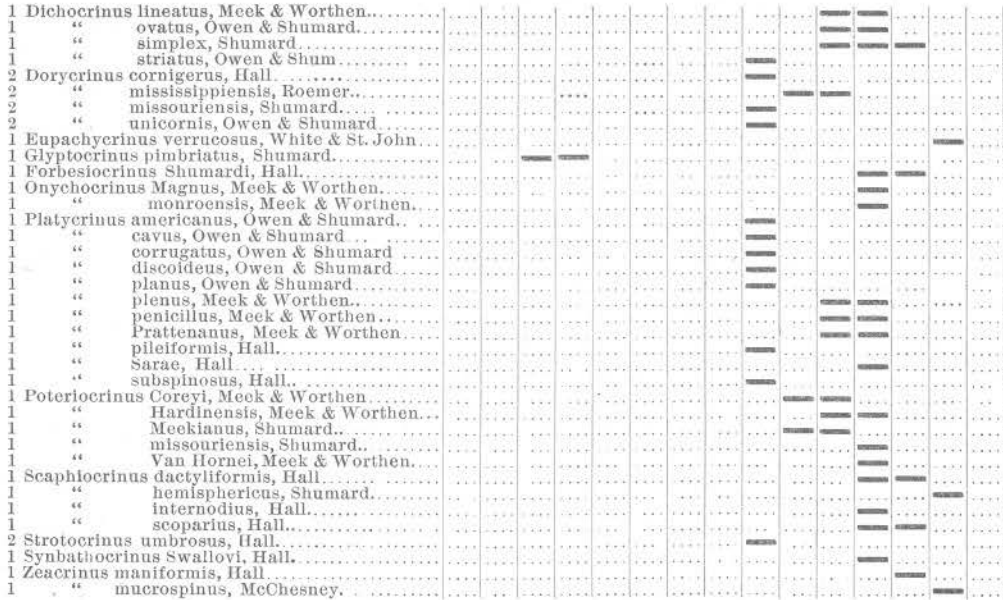
	NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
		Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Rv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
1	Acervularia Davidsoni, Edw. & Haime																St. Louis Co.
3	Alveolites niagarensis, Rominger																" "
5	Aulopora conferta, Winchell																" "
1	Campophyllum torquium, Owen																" "
3	Chætetes lycoperdon, Hall																" "
3	" rugosus "																" "
3	" pulchellus, Edw. & Haime																" "
1	Chonophyllum Sedaliense, W. & W																Pettis Co.
1	Cyathophyllum rugosum, Edw. H																St. Louis Co.
2	Cyathaxonia distorta, Worthen																" "
3	Favosites hemispherica, Yandell & Shum																" "
3	" basaltica, Goldfuss																" "
3	" polymorpha, Goldfuss																" "
3	" limitaris, Rominger																" "
3	" radiatus, "																Jefferson Co.
3	" epidermatus, Rominger																" "
1	Lithostrotion mamillare, Edw. & H																St. Louis Co.
1	" proliferum, Hall																" "
3	Michelinia expansa, W. & W.																Pettis Co.
3	Michelinia placenta, W. & W																" "
6	Plumalina gracilis, Shumard																Pike Co.
4	Syringopora multattenuata, McChesney																St. Louis Co.
4	" perelegans, Billings																Cooper Co.
4	" tubiporoides, Yandell & Shum																St. Louis Co.
1	Areptelasma cornicula, Hall																" "
1	" crassa, Hall																" "
1	Zaphrentis spinulifera, Hall																" "
1	" calceola, W. & W																Pettis Co.
1	" corniculum, Edw. & H																St. Louis Co.

Sub-Kingdom Echinodermata.

1. Class — Crinoidea.

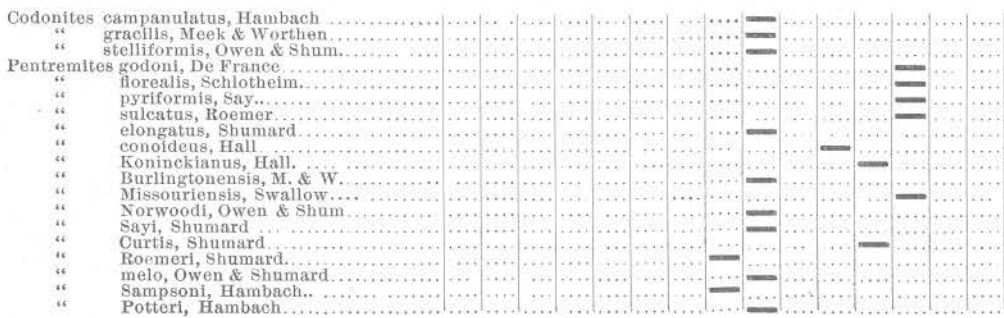
1. Family Cyathocrinidæ. — Agassizocrinus, Barycrinus Cyathocrinus, Dichocrinus, Eupachycrinus, Forbesiocrinus, Onychocrinus, Platycrinus, Poteriocrinus, Scaphiocrinus, Synbathocrinus, Zeacrinus, Glyptocrinus.
2. Family Actinocrinidæ. — Actinocrinus, Agaricocrinus, Batocrinus, Dorycrinus, Strotocrinus.

	NAME.	Lower Silurian: Magnesian L. S. Series.	Lower Silurian: Trenton, L. S.	Lower Silurian: Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Upper Silur.: Niagara Gr.	Upper Silur.: Lower Helderberg.	Devonian: Oriskany S. S.	Devonian: Hamilton Gr.	Devonian: Chemung. Gr. (Choteau L. S. & Verm. S. S.)	Sub-Carboniferous: Burlington.	Sub-Carboniferous: Keokuk.	Sub-Carboniferous: Warsaw.	Sub-Carboniferous: St. Louis.	Sub-Carboniferous: Chester.	Coal Measures.	Permian.	LOCALITY.
2	Actinocrinus concinus, Shumard.									▬							Marion Co.
2	" Koninckí, Shumard									▬							" "
2	" Verneuilianus, Shumard									▬							" "
2	" nashvillæ, Hall										▬						Clark Co.
2	" pernodosus, Hall										▬						Warren Co.
2	" Lowii, Hall										▬						Clark Co.
2	" multiradiatus, Shumard									▬							Cooper Co.
2	" proboscidialis, Hall									▬							" "
2	" biturbinatus, Hall		▬							▬							" "
2	" pentagonus, Hall									▬							" "
2	" parvus, Shumard									▬							St. Louis Co.
2	" verrucosus, Hall									▬							Cooper Co.
2	" ventricosus, Hall									▬							" "
2	Agaricocrinus tuberosus, Hall										▬						Clark Co.
2	" Wortheni, Hall										▬						" "
1	Agassizocrinus daetyliformis, Hall											▬	▬	▬			St. Louis Co.
1	" Chesterensis, Worthen											▬	▬	▬			" "
2	Batocrinus æqualis, Hall									▬							Cooper Co.
2	" Christyi, Shumard									▬							" "
2	" longirostris, Hall									▬							" "
2	" pyriformis, Shumard									▬							Marion Co.
2	" papillatus, Hall									▬							Pettis Co.
2	" rotundus, Yandell & Shumard									▬							Marion Co.
1	Cyathocrinus Hoveyi, Meek & Worthen										▬						Clark Co.
1	" intermedius, Hall											▬	▬				Cooper Co.
1	" magister, Hall											▬	▬				" "
1	" stellatus, Hall											▬	▬				St. Louis Co.
1	" spurius, Hall											▬	▬				" "



1	Dichocrinus lineatus, Meek & Worthen	" "
1	" ovatus, Owen & Shumard	" "
1	" simplex, Shumard	St. Genevieve Co.
1	" striatus, Owen & Shum	Jefferson Co.
2	Dorycrinus cornigerus, Hall	Jasper Co.
2	" mississippiensis, Roemer	Clark Co.
2	" missouriensis, Shumard	Marion Co.
2	" unicornis, Owen & Shumard	Pettis Co.
1	Eupachycrinus verrucosus, White & St. John	Jackson Co.
1	Glyptocrinus pimbriatus, Shumard	Cape Girardeau.
1	Forbesiocrinus Shumardi, Hall	St. Louis Co.
1	Onychocrinus Magnus, Meek & Worthen	" "
1	" monroensis, Meek & Worthen	" "
1	Platycrinus americanus, Owen & Shumard	Cooper Co.
1	" cavus, Owen & Shumard	" "
1	" corrugatus, Owen & Shumard	" "
1	" discoideus, Owen & Shumard	" "
1	" planus, Owen & Shumard	Pettis Co.
1	" plenus, Meek & Worthen	Warren Co.
1	" penicillus, Meek & Worthen	St. Louis Co.
1	" Prattenanus, Meek & Worthen	" "
1	" pileiformis, Hall	Cooper Co.
1	" Sarae, Hall	St. Louis Co.
1	" subspinosus, Hall	Cooper Co.
1	Poteriocrinus Coreyi, Meek & Worthen	" "
1	" Hardinensis, Meek & Worthen	St. Louis Co.
1	" Meekianus, Shumard	Moniteau Co.
1	" missouriensis, Shumard	St. Louis Co.
1	" Van Hornei, Meek & Worthen	" "
1	Scaphiocrinus dactyliformis, Hall	" "
1	" hemisphericus, Shumard	Jackson Co.
1	" internodius, Hall	St. Louis Co.
1	" scoparius, Hall	Cooper Co.
2	Strotocrinus umbrosus, Hall	St. Louis Co.
1	Synbathocrinus Swallovi, Hall	" "
1	Zeacrinus maniformis, Hall	St. Genevieve Co.
1	" mucrospinus, McChesney	Jackson & Platte Co.

2. Class — Blastoidea.



	Codonites campanulatus, Hambach	Pettis Co.
	" gracilis, Meek & Worthen	" "
	" stelliformis, Owen & Shum	" " & Pike Co.
	Pentremites godoni, De France	Perry Co.
	" florealis, Schlotheim	" "
	" pyriformis, Say	St. Genevieve Co.
	" sulcatus, Roemer	" "
	" elongatus, Shumard	Pike Co.
	" conoideus, Hall	Cooper Co.
	" Koninckianus, Hall	St. Louis Co.
	" Burlingtonensis, M. & W	Jasper Co.
	" Missouriensis, Swallow	St. Louis Co.
	" Norwoodi, Owen & Shum	Boone & Pettis Co.
	" Sayi, Shumard	" " " "
	" Curtis, Shumard	St. Louis Co.
	" Roemeri, Shumard	Boone Co.
	" melo, Owen & Shumard	Cooper & Pettis & Pike Co.
	" Sampsoni, Hambach	Pettis Co.
	" Potteri, Hambach	Cooper Co.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
Pentremites obliquatus, Roemer											▬					Cooper Co.
" Wortheni, Hall.											▬					" "
" bipyramidalis, Hall.											▬					" "

3. CLASS — ECHINOIDEA.

1 FAMILY PALÆCHINIDÆ. — Melonites, Oligoporus.

2 FAMILY ARCHÆOCIDARIDÆ.

2 Archæocidaris aculeatus, Shumard.														▬		Jackson Co.
2 " biangulatus, Shumard.														▬		Lafayette Co.
2 " Keokuk, Hall										▬						Clark Co.
2 " megastylus, Shumard														▬		Jackson & St. Louis Co.
2 " mucronatus, M. & W.														▬		Andrew Co.
2 " Norwoodi, Hall.												▬				St. Louis Co.
2 " Newberryi, Hambach												▬				" "
2 " Shumardana, Hall.												▬				" "
2 " Wortheni, Hall												▬				" "
1 Melonites crassus, Hambach.												▬				" "
1 " irregularis, Hambach												▬				" "
1 " multipora, Owen & Nor												▬				" "
1 Oligoporus parvus, Hambach												▬				" "
1 " Danae, M. & W.										▬	▬	▬				Jasper Co.

Sub-Kingdom Mollusca.

1. Class — Annelida.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
Cornulites carbonarius, Gurley								—								Pike Co.
Spirorbis kinderhookensis, Gurley								—								" "

2. Class — Bryozoa.

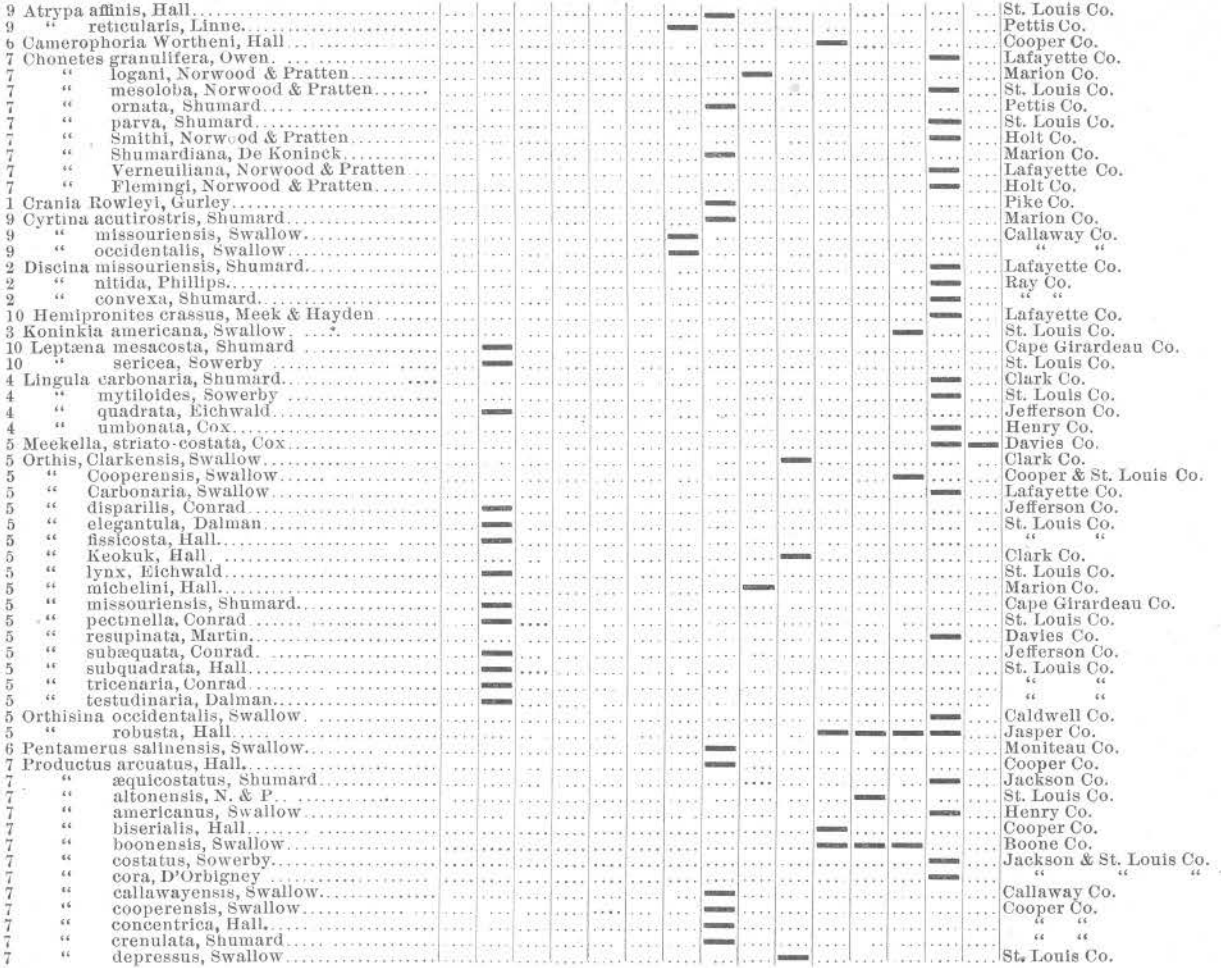
1 Family Reteporidæ. — Archimedes, Evactinopora, Fenestella, Fenestralia.
2 Family Escharidæ. — Coscinium, Ptilodictya.
3 Family Tubuliporidæ. — Cyclopora.

1 Archimedes Wortheni, Hall.											—					Howard & Jasper Co.
2 Coscinium plumosum, Prout.												—				St. Louis Co.
3 Cyclopora fungia, Prout.									—	—						Clark Co.
1 Evactinopora radiata, M. & W.									—							St. Louis Co.
1 Fenestella banyana, Prout			....										—			" "
1 " hemitrypa, Prout													—			" "
1 Fenestralia St. Ludovici, Prout												—				" "
2 Ptilodictya arguta, Billings		—														" "
2 " recta, Hall.		—														" "

3. Class — Brachiopoda.

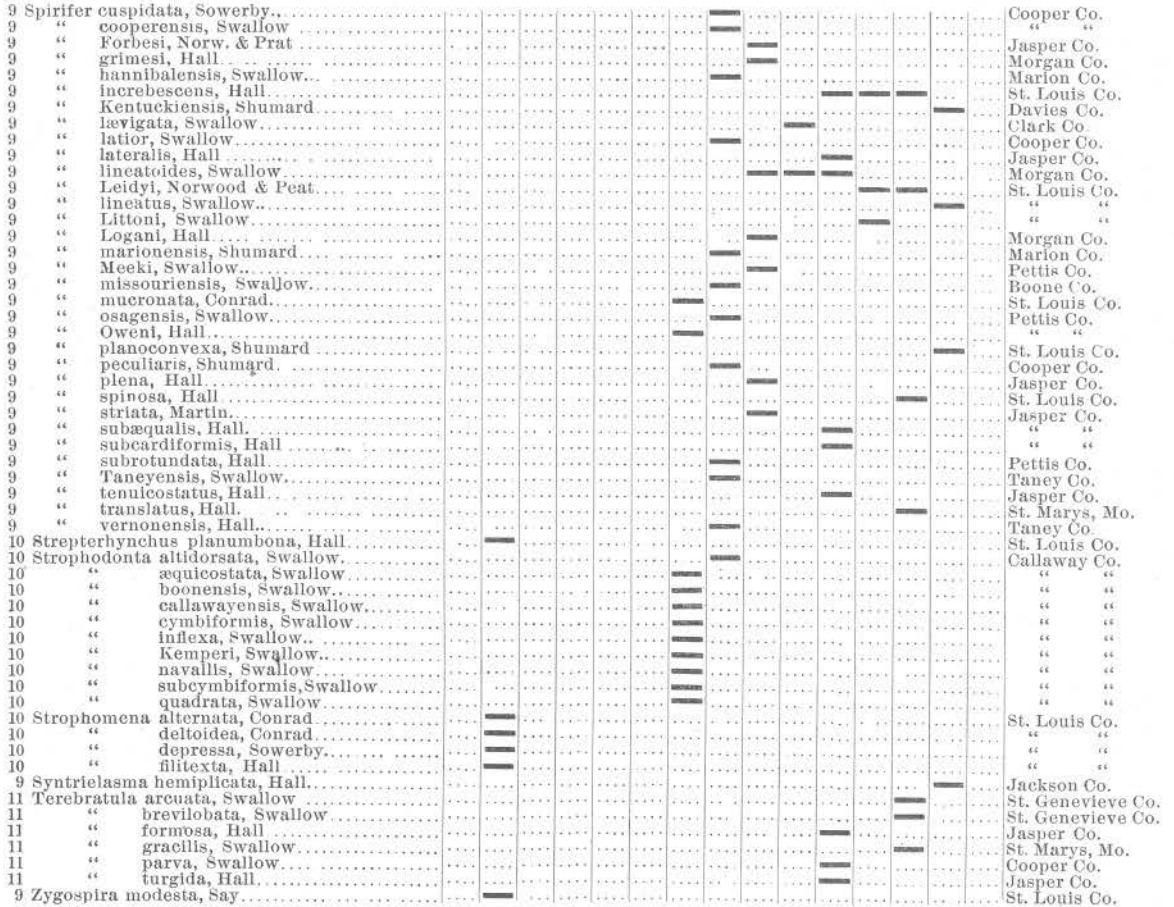
1 Family Craniidæ. — Crania.
2 Family Discinidæ. — Discina.
3 Family Koninckiidæ. — Koninckia.
4 Family Lingulidæ. — Lingula.
5 Family Orthidæ. — Meekella, Orthis, Orthisina.
6 Family Pentameridæ. — Camarophoria, Pentamerus.
7 Family Productidæ. — Chonetes, Productella, Productus.
8 Family Rhynchonellidæ. — Rhynchonella.
9 Family Spiriferidæ. — Athyris, Atrypa, Cyrtina, Retzia, Spirifer, Syntrielasma, Zygospira.
10 Family Strophomenidæ. — Leptæna, Streptorhynchus, Strophodonta, Strophomena, Hemipronites.
11 Family Terebratulidæ. — Terebratula.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
9 Athyris americana, Swallow.													—			St. Genevieve Co.
9 " charitonensis, Swallow														—		Chariton Co.
9 " clintonensis, Swallow											—	—	—			St. Genevieve Co.
9 " caput-serpentis, Swallow														—		Central Mo.
9 " euzona, Swallow.											—					Cooper Co.
9 " fultonensis, Swallow								—								Callaway Co.
9 " hannibalensis, Swallow								—								Pettis Co.
9 " Hawani, Swallow														—		Central Mo.
9 " Jacksoni, Swallow														—		Cass Co.
9 " maconensis, Swallow														—		Montgomery Co.
9 " minima, Swallow							—									Callaway Co.
9 " missouriensis, Swallow														—		Chariton Co.
9 " plattensis, Swallow														—		Audrain Co.
9 " Prauti, Swallow								—								St. Louis Co.
9 " reflexa, Swallow											—	—	—			" "
9 " Singletonii, Swallow														—		Audrain Co.
9 " sublamellosa, Hall													—			St. Louis Co.
9 " subtilita, Hall														—		Lafayette Co.
9 " subquadrata, Hall													—			St. Louis Co.
9 " trinucleus, Hall													—			" "



9	Atrypa affinis, Hall	St. Louis Co.
9	" reticularis, Linne	Pettis Co.
6	Camerophoria Wortheni, Hall	Cooper Co.
7	Chonetes granulifera, Owen	Lafayette Co.
7	" logani, Norwood & Pratten	Marion Co.
7	" mesoloba, Norwood & Pratten	St. Louis Co.
7	" ornata, Shumard	Pettis Co.
7	" parva, Shumard	St. Louis Co.
7	" Smithi, Norwood & Pratten	Holt Co.
7	" Shumardiana, De Koninck	Marion Co.
7	" Verneuiliana, Norwood & Pratten	Lafayette Co.
7	" Flemingi, Norwood & Pratten	Holt Co.
1	Crania Rowleyi, Gurley	Pike Co.
9	Cyrtina acutirostris, Shumard	Marion Co.
9	" missouriensis, Swallow	Callaway Co.
9	" occidentalis, Swallow	" "
2	Discina missouriensis, Shumard	Lafayette Co.
2	" nitida, Phillips	Ray Co.
2	" convexa, Shumard	" "
10	Hemipronites crassus, Meek & Hayden	Lafayette Co.
3	Koninkia americana, Swallow	St. Louis Co.
10	Leptæna mesacosta, Shumard	Cape Girardeau Co.
10	" sericea, Sowerby	St. Louis Co.
4	Lingula carbonaria, Shumard	Clark Co.
4	" mytiloides, Sowerby	St. Louis Co.
4	" quadrata, Eichwald	Jefferson Co.
4	" umbonata, Cox	Henry Co.
5	Meekella, striato-costata, Cox	Davies Co.
5	Orthis, Clarkensis, Swallow	Clark Co.
5	" Cooperensis, Swallow	Cooper & St. Louis Co.
5	" Carbonaria, Swallow	Lafayette Co.
5	" disparilis, Conrad	Jefferson Co.
5	" elegantula, Dalman	St. Louis Co.
5	" fissicosta, Hall	" "
5	" Keokuk, Hall	Clark Co.
5	" lynx, Eichwald	St. Louis Co.
5	" michelini, Hall	Marion Co.
5	" missouriensis, Shumard	Cape Girardeau Co.
5	" pectinella, Conrad	St. Louis Co.
5	" resupinata, Martin	Davies Co.
5	" subæquata, Conrad	Jefferson Co.
5	" subquadrata, Hall	St. Louis Co.
5	" tricenaria, Conrad	" "
5	" testudinaria, Dalman	" "
5	Orthisina occidentalis, Swallow	Caldwell Co.
5	" robusta, Hall	Jasper Co.
6	Pentamerus salinensis, Swallow	Moniteau Co.
7	Productus arcuatus, Hall	Cooper Co.
7	" æquicostatus, Shumard	Jackson Co.
7	" altonensis, N. & P.	St. Louis Co.
7	" americanus, Swallow	Henry Co.
7	" biserialis, Hall	Cooper Co.
7	" boonensis, Swallow	Boone Co.
7	" costatus, Sowerby	Jackson & St. Louis Co.
7	" cora, D'Orbigney	" " "
7	" callawayensis, Swallow	Callaway Co.
7	" cooperensis, Swallow	Cooper Co.
7	" concentrica, Hall	" "
7	" crenulata, Shumard	" "
7	" depressus, Swallow	St. Louis Co.

	NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
		Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Rv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
7	Productus elegans, N. & P.													▬			St. Louis Co.
7	" Flemingi, Sowerby														▬		" "
7	" gradatus, Swallow										▬						" "
7	" fentonensis, Swallow										▬						" "
7	" magnicostatus, Swallow														▬		Johnson Co.
7	" magnus, M. & W												▬				Jasper Co.
7	" marginacinctus, Prout													▬			St. Louis Co.
7	" murchisonianus, Koninck								▬								Cooper Co.
7	" muricatus, N. & P.														▬		Henry Co.
7	" nebrasciensis, Owen														▬		" "
7	" Prattenianus, Norwood														▬		St. Louis Co.
7	" punctatus, Sowerby									▬	▬	▬	▬	▬	▬		Jackson & St. Louis Co.
7	" semireticularis, Fleming														▬		Henry Co.
7	" splendens, N. & P.														▬		" "
7	" symmatricus, McChesney														▬		Jackson Co.
7	" subaculeatus, Murchison								▬								Cooper Co.
7	" tenuicostus, Hall												▬	▬			Jasper Co.
7	" wabashensis, N. & P.														▬		Henry Co.
7	" wortheni, Hall												▬				Jasper Co.
7	Productella subalata, Hall								▬								Callaway Co.
9	Retzia punctilifera, Shumard														▬		Howard Co.
9	" oragensis, Swallow								▬								Cooper Co.
9	" vera, Hall													▬			St. Louis Co.
8	Rhynchonella arctirostrata, Swallow												▬				Cooper Co.
8	" capax, Conrad			▬													St. Louis Co.
8	" cooperensis, Shumard								▬								Pettis Co.
8	" osagensis, Swallow														▬		Howard Co.
8	" missouriensis, Shumard								▬								Cooper Co.
8	" perrostellata, Swallow												▬				" "
8	" recurvirostra, Hall		▬														St. Louis Co.
8	" ringens, Hall											▬					Callaway Co.
8	" warrenensis, Swallow								▬								" "
8	" boonensis, Shumard								▬								Boone Co.
8	" Grosvenori, Hall												▬				Jasper Co.
8	" mutata, Hall												▬				" "
8	" macra, Hall												▬				" "
8	" subcuneata, Hall												▬				" "
9	Spirifer Annae, Swallow							▬									Callaway Co.
9	" boonensis, Swallow														▬		Boone Co.
9	" camerata, Morton														▬		St. Louis, Jackson and other Co.
9	Spirifer clarus, Swallow													▬			St. Genevieve Co.



9	Spirifer cuspidata, Sowerby	Cooper Co.
9	" cooperensis, Swallow	" "
9	" Forbesi, Norw. & Prat	Jasper Co.
9	" grimesi, Hall	Morgan Co.
9	" hannibalensis, Swallow	Marion Co.
9	" increbescens, Hall	St. Louis Co.
9	" Kentuckiensis, Shumard	Davies Co.
9	" lævigata, Swallow	Clark Co
9	" latior, Swallow	Cooper Co.
9	" lateralis, Hall	Jasper Co.
9	" lineatoides, Swallow	Morgan Co.
9	" Leidyi, Norwood & Peat	St. Louis Co.
9	" lineatus, Swallow	" "
9	" Littoni, Swallow	" "
9	" Logani, Hall	Morgan Co.
9	" marionensis, Shumard	Marion Co.
9	" Meeki, Swallow	Pettis Co.
9	" missouriensis, Swallow	Boone Co.
9	" mucronata, Conrad	St. Louis Co.
9	" osagensis, Swallow	Pettis Co.
9	" Oweni, Hall	" "
9	" planoconvexa, Shumard	St. Louis Co.
9	" peculiaris, Shumard	Cooper Co.
9	" plena, Hall	Jasper Co.
9	" spinosa, Hall	St. Louis Co.
9	" striata, Martin	Jasper Co.
9	" subæqualis, Hall	" "
9	" subcardiformis, Hall	" "
9	" subrotundata, Hall	Pettis Co.
9	" Taneyensis, Swallow	Taney Co.
9	" tenuicostatus, Hall	Jasper Co.
9	" translatus, Hall	St. Marys, Mo.
9	" vernonensis, Hall	Taney Co
10	Strepterhynchus planumbona, Hall	St. Louis Co.
10	Strophodonta altidorsata, Swallow	Callaway Co.
10	" æquicostata, Swallow	" "
10	" boonensis, Swallow	" "
10	" callawayensis, Swallow	" "
10	" cymbiformis, Swallow	" "
10	" inflexa, Swallow	" "
10	" Kemperi, Swallow	" "
10	" navallis, Swallow	" "
10	" subcymbiformis, Swallow	" "
10	" quadrata, Swallow	" "
10	Strophomena alternata, Conrad	St. Louis Co.
10	" deltoidea, Conrad	" "
10	" depressa, Sowerby	" "
10	" filitexta, Hall	" "
9	Syntrielasma hemiplicata, Hall	Jackson Co.
11	Terebratula arcuata, Swallow	St. Genevieve Co.
11	" brevilobata, Swallow	St. Genevieve Co.
11	" formosa, Hall	Jasper Co.
11	" gracilis, Swallow	St. Marys, Mo.
11	" parva, Swallow	Cooper Co.
11	" turgida, Hall	Jasper Co.
9	Zygospira modesta, Say	St. Louis Co.

4. Class — Pterapoda.

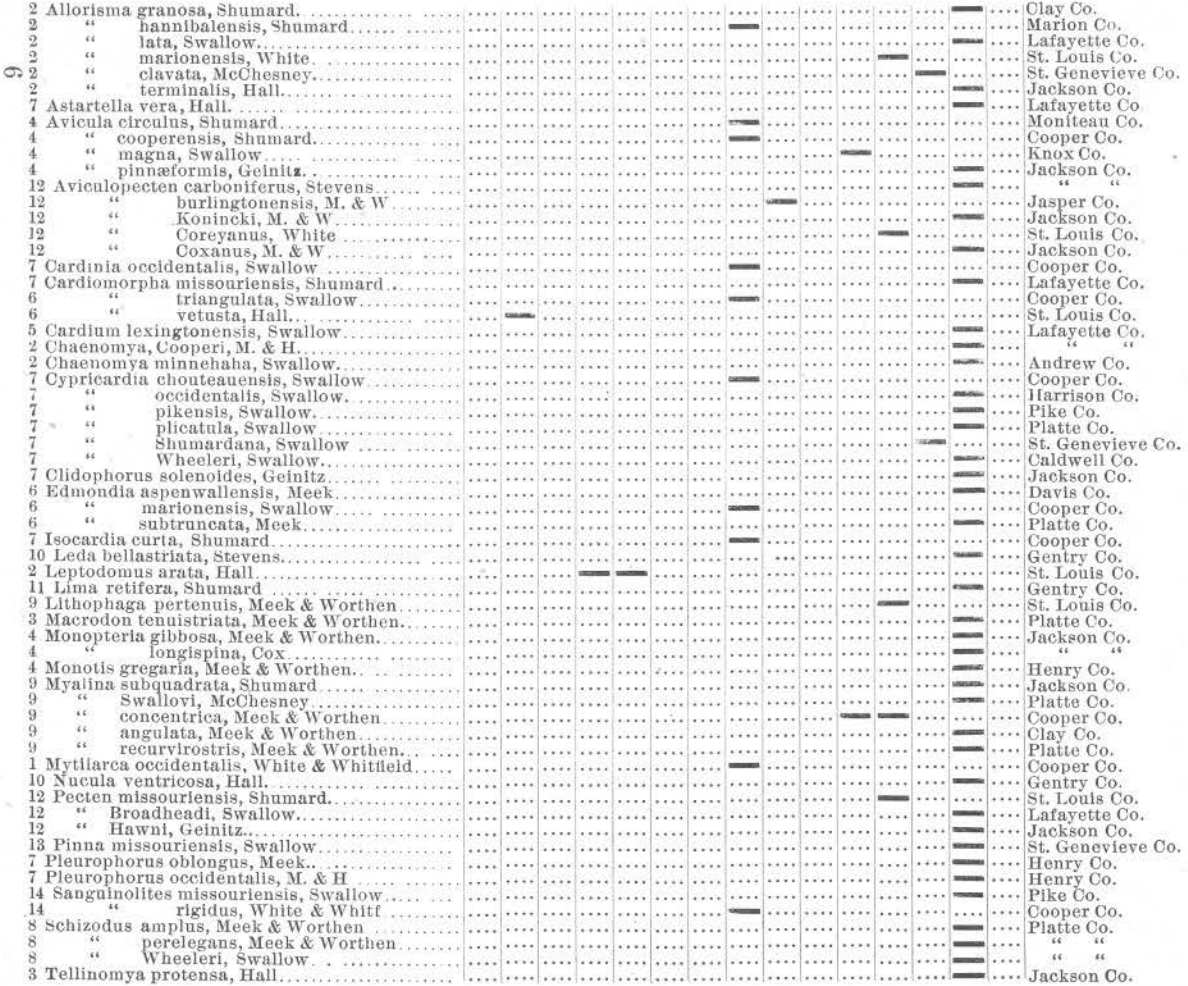
1 Family Conulariidæ. — Conularia.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.						COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Rv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.				
1 Conularia crustula, White	....	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
1 " marionensis, Swallow	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	....	Marion Co.
1 " missouriensis, Swallow	....	....	....	....	....	....	....	....	....	....	....	▬	▬	....	....	....	St. Louis Co.
1 " Osagensis, Swallow	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	Cooper Co.
1 " subulata, Hall	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
1 " subcarbonaria, Meek & Worthen	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	Clark Co.
1 " triplicata, Swallow	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	....	Marion Co.

5. Class — Lamellibranchiata.

1 Family Ambronychiidæ. — Mytilarca.
2 " Anatinidæ. — Allorisma, Chænomya, Leptodomus.
3 " Arcidæ. — Macrodon, Tellinomya.
4 " Aviculidæ. — Avicula, Monopteria, Monotis.
5 " Cardiidæ. — Cardium.
6 " Cardiomorphidæ. — Cardiomorpha, Edmondia.
7 " Cyprinidæ. — Astartella, Cardinia, Cleidophocus, Cypricardia, Isocardia, Pleurophorus.
8 " Cytherodontidæ. — Schizodus.
9 " Mytilidæ. — Lithophaga, Myalina.
10 " Nuculidæ. — Leda, Nucula.
11 " Ostreidæ. — Lima.
12 " Pectinidæ. — Aviculopecten, Pecten.
13 " Pinnidæ. — Pinna.
14 " Sanguinolitidæ. — Sanguinolites.

2 Allorisma antiqua, Swallow	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	St. Louis Co.
2 " cuneata, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Lafayette Co.
2 " ensiformis, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Clay Co.

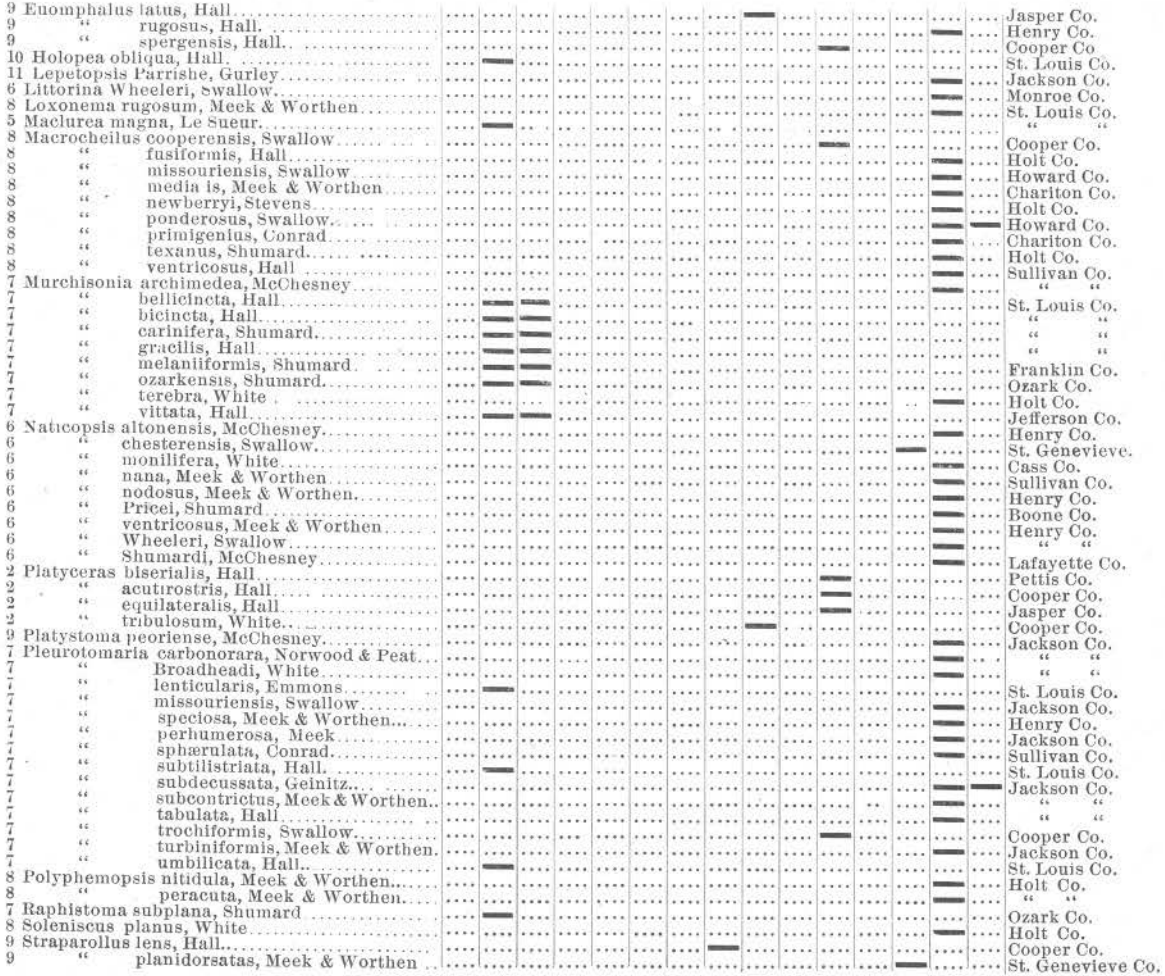


2	Allorisma granosa, Shumard	Clay Co.
2	" hannibalensis, Shumard	Marion Co.
2	" lata, Swallow	Lafayette Co.
2	" marionensis, White	St. Louis Co.
2	" clavata, McChesney	St. Genevieve Co.
2	" terminalis, Hall	Jackson Co.
7	Astartella vera, Hall	Lafayette Co
4	Avicula circulus, Shumard	Moniteau Co.
4	" cooperensis, Shumard	Cooper Co.
4	" magna, Swallow	Knox Co.
4	" pinnæformis, Geinitz	Jackson Co.
12	Aviculopecten carboniferus, Stevens	" "
12	" burlingtonensis, M. & W	Jasper Co.
12	" Koninckii, M. & W	Jackson Co.
12	" Coreyanus, White	St. Louis Co.
12	" Coxanus, M. & W	Jackson Co.
7	Cardinia occidentalis, Swallow	Cooper Co.
7	Cardiomorpha missouriensis, Shumard	Lafayette Co.
6	" triangulata, Swallow	Cooper Co.
6	" vetusta, Hall	St. Louis Co.
5	Cardium lexingtonensis, Swallow	Lafayette Co.
2	Chaenomya, Cooperi, M. & H	" "
2	Chaenomya minnehaha, Swallow	Andrew Co.
7	Cypricardia chouteauensis, Swallow	Cooper Co.
7	" occidentalis, Swallow	Harrison Co.
7	" pikensis, Swallow	Pike Co.
7	" plicatula, Swallow	Platte Co.
7	" Shumardana, Swallow	St. Genevieve Co.
7	" Wheeleri, Swallow	Caldwell Co.
7	Clidophorus solenoides, Geinitz	Jackson Co.
6	Edmondia aspenwallensis, Meek	Davis Co.
6	" marionensis, Swallow	Cooper Co.
6	" subtruncata, Meek	Platte Co.
7	Isocardia curta, Shumard	Cooper Co.
10	Leda bellastriata, Stevens	Gentry Co.
2	Leptodomus arata, Hall	St. Louis Co.
11	Lima retifera, Shumard	Gentry Co.
9	Lithophaga pertenuis, Meek & Worthen	St. Louis Co.
3	Macrodon tenuistriata, Meek & Worthen	Platte Co.
4	Monopteria gibbosa, Meek & Worthen	Jackson Co.
4	" longispina, Cox	" "
4	Monotis gregaria, Meek & Worthen	Henry Co.
9	Myalina subquadrata, Shumard	Jackson Co.
9	" Swallovi, McChesney	Platte Co.
9	" concentrica, Meek & Worthen	Cooper Co.
9	" angulata, Meek & Worthen	Clay Co.
9	" recurvirostris, Meek & Worthen	Platte Co.
1	Mytilarca occidentalis, White & Whitfield	Cooper Co.
10	Nucula ventricosa, Hall	Gentry Co.
12	Pecten missouriensis, Shumard	St. Louis Co.
12	" Broadheadi, Swallow	Lafayette Co.
12	" Hawni, Geinitz	Jackson Co.
13	Pinna missouriensis, Swallow	St. Genevieve Co.
7	Pleurophorus oblongus, Meek	Henry Co.
7	Pleurophorus occidentalis, M. & H	Henry Co.
14	Sanguinolites missouriensis, Swallow	Pike Co.
14	" rigidus, White & Whitf	Cooper Co.
8	Schizodus amplus, Meek & Worthen	Platte Co.
8	" perelegans, Meek & Worthen	" "
8	" Wheeleri, Swallow	" "
3	Tellinomya protensa, Hall	Jackson Co.

6. Class — Gasteropoda.

1 Family Bellerophontidæ. — Bellerophon, Bucania.
2 " Calyptræidæ. — Platyceras.
3 " Dentaliidæ. — Dentalium.
4 " Halicidæ. — Streptaxis.
5 " Macluræidæ. — Maclurea.
6 " Naticidæ. — Naticopsis, Littorina.
7 " Pleurotomariidæ. — Murchisonia, Pleurotomaria, Raphistoma.
8 " Pyramidellidæ. — Chemnitzia, Loxonema, Macrocheilus, Bulimorpha, Polyphemopsis, Soleniscus, Subulites.
9 " Solaridæ. — Euomphalus, Platyostoma, Steaparollus.
10 " Turbinidæ. — Cyclonema, Holopea.
11 " Patellidæ. — Lepetopsis.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Chouteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
1 Bellerophon bilobatus, Sowerby.	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
1 " carbonarius, Cox	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Sullivan Co.
1 " crassus, Meek & Worthen	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	St. Genevieve Co.
1 " ellipticus, McChesney	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
1 " Meekanus, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Howard Co.
1 " missouriensis, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	St. Mary's.
1 " montfortanus, Norwood & P.	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Sullivan Co.
1 " nodocarinatus, Hall	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
1 " percarinatus, Conrad.	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Holt Co.
1 " Stevensanus, McChesney	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Holt Co.
1 " textiliformis, Gurley	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
1 " Blaneyanus, McChesney	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Sullivan Co.
1 " sublævis, Hall	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	Cooper Co.
1 Bucania expansa, Hall	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
8 Bulimorpha bulimiformis, Hall	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	" "
8 Chemnitzia tenuilineata, Shumard.	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Cooper Co.
10 Cyclonema leavenworthana, Hall	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	St. Louis Co.
3 Dentalium missouriense, Swallow.	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	St. Mary's.
9 Euomphalus boonensis, Swallow	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	Jasper Co.
9 " catilloides, Conrad	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	" "



9	Euomphalus latus, Hall	Jasper Co.
9	" rugosus, Hall.	Henry Co.
9	" spergensis, Hall.	Cooper Co
10	Holopea obliqua, Hall.	St. Louis Co.
11	Lepetopsis Parrishe, Gurley	Jackson Co.
6	Littorina Wheeleri, Swallow	Monroe Co.
8	Loxonema rugosum, Meek & Worthen	St. Louis Co.
5	Maclurea magna, Le Sueur.	" "
8	Macrocheilus cooperensis, Swallow	Cooper Co.
8	" fusiformis, Hall	Holt Co.
8	" missouriensis, Swallow	Howard Co.
8	" media is, Meek & Worthen	Chariton Co.
8	" newberryi, Stevens	Holt Co.
8	" ponderosus, Swallow.	Howard Co.
8	" primigenius, Conrad	Chariton Co.
8	" texanus, Shumard	Holt Co.
8	" ventricosus, Hall	Sullivan Co.
7	Murchisonia archimedea, McChesney	" "
7	" bellicincta, Hall	St. Louis Co.
7	" bicincta, Hall	" "
7	" carinifera, Shumard	" "
7	" gracilis, Hall	" "
7	" melaniiformis, Shumard	Franklin Co.
7	" ozarkensis, Shumard.	Ozark Co.
7	" terebra, White	Holt Co.
7	" vittata, Hall	Jefferson Co.
6	Naticopsis altonensis, McChesney	Henry Co.
6	" chesterensis, Swallow.	St. Genevieve.
6	" monilifera, White	Cass Co.
6	" nana, Meek & Worthen	Sullivan Co.
6	" nodosus, Meek & Worthen.	Henry Co.
6	" Pricei, Shumard	Boone Co.
6	" ventricosus, Meek & Worthen	Henry Co.
6	" Wheeleri, Swallow	" "
6	" Shumardi, McChesney	Lafayette Co.
2	Platyceras biserialis, Hall	Pettis Co.
2	" acutirostris, Hall	Cooper Co.
2	" equilateralis, Hall	Jasper Co.
2	" tribulosum, White.	Cooper Co.
9	Platystoma peoriense, McChesney.	Jackson Co.
7	Pleurotomaria carbonorara, Norwood & Peat	" "
7	" Broadheadi, White	" "
7	" lenticularis, Emmons	St. Louis Co.
7	" missouriensis, Swallow	Jackson Co.
7	" speciosa, Meek & Worthen.	Henry Co.
7	" perhumerosa, Meek	Jackson Co.
7	" sphærulata, Conrad.	Sullivan Co.
7	" subtilistriata, Hall.	St. Louis Co.
7	" subdecussata, Geinitz.	Jackson Co.
7	" subcontrictus, Meek & Worthen.	" "
7	" tabulata, Hall	" "
7	" trochiformis, Swallow.	Cooper Co.
7	" turbiniformis, Meek & Worthen.	Jackson Co.
7	" umbilicata, Hall.	St. Louis Co.
8	Polyphemopsis nitidula, Meek & Worthen.	Holt Co.
8	" peracuta, Meek & Worthen.	" "
7	Raphistoma subplana, Shumard	Ozark Co.
8	Soleniscus planus, White	Holt Co.
9	Straparollus lens, Hall.	Cooper Co.
9	" planidorsatas, Meek & Worthen	St. Genevieve Co.

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	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recup. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Chotean L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
9 Straparollus valvatiformis, Shumard	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Ozark Co.
4 Streptaxis Whitfieldi, Meek	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Adair Co.
8 Subulites elongatus, Emmons	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.

7. Class — Cephalopoda.

1 Family Cyrtoceratidæ. — Cyrtoceras.
2 " Goniatitidæ. — Goniatites.
3 " Nautilidæ. — Discites, Lituites, Nautilus, Temnocheilus, Trocholites.
4 " Orthoceratidæ. — Endoceras, Gonioceras, Ormoceras, Orthoceras.

1 Cyrtoceras annulatum, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
3 Discites Toddanus, Gurley	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
4 Endoceras gemelliparum, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
4 " proteiforme, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	" "
4 " approximatum, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	Jefferson Co.
4 " proteiforme, var. lineolatum, H.	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
2 Goniatites Holmesi, Swallow	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Cooper Co.
2 " minimus, Shumard	....	....	....	....	....	....	....	▬	....	....	....	....	....	▬	....	Lafayette Co.
2 " morganensis, Swallow	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Cooper Co.
2 " osagensis, Swallow	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	" "
2 " planorbiformis, Shumard	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Lafayette Co.
2 " politus, Shumard	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	" "
4 Gonioceras anceps, Hall	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	Jefferson Co.
3 Lituites complanatus, Shumard	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	Ozark Co.
3 Nautilus digonus, Meek & Worthen	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Callaway Co.
3 " Forbesanus, McChesney	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
3 " Gilpini, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Lafayette Co.
3 " Lawsi, Swallow	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	....	Callaway Co.
3 " missouriensis, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Boone Co.
3 " ponderosus, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
3 " quadrangularis, McChesney	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	" "
3 " spectabilis, Meek & Worthen	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	St. Louis Co.
3 " sangamonensis, Meek & Worthen	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	" "
4 Orthoceras aculeatum, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
4 " chemungense, Swallow	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Cooper Co.
4 " chesterense, Swallow	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	St. Marys, Mo.
4 " cribrosum, Geinitz	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
4 " junceum, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
4 " ozarkense, Shumard	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	Ozark Co.
4 " primigenium, Vanuxem	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	Jefferson Co.
4 " vertebrale, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	" "
4 Ormoceras tennifilum, Hall	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	" "
3 Tennocheilus Winslowi, Meek & Worthen	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Lafayette Co.
3 Trocholites ammonius, Conrad	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	Jefferson Co.

Sub-Kingdom Articulata.

1. Class — Crustacea.

1 Family Acidaspidæ. — Acidaspis.
2 " Asaphidæ. — Asaphus, Illaenus.
3 " Calymenidæ. — Calymene.
4 " Ceraurida. — Ceraurus, Encrinurus.
5 " Cyphaspidæ. — Cyphas.
6 " Cytheridæ. — Cythere.
7 " Phacopidæ. — Phacops, Dalmanites.
8 " Prœtidæ. — Griffithides, Prœtus, Phillipsia.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. and Vern. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
1 Acidaspis Halli, Shumard	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	Cape Girardeau Co.
2 Asaphus jowensis, Owen	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
2 " megistos, Locke	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	" "
3 Calymene rugosa, Shumard	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Cape Girardeau Co.
3 " senaria, Conrad	....	▬	▬	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
4 Ceraurus pleurexanthemus, Green	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	" "
5 Cyphaspis girardeauensis, Shumard	....	....	....	▬	....	....	....	....	....	....	....	....	....	....	....	Cape Girardeau Co.
6 Cythere sublaevis, Shumard	....	....	....	▬	....	....	....	....	....	....	....	....	....	....	....	St. Genevieve Co.
7 Dalmanites tridentiferus, Shumard	....	....	....	▬	....	....	....	....	....	....	....	....	....	....	....	Cape Girardeau Co.
4 Encrinusus deltoideus, Shumard	....	....	....	▬	....	....	....	....	....	....	....	....	....	....	....	" " "
8 Griffithides Sedaliensis, Vogdes	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Pettis Co.
2 Illænus crassicanda, Wahlenberg	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	St. Louis Co.
2 " trentonensis, Emmons	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	" "
7 Phacops callicephalus, Hall	....	▬	....	....	....	....	....	....	....	....	....	....	....	....	....	" "
8 Phillipsia major, Shumard	....	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	Jackson Co.
8 " meramecensis, Shumard	....	....	....	....	....	....	....	....	....	▬	▬	....	....	....	....	St. Louis Co.
8 " missouriensis, Shumard	....	....	....	....	....	....	....	....	....	....	▬	....	....	▬	....	Lafayette Co.
8 " Sampsoni, Vogdes	....	....	....	....	....	....	....	....	....	▬	▬	....	....	....	....	Pettis Co.
8 Proetus missouriensis, Shumard	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	Cooper Co.
8 " Swallowi	....	....	....	....	....	....	....	▬	....	....	....	....	....	....	....	" "

Sub-Kingdom Vertebrata.

1. Class — Pisces.

Order Ganoidei.

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					COAL MEASURES.	PERMIAN.	LOCALITY.
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.	St. Louis.	Chester.			
Amacanthus gibbosus, Newberry & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
Asteroptychius St. Ludovici, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	" "
Aspidodus crenulatus, N. & W.	....	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	" "
Batacanthus baculiformis, St. John & W.	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	St. Francisville, Mo.
Cladodus eccentricus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
" elegans, Newberry & Worthen.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" ferox, Newberry & Worthen	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" ischypus, Newberry & Worthen.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" euglypheus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" spinosus, Newberry & Worthen	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Chomatodus incrassatus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" parallelus, St. John & W.	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	Cooper Co.
Cochliodus obliqus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
" Van Hornii, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Copodus Van Hornii, St. John & W	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Ctenacanthus costatus, Newberry & W	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" excavatus, St. John & W.	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	Lewis Co.
" gracillimus, Newberry & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
" pugiunculus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Dactylodus princeps, Newberry & W	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Daltodus cinctulus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" Littoni, Newberry & Worthen.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" parvus, St. John & Worthen.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" rhomboideus, Newberry & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Deltodapsis St. Ludovici, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
Deltoptychius expansus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "
" Wachsmuthi, St. John & W.	....	....	....	....	....	....	....	....	....	▬	▬	....	....	....	....	Cooper Co.
Desmiodus costelliferus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
" flabellum, St. John & W.	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	Cooper Co.
" ligoniformis, St. John & W.	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	" "
Drepanacanthus reversus, St. John & W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	St. Louis Co.
" stellatus, N. & W.	....	....	....	....	....	....	....	....	....	▬	....	....	....	....	....	" "
Erismacanthus McCoyanus, St. John &. W.	....	....	....	....	....	....	....	....	....	....	....	▬	....	....	....	" "

Gampsacanthus latus, St. John & W.										—	—					Cooper Co.
" squamosus, St. John & W.												—				St. Louis Co.
" typus, St. John & W.												—				" "
Geisacanthus stellatus, St. John & W.												—				" "
Harpacodus occidentalis, St. John & W.												—				" "
Helodus consolidatus, Newberry & W.										—						St. Francisville, Mo.
" crenulatus, Newberry & Worthen.										—						St. Louis Co.
Homacanthus gibbosus, Newberry & Worthen.												—				" "
Lambdodus calceolus, St. John & W.									—							Cooper Co.
" costatus, St. John & W.									—							Lewis Co.
Lecracanthus unguiculus, St. John & Worthen												—				St. Louis Co.
Lisgodus curtus, St. John & Worthen.									—							Cooper Co.
" selluliformis, St. John & W.												—				St. Louis Co.
Listracanthus hystrix, Newberry & Worthen.														—		Andrew Co.
Leptacanthus occidentalis, Newberry & Worthen.												—				St. Louis Co.
Marracanthus rectus, Newberry & Worthen.												—				" "
Oracanthus consimilis, St. John & W.												—				" "
" vetustus, Leidy.										—	—					" "
Orodus plicatus, Newberry & Worthen												—				" "
" variocostatus, St. John & W.									—							" "
Peltodus quadratus, St. John & W.												—				" "
Petalodus destructor, Newberry & Worthen														—		Jackson Co.
" linguifer, Newberry & Worthen.													—			St. Louis Co.
Petalorhynchus distortus, St. John & W.												—				" "
" pseudosagittatus, St. John & W.												—				" "
Petrodus occidentalis, Newberry & Worthen.														—		Henry Co.
Physonemus falcatus, St. John & W.												—				St. Louis Co.
" parvulus, St. John & W.										—						Cooper Co.
Polyrhizodus Littoni, Newberry & Worthen												—				St. Louis Co.
" amplus, St. John & W.												—				" "
" Williamsi, " "										—						Boone Co.
Poecilodus vassoviensis, " "												—				St. Louis Co.
Psammodus plenus, " "												—	—			" "
" cælatus, " "												—				" "
" reticulatus, " "													—			" "
Prephodus latus, " "												—				" "
Sandalodus crassus, Newberry & Worthen.												—				" "
" laevissimus, Newberry & Worthen										—						" "
" spatulatus, Newberry & Worthen.												—				" "
Tanaodus prænuntius, St. John & Worthen.												—				" "
" sculptus, St. John & Worthen.												—				" "
Venustodus Leidyi, St. John & Worthen.												—				" "
" tenuicristatus, St. John & Worthen										—						St. Francisville, Mo.
Vaticinodus simplex, St. John & Worthen.												—				St. Louis Co.
Xystrodus imitatus, " "												—				" "

BLUFF OR LOESS FORMATION.

SUB-KINGDOM MOLLUSCA.

Name.	*Locality.*
Amnicola lapidaria, Say	Near St. Louis.
Helix rufa, De Kay	St. Joseph Landing.
albolabris, Say	One-half mile below Great Nemaha.
alternata, Say	Bellevue, Lexington.
concava, Say	Near St. Louis.
thyroideus, Say	Bluff City Landing.
profunda, Say	Lexington.
multilineata, Say	Near mouth Big Nemaha and Platte River.
clausa, Say	Near mouth Big Nemaha and Platte River.
strialella, Anthony	St. Louis, Boonville.
monodon, Rackett	St. Louis.
electrina, Gould	St. Louis and Boonville.
arborea, Say	St. Louis.
indentata, Say	Below mouth of Platte River.
hirsuta, Say	Near St. Louis.
lineata, Say	Mouth of Platte River.
minuta, Say	Mouth of Platte River.
labyrinthica, Say	St. Louis.
Helicina occulta, Say	Boonville and St. Louis.
Limnea fragilis, Lin	Lexington.
" reflexa, Say	Bluff City Landing.
" umbrosa, Say	Near mouth of Nemaha.
Physa plicata, De Kay	Near mouth of Wolf River.
" heterostropha, Say	Mouth of Platte River.
" elongata, Say	Mouth of Platte River.
" gyrinea, Say	Below Platte River.
Planorbis trivolvis, Say	Bluff City Landing.
" armigerus, Say	Mouth of Wolf River.
Pupa armifera, Say	Near St. Louis.
Succinea obliqua, Say	Bluff City Landing.
" campestris, Say	Bluff City Landing.
" ovalis, Say	Bluff City Landing.
Valvata tricarinata, Say	Bluff City Landing.

SUB-KINGDOM VERTEBRATA.

CLASS MAMMALIA.

Names.	*Locality.*
Bootherium cavifrons, Leidy	Benton Co.
Mastodon giganteus, Cuv	Pettis and St. Louis Co.
Elephas primigenius, Blume	Boone Co.
Tastor fiber, Ow	Near mouth of Big Nemaha.

VEGETABLE KINGDOM.

PLANTÆ.

1. CELLULAR CRYPTOGAMOUS PLANTS.

2. Class — Thalassophytes.

NAME.	Coal Measures.	
Conostychus Broadheadi, Lesqx	—	Vernon Co.
" prolifer, "	—	" "
Taonurus Colletti, "	—	Henry Co.

2. VASCULAR CRYPTOGAMOUS PLANTS.

ACROGENS.

3. Class — Equisetaceæ.

NAME.	Coal Measures.	
Order 1. Calamariæ.		
Annularia angustifolia, Lesqx	—	Henry Co.
" longifolia, Brgt	—	" "
" sphenophylloides, Lenk & Gutb.	—	" "
Asterophyllites fasciculatus, Lesqx	—	" "
" rigidus, Brgt	—	" "
Calamites cistii, "	—	" "
" Suckowii "	—	" "
Sphenophyllum erosum, Ll. & Hutt	—	" "
" filiculme, Lesqx	—	" "
" longifolium, Germ	—	" "
" oblongifolium, "	—	" "
" Schlotheimi, Brgt	—	" "

4. Class — Filicaceæ (Ferns.)

Order 1. Neuropterids.		
Neuropteris angustifolia, Brgt	—	Henry Co.
" cordata, "	—	" "
" dilatata, Ll. & Hutt	—	" "
" fimbriata, Lesqx	—	Jasper Co.
" flexuosa, Brgt	—	Henry Co.
" hirsuta, Lesqx	—	" "
" Loshi, Brgt	—	" "
" missouriensis, Lesqx	—	" "
" rarinervis, Buby	—	" "
" tenuifolia, Brgt	—	" "
Odontopteris heterophylla, Lesqx	—	" "
" sphenopteroides, "	—	" "
" subcrenulata, "	—	" "
Dictyopteris obliqua, Buby	—	" "

NAME.	Coal Measures.	
Order 2. Alethopterids.		
Alethopteris ambigua, Lesqx	—	Henry Co.
" lonchitica, Schloth	—	" "
" serlii, Brgt	—	" "
Callipteridium membranaceum, Lesqx	—	" "
" Owenii, "	—	" "
" Sullivantii, "	—	" "
Order 3. Pseudopecopterids.		
Pseudopecopteris acuta, Brgt	—	Henry Co.
" irregularis, St	—	" "
" macilenta, Ll. & Hutt	—	" "
" nummularia	—	" "
" obtusiloba	—	" "
" Sillimanni, Brgt	—	" "
Order 4. Pecopterids.		
Pecopteris arborescens, Brgt	—	Henry Co.
" clintoni, Lesqx	—	" "
" cristata, Gutb	—	" "
" dentata, Brgt	—	" "
" erosa, Gutb	—	" "
" pennæformis, Brgt	—	" "
" vestita, Lesqx	—	" "
Order 5. Sphenopterids.		
Sphenopteris Brittsii, Lesqx.	—	Henry Co.
" chærophylloides, St	—	" "
" crystata, St	—	" "
" dubuissonis, Brgt	—	" "
" furcata, "	—	" "
" Gravenhorsti "	—	" "
" mixta, Schp	—	" "
" spinosa, Göpp	—	" "
" splendens, Lesqx	—	" "
" tridactylites, Brgt	—	" "
Eremopteris missouriensis, Lesqx	—	" "
Ferns of uncertain attribution.		
Rhacophyllum adnascens, Ll. & Hutt	—	Henry Co.
" arborescens, Lesqx	—	" "
" filiciforme, Schp	—	" "
" fimbriatum, Lesqx	—	" "
" hamulosum, "	—	" "
" hirsutum, "	—	" "
" lactuca, St	—	" "

NAME.	Coal Measures.	
Ferns of uncertain attribution (continued).		
Rhacophyllum membranaceum, Lesqx	—	Henry Co.
" spinosum, "	—	" "
Sorocladus ophioglossoides, "	—	" "
Megaphytum Goldenbergii, Weiss	—	" "
5. CLASS — LYCOPODIACEÆ.		
Lepidodendron aculeatum, St	—	Vernon Co.
" Brittsii, Lesqx	—	Henry Co.
" cyclostigma, "	—	" "
" lanceolatum, "	—	" "
" marginatum, "	—	" "
" Sternbergi, Ll. & Hutt	—	" "
Lepidophloios dilatatus, Lesqx	—	" "
" sigillarioides, Lesqx	—	" "
Lepidophyllum majus, Brgt	—	" "
" minus, Lesqx	—	" "
Lepidostrobus Goldenbergii, Schp	—	" "
Order Sigillariæ.		
Sigillaria fissa, Lesqx	—	Henry Co.
" menardi, "	—	" "
" reniformis, Brgt	—	" "
" sculpta, Lesqx	—	" "
" spinulosa, Germ	—	" "
Pinnularia capillacea, Lesqx	—	" "
6. CLASS — CORDAITEÆ.		
Cordaianthus dichotomus, Lesqx	—	Henry Co.
" gemmifer, "	—	" "
Cordaites communis, "	—	" "
" diversifolius, "	—	" "
Desmiophyllum gracile, "	—	Jasper Co.
Lepidoxylon anomalum, "	—	Henry Co.
Trigonocarpus Dawe-ii, Ll. & Hutt	—	Cedar Co.
" olivæformis, Ll. & Hutt	—	" "