NEW YEAR ANNOUNCEMENT

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NEW YEAR ANNOUNCEMENT.

To His Excellency, Lon V. Stephens, President, the other Honorable Members of the Board of Managers and the Public:

That all, who read and think and are in any way interested in the geology or mineral resources of Missouri, may share equally in the valuable information collected in the field, I beg to submit this New Year Announcement.

When I started on field work, some two years ago, the geological record (sedimentary rocks) of Missouri had never been differentiated, described and named. The Silurian, Devonian and Subcarboniferous sections, between the Magnesian Lens and the Coal Measures, had been much discussed and thus made somewhat familiar objects to a comparatively few people. But the ten (10) Cambrian and eight (8) Silurian members of the Magnesian Lens had never been differentiated, described and named. Neither had the twenty-nine (29) Coal horizons of the Lower, Middle and Upper Coal Measures been differentiated, described and named.

I have been two years making a personal reconnoissance of the State and differentiating its rocks, so that I could proceed logically in the delineation of its geology. Very many readers will, I trust, appreciate both the importance of that work and the unselfish effort required to make it exhaustive. The rocks are now differentiated, by their individual lithologic and fossil characters, but another season of active field work will be required to get the exact boundaries of the areas in which some of the most important rocks are now the surface rocks. Then, we will have gotten the requisite data for Reports on Structural and Economic Geology; as well as, the essential data for delineating the Vertical Zones and for an up-to-date Geological Map of Missouri.

In the meantime, all of the publications of former State Geologists, books and maps alike, that contained anything of practical value, have been distributed. Realizing the importance of proceeding logically, it was the original intention of the Board of Managers that I should complete my personal reconnoissance of the State and collect

all of the required data, before publishing any Reports or Maps. But the demand for definite information, about the geology and mineral resources of Missouri, is growing so rapidly I have been ordered to discontinue field work for the present and get out a Preliminary Report this winter.

Pending that, my desk is flooded each day with polite requests for specific information, which doubtless belongs to the public, as much as to the individual. And that is the explanation I have to offer for this prelude to the forthcoming Preliminary Report. I cannot undertake to convey to the public, all of the valuable information I have collected in the field, through individual letters. Neither can I do justice to such an extensive correspondence while preparing the Report.

OUR GREAT COUNTRY ROCKS.

Commencing with the Primordial Base of our geological record, the rocks involved in it are chiefly granite, gneiss and mica-schist; with the dyke rocks, pegmatite, diabase and porphyry, characteristic of such country. That the topography of our Primordial base is sharply defined, or rugged, is a fact of great economic importance. As will be shown hereafter, an acute knowledge of the basal topography helps us to analyze the local structure and determine the subdrainage zones, wherein our greatest ore bodies have been concentrated.

In the Primordial areas of Wayne, Madison, Iron, St. Francois and Ste. Genevieve counties, in which the granite rocks have been denuded of their sedimentary covering, the same general conditions obtain under which rich metal veins are found in other countries. The only reason, I can conceive, why those areas of granite country rock have not been explored for true fissure veins, is because they were not situated in some more romantic or *windy* country. To say the least, they are very old rocks, on which has doubtless stood a vertical mile of ore-bearing rocks, that have been resolved into their constituent elements and carried away to the sea floor; or precipitated in the fissures and other cavities in these ancient bed-rocks.

Again, the innumerable dykes of diabase, pegmatite and porphyry suggest that if there really are such things as sublimation veins, they ought to be found in the granite country of Southeast Missouri. If the money that has been wasted on the proverbially barren porphyry had been judiciously expended in searching for metal veins in the granite, it is more than probable that rich deposits would have been found. A few iron-ore concentrations, in the upper surface of porphyry is about all of value that has been found in that sort of country.

Porphyry talus has, it is true, in some cases, served as a receptacle for lead and copper ores that have been derived from decomposed or weathered-out limestones. Some of my readers will doubtless demur to this proposition. They have a right to do so, if they like, for I am no oracle; but merely a close observer of nature—of men as well as rocks. However, I am not ready yet to argue that question to a finish, but merely call your attention to this conclusion; that all of our ore bodies are water concentrations, pure and simple. Neither hot water concentrations, nor salt water concentrations; but common cold water concentrations of the metallic elements of decomposed or reconstructed rocks.

The maternal function of this cosmic body which we call Earth precludes the possibility of purely metallic masses having been thrown up from below. Furthermore, when it is known that all of our great ore bodies occur in the once open structure of certain country rocks and are resting on practically impervious floors, it will devolve on the other side of the house to show at least one place in the Earth through which these ore bodies in Missouri have been thrown up.

The Earth is evolving some seventy-four chemical elements with which we are more or less familiar. Everything in nature has a physiological function to perform, because it is a part of an organized living whole. Knowing that Earth's water and atmosphere are the vehicles in which are diffused or suspended the essential elements of organic life, that our bodies are not only made up of those elements but continually renewed by them, as well as all of the myriads of forms and individuals of animal and vegetable life, is it not reasonable to suppose that Earth's water and atmosphere have to be renewed? Call to mind that this entity which we call life and cling to so tenaciously would cease in five minutes, were it not for the one element, oxygen, that is suspended in the atmosphere.

The first essential element of organic life is cosmic light, derived from the Sun. Co-operating with our Imperial Motor, the Sun, our cosmic mother, Earth, evolves the other essential elements; and that is a part of the Synthetic Method, the Physiology, of Nature.

Moreover, if everything in nature has a function to perform, for what purpose are the three or four hundred active volcanoes sending out continuous streams of gases and vapors? Earth's maternal function is the key to the whole problem. Her elements are diffused in her water and atmosphere, metals and metalloids alike, and are afterwards concentrated into economic bodies. As I proceed with the delineation of what I have observed in the field, please keep this fundamental fact before you.

On that Primordial base of granite, gneiss and mica-schist, traversed and diversified, as it is, by dykes and bosses of diabase, pegmatite and porphyry, rests the famous Magnesian Lens of Missouri. The plane of contact between the Primordial base and the Magnesian Lens is essentially rugged. Manifestly, because the topography of the base is sharp and the lower members of the Lens represent the first Paleozoic sediment deposited on the floors of valleys and basins, in the rugged surface of the Primordial base.

THE MAGNESIAN LENS.

The Magnesian Lens of Missouri is essentially unique. It has not an exact equivalent in North America. It is made up of eighteen (18) individual members, the lower ten (10) of which have been differentiated as Cambrian and the upper eight (8) of which belong in the Lower Silurian. Sharp granite peaks, porphyry dykes and pegmatite bosses stand up in places, one thousand feet above the common level of the Primordial base and the areas between have been filled up with Cambrian and Silurian deposits. Hence we have contacts, at various angles, between the Cambrian and First Silurian limestones on the one hand and granite, gneiss, mica-schist, pegmatite or porphyry on the other.

CAMBRIAN SECTION.

Our Missouri Cambrian Beds have been divided into two sections, viz: Lower and Upper Cambrian. The Lower Cambrian, including the Basal sandstone, consists of five members: First—The Basal sandstone is a fine-grained, pure white, quartzose sandrock about fifty feet thick, in the central zones of the Primordial valleys, and a variable conglomerate along its outer margins; where its materials were derived directly from the granites and porphyries. Second—The White Lead (leed) or First limestone rests conformably on the Basal sandstone. It is usually a white, intensely crystalline and cavernous rock, varying in thickness between ten and fifty feet. This is the horizon or country rock, of some of the greatest disseminated ore bodies in the known world. Third—The Dead Rock or Second limestone is an exceedingly fine-grained rock, varying in thickness between ten and one hundred and fifty feet. It carries no ores except in the form of vertical fissures or "feeders." Fourth—The Black Lead (leed) or Third limestone is usually a very dark colored coarsely crystalline and cavernous rock, varying in thickness between five and twenty feet. Fifth—The Massive Crystalline Cap-rock or Fourth limestone is a very cavernous rock that has undergone vast reconstruction. Its

structure is gnarled and cavernous, but the ore bodies lie mainly in the White and Black Leads or First and Third limestones. This massive crystalline Cap-rock of the Lower Cambrian varies in thickness between two hundred and fifty and three hundred feet. Hence the average total thickness of Lower Cambrian is about four hundred and fifty feet. Persistent sheets or thin lenses of Lingulella shales, at the top and bottom of the Black Lead, will be described in the forthcoming Reports, along with six or seven other fossil horizons in the Cambrian.

The Upper Cambrian consists also of five members: First—The Lower Green Shales (greywackes) about twenty feet thick and including some thin layers and isolated lenses of argillaceous limestone. Second—The Lower Mud-rock, about twenty feet thick. Third—The Upper Green Shales (greywackes) about twenty feet thick and also containing some thin layers and lenses of argillaceous limestone. Fourth—The Upper Mud-rock, an argillaceous limestone, about forty feet thick and yielding some good dimension building stone. Fifth—The last or Siliceous Cap-rock of the Upper Cambrian section is about one hundred and fifty feet thick.

Right here, I would like to impress upon the mind of the reader, the very important fact, that this last named Siliceous Cap-rock of the Upper Cambrian is the only siliceous limestone in our whole Cambrian section. The other Cambrian limestones, under it, make absolutely no cherts, no drusy quartz, or other siliceous products. This Siliceous Cap-rock is unique in two particulars; it makes vast quantities of convoluted cherts and drusy quartz and it weathers in tall narrow columns. In fact, its weathered faces or cliffs have much the same appearance as the columnar structure of basalt.

The Upper Cambrian is about two-hundred and fifty feet thick and our whole Cambrian section, including the Basal sandstone, is about seven hundred feet thick, in the areas already explored. These rocks will, of course, be more minutely described and their characteristic fossils given in the forthcoming Preliminary Report. Mr. D. K. Greger, late of the New York Survey, and a very enterprising Paleontologist, has been with me, in the field, since Sept. 1st and has rendered inestimable assistance.

The scientific world will doubtless be surprised to learn that we have already located six or seven different fossil horizons, a dozen or more different genera and two or three dozen different species, in the Cambrian Beds of Missouri. Moreover, these fossil horizons are literally packed, in certain zones, with well preserved fossils. Indeed, fossils are very abundant in both the limestones and the

shales. Parts of two or three hundred individual Trilobites have been found in one small slab of this Cambrian limestone. Well preserved Brachiopods and Gasteropods occur abundantly in the limestone at different horizons.

LOWER SILURIAN.

Our Lower Silurian section of the Magnesian Lens consists of eight members; four Infusorial sandstones and four Magnesian limestones, in alternate succession, described and named as follows:—1st, the Roubidoux or basal sandstone with an average thickness of about fifty feet; 2nd, the First Silurian limestone with an average thickness of about four hundred feet; 3rd, the St. Thomas sandstone with an average thickness of about fifty feet; 4th, the Second Silurian limestone with an average thickness of about two hundred feet; 5th, the Moreau sandstone with an average thickness of about fifty feet; 6th, the Third Silurian limestone with an average thickness of about three hundred feet; 7th, the St. Peter sandstone with an average thickness of about fifty feet; 8th, the Fourth Silurian limestone with an average thickness of about two hundred feet (same as Swallow's First Magnesian). Add to this the Black River and Trenton limestones and the Hudson River beds, and you have a complete section of our Lower Silurian.

First—The Roubidoux, or basal sandstone of the Lower Silurian, is usually a pure white quartzose sandrock, varying in thickness between ten and two-hundred feet. Roubidoux rests unconformably on all of the upper members of the Cambrian, from the top of the Siliceous Cap-rock down to the Massive Crystalline Cap-rock of the Lower Cambrian. Indeed, the under surface of Roubidoux is seen in many places projecting down into old ditches or eroded channels in the upper surface of the Massive Crystalline Cap-rock of the Lower Cambrian; with all of the Upper Cambrian section missing. This fact suggests a very long interval of time and a very considerable erosion of the Cambrian surface before the Roubidoux sandstone was deposited. This remarkable contact, together with the radical differences in lithologic and fossil characters of the rocks below and above it, makes a deeply-marked divisional plane between our Cambrian and Silurian sections.

The Roubidoux sandstone, barring its numerous Fucoid casts, is not unlike the St. Thomas, the Moreau or the St. Peter sandstone. All of them are massive and false-bedded in places, all of them are thin bedded and stratified in places. All of them are soft and friable in places, all of them are homogeneous quartzites in places. All of

them are oolitic quartzites in places, all of them are iron-stained, brown or red in places. And last, but not least, all of them are equally persistent.

Inasmuch as it is always present and a very conspicious benchmark, around the Cambrian areas now recognized in eighteen (18) different counties, the Roubidoux sandstone is one of the most important rocks in our geological record. Its Fucoid casts and its geological relations are, however, its only constant characters, so far observed, in Missouri.

Second—the First Silurian limestone rests conformably on Roubidoux sandstone and has an average thickness of about four hundred feet. It is the second great sedimentary country rock, or ore-bearing horizon in the Magnesian Lens; and it is the surface rock over large areas in thirty different counties. Its immense thickness and the constancy of its characters make it the greatest individual rock in our geological record. It is the most siliceous limestone in the Magnesian Lens; and next to the crystalline limestone of the Cambrian it has undergone most reconstruction. In fact, its gnarled and cavernous structure so closely resembles that of the Cambrian limestones that either of them is easily mistaken for the other.

However, when characteristic fossils cannot be found and geological relations are obscured, there are certain characteristic cherts in this rock that are absolutely constant. Indeed, its cherts are better witnesses to its identity than its fossils. First, because its fossils are mostly obliterated and hard to find; and when found, they are not unlike the fossils in some of the other magnesian limestones above it. Second, because its cherts are always present and bear certain individual characters that do not occur in the cherts of any other rock.

Such things will, of course, have to be brought out by the photographer. It is impossible to describe the individualities of these different cherts with any words in the English language. It may seem surprising to the casual observer, that by close and persistent observation, the eye can be trained to recognize the siliceous concretions (cherts and drusy quartz) of any rock in our geological record, but it is nevertheless true. The cherts of each and every limestone are stamped with some individual character that remains in them until they are reduced to atoms.

When I think of the magnitude of the First Silurian limestone—of the magnificent Greer Spring in Oregon County, the Jumping Spring in Carter, the Blue Spring in Shannon, the Meramec Spring in Phelps, and the Bennett Spring in Laclede, all flowing out of its dark

and mysterious caverns, I am almost persuaded that it is the greatest rock in the world.

But when I think of the deep serene of the Round Spring and the weird splendor of Cyclop's Cave, exquisite gems of the Cambrian of Shannon, and more than all, of the wild Niangua and the laughing Ha Ha Tonka with its matchless freaks and inspiring scenery, in the Cambrian zone of Camden, I am at least constrained to say that our Cambrian rocks have no parallels, in mineral wealth or scenic beauty, outside of this unique Magnesian Lens of Missouri.

I have now described two of the three great country rocks of Missouri, viz: the First Cambrian (bottom limestone of all) and the First Silurian limestone. You will now have to excuse me for hurrying up the column, or vertical section of our sedimentary rocks, about ten or twelve hundred feet, to our third great country rock (with reference to age) known as the Burlington-Keokuk or Carthage limestone. It is the second member of our Subcarboniferous section (Bed-Rocks of the Coal Measures) about two hundred and fifty feet thick in its greatest development and rests on the first member of that section, the argillaceous Chouteau Beds.

Burlington-Keokuk or Carthage limestone has two alternating aspects or typical phases; it is typical Burlington at one place and typical Keokuk at another. But it carries certain constant characters, lithologic and fossil, under all conditions of occurrence. It is the wall rock, or country rock, of all those rich ore bodies now being mined in the Spring River Valley, in Southwest Missouri.

You now have brief descriptions of the three great country rocks of Missouri. These are the most crystalline and cavernous rocks in Missouri—occurring, not consecutively, but in the order named, with reference to age. In other words, they are several hundred feet apart in a vertical section, and for that reason, are the surface rocks of distinctly different areas.

ORE BODIES AND HOW DISTRIBUTED.

Briefly stated, the ore bodies in the First Cambrian limestone are chiefly lead, nickel and cobalt (sulphides) disseminated in the bedding seams and porous texture of this country rock, in wide zones; and copper ores deposited at its contact with porphyry, pegmatite or granite. The ore bodies in the First Silurian limestone are chiefly lead, zinc, iron, copper and barium (sulphides, sulphates, oxides and carbonates) deposited in clay-blankets and in vertical fissures. The ore bodies in the Burlington-Keokuk or Carthage limestone are chiefly lead, zinc and cadmium (sulphides, silicates and carbonates) deposited

in reconstructed channels or narrow zones, on lines of fissure, coincident with original joint structure in the country rock.

With one or two exceptions, all of the paying mines in Missouri are located in the (one time) open structure of one or the other of the above described, three great country rocks. There is, towards the bottom of the Second Silurian limestone, between a cotton rock floor and a true limestone roof, a certain persistent chert bed, which makes a proper receptacle for water concentrations, when the beds are all tilted and the chert bed has the requisite open structure. But these requisite conditions, in the Second Silurian limestone, seem, so far, to have been rarely developed.

There are hundreds of mineral prospects and occasionally a small rich deposit in all of the intervening rocks between the First Cambrian, the First Silurian and the Carthage limestones, but there are no extensive or lasting deposits save one, found in any of them. Manifestly, for the simple reason that they have not the requisite structure. Open structure is evidently an essential condition for large water concentrations of metallic elements. In other words, there must have been, at some time, open structure or suitable receptacles, in the present surface rocks, for the concentration of metallic elements derived from the rocks that have been decomposed and removed. Otherwise, they surely would not now be found under conditions so suggestive of water concentrations.

In short, it is simply wasting time and money to explore for rich deposits of metallic ores, in the close textured, stratified and undisturbed argillaceous cotton rocks of the Second, Third and Fourth Silurian limestones, or in the Mud-rocks and Clay-shales of the Chouteau Beds. Where there is loose structure in the upper surface of any one of these rocks, such as dislocations, old canyons, clay-blankets and sinks, it is well enough to prospect, when you have nothing else to do. But it is absurd to expect deposits of such magnitude as are found in either of the three great country rocks. And I feel that it is my duty to insist that people quit digging and drilling in the undisturbed, stratified beds of the intervening rocks where there could not possibly have been a deposit of any importance, for the want of room.

If those "unselfish" and "all-knowing" seers, who are continually urging the inexperienced to *go deeper* and "throw their money at the birds," would "ring-off" or find other employment, their own brains might have a chance to act. The brains of the inexperienced prospectors would at least have a chance to act before they have thrown all of their money away. When you have struck solid, undisturbed,

stratified beds in any of these rocks—even the two great country rocks after the Cambrain—it is time to stop and reflect. You have to sink through stratified Cambrain beds to reach the ore-bearing member. In southwest Missouri you have, sometimes, to sink through the uncrystalline, blue, Upper Burlington-Keokuk, cap-rock, to reach the open structure in the crystalline country rock. Outside of these two exceptions, you are simply throwing away your time or money when you dig or drill in the solid, unaltered and undisturbed stratified beds of any other rock.

Another fundamental fact, which I want to impress on the mind of the reader, is this: Each one of our three great country rocks rests on a practically impervious floor. This fact suggests that one of the essential conditions for large water concentrations is, primarily, that the impervious floor should lie in the form of a basin or trough; wherein the subdrainage, through the open structure of the country rock, will naturally flow by converging lines towards a central zone in the trough or basin.

That calls to mind: the matchless disseminated lead deposits in the Cambrian valleys of Big River and its tributaries, in St. Francois County; the great fissure deposits in the First Silurian in the Meramec Valley, in Franklin County; the marvelous accumulations of ores and gangue-minerals in the reconstructed channels of the Burlington-Keokuk in the Spring River Valley, in southwest Missouri. However I will have more time and space and better facilities for describing these rocks and discussing the essential structure in each for great economic deposits, in the forthcoming Preliminary Report. Still more time and exhaustive data for making them simple and easy in the later Reports on Structural and Economic Geology, with cross-sections, delineated in vertical zones, and a Geological relief Map, for adjuncts.

I simply want to say here and now, to those who are besieging me for definite information in detail, along this line, digest what I have said in this paper and let your own brains act—get into the right structure in one of the three great country rocks, if you want to find a great ore body; or if you are not living on one of these rocks and want to dig near home, get into the kind of structure I have described in the other rocks in which smaller ore bodies are found and dig or drill and keep at it until I have had time to finish my report. Hoping the information herein contained may help to solve the problems that are now worrying many good people, I am now begging to be let alone, a month or two, while preparing a Report that will still further simplify the subject.

I have recognized Cambrian country in eighteen (18) different counties, viz: Morgan, Camden, Dallas, Laclede, Shannon, Carter, Reynolds, Wayne, Bollinger, Perry, Ste. Genevieve, Madison, St. Francois, Jefferson, Washington, Crawford, Dent and Iron.

I have recognized First Silurian Country in thirty different counties, viz: Benton, Morgan, Miller, Camden, Dallas, Laclede, Pulaski, Texas, Phelps, Maries, Cole, Osage, Gasconade, Franklin, Crawford, Dent, Shannon, Oregon, Ripley, Butler, Carter, Reynolds, Iron, Washington, Jefferson, Ste. Genevieve, Perry, Bollinger, Wayne and Madison.

I have recognized ore-bearing Burlington-Keokuk in twenty one different counties, viz: Moniteau, Cooper, Saline, Pettis, Benton, St. Clair, Hickory, Cedar, Polk, Webster, Wright, Christian, Stone, McDonald, Green, Lawrence, Dade, Barton, Jasper, Barry and Newton. With emphasis on the last named seven counties, because they lie in the original Spring River Invert. I mean by that—the subdrainage lines from the Magnesian Lens into the open structure of the Burlington-Keokuk, before the development of the Rocky Mountains, have never been reversed. The Magnesian Lens has been relatively let down but the subdrainage of the Spring River Valley has not been reversed. While I shall go on contending that these ore bodies are all cold water concentrations of metallic elements that were once diffused mainly in the different members of our Magnesian Lens, I will try to show that in the three great country rocks only, are to be found the requisite cavernous structure resting on the impervious floors of troughs and basins and, therefore, exposed from time immemorial, to the reconstructive operations of both surface and subdrainage. It was for the ultimate purpose of demonstrating such fundamental facts as these that the special appropriation for core-drilling was made by the 40th General Assembly.

This great Magnesian Lens, or "Mother Lode," whence all or most of the metallic elements, in our great ore bodies, have been derived, by the decomposition or reconstruction of its rocks, is a decidedly unique mass. It has been known by the popular name of "Ozark Uplift." But, with reference to the later development of the Rocky Mountains, it is better named the Magnesian Lens of the Ozark Range. The Ozark Range is an unevenly developed upward fold beginning in Lake Superior and ending in southwestern Texas. In other words, it is a continuation of the eastern axis of our Primordial Continent.

"Ozark Uplift" carries with it a radically wrong impression. It is, in fact, rather a down lift than an uplift. The difference in the altitudes of the highest and lowest places in Missouri is little more

than one thousand feet, or about half the thickness of the Magnesian Lens. The Ozark Range must have been, one time, relatively higher and more sharply defined than it now is. The well known fact that the later development of the Rocky Mountains lifted the floor of an inland sea into land surface and inclined it towards the center of the Mississippi Basin, is suggestive of some very great alterations. The contour of the Ozark Range must have been greatly modified and the drainage lines of west-central Missouri must have been reversed.

Howbeit, the unique character of the Magnesian Lens is due to other things entirely. It is manifestly a local lens, ending wedge-like in all directions, save in the narrow sinuous ridge, or deep-seated upward fold, in which some of its later rocks occur all the way to Lake Superior. The eighteen members of this Magnesian Lens already named and partially described, are, altogether, a rare combination, without an exact equivalent in North America.

It is a fundamental fact that we reason only by analogy. Knowing, as we do, that certain forms of marine life, plant and animal, take for their food certain elements directly from the water, and that the organic acids which they give back are very active reagents, we naturally conclude that a vast aggregation of these forms in some quiet spot in the ocean, would produce, in the course of time, a vast accumulation of heterogeneous organic products and other rock minerals, on that spot in the sea floor. If that spot should be sometime relatively raised into land surface, by the subsidence of other areas in the sea floor, which is the most logical explanation of emergence, would you not expect something unique in the rocks of that area?

We have just such conditions of deposit in the three great sargasso seas of the present time. In those three great filtering areas of the present ocean, we have vivid illustrations of the conditions and processes by which our unique Magnesian Lens was doubtless formed in early Paleozoic time. Now, with the metallic elements diffused in the rocks, it is not difficult to understand that, by the decomposition of part and the reconstruction of all, these marvelous ore deposits might easily have been concentrated from the diffused state into economic bodies. Indeed, it is so simple and logical that it must be so. The human mind cannot conceive anything so logical as the Synthetic Method of Nature.

I will, therefore, say to our inexperienced prospectors, quit listening to the silly theories of "old experienced miners," quit looking for "blow-outs," "upheavals," and "volcanic eruptions" in Missouri. Quit looking for impossibilities anywhere; but give Great Nature a reasonable chance. Never look backwards for perfection, but look always

ahead. Human perfection is never behind the procession, but always in front of it. Get into one or the other of the three great country rocks, look for the kind of structure in it that I have described as peculiar to it, and dig in the kind of ground in which rich ore bodies are found elsewhere. Let your own brain act, if you ever expect to be a successful miner, and dig or drill as your own common sense may suggest.

Having thus outlined the scope of the forthcoming Preliminary Report, I will say further that Mr. C. E. DeGroff, an expert field photographer, was in our party during the months of October, November and a part of December, and with our assistance photographed some of the most instructive exposures of all our Missouri rocks, from the granite base up to the basal sandstone of the Coal Measures. Our plan is to continue this feature of the work, under favorable conditions, until we have two or three good exposures, and they as widely separated as possible, of each important rock in our geological record.

Then, with our whole vertical section differentiated, in its natural order of occurrence, in suitable colors, each member named and described by its lithological and fossil characters, and further emphasized by photographs of two or three of its best exposures, it will be an easy matter for the student or the prospector to follow any one of these rocks, as it occurs throughout all vertical zones and geological maps that will be hereafter published. More than that, he can go into the field, recognize the rocks and work out for himself the structural and economic geology of his own locality. Then, the Geological Survey of Missouri will have accomplished the fundamental part of the great educational work for which it was established.

CORE-DRILLING.

It is now generally known throughout the State that the Fortieth General Assembly made a special appropriation for core-drilling, to be expended at the discretion and under the supervision of the Geological Survey. But how and where and for what specific purpose, it is to be used, is not generally known. Therefore, the public is entitled to at least a brief explanation.

Having found, in my personal reconnoissance of the State, that millions of dollars are being thrown away annually on experimental drilling and digging for water, oil, gas, coal and the various metallic ores, in the most improbable rocks or structure for such things to exist in paying quantities, it occurred to me that, with a small appropriation for the express purpose of demonstrating that those things

do exist in great abundance in certain rocks and certain kinds of structure, millions of dollars might be saved to an enterprising class of people and billions of mineral wealth brought to the light. In the meantime, such experimental core-drilling would supply data, for scientific use, that cannot be otherwise obtained.

I had already recognized Cambrain country in a dozen or more counties in South Missouri. I had already recognized a probable gas zone in Cass, Ray, Carroll, Livingston, Grundy and Mercer counties; an important coal zone and probable oil zone under it, in Caldwell, Daviess and Harrison counties; a probable coal zone of great local importance in the Platte Valley; a probable coal and oil basin in Holt county.

Making, in all, a dozen or more unexplored Cambrian zones in South Missouri and the four zones in North Missouri, just described; none of which have ever been explored to any considerable depth. The probable gas zone mentioned is merely a continuation of the same arch or upward fold, in the same rocks, in which the Iola gas wells are situated. This fold is apparently well developed about Belton, in Cass county, rising again in Ray county and extending in a broken line far into Mercer County. If gas should be found in paying quantities, at any point in that zone, it would be an easy matter to trace it in either direction to points where it might be utilized to greater advantage.

In the probable oil zone which lies in Caldwell, Daviess and Harrison counties, there are two sharply defined local basins. Being situated, as they are, in the regular coal measures, those sharply defined local basins are almost certain to contain coal beds of great economic value, which would be demonstrated by core-drilling even though oil should not be found in paying quantities under them. I have, however, personal knowledge of the fact that oil (not black bituminous but genuine petroleum) does occur in the zone just mentioned. If explored to a greater depth and with reference to local structure, it seems quite probable that oil deposits of great value might be located.

In the Platte Valley is a sharply defined invert or trough in which the Leavenworth coal lies and is now being worked extensively both in Kansas and Missouri. It would be the most logical thing conceivable for the Leavenworth coal to extend, in isolated productive lenses, on the floor of that trough, to the Iowa line. And there are reasons for believing that some other horizons than that of the Leavenworth coal might be found productive. I mean, of course, thick enough for profitable mining.

Finally, the most pronounced basin of all lies near Forest City, in Holt County. But a very deep hole would be required to explore it.

Now, if the unexplored Cambrian country, in the sixteen other South Missouri counties, should be found to contain a few zones of disseminated lead, as rich and extensive as those now being worked in Madison and St. Francois, or, should large copper deposits be found which is quite probable, it would be a great saving to Missouri, to have those ores smelted at home or with home fuel.

To further simplify this core-drilling proposition, I will say it is a well known fact, that the core-drill cannot be used sucessfully in the reconstructed channels of the Burlington-Keokuk or country rock of southwest Missouri. The only deep-seated ore bodies in the First Silurian are deposited in narrow, vertical fissures, from three to ten feet wide. What practical man would think of going out with a core-drill to look for a fissure? Having found a fissure, only the pick and shovel or the churn-drill can be used successfully in that kind of ground.

On the other hand, oil, gas, coal and disseminated lead are deposited in wide horizontal zones and there are no physical reasons why they should not be explored sucessfully with a core-drill. The disseminated lead deposits in our Cambrian limestones are practically inexhaustible. Therefore, if once demonstrated that one or more of those unexplored Cambrian areas contain rich deposits of disseminated lead, the Managers of R. R. lines need not have any fears that it will be quickly exhausted. The zones of disseminated lead now known to exist in Cambrian country will not be exhausted in a thousand years; even though they should be worked three times as rapidly as they are now being worked. They are doubtless the most extensive ore bodies and the safest mining propositions in the known world.

Further than that, I cannot afford to go, in this announcement. I would not have the people of Missouri think this Survey either supercilious, erratic, arbitrary or ungrateful, for the whole amount of the special appropriation. But I cannot go further into the details of this matter, for the simple reason that we want to make the best possible contracts for core-drilling; and should we make contracts for drilling, we will have to make contracts with the land owners, by which they will be compelled to pay half of the cost of drilling, in case it should be a failure, and the whole cost of drilling in case the object sought is found in paying quantities.

This core-drilling proposition is, of course, a new departure in this country. It is not a new departure in some other countries, inhabited by a very progressive people. However, it was an original proposition, a new departure, with us; for we had not then been advised of the fact that it is the only method by which the three Australian governments are developing the mineral resources of that great country. In as much as it was a new departure with us, we wanted to make sure that it would prove to be a wise departure. Hence we could not afford to act hastily, and my personal reconnoissance of the State had not been finished, until the annual meeting of the Board of Managers in December, 1899.

In the meantime, while we were busy with other work and could not keep up with correspondence, the newspapers reported us in such a way as to make the impression on the people that all they had to do was to invite us to come and drill, at the expense of the State, wherever they might suggest. Think of it—millions thrown away each year, drilling and digging in barren ground and the State going out to drill on the same kind of propositions.

I am proud to say that some of the best business men in Missouri are active members of the Board of Managers of this Department. Therefore, when the special appropriation has been expended and the smoke has cleared away, we cannot for many reasons, afford to have it said truthfully that we have developed private property or made individuals rich at the expense of the State. Now, there can be but one logical conclusion; while there is no law compelling this Survey to expend that appropriation, we will either go free-handed about this matter and expend it where we think it will do the most for the development of the mineral resources of Missouri, and for the specific purpose for which it was intended, or else, we will leave it in the State Treasury.

Having thus eliminated everything but the four zones, indicated, in North Missouri and the Cambrian country in South Missouri, we are ready to receive bids for core-drilling to depths of 1000 to 3000 feet in North Missouri; and we are ready to receive bids for core-drilling to depths of 300 to 600 feet in the Cambrian limestones of South Missouri. Bids to be opened at the next regular Board Meeting, Second Tuesday in February, 1900. The Board reserving the right to reject any or all bids and to award separate contracts, or not, as it may elect.

After the bids have been opened and contracts awarded (if any contracts shall have been awarded) and before any drilling is done, on the part of the State, special surveys will be made and the land owners notified that the Geological Survey will assume one-half of the

risk of demonstrating the existence of oil, gas, coal or metallic ores (as the case may be) in paying quantities in the ground selected by the Geological Survey. Then, if the land owners, individual or corporation holding, under lease or option, the ground selected by the Geological Survey, shall respond by entering into such a contract as shall have been approved by the Attorney General of Missouri, core-drilling will proceed as rapidly as practicable under the then existing conditions.

The Geological Survey will not be "open to conviction;" neither will it be looking for opportunities to divide losses. On the contrary, it will be looking with all of its might for the exact places wherein the logical method of nature might have made such deposits, regardless of personal, political or any other influence.

In short, the Survey will be looking for opportunities to make the other fellows pay for the drilling; and by that method, to get a large amount of drilling, a large amount of valuable information for scientific use and the best possible results, for the public money expended.

If we should be successful in one or more of these localities, in each field, the information thus gained would have a positive value and could be utilized in other like localities. If we should fail in all of them, the information gained by the experiment would still have a negative value which might be utilized to some advantage in other localities. However, I have a conviction that, if there is in this world, any one thing which God loves more than all others, *it is an honest effort.*

Wishing you all a happy and prosperous New Year, I remain,

Yours sincerely,

JOHN A. GALLAHER.

PUBLICATIONS OF THE
GEOLOGICAL SURVEY OF MISSOURI.

SURVEY OF 1853 TO 1862.

G. C. SWALLOW, STATE GEOLOGIST.

The First and Second Annual Reports of the Geological Survey of Missouri, by G. C. Swallow, State Geologist, Jefferson City. 1855. Parts I and II, 208 and 240 pp., 69 illustrations and 5 small county maps.

Contents: First Annual Report—Administrative—pp. 19-22. Second Annual Report: Introduction, pp. 25 to 28. Part I, Chapter I: Geology of Missouri, pp. 59 to 136, by G. C. Swallow. Chapter II: Economical Geology, Soils, pp. 137 to 170. Chapter III: Special Report on Marion county, pp. 171 to 185. Chapter IV: Special Report on Cooper county, pp. 186 to 204. Chapter V: Geology of the Southwest, pp. 204 to 207. All preceding by G. C. Swallow.

Part II: Report on Lead Mines and Mining of Southeast Missouri, in the counties of Franklin, Jefferson, Washington, St. Francois and Madison, pp. 1 to 94, by A. Litton. Special report on Moniteau county, pp. 95 to 119, by F. B. Meek. Description of the formations along the Hannibal & St. Joseph Railroad, with a catalogue of fossils collected, pp. 121 to 136, by F. Hawn. Geological Section of the Mississippi river, pp. 139 to 157; Special report on Franklin county, with map, pp. 157 to 169; Special report on St. Louis county, with map, pp. 169 to 184; Paleontology, including a description of 48 new species of fossils, with three plates of same, pp. 185 to 208, all by B. F. Shumard. Appendix, 31 pp., containing a list of publications previously made relating to the Geology of Missouri; a paper on the use of fossils, a catalogue of the fossils of Missouri and of her trees and shrubs, and a glossary of geological and other scientific terms.

Edition Exhausted.

The Third Report of Progress was transmitted in December, 1856, and is of 4 pages. It recites briefly what work has been done during the years 1855 and 1856.

Edition Exhausted.

The Fourth Report of Progress was made in December, 1858, and is of 14 pages. This describes, in greater detail, the operations of the Survey during the years 1857 and 1858, and gives, in tabular form, a statemnt of progress to date.

Edition Exhausted.

The Fifth Report of Progress of December 30, 1860, is of 13 pages and is a similar statement of operations during the years 1859 and 1860, with a brief reference to the results reached concerning the coal, lead and iron deposits and the soils of the State. In this report the product of the Survey to that time is given in tabular form.

Edition Exhausted.

SURVEY OF 1870 TO 1874.

A. D. HAGAR, RAPHAEL PUMPELLY AND G. C. BROADHEAD, STATE GEOLOGISTS.

Annual Report of the State Geologist of the State of Missouri (Albert D. Hagar, Nov. 30, 1870), 23 pp., no illustrations. The progress of the Survey is described and the principal minerals and building stones are briefly noticed.

Edition Exhausted.

Report of the Geological Survey of the State of Missouri, 1855-1871. By G. C. Broadhead, F. B. Meek and B. F. Shumard, Jefferson City. 1873. pp. 323 and iv. 29 illustrations, 9 small county maps.

Contents: It contains chapters on Maries, Osage, Warren, Shelby, Macon and Randolph counties by G. C. Broadhead; on Miller, Morgan and Saline counties by F. B. Meek; on Ozark, Douglas, Wright, Laclede, Pulaski, Phelps, Crawford, Cape Girardeau, Perry, Ste. Genevieve, Jefferson and Clark counties by B. F. Shumard.

Edition Exhausted.

Preliminary Report on the Iron Ores and Coal Fields from the field work of 1872, with 190 illustrations in the text, and an Atlas. 1873. pp. xvi, 214 and 241. Atlas accompanying, 22x28 inches, with 14 large sheets. Jefferson City. 1874.

Contents: Part I, Chapter I.—Notes on the Geology of Pilot Knob and its vicinity, by R. Pumpelly, pp. 3 to 28. Chapter II: Analysis of Ores, Fuels and Pig Irons, pp. 29 to 44. Chapters III, IV, V and VI, constitute a partial report on the Iron Ores of Missouri, by Dr. Schmidt, pp. 45 to 214.

Part II, Chapters I, II, III, IV, V and VI, contain general matter relating to the Coal Fields, by G. C. Broadhead, pp. 1 to 213. Chapters VII and VIII are on the geology of Lincoln county, by Wm. B. Potter, pp. 215 to 289. Chapters IX to XV, are reports by G. C. Broadhead on Livingston, Clay, Platte, Buchanan, Holt, Atchison and Nodaway counties, pp. 290 to 402. Appendices A, B and C contain, respectively, the results of some tests of strength of building materials, a note relating to Missouri rocks which admit of a fine polish, and a list of Coal Measure fossils, pp. 403 to 420.

Edition Exhausted.

Report of the Geological Survey of the State of Missouri, including field work of 1873-1874, with 91 illustrations and one Atlas, 13x15 inches, containing 15 sheets. Garland C. Broadhead, State Geologist, Jefferson City, Mo. 1874. pp. 734; L. 4, 56.

Contents: Chapters I and II contain an historical introduction and a brief description of the General Geology of the State, pp. 5 to 34. Chapters III, IV and V treat, in a general way, of Caves and Water Supply, and of Soils and Timber, and the last Chapter contains a brief list of the Minerals of the State, pp. 35 to 56. Chapter VI contains remarks on the Southwest Coal Field, and is accompanied by a general section, pp. 56 to 61. Chapters VII to XXI, inclusive, are reports on Cedar, Jasper, Barton, Vernon, Bates, Howard, Sullivan, Adair, Linn, Putnam, Schuyler, Andrew, Daviess, Cole and Madison counties, pp. 62 to 379, all the preceding by G. C. Broadhead. Chapters XXII to XXVIII constitute a report on the Lead Region of Southwest Missouri, in which the general characteristics of the region and its ores are given,

together with a description of a number of its deposits, pp. 381 to 502, by Dr. A. Schmidt. Chapters XXIX to XXXII treat similarly of the Lead Deposits of Central Missouri, pp. 503 to 577, also by Dr. Schmidt. Chapter XXXIII contains rules for the development of Iron Ore Deposits and Notes on the Metallurgical Properties of Missouri Iron Ores, pp. 578 to 600, by A. Schmidt. Chapter XXXIV is on the Lead Region of Southeast Missouri, pp. 601 to 637, by J. R. Gage. Chapter XXXV is on the Iron Ore of the same region, pp. 638 to 671, by P. N. Moore. Appendices A. B. C and D are brief papers on the "History of Lead Mining in Missouri," on "Lead Mines in Upper Louisiana," on "Metallic Statistics," and on "Mineral Springs of Missouri." Appendix E contains results of analyses of ores, fuels and minerals, pp. 672 to 734.

Edition Exhausted.

SURVEY OF 1876 TO 1879.

CHAS. P. WILLIAMS, ACTING STATE GEOLOGIST.

Industrial Report on Lead, Zince and Iron, together with notes on Shannon county and its copper deposits, by Chas. P. Williams, Ph. D., Acting State Geologist, Jefferson City. 1877. pp. 183 and xvi, 11 illustrations.

Edition Exhausted.

PUBLICATIONS OF RECENT SURVEY.

BIENNIAL ADMINISTRATIVE REPORTS.

225 Plates, 13 Pages, 6 Diagrams.

All Editions Exhausted.

1. Biennial Report of the State Geologist, transmitted by the Bureau of Geology and Mines, to the Thirty-sixth General Assembly.
2. Biennial Report of the State Geologist, transmitted by the Bureau of Geology and Mines, to the Thirty-seventh General Assembly.
3. Biennial Report of the State Geologist, transmitted by the Bureau of Geology and Mines, to the Thirty-eighth General Assembly.
4. Biennial Report of the State Geologist, transmitted by the Bureau of Geology and Mines, to the Thirty-ninth General Assembly.
5. Biennial Report of the State Geologist, transmitted by the Bureau of Geology and Mines, to the Fortieth General Assembly.

BULLETINS. (Series discontinued.)

470 Pages, 13 Plates, 11 Figures.

No. 1. Administrative Report; Coal Beds of Lafayette County; Building Stones and Clays of Iron, St. Francois and Madison counties; Preliminary Catalogue of Fossils occurring in Missouri.

No. 2. Bibliography of Geology of Missouri.

No. 3. Clay, Stone, Lime and Sand Industries of St. Louis City and County; Mineral Waters of Henry, St. Clair, Johnson and Benton Counties.

No.4. Description of Lower Carboniferous Crinoids of Missouri.

No. 5. Age and Origin of the Crystalline Rocks of Missouri; Clays and Building Stones of Certain Western-Central Counties Tributary to Kansas City.

VOLUME I. PRELIMINARY REPORT ON COAL.

By Arthur Winslow.

227 Pages, 1 Plate, 131 Figures.

Contents:

Chapter I. Coal Measures.
Chapter II. Coal Beds.
Chapter III. Coal Industry.
Chapter IV. Systematic Description of Coal Beds.
Appendix A. Coal Mining in Thin Beds.
Appendix B. Coal Operators of Missouri.

VOLUME II. IRON ORES.

By Frank L. Nason.

366 Pages, 9 Plates, 62 Figures.

Contents:

Chapter I. Ores of Iron.
Chapter II. Iron Ores of Missouri.
Chapter III. Specular Ores of the Porphyry Region.
Chapter IV. Red Hematites of Missouri.
Chapter V. General Geology of the Ozark Uplift.
Chapter VI. Specular Ores of Sandstone Region.
Chapter VII. Limonite Ores.
Chapter VIII. Introduction of Iron Ore Localities.
Chapter IX. Specular Ores in Sandstone.
Chapter X. Limonites.
Chapter XI. Red Hematites.
Appendix A. Iron Ore Deposits of Northeastern Arkansas.
Appendix B. Historical and Statistical Sketch of Iron Industry.

Edition Exhausted.

VOLUME III. MINERAL WATERS.

By Paul Schweitzer.

256 Pages, 34 Plates, 11 Figures.

Contents:

Chapter I. Origin of Mineral Waters.
Chapter II. Analysis and Composition of Mineral Waters.
Chapter III. Therapeutics of Mineral Waters.

Edition Exhausted.

VOLUME IV. PALEONTOLOGY (PART I.)

By Charles Rollin Keyes.

314 Pages, 34 Plates, 9 Figures.

Contents:

Edition Exhausted.

VOLUME V. PALEONTOLOGY (PART II.)

By Charles Rollin Keyes.

320 Pages, 22 Plates, 2 Figures.

Contents:

Edition Exhausted.

VOLUME VI. LEAD AND ZINC DEPOSITS (SECTION 1.)

By Arthur Winslow.

387 Pages, 12 Plates, 71 Figures.

Contents:

Edition Exhausted.

VOLUME VII. LEAD AND ZINC DEPOSITS (SECTION II.)

By Arthur Winslow.

401 Pages, 28 Plates, 196 Figures.

Contents:

Edition Exhausted.

VOLUME VIII. ANNUAL REPORT, FOR 1895.

By Charles Rollin Keyes.

406 Pages, 30 Plates, 16 Figures.

Contents:

3. Dictionary of Altitudes, by Curtis Fletcher Marbut.
4. Characteristics of the Ozark Mountains, by Charles Rollin Keyes.
5. Coal Measures of Missouri, by Garland C. Broadhead.

Edition Exhausted.

VOLUME IX. AREAL GEOLOGY.

432 Pages, 4 Folio Maps, 25 Plates, 53 Figures.

CONTENTS:

1. Areal Geology and its Relations to other Geological Work, by Charles Rollin Keyes.
2. Report on the Higginsville Sheet, in Lafayette county, by Arthur Winslow.
3. Report on the Bevier Sheet, including portions of Macon, Randolph and Chariton counties, by C. H. Gordon.
4. Report on the Iron Mountain Sheet, including portions of Iron, St. Francois and Madison counties, by Arthur Winslow, Erasmus Haworth and Frank L. Nason.
5. Report on the Mine la Motte Sheet, including portions of Madison, St. Francois and Ste. Genevieve counties, by Charles Rollin Keyes.

Edition Exhausted.

VOLUME X. SURFACE FEATURES.

534 Pages, 22 Plates, 24 Figures.

CONTENTS:

1. Physical Features of Missouri, by Curtis Fletcher Marbut.
2. Formation of Quarternary Deposits, by James E. Todd.
3. Bibliography of Missouri, by Charles Rollin Keyes.

VOLUME XI. CLAY DEPOSITS.

BY H. A. WHEELER.

622 Pages, 39 Plates, 15 Figures.

CONTENTS:

Chapter I. Introductory.
Chapter II. Geological Occurrence of Clays.
Chapter III. Chemical Properties.
Chapter IV. Physical Properties.
Chapter V. Plasticity.
Chapter VI. Shrinkage.
Chapter VII. Fusibility.

Edition Exhausted.

VOLUME XII. AREAL GEOLOGY.

By Shepard & Broadhead.

1,000 Pages, 5 Folio Maps, 6 Plates, 13 Figures.

Contents:

From the foregoing it will be seen that the editions of all publications of this Department are now exhausted, except Vols. I, X and XII of the recent Survey and very few copies of these are left in the office.