REPORT

OF A

GEOLOGICAL RECONNOISSANCE

OF A PART OF THE

State of Arkansas.

MADE DURING THE YEARS 1871-2.

By GEORGE HADDOCK, Assistant State Geologist.

LITTLE ROCK:
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PREFACE.

A report professing to give the geology of a part of a State, so extensive and possessing so many geological features as Arkansas, after the labors of a few months only, may seem to be premature; but the law under which the survey was organized, and the universal anxiety to learn the general features of our geology, have made it necessary and expedient.

A survey may gain temporary popularity by exaggeration, but the results must prove alike fatal to the geologist and those who credit his statements. It has, therefore, been my aim to give no opinion which is not based upon the very best evidence; and to place my estimate below, rather than above, the reality. Some may be disappointed by this course, but the truth of science and the general and permanent utility of the work must be preferred to the personal interest of the few.

The haste in which this report has been gotten up has doubtless caused violations of elegance and accuracy of style; but for errors in matters of fact and scientific deductions I ask no indulgence. My object has been to give a true and unvarnished statement of the facts observed, and the deductions which may be legitimately derived from them. Those, therefore, who correct my errors, either in matters of fact or scientific deduction, will aid me in my labors and be entitled to my gratitude. All errors will be cheerfully corrected when they are made known.

REPORT.

To His Excellency O. A. HADLEY,
Governor of Arkansas:

SIR: The following report is respectfully submitted, as the result of that portion of my labors which I have had time to write.

THE ADVANTAGES TO BE DERIVED FROM A GEOLOGICAL SURVEY.

Many men, devoted to the industrial pursuits of life, do not seem to understand how the sciences aid them in their particular calling. And yet it would be easy to show that science has been of essential service to every economical pursuit in life. There is not a trade or profession now in my mind, in which man earns his bread by the sweat of his brow or by the exercise of his mental energies, that has not had means of facilitating its operations doubled, and in many instances quadrupled by the direct application of science.

Many distinguished scientific men have never made any apparent practical use of the vast fund of scientific knowledge which they have acquired. Nor is it strange that men successful in interrogating nature, should become so absorbed in the delightful pursuit, as to forget the many applications of their scientific knowledge by which human industry, wealth and happiness might be promoted.

But the most prominent cause is that science has not been rightly understood. Many have supposed it the mere theories fine-spun, from the imaginations of learned men, without any foundation in fact or experience; whereas, science properly understood is but a classification of all known facts—all the experience of all the past, so arranged and classified as to

manifest all those great principles which lie at the foundation of the principal pursuits of life.

We often hear that "experience is more valuable than science," but science is the very essence of experience. The science of agriculture concentrates all the known experience of all farmers, from Adam to the present moment. And yet, even unskilled farmers say, we want no scientific farming; i e: we want none of the experience of the Egyptians, whose agriculture fed the world; none of the experience of the venerable Cincinnattus, who loved the plow better than the scepter; none of the experience of those men whose agricultural science has doubled the products of western Europe.

Again, the science of mining and metallurgy, containing all the known experience of all miners, and workmen of metal, from Tubal Cain to our day. And yet it is not uncommon to hear the miner, who has never seen but one coal pit or one lead vein, ridicule book-mining. We know how to dig better than the geologist. We know more than all the miners of Siberia, Saxony, Prussia, France, England, Golconda and California combined.

The science of geology comprises all that is known of the earth and its formations. Men skilled in all professions, in all sciences, have brought all their knowledge into its vast treasury. A thousand eyes have examined every nook and crevice of the earth's crust. Such men as Humboldt and Cuvier, have explored every continent and island, have scaled the Alps and the Andes; they have traversed the burning sands of the equator, and the frozen shores of either pole.

They have interrogated nature in the deep pit of the miner, and in the smoking crater of the volcano. They have examined the strata, the shells, the bones, the stems, the leaves, and every impression of the animate and inanimate, left upon the rocks of the pre-adamite earth. With chemistry and philosophy in one hand, and botany and zoology in the other, they have interpreted those wonderful records, impressed by nature's hand upon earth's everlasting strata; and presented to our wondering gaze, those gigantic animals, huge monsters and

tiny fishes, which stalked through the forests and gamboled in the waters of the primeval world.

So fixed are the laws of nature, so minute has been this examination, that from the leaf of a plant, the scale of a fish, or the hoof and teeth of an animal, the size, habits and food of each can be determined. The rocks which contain the ores and useful minerals are definitely indicated by the same unerring laws of geological science.

In short, geology comprehends all the facts ever known respecting the rocks and minerals of the earth, and all the uses to which they have been applied. It has treasured up the agricultural capacities of every soil, and the best means of developing those capacities. And yet some doubt whether such a science can aid in developing the unparalleled resources of our State.

But fortunately our farmers, mechanics, and legislators are beginning to see what it has done for other States and countries, and to appreciate what it can do for our own. Nature has given us one of the richest domains in the world. Let her agricultural and mineral, mechanical and mercantile resources be developed and she will soon be among the most progressive of the States.

As yet we have done but little; nature has done so much we have been content with her gifts, while the practical deductions of science have given a new impulse, have infused new life and new energy into almost every department of human industry. We are cultivating our farms as did our sires and grandsires before us; while, by the application of science, the farmers of New York and Massachusetts, led by such men as Norton and Webster, have doubled the products of their soil; while Watt and Fulton have given us steamships to spurn the winds and stem the currents of our mighty rivers; while the steam-horse is puffing his way along the iron track to our rich lands; while the lightning speeds to us the last changes in stocks and merchandise, and every move upon the political chess-board; while, in short, progress is stamped upon every department of business, our farmers and mechanics,

to a great extent, are plodding on "in the good old way of our fathers." The result is, we in this land of mighty forest are importing and paying two prices for all our furniture, from a sideboard and piano to a common chair. We "go east" for our agricultural and mechanical implements of every grade, from the steam engine and cotton gin to the plow and even the axe-helve. With plenty of iron and a vast area of coal-beds, we import every article of iron, from the anvil to the ten-penny nail. Our mineral veins contain nearly every paint, from the terresienna to the yellow ochre, and yet all we use, with perhaps a single exception, comes from a foreign market. While we are exhausting the richest soil the sun shines upon, some of our crops are no better than those harvested from the once barren hills of New England.

But you may say "we are doing very well as we are." Perhaps "we are doing well enough," yet if we listen to that siren song, we may be aroused from our pleasant dreams to the humiliating reality that our neighbors, with fewer natural advantages, are making richer harvests and supplying our markets with their domestic manufactures.

While the planters of Virginia were doing well enough, many of them were surprised to find their soils exhausted and their plantations unproductive. Many are doing well enough with mule wagons and mud roads, but the steam horse with his iron sinews proclaims their thriftless folly. While the "jolly flat-boatman" was doing almost too well, the steam whistle startled him from his easy jollity, and gave a hundred fold energy to the commerce of our western rivers. When perfection is reached, then and not till then should an Anglo-Saxon let well enough alone.

The divine economy wisely provides that we shall earn our bread by the sweat of the brow, yet no divine or human wisdom demands that we shall toil and sweat, and sweat and toil on from year to year, simply for the corn-cake and bacon our appetite demands. We can do better—we can become better farmers and better merchants and mechanics. Then, like men, let us go about it.

But how will the geological survey aid us in this matter? If properly conducted it cannot fail to develop the mineral resources of our State, and place our mining interests on a more permanent basis by inviting capital, and by securing systematic and profitable operations. It will increase our mechanical and manufacturing interests, by pointing out the raw materials and the facilities for converting them into articles of domestic and foreign trade. Agriculture will be advanced by investigating the structure and the chemical properties of the soil, as the results will enable us to determine the modes of culture necessary to sustain and even increase their productive energies. Commerce will receive a new impulse from the increased products of the farm, the mine, and the workshop. Should the survey be made with sufficient minuteness to point out the soils of each township, the facilities for settling, and the great prosperity of our agricultural communities, the report will attract thousands of those who are yearly seeking homes in this great valley. The increase of our yeoman population and tax-payers thus secured, would soon be felt in the financial and political resources of the State. The development of the mineral and agricultural resources will so enhance the value of land in the State as to make an aggregate increase of a vast amount. The survey will, in no small degree, promote the interest of our railroads, by showing the existence of vast mineral deposits along their lines, awaiting the means of transportation to some good market.

But let us examine these subjects a little more in detail.

MINES AND MINING.

A few considerations will illustrate the advantages of a geological survey in developing our mineral wealth, and in extending and directing our mining operations.

It is a well-known principle of science that the various ores, coal and minerals are found in certain strata, and in these only. Now, when the geologist has pointed out the position and extent of each stratum, and indicated what minerals may

be found in each, he will have done much to aid the explorer. Thousands will be saved which are spent in searching where nothing can be found; and the field of search will be limited to the proper localities, that the chances of success will be greatly increased. When the report has pointed out the quality and locality of a coal bed, its extent and thickness of the superincumbent strata, and the facilities for draining, the capitalist will have all needed data to determine whether a profitable investment can be made. It will then prevent the investment of capital where profit is doubtful, and encourage it where success is certain. Mining will thus be rendered more profitable and permanent, and more capital will seek investment in it.

Several companies are now ready to invest large amounts in mining and manufacturing so soon as it shall be ascertained that a sufficient quantity of coal and iron can be obtained convenient to certain localities. We shall prove the existence of the coal and iron desired, and prove the practicability of establishing profitable works in several parts of the State where none have yet been started. Capital is sure to follow where profitable investments are made certain.

These principles are not a matter of theory merely, but have often been realized in practice. In Pennsylvania the truth has been triumphantly vindicated. Before the geological survey of that State, coal mining was uncertain and vacilating; sometimes profitable, often ruinous. In some years, according to the census reports, the quantity raised would greatly increase; in others, decreased as much. In 1837 the increase in the anthracite mines alone was 189,000 tons, but in the next year there was a decrease of 141,000 tons. But since the accurate surveys of the geologist demonstrated the abundance of the coal, and the sure profits of systematic mining, capital has been freely invested, and the amount raised has constantly and rapidly increased. The increase from the anthracite mines alone is about 1,000,000 tons. From 1850 to 1851, it was more than 1,000,000 tons.

The same happy results have been realized in the Lehigh

and other mines. Now, nothing but a geological survey by State or individual enterprise could have secured the confidence necessary to accomplish these results, and enabled Pennsylvania to supply the coal markets of the Union. And this is but one of the many happy results of that survey.

But England, perhaps, affords the best illustration of wealth and power resulting from a scientific development of mineral resources. England, though about equal to Arkansas in extent, has spent millions in geological surveys; and yet the capital invested has returned a thousand fold from her mines alone. Our mineral wealth is probably as great as hers. She depends mostly upon her iron and coal, and still we may have more and better iron, and our coal measures will prove as extensive, yet, while England annually raises from her mines $100,000,000 worth of raw materials, we raise but a few thousands. This difference is not because nature has done less for us, but that science has done more for her.

What, then, shall prevent us from attaining to an equal development of our mineral wealth when this survey shall have proved, as it will, that we have as much and better iron than England, and good coal sufficient for many generations to come?

Some of us, doubtless, envy California her golden destiny, but our antimony, and zinc, and lead, and iron; our silver-leads, and coal, and marble, and soil, are a better foundation for national wealth and greatness than golden sands. The latter may give temporary prosperity, but the former will insure permanent greatness.

Scarcely three centuries have elapsed since the united thrones of Castile and Arragon swayed as powerful a scepter as the combined crowns of Albion and Scotia. Spain extended her sway over the best and largest portions of the western world, and held the commerce of both hemispheres. Galleon after galleon deeply laden with the precious metals from the mines of Mexico and Peru, poured them in unparalleled profusion into the treasury of the home government. England, on the other hand, was pushing her mining and manufacturing interests by

all possible applications of science and capital. England was digging for iron and coal, while Spain was mining for gold and silver. Spain squandered her gold and has become a mere pensioner upon Cuba. But England holds the commerce of both Indies, and the world pays a golden tribute to her iron and coal.

To come near home, Massachusetts, according to the census of 1840, has derived more wealth from her granite quarries than Alabama, Georgia, South Carolina, North Carolina and Virginia have from all their gold mines.

We shall show the existence of many inexhaustible quarries of marble and granites in various parts of the State. If Massachusetts makes money by transporting her granite to New Orleans, cannot Arkansas make more by bringing her marbles and granite into southern markets?

In addition to this, we shall show that capital and systematic mining alone, are waiting to render our copper and lead mines sources of vast wealth. The survey, besides pointing out the quantities and properties of the mineral deposits already known, will bring to light many unknown deposits of the same minerals, and perhaps, other valuable ores not known to exist in the State. Our miners may be at the present throwing away minerals even more valuable than those for which they are mining.

Nothing is more probable than that our vast territory, still unexplored, will furnish some minerals hitherto not known to exist in our State. But besides the metals we have already discovered large deposits of limestone, fireclay, lithographic limestone, mineral paints, and coal in vast quantities.

Since then, we have so many and so abundant sources of mineral wealth, whose development is unattended by the exciting and demoralizing influences that ever accompany the mining of the precious metals, why should we prefer the destiny of California? None have more and better natural resources than Arkansas, and if true to herself, none will surpass her in wealth and population.

MECHANICS AND MANUFACTURERS.

A passing notice must suffice to illustrate the advantages of such a survey to the mechanical and manufacturing interests of the State. There is every reason to believe, from the geological formations of the State, that a survey would prove the existence of abundant materials of the very best quality for glass and porcelain manufactures, and thus secure the establishment of manufactories of those wares to such an extent, that Arkansas would not only supply her own markets, but have surplus for exportation.

If surveys already made are correct, we have excellent coal beds for the manufacture of iron, and in a short distance of the coal a deposit of good iron ore, and all the needful fluxes. Should an accurate survey prove these coal beds as abundant as appearances indicate, and also the iron, iron works then could compete with other States. Such a combination of favorable circumstances seldom, if ever occurs. At all events, when our railroads are prepared to take the iron ore and coal of the north-western part of the State to Little Rock, our proud city may become a considerable iron mart.

Our geological surveys will point out the best lumbering regions and mill sites, and the various facilities for the lumber business, as they are now known to exist. Not many years will elapse before those men, before whom the forests of Maine have fallen, and been distributed to all the cities along the Atlantic coast, to New Orleans, the West Indies, South America, Europe, the Sandwich Islands and California; who have sent companies of lumbermen into the forests of the Carolinas, Georgia and Florida, on to the headwaters of the Deleware, the Susquehanna and the Ohio, the Illinois and the Mississipi; not many years before those men will fill our forests with indomitable lumbermen, and make our streams dance to the music of a thousand saws, and what is still better, they will furnish our lumber at half its present prices. Companies have already expressed a desire to invest capital in this business as soon as the most desirable location shall be made known.

These, and many similar facts show that the survey will benefit our manufacturing and mechanical interests more than sufficient to pay all the outlay of labor.

AGRICULTURAL IMPROVEMENTS

But your attention is particularly and earnestly invited to the advantages of such a survey to the agriculture of the State.

Agriculture is the true basis of all national greatness. For the farmers then, we ask the aid and sympathy of all professions; not for their benefit only, but that in their success we all may be prospered. They are the great heart of the body politic; if its pulsations are languid, the life blood will flow feebly in every department of human industry. We do not ask it as a favor, but demand it as a debt of long standing, one so just, that all have frankly confessed the obligation, whenever and wherever its claims have been presented.

Since man was driven from Eden, they have fed and clothed the world, and filled its dwellings with plenty, and luxury; they have been freely taxed for the support of public schools, and have contributed liberally for the endowment of colleges and universities, for the education of physicians and lawyers, clergymen and gentlemen; and yet we look in vain for a school where the science is practically taught. They have also been taxed to give manufactures and commerce the aid of science; but have themselves been scarcely permitted to know there is any genuine valuable science for agriculture.

Some object to the science of agriculture, because its principles do not succeed in all cases. But this want of success is owing to a neglect of a part of the principles of the science.

Chemistry teaches us that plants contain a large portion of the four organic elements; viz: carbon, oxygen, hydrogen and nitrogen; that they also have more or less of the same twenty inorganic elements, such as lime, silicia, potash, phosphorus, alumina, soda, etc. Those substances are found in different proportions in different species of plants, but it is to be kept constantly in mind, that a perfect plant of any given species

contains the same elements, and those in the same proportions as every other perfect plant of that species. Upon this uniform law of the vegetable kingdom is based the whole structure of agricultural chemistry, or the adaptation of the soil to any particular crop.

Botany or vegetable physiology teaches us that plants draw a portion of their organic elements from the air through their leaves, and the remainder of the organic, together with their inorganic elements from the water and the soil through their roots.

By analysis we learn that an acre of wheat assimilates besides the sap, which evaporates on drying, some three thousand pounds of organic and two hundred pounds of inorganic matter, about a ton and a half per acre for each crop of wheat. Now all of the inorganic matter and a large portion of the organic must come from the soil; and such a yearly draft upon its fertilizing properties, which always exist in small quantities, must eventually exhaust them. And this has been the sad result in some of the most fertile counties of New York, Maryland and Virginia.

But it is said our soil is rich and we need not fear its exhaustion. The farmers of Duchess, one of the most fertile counties of New York, once thought so, but a late average crop of five bushels of wheat per acre, shows how false their theory and how desolating its results.

But we need not go out of Arkansas to find examples of exhausted lands. Many of our farmers have seen their crops grow gradually less from year to year, until exhausted lands are a sad reality.

In the minds of many, large crops and a ready market are the only conditions necessary to the prosperity of a rural community. Could these conditions be maintained in perpetuum all might assent to the proposition. But with the present exhausting mode of culture the large crop must soon fail, and then the ready market will avail nothing. Under such a system, the larger the crop and the nearer the market the more certain will be the deterioration of the soil.

This proposition may appear strange, yet the short history of our own country furnishes many sad examples to prove its truth. If we inquire in New York, Maryland and Virginia, what lands were most effectually exhausted, we shall find them to be the richest bottom lands along their navigable waters, which were at once the most fertile and accessible to market.

There, greedy of present gain and unmindful of the future, the husbandman taxed the generous soil to its utmost powers. Cargo after cargo of its fertilizing ingredients, corn and wheat, went to feed and fumigate the busy city, and the golden return was invested in stock and merchandize. Thus the unwary fathers robbed their sons of good farms, God's richest gifts, and laid the strongest of all temptations for them to leave the moral, happy influences of a rural community, for the exciting bustle and tempting pleasure of the city.

"How shall we preserve and increase the fertility of our soils?" has become the great question in our political economy.

Agricultural science alone can answer this great question. Give us an agricultnral school where our sons can acquire a thorough practical knowledge of agricultural science, and we will have men prepared to do this great work.

But it may be said we have good schools now. This is true; and it is doubtless true that they answer all the purposes of the learned professions; yet, something should be done to make farming and the mechanical arts learned professions. Farmers and mechanics should be so educated, that they could bring all the treasures of science to the improvements of the farm and and the work-shop.

Our sons are taught to trace the root of a word up through the French, Italian, Greek and Sanscrit to discover its meaning; but who of them can trace the root of a potato beneath the soil and discover the food it seeks there?

It is not expected that an agricultural school will educate the present race of farmers. But the geological survey is the best possible arrangement to supply their present wants, to give them such information as will enable them to adopt the best modes of culture to prevent the exhaustion of their rich soils.

Let us make careful examinations of the sub-soils and underlying strata; let us thoroughly analyze the soils; let us examine all the mineral deposits suited to sustain or improve the fertility of these soils, such as humus, green sand, plaster of paris and marl, and we shall be able to give such a report as would enable every farmer, not only to preserve, but even to increase the productive energies of his lands. This will greatly increase the profits of agriculture, and preserve and increase the intrinsic value of cultivated lands.

Some of our best farmers have estimated the annual decrease of fertility in our cultivated lands to be sufficient to lessen the profits of cultivation fifty cents per acre; some higher than that, and others still lower. Let us set it down at fifty cents per acre. That would give us an annual loss upon our 2,000,000 acres of cultivation of $1,000,000.

The farmers, by the exhausting system, have annually placed a mortgage of $1,000,000 upon their farms; and this mortgage must be removed or scanty crops will publish its foreclosure, and send us westward for new lands.

A geological survey will point out the means of redeeming those farms and preventing such a calamity, is morally certain. When the expenditure of a few thousands will save such sums, shall we hesitate even on the score of economy?

Should we be able to make such improvements as would increase the products of cultivated lands one dollar per acre, that would make a balance in our favor of $2,000,000 a year.

Here again we are not left with nothing but theory and logic to rely upon. We have the facts to sustain us—we have the proof in the results of the surveys and other means of agricultural improvements in New York, Massachusetts, South Carolina, North Carolina, and other States.

New York is an old State, and large portions of her soil were much exhausted, and she had comparatively little new lands to come into cultivation, so that nearly all increase of products must arise from improved culture. She spent $130,000 in a thorough survey. The reports, which are an imperishable monument to her far-sighted liberality, gave every

department of business a fresh impulse. Her agriculturalists commenced an improved system of culture which has resulted in increasing the annual products of her farms some $50,000,000. The increase in corn and hay alone is over ten millions for the last ten years, say one million per annum, which would be from two staples only, the interest, at six per cent., on more than sixteen and a half millions. Provided that only one-tenth of this increase was the result of the geological survey, still it has annually repaid the whole outlay for the most liberal survey ever made in this country, with enough left to sustain several such surveys as that.

But we already have results in our own State still more surprising. The State Geologist, on examining the soil of the State in 1859, at once saw the benefits which would result from sub-soil plowing. Those conclusions were made known to many of our farmers, who have adopted the system with wonderful success.

Wherever the ground has been plowed from ten to twelve inches deep, the increase of each crop, I should estimate, amounted to twenty-five per cent.; and the increased profit of cultivation by the system of deep plowing, at from twenty to thirty per cent. Some plantations have been sub-soiled and the crops were double, and the profits doubled, by this system of cultivation.

Now, these results are most satisfactory; but still more surprising effects would have resulted had the sub-soil plow reached a greater depth. Several fields thus sub-soiled did not even wilt beneath the unprecedented drought of the season, while those adjoining were very badly burned.

Now three-fourths of the land in Arkansas would be equally benefited by deep plowing. When this fact is proven, for all the counties of the State, and when our farmers shall adopt the system, one million at least of our cultivated lands will give an increased annual profit of from one to five dollars per acre.

Such a result is as certain as any future event in political economy can be, and who will estimate the pecuniary advantages resulting from such an improvement.

INCREASED VALUE OF LANDS

Is a matter of no small importance to the State, or to individuals. That a survey will greatly increase the value of land in many parts of the State, is placed beyond a doubt. It will make known treasures not before supposed to exist.

With but few exceptions, the coal beds of our State have exerted but little influence upon the price of the lands in which they exist. In Johnson, Pope, Yell, Scott, Sebastian, Crawford, Franklin and several other counties, it is known that coal crops out in many places, and in some few it is worked for local use. But little was known of the amount or value of this mineral upon a hundred acres in either of these counties. When it is proven that a large portion of these counties is underlaid by from two to three beds of this mineral, whose average aggregate thickness varies from three to four feet; that every acre contains 2000 or 3000 tons, whose value in the pit is not less than fifty cents per ton—$10,000 00 per acre; that farms of a hundred acres, now selling at $2,000 00 and $3,000 00 actually have beneath their rich soil $100,000 00 worth of coal. When this is proven, will not the price of those lands increase? We might show the same necessary results from the discovery of lead, iron, copper, cobalt zinc, antimony, silver and other minerals.

The results in States where surveys have been made, fully justify our expectations in this. The following extract from a Tennessee paper shows how the matter stands there.

"Within the last few years lands in Polk county, East Tennessee, have advanced in value almost incredibly. It is now asserted by those who profess to know how the fact is, that within the time minerals have been developed in that region, which make the land worth ten million dollars more than before."

An Ohio journal makes the following statement:

"In several counties where it is supposed coal existed to the extent of a few rods or hundred yards at most, the geologist informed them that they might consider their supply inexhaustible. The rise in real estate in different counties was

variously estimated from $100,000 00 to $500,000 00, when it was known that manufacturing means were possessed in unexpected abundance."

A more general though not less satisfactory account of the results in North Carolina is thus given:

"A few years ago the Legislature of North Carolina made a small appropriation for a geological survey. The discoveries of the first year, developed the existence of copper and gold ores, drew to them the attention of capitalists, and have already increased the revenues of the State to five times the cost of the whole survey. In the second year, seams of the purest bituminous coal, some of them fifteen feet in thickness, extending through a region of some forty-five square miles, rewarded their investigations. It is estimated that every thousand acres of these seams will yield thirty millions of tons of bituminous coal of the best quality.

BENEFIT TO OUR RAILROADS.

To secure the building of railroads at this day, it is only necessary to show the existence of an abundance of merchandise, seeking transportation, and a population to supply the travel.

The survey will do much towards showing the existence of these conditions, for at least some of our projected and finished railroads. We already have data, which will settle these facts for some of these roads.

This report will show the existence of at least two workable beds of good coal in the counties of Pope, Johnson, Franklin and Crawford. The thickness of these beds varies from three to four feet, altogether they will furnish seven or eight feet of good coal. The Little Rock and Fort Smith railroad will run through this coal region for eighty miles. Suppose we take twenty sections to the mile, there will be 1600 square miles. It is estimated by the best mining engineers of England, that every foot of workable coal will furnish 1,000,000 tons per square mile, which would give us 1,600,000 tons for every foot in these beds. Now, if we multiply this by the thickness of

the strata, and deduct some for waste, we shall have 8,000,000 tons of workable coal. This would freight the road 300 years, which is quite as long as the stockholders need provide for themselves and their heirs; as by that time Young America will have a network of railroads.

But few, if any railroads run through so good a body of land as the Cairo and Fulton. The facilities afforded by the road will bring this land into market, and settle it with a stirring agricultural population, unless speculators place its price above that of other lands possessing similar qualities and advantages.

Coal mining will also bring in an increase of population to swell the travel over the road.

But without enlarging upon the advantages that such a survey would confer upon commerce, how it would draw settlers to our rich acres; how aid the cause of education by furnishing materials and facts for the practical application of the principles of chemistry, geology and mineralogy to mining, farming and mechanics, it is hoped the considerations already presented will be thought sufficient to prove the economy of a liberal survey.

What should be expected in this report?

A geological survey proposes to accomplish various objects by application of scientific principles:

First. To point out the mineral wealth of the State.

To do this the geologist must first determine the formation in the state, the areas covered by each, and what valuable minerals it contains. When these facts are ascertained he is prepared to enter upon the detailed examinations, which will enable him to show the probable value of the useful minerals in the State. And the scientific explorations for determining the geological structure of the country to be examined, must precede and lay the foundation for the economical and utilitarian labors of the laboratory and the office.

Second. To develop the agricultural capacities of the soil of the State.

In order to determine the productive power of the soil, it

is necessary to know the rocks which have or which may enter into their composition; to know their mechanical properties, their chemical compositions, and the trees and plants they produce.

Now, to analyse the soil of every man's farm would be impracticable, and the same results must be obtained in some other way. Large tracts are found to possess soils derived from the same rocks, having the same composition, and sustaining the same plants. The whole State even will furnish but few varieties of soils.

Economy, then, requires us to make careful examinations to determine those varieties, and the area occupied by each, so that when we have analysed one or two specimens of each variety, and determined its agricultural capacity, what crops and what modes of culture are adapted to it, we can at once point out the kind of soil to which these results are applicable, and that part of the State occupied by it.

A geological map would be of great importance to the State, in which the area of the geological formations can be distinctly laid down, and their boundaries accurately defined. It will become necessary, on the confines of two geological formations, as well as in the mineral districts, to define the ridges, hills and mountain ranges, on sectional maps, since the limits of formation often conform to and are intimately connected with the relief and topography of the country.

The palaeontological department of this work must not be neglected; that is the collection of the organic remains of fossils of the different rocks, and the ultimate determination of their generic and specific characters. In fact, without attention to this, the geologist would dispense with one of his principal aids in drawing important practical inferences and proofs corroborative of his assertions.

What can be more extraordinary, that we, the generation of the nineteenth century, should exhume from out the hard substances of the solid rocks the delicate forms of organic beings of by-gone ages, and display to the wondering eye of the naturalist, even their minute anatomical details? And this, not

alone of races which inhabited this earth in times immediately preceeding the human epoch; we are even permitted to contemplate and restore to our perceptions the very fishes, mollusks and corals that remained in the carboniferous seas millions of ages ago. The animal matter composing their tissue and bones, is indeed gone, but the simultaneous mineral infiltrations preserve a perfect counterpart. We can depict those remarkable and elegant forms of vegetation, which constituted the forest that fringes the shores of the same treacherous and overwhelming ocean. We seize them in the very act of uncoiling their frond, and unfold to the admiring gaze of the botanist the luxuriant canopy of foliage that once waved in the sea breeze, nurturing their stems. We accomplish even more than this; we can read the records of myriads of the lower orders of animals, that date their existence yet further back than the times that gave growth to trees, now stored up as mineral fuel in the bowels of the earth—to times at least as long prior to the coal formation, as that geological era is antecedent to the present time; we can assign to each its place in the zoological systems, and fill up gaps in the existing orders of the animal and vegetable kingdoms.

GEORGE HADDOCK,

Assistant State Geologist.

GEOLOGICAL RECONNOISSANCE.

MARION COUNTY.

Mountain Home, in Marion county, is located in Rapp's Barrens. It is a flourishing little town, containing one hundred inhabitants, four stores and a large academy. On Pigeon Creek, four miles north of town, the prospects for lead are very flattering, and considerable quantities of lead ore have been found in several places. There is also lead ore found in section 9, township 19 north, range 14 west. Major Moony lives not far from Mountain Home. His residence is on a high bluff, and his plantation is in the White river bottom. He has three hundred acres of land and seventy acres in cultivation. He also owns a ferry on White river. There is sulphuret of lead in a dolemite rock not far from his house.

The light impure limestone, "white rock," with its associates, greenish marly shales, is seen over a great portion of this county, and forms the substratum to the gently undulating tracts of land, known by the name of "Barrens." The principal of these are the Flippin, Rapp and Talbert Barrens.

A number of fine specimens of fossils, also ores of lead and zinc and marble rock, were presented to the survey by Judge Flippin, among which are several crinoids, actinocrinus, finistella, corniculem, jephrontis and strophemena. Within fifty yards of White river, in section 28, township 20 north, range 15 west, in what is called the Horseshoe Bend of the river, a magnesian limestone, alternating with sandstone, forms a conspicuous bluff, in all some two hundred and fifty feet thick. A number of rock-house caves have been formed by the disintegration of the magnesian member of this series, in which

large quantities of nitre earth have been formed. The principal of these caves is known generally as Bean's Cave.

T. M. Flippin accompanied me to the lead and zinc mines, also to Bean's Cave. At this cave there has been large quantities of saltpetre made before and in time of the war between the north and the south.

This cave is about forty feet wide at the entrance and extends back one hundred and fifty feet, where it becomes much wider. Its hight will average about eight feet. Its walls, or sides of the cave, are composed of laminated ferruginous clay, the lamina having a varied color, from pale yellow to dark red. The upper and lower portion of this laminated clay forming the walls of the cave, are partly dry. The center, for about two feet, is quite damp. These nitre earths yield from three to six per cent. of saltpetre.

About one hundred yards from Bean's Cave, in the same bluff, and occupying the same level, is another cave one hundred and sixty feet wide at the mouth and nearly as many feet in depth. The thickness of the deposit of laminated nitre earth, though not as great as in Bean's Cave, is, nevertheless, from four to seven feet, and there is good reason to believe that the earth will be found continuous from one cave to the other.

Section of strata of lower silurian date, between Boone and Marion counties, on the waters of Sugar Loaf creek, upper strata buhr-stone and other varieties of flinty silicious rocks, thirty-seven feet thick; white encrinital marble rock four feet thick; fragments of chert and buhr-stone on the slope thirty-eight feet; red and variegated limestone or marble rock twenty-five feet; white encrinital marble rock nineteen feet thick; impure *silicious limestone* sixteen feet thick; soft coarse-grained sandstone eight feet thick; thin bedded magnesian limestone eight feet thick; white fossiliferous limestone, brittle, two feet thick; birdseye structured limestone three feet thick; magnesian limestone, various colors, five feet; silicious limestone, drab color, ten feet thick; calcarious sandstone, light yellow, ten feet thick; buff-checkered limestone thirty-

five feet thick; light colored limestone (cotton rock) twelve feet; gray, rough weathering, magnesian limestone four feet; light colored limestone twenty-one feet; bench of gray magnesian limestone twelve feet; bench of solid gray magnesian limestone ten feet; thin bedded magnesian limestone extending down into the bed of Sugar Loaf creek twenty feet; in all three hundred and seven feet.

On George's creek, in the metaliferous limestone, on section 13, township 19 north, range 17 west, there is a zinc mine, where quantities of ore are on the surface. The surface indications here are quite flattering, and lead to the inference that considerable bodies, both the carbonate and the sulphuret of zinc, exist more deeply seated in the crevices of the rock.

Several shallow openings have been made at different points a few hundred yards apart, in all of which good specimens of zinc ores have been found, associated occasionally with some sulphuret of lead and small quantities of sulphuret of copper.

On the top of a bald ridge belonging to Judge Flippin, there is a well defined strata of metalliferous lime rock, containing sulphuret silicate and carbonate of zinc. In the same section of the county there is a strata of buhr rock which would make very good mill rock.

The highest part of the hills in this part of Marion county are capped with cherty rocks of subcarboniferous date, but the lower part of the hills belong to the silurian division.

Nigh Yellville there are quantities of crystalline marble rock of various colors, red, green, spotted, mottled and variegated; also some of the beds are pink, others nearly white and studded with entrochites, those flower-like animals which flourished in such profusion in the ancient seas, in which the deposits and chemical precipitates were accumulating, that produce the so-called silurian, devonian and carboniferous rocks. These contribute greatly to the beauty of the marble of which they form a part, appearing often of different shades of color, form the matrix in which they are inclosed, and give to the rock that variety of tint so agreeable to the eye and so much esteemed by the worker in marble.

The magnesian limestone of this county furnishes some of the most beautiful rocks for building in the country. The cotton-rock is generally well adapted for this purpose. It is wrought easily, and many of the layers have the appearance of durability. Buildings constructed of this rock have a peculiarly neat appearance. Very little change takes place from exposure.

LITHOLOGICAL APPEARANCE.

The beds now under notice, near their junction with the sand-stone, consist usually of alternations of buff and gray magnesian lime-stone, chert and indurated sand-stone, but sometimes of a rough cherty mass with irregular shaped cavities, occasionally lined with crystals of quartz. The magnesian layers are chiefly of fine-grained earthy texture, varying very much in hardness, being sometimes so soft that they can be cut with a knife, and at other times very compact and tough. Below these we have beds of magnesian limestone, varying from a foot to several feet in thickness, with bands of chert interstratified.

The magnesian beds consist chiefly of two distinct varieties. One is a compact sub-crystalline, even-bedded calcareo-magnesian rock, breaking with an angular fracture, and of a light gray or delicate flesh color; the other is a buff, earthy-looking magnesian limestone, of a finely granular texture.

GEOLOGICAL RECONNOISSANCE.

BOONE COUNTY.

In the north eastern part of the county, on the upper Sugar-Loaf creek, and within fifty yards of John H. Blackwell's house, there is a voluminous spring that issues from a cavernous space in the lime-rock, affording a valuable water-power, available at all seasons of the year with but little variation as to quantity and temperature. Also on the east side of lower Sugar-Loaf creek there is another large spring. A sufficient quantity of water flows from either of these springs to propel a considerable amount of machinery. There is, also, a quantity of lead, iron and zinc ores in Boone county; also crystalline marble rock of various colors: some of the beds are pink, variegated with white or light gray, and often studded with entrochites; this is the disjointed stems of those singular flower-like animals known by the name of encrinites, which flourished in such profusion in the ancient seas.

Sulphuret of lead has been found more or less abundantly at various locations. The most noted places are on the waters of Sugar-Loaf creek, not far from Lead hill. In this section, and on Short mountain, some men have sunk several shafts, and are getting out from fifteen hundred to two thousand pounds of lead ore per day and averaging fifty thousand pounds per month. Five miles south of Lead hill, on the waters of Sugar-Loaf creek, there is lead, iron and green carbonate of copper ores. Ellingsworth lead mine is in five miles, south-west, of Lead hill. Two miles from John H. Blackwell's house, a man by the name of Chauncy Williams has sunk several shafts on the side of a hill and got out some lead, what quantity is

not known. Charles Case's lead mine is within seven miles of Lead Hill; zinc ore five miles west.

Lead Hill is a small town located on Lower Sugar-Loaf creek, in a handsome valley. It is improving very fast: it contains one hundred inhabitants and five business houses, one school-house and a lead smelter. At this furnace there are fifteen hundred pounds of lead smelted in a day.

The high ridge between Blackwell's, on Crooked creek, according to Aneroid's barometer, is five hundred feet high. In this section considerable variation is observable in the composition of the various beds of which it is made up. The formation, as a whole, is perfectly analogous to the strata in Marion county, except that the beds of magnesian limestone are thinner bedded and less massive, and hence do not appear in as bold cliffs. The fossils in the limestone at an elevation of two hundred feet are mostly casts, and imperfect, imbedded impressions, so that even the genera can hardly be made out; but so far as they are recognizable, they, as well as the lithological character of the strata, indicate the geological horizon of these rocks, as contemporaneous with the lower magnesian limestone and interstratified sandstone of southern Missouri.

Five miles north-west of White Oak there is a quantity of buhr rock where several mill stones have been obtained, which proved to be very good.

Near John Smith's, on Crooked creek, there is zinc ore in several places, and a few pit holes have been sunk in search of lead.

In one mile of Bellfont there is a light-colored red and green marble, which is crystalline and of bright hue and easy dressed.

Bellfont is a handsome inland town, situated in a rich portion of the county, and contains six handred inhabitants, one church, one high school, one free school, eight stores, one post-office and a tobacco factory.

Harrison, the county-seat of Boone county, is located on Crooked creek, in a handsome valley, and surrounded by a

rich country, and is improving very fast. It contains three hundred inhabitants, four business houses, two hotels, a large new court-house and school-house.

Sandstone caps the heights of Boone and Newton counties. The upper part of the millstone grit series is here pebbly and underlaid by grits without pebbles, all the members together occupying a thickness of two hundred and fifty feet. These repose upon the yellow upper strata of the sub-carboniferous group, including the archimides and pentrimital beds, which are, however, mostly concealed by forest and vegetation, in all about one hundred and sixty feet in thickness.

Beneath these are coarser textured and sub-crystallian members of the same group, occupying a space of three hundred and ten feet.

These coarse textured, subcarboniferous limestone are underlaid by sixty feet of sandstone, which reposes on the black bituminous shales, with calcarious and ferruginous segregations and septaria, which occupy a space along the slope of the base of the mountain of sixty or seventy feet. The correction for dip will, however, probably reduce its actual thickness to forty or fifty feet.

The black shale reposes on the light gray, cherty limestone that constitutes the base rock of Marshall's Prairie, which is probably referable to the subcarboniferous era, being a part of the cherty limestone groupe overlying the limestone on Cove creek, and elsewhere in Newton and Searcy counties. It is probable that all the high ranges of hills constituting the Boston Mountain range of Newton county have a geological structure analogous to the section here presented of the Boat Mountain, with, probably, local variations in the relative thickness of the different members, since, in many instances, conglomerate sandstones have been either in place or in loose blocks on the slope and at the foot of the mountains. Detached masses have evidently rolled either from the summit of the adjacent hills, or at least from elevated positions on their flanks.

The black slate is perhaps, not everywhere present as an

important member of the subcarboniferous group, since it has not everywhere been found at the base of the hills; but being prone to crumble to clay, and being, no doubt, sometimes locally reduced in thickness to a few feet, it is then generally completely concealed by debris and thus frequently overlooked.

GEOLOGICAL RECONNOISSANCE.

NEWTON COUNTY.

Near William Prewitt's and on the road leading from Harrison to Coxe's steam saw-mill, there is a conspicuous range of hills, lying partly in Boone and partly in Newton counties, whose northern termination bounds the Marshall Prairie on the south. It is composed of two flanking peaks and central flat-topped ridges. The most southern of these conical peaks is known as the Pilot Mountain. The northern is called the Stack Mountain, while the other ridge has received the name of Boat Mountain, from its fancied resemblance to a boat, rising out of the adjacent prairie like some gigantic water-craft resting on the ocean.

From the top of this mountain can be seen an extensive valley, dotted over with plantations and prairies. Beyond this can be seen mountains looming up in the distance, like the waves of the ocean.

On the waters of Cove creek, about six miles from its mouth, a liver-colored marble rock forms the base of a cliff at an elevation of twenty feet above the bed of the creek, overlaid by cherty limestone. In this nitre caves have formed by the disintegration of the liver-colored marble limestone under the cherty limerock. The principal nitre cave is in section 27, township 15 north, range 19 west. The dark brown nitre earth, which forms the floor, is seven or eight feet deep.

There is a nitre cave on Big Buffalo, eighteen miles above Jasper. T. B. Fowler worked at this cave in 1861-2. He says there were six thousand pounds of nitre made at this cave. On Cove creek there is a spacious cavern containing a

quantity of nitre earth. It is reported that twenty-two thousand pounds of saltpetre were made at this cave in time of the war. There is a noted lead mine near this cavern belonging to the Great Western Mining Company—Welch, Burn & Kizer. It is in township 16 north, range 22 west, on Villian's creek. Persons wanting information can address J. W. Welsh, Jasper, Newton county.

Round top peak of the Judah Mountain of the Boston range is a conspicuous land mark, and, according to Aneroid's barometer, has attained an elevation of thirteen hundred feet above the general water-shed of the country. Newton county is one of the most mountainous counties in the State, and affords many fine streams of water; those streams are voluminous enough to propel all the machinery needed in the county. The valleys along these streams are very productive, producing various kinds of cereals—wheat, oats, rye and corn—also, various kinds of vegetables.

The encrinital marble limestone are well exposed at the foot of the Judah peak, not far from Jasper. The strata exposed immediately on the bank of the Hudson fork of Buffalo. Below Jasper are alternations of limestone and sandstone. The sandstone has a peculiar porous, or honey-comb structure; on this rests a light bluish-gray limestone. Near the mouth of this stream a high escarpment of sandstone and limestone forms a permanent feature in the landscape. Most of the ledges are probably of lower silurian date, but the perpendicular nature of this cliff prevents a critical examination of the individual members at this point.

On one prong of the Hudson fork of Buffalo, and on Lamar's creek, there is a large cave, fourteen miles south-west from Jasper. Seventy feet from the mouth of this cave it forks; the right hand prong takes a northerly course; the left is nearly west. The right hand cavern is called the rattle snake's den, from the quantity of rattle snakes found there by the first settlers of the county. In this cave there is a quantity of laminated nitre earth, in which the bear has dug many holes at various depths.

There is a stream of water in this cave four hundred feet from its entrance, which can be conveyed to the mouth of the cave in troughs. There is marble rock of various kinds within one mile of Jasper. It is light drab and regularly dotted with crystals, which radiate from a centre, evidently of some undescribed fossil.

In this section of the county, it appears that the surface of the magnesian limestone under the sandstone, has suffered from irregular denudation, previous to the depositions of the sand, which went to form the succeeding stratum, which is, in consequence, sometimes quite irregular in its thickness, even in short distances, where the sand has been swept into the eroded cavities; such an action has taken place in this county. The great mass of isolated sandstone, which has resisted the action of decomposing agencies, beyond that of the adjacent members, stands out as a bold mass, as if it might have been a wall or dike form, easily enclosed between walls of the adjacent magnesian limestone, and now forms a conspicuous feature in the landscape of that region.

The two main branches of White river take their rise among these high peaks of Newton and Madison counties; the largest branch, deflected around this great axis of upheavel, pursues a circuitous course through the latter county into Benton county, and thence making a great sweep to the north, traverses Barry and Taney counties in Missouri, before it again waters the State of Arkansas, in the north-east corner of Carroll.

Jasper, the county seat of Newton county is located in a fine valley, on Hudson fork of Buffalo. It contains one hundred and fifty inhabitants, one school, one church, one free-masons' hall, two stores, two hotels, and a tobacco manufactory.

On Cave creek several nitre caves have been formed by the disintegration of the liver-colored marble limestone under the cherty limestone. The dark brown nitre earth which forms the floor of these caves, is rich in salts of nitric acid, owing, no doubt, to the large quantity of organic matter incorporated with the earth. The nitre earth has been traced from fifty to sixty yards back into the cave, and for seven or eight feet deep.

It appears that this cave must have been once the habitation of the aborigines, since not only bones of men, animals and birds, such as the buffalo, deer and turkey, have been found on removing the earth, but even the entire skeleton of an infant, enveloped in rags, and lying in a willow basket. The bones are frequently found under a bed of ashes. A polished ivory breast dirk, with three holes in it for the attachment of a handle, and a long piece of rope were also found in this cave, together with a broken sea shell.

On the above mentioned creek there is a large rock house. One of the early settlers has taken advantage of this natural rock house, to make it serve as a roof, back and front of the side walls to a house, closing the south front with pine slabs; on either side a stone chimney, and cutting two doors and windows, he has managed to construct, at little expense and labor, a complete house.

GEOLOGICAL RECONNOISSANCE.

PULASKI COUNTY.

In Pulaski county, north of Arkansas river, the stratigraphical character of the rock is very much the same as the counties laying to the west. The mill-stone grit still forms the capping to the highest hills, while the cuts in the valleys have laid bare the reddish and dark underlying shales, which seem to augment in thickness to the south and east, while the sand-stone of the mill-stone grit appear to become more schistose in structure.

On the road leading from Little Rock to the Kellogg lead mines, upon the surface of some of the sand-stones, quarried out to improve the road over the hills, clusters of transparent crystals were found attached. The upper part of this quartz-bearing sand-stone, which caps the hills, is a coarse grained reddish rock which crumbles easily to sand.

There is a very important mineral locality in Pulaski county, south of the Arkansas river, situated on Kellogg creek, and known as the Kellogg lead mines. The principal mines are in township 3 north, range 11 west, and about ten miles north-east of Little Rock. In this valley there is a large growth of timber, a plenty of water, and good land. The timber in the bottom is hickory, white oak, elm, sweet-gum, black-gum, and maple. On the hills it is black-oak, post-oak and black-jack.

The mill-stone grit occupies the highest position, not only in the hills adjacent to the mouth of Palarm bayou, and in the ridge dividing the waters of the stream from Kellogg's creek, in Pulaski county, but also in the Bull mountains, in the north-east corner of Conway. The underlying shales are exposed in sections on the Arkansas river, near the Palarm bayou, as well as on Bull bayou, in the north-eastern part of Conway county. It is through them that the veins of quartz reach the surface in the north-east portion of Pulaski county.

Locally a bed of soft sand-stone is intercolated among these shales, succeeded by thirty feet of hard shale or slate, intersected with lines of cross fracture, probably caused by shrinking. The lower stratum of this section comprises the shales forming the valley of Kellogg creek, which are traversed by a section of metaliferous veins, containing a rich silver lead, associated with quartz, copper pyrites, spathic iron and blende, or sulphuret of zinc. The principal veins have a course nearly east and west. These veins are found occupying a belt of country nearly a mile wide, and probably may be traced from this locality in a south-west direction across the State to the Indian boundary line, and beyond, and perhaps also to a considerable distance to the north-east; also the same silicious and argillicious shale and crystalline rock, at the aforementioned mines, can be traced in the same direction and to the same places. It is found from six to ten miles on either side of a range of novaculite mountains and hills, which extend from Saline county nearly in a south-westerly course to the Indian line; while the granitic axis, which gave to Arkansas its peculiar geographical features, crops out at various places, from ten to twenty miles south of the aforementioned mountain. This granitic rock is associated with horneblendic augitic and amirgdaloidal basaltic rocks, of igneous origin. These mineral veins which have been detected, traversing the neighboring strata, have, no doubt a connection, and owe their origin to the causes brought into action during the production of these crystalline rocks and the metamorphose of the strata.

A description has been given of the geological position and mineral character of a vein of argentiferous galena, as it occurs on Kellogg's creek, in Pulaski county, and veins possessing very similar character have been observed at various points in the western part of Pulaski, Saline, Hot Spring, Montgomery, Clark and Pike counties, but more especially in Sevier county,

all having a constant bearing nearly in the same north-east and south-west course, and running almost parallel to the aforementioned mountain range of the out-erop of the crystalline rocks.

According to Whitney's "Metalic Wealth," the mines of Nassau and Holzappel contain the same kind of vein, stone and argentiferous, lead ores and other minerals, as the section of Arkansas already mentioned.

The mines of Holzappel, Obernhof, Marienfels, Welmich and Werlau, resemble each other most strongly. Their direction is nearly east, north-east and west, south-west, and they dip at an angle of from 50° to 80°. The vein stone is generally quartz; the ores argentiferous galena, blende, copperpyrites and spathic iron. Near the surface the above mentioned ores have been converted into carbonate and sulphate of lead, malachite, azurite, gossen, etc. The lodes generally consist of several branches, running parallel with each other.

This "zug" or group of veins, stretches from Holzappel, on the Lahn, to Welmich and Werlan on the Rhine, and is enclosed in argillaceous slate and grauwack of the silurian system. Its whole length is between thirty and forty miles, although there are portions of the ground included in this range which have not yet been worked, and the veins are not actually known to be continuous for the whole distance; yet they are so much alike in their principal features, that they must be regarded as belonging to the same system. The metaliferous deposits, wherever opened, are characterized by a near coincidence in strike and dip with the strata in which they are enclosed, and they are cut through by cross veins, running east and west, which heave them from their regular course. There are two of these cross courses which are particularly conspicious, and they are known as the eastern and western cross courses. They divide the lode into three portions, each one of which exhibits certain peculiarities of structure. The veins have regular, smooth and polished selvages. Frequently the mass of the lode is traversed by fissures, running across its whole width, at right angles to it, whose sides are

lined generally with fine crystals. They are in some cases empty, and in others filled with flucon. The productive, or ore bearing portion of the lodes are confined in their extent within certain limits, marked by planes, dipping east at an angle of 14° to 20°, which divide the veins into a number of alternate rich and poor sections; the rock adjacent to the unproductive portions, being usually softer and more decomposed than where the lode is rich in ores. This comparison may be some advantage to those who work at the Kellogg mines. At this mine there has been several shafts sunk, from fifty to one hundred feet deep, and many pit holes dug at various places. A large quantity of copper pyrites, sulphuret of zinc, silver, lead, and spathic iron was found among the rubbish that was thrown out of these shafts.

The mineral bearing argilliceous shales, and quartz rock of Kellogg creek are underlaid by the subcarboniferous limestone which we have every reason to believe would be more favorable to mining than the overlying shales, besides the surface indications of this system of veins, give evidence that the deeper they are followed the richer they become.

The silver lead from those mines gave, by reduction, eighty per cent of metallic lead; by cupellation, thirty-nine ounces of silver to the ton.

According to the history of Europe, the argentiferous ores of that country contain from seventy to eighty ounces of silver to the ton. From this it will be seen that the silver lead from the Kellog mines, greatly exceed in richness the silver lead ores of Europe, and in the comparison, leaves a margin for profit so broad, that no doubt can be entertained of the practicability of working these ores, not only for the lead, but for the silver.

Fourche Cove, when viewed from the top of the moutain, at the north-west corner of section 27, has the appearance of an ellipse. The opening is at the north-east. Its diameter, north-east and south-west, is three miles, and from south-east to north-west two miles. This mountain partly surrounds and forms Fourche Cove. It is, in fact a ridge, composed of feld-

spathic granite, granite, syenite and gneiss, and is from two to three hundred and sixty feet in hight, ranging north-east and south west, and sending off a few subordinate spurs. This valley is undulating in places, and in other parts level. The growth is hickory, pine, post oak, black oak, red oak, willow oak and dogwood. In the north-east corner of section twenty eight, in township 1 north, range 12 west, there is a granite declivity favorably situated for quarrying, for building purposes. Not far from this place, and on the top of the mountain, there is a stratified rock that very much resembles gneiss, and has been quarried for millstone.

In section 33, township 1 north, range 12 west, there is a kind of basalt rock, composed largely of augite, and showing a somewhat porphyritic appearance. In section 9, township 1 south, range 12 west, some $200 has been expended in search of ore. The rock here is ferruginous amygdaloid of rather a peculiar character. The amygdules is very globular; it has the appearance of pea stone. This rock bears north; it occurs again on the south-west quarter of section 4, where old diggings are visible, made in search of gold. Several old diggings were found in this same kind of rocks, and not far from the same place, but whether there was any mineral found I did not ascertain.

On section 9, same township and range, a white trachyte wack was found, which is passing into a white kaolin or porcelain clay. In the same vicinity there are the remains of an old mill. On a small branch close by the mill there is the appearance of an old furnance, in which by appearance of the slag they seem to have attempted to smelt some ore.

On section 4, township 1 south, range 12 west, there occurs a white argillaceous rock, having the appearance of disintegrated trachyte. In the vicinity of this rock there are symptoms of a good deposit of porcelain clay. On the north-east quarter section 33, township 1 north, range 12 west, the rock is very ponderous, black porphyritic, basalt, composed chiefly of augite, with large imbedded crystals of jet black augite. The greatest portion of this rock is oxide of iron. On section

27, close to the line, is a kind of ferruginous trap associated with a quartzose rock. On the east half of the section the quartz is in great quantities, which has induced the mine hunters to prosecute their mining prospects in this direction.

One of the most important places of limonite iron ore is in section 11, township 1 south, range 12 west; and section 2, same range, almost every tree blown down by the wind shows ore entangled in its roots, and in some places the ground is literally covered with it. The granite is composed of feldspar, quartz, mica and horneblende, and is hard and durable. It has stood the test of all the destroying agents of by-gone ages The edges of the rock show no signs of decomposition.

GEOLOGICAL RECONNOISSANCE.

WHITE COUNTY.

Round-Top mountain in White county is one mile in length from east to west, and when viewed from the mountains on the south, it looks like a gigantic water craft floating among the billows of the ocean. From the summit of this mountain can be seen the surrounding valley, which is six miles wide, and dotted with plantations. Beyond this valley can be seen mountains looming up in the distance in every direction.

Round-Top mountain, according to Aneroid's barometer, is two hundred and fifty feet high, index hand at 29½, thermometer 60°. A bed of coal from six to ten inches in thickness occurs sixty feet up in a ridge known by the name of Round Top, near Cypress bayou. The base of the hill consists of black and ferruginous shale, surmounted by thick bedded sandstone capping its summits. Ferruginous shale are strewed on the slope under the sandstone for seventy-five feet. Beneath this, for the depth of five feet, is a bluish shale, enclosing oval concretions. The immediate roof of the coal is a peculiar, rusty, talcous-looking scaly shale, unctuous to the touch, and crumbling to pieces with the least friction. The base of the hill, for sixty feet under the coal, is composed of dark bluish gray shale, including considerable quantities of carbonate of iron. The same bed of coal crops out on the western declivity of the hill. This coal has been partially opened for the use of the blacksmiths in this part of White and the adjacent portion of Conway county; but where it has been worked it has not afforded a coal altogether free from the pyritiferous impurities required for shop use. The thickness, too, is not sufficient to warrant the expense of running a drift into it for any great distance. Iron pyrites is quite common in the shales of

the coal measures, and the vermicular sandstone and shales when exposed to the air readily decompose, and the sulphur unites with oxygen, forming sulphuric acid, which reunites with the iron and forms sulphate of iron, or with the alumina and potash of the shales and forms the alum so often present in the waters percolating through these rocks. Sulphuret of iron is also found in the coal in greater or less abundance. It produces those sulphurous fumes so annoying and injurious to those who use such coal either in the house or shop. Its sulphur also unites with the iron and steel worked with the coal, and renders them brittle and worthless for many purposes.

A good soil is the most useful and enduring wealth of a country. Without the fear of contradiction, the White river bottom possesses one of the best soils in the State for the cultivation of cotton and corn, and other great staples, hemp, wheat and tobacco.

The alluvial bottom of White and Little Red rivers, in White county, present a loose vegetable soil, which sustains a rank growth of vegetation, which, together with the fine sediments of the waters, adds greatly to the vast amount of fertilizing matter in the soil. When these lands are eventually reclaimed, they will be very productive and well nigh inexhaustible.

Under the bluffs, where the shales of the vermicular sandstone and other shales of various kinds, are exposed, we find a wet, heavy, clayey soil, rich in vegetable matter. It sustains a growth of rank weeds and heavy timber. Through draining and subsoiling alone, this soil can be fitted for common agricultural purposes; but when once reclaimed it will be very permanent and productive for oats, grasses and all kindred crops. The timber is a growth of bur, red, swamp, white and laurel oaks; box-elder, buck-eye and pawpaw.

But few counties are so well watered as White. A glance at the map will show how admirably every portion of it is intersected by rivers, creeks and branches. The Little Red and White rivers, Bayou Departy, Bayou DesArc, Cypress bayou, besides numerous branches intersect nearly every township in

the county. Water-power and mill sites are plenty. These streams abound in fish, particularly the sloughs and bayous.

The bluffs along the streams are most beautiful when clothed with the rich foliage and numerous flowers which adorn them. In the months of April, May and June, these bluffs are beautified by a gaudy and delicate flora, the snowy white lilly, fairy like sensitive brier, bladder-wort, yellow jessamine, etc. In the western part of White county there are hills and mountains, some are capped with sandstone of the millstone grit, others with shale. A yellow sandstone occupies the surface. At Rocky Point the hills are composed of shale slate and ferruginous sand rock. A similar sandstone crops out on the slope descending to Cypress bayou, on the confines of White and Prairie counties. All this strata is no doubt referable to millstone series at the base of the coal measure.

Thomas Goodlow's plantation is on Cedar creek, in section 29, township 8 south, range 10 west. The land here is a dark red color and very productive. The timber is white-oak, hickory, sweet-gum and ash. On the south bank of this stream, and not far from the house, the tilted strata lie at various angles, dipping from 3° to 40°, yet the belt of disturbance is quite narrow, not more than six feet, and some of the broken slabs of rocks appear as if they had partially slipped into a yawning fissure and become entangled in the closing of the gap. The course of this disturbance runs obliquely across the bed of Cadron, with a slightly curved bearing south southwest, and forms a kind of artificial dam. This rupture of the strata can be traced for three quarters of a mile. In some parts of its course the fractured layers form a complete arch, dipping both ways from the central axis.

El Paso, in White county, at Peach Orchard gap, is said to be one of the healthiest towns in the State. It is improving very fast. It has two business houses, two churches, two school houses, one masonic lodge. There is also a second class chalybeate spring in three hundred yards of the place.

M. L. Booth's plantation is in one mile of town. He has one hundred and fifty acres in cultivation, and a young orchard, containing four hundred apple trees.

GEOLOGICAL RECONNOISSANCE.

IZARD COUNTY.

Night's cove is near a spur of the Blue mountain, in Izard county. This cove is well watered and supports a large growth of timber. The soil is of a dark color and very productive. The growth is walnut, ash, sugar tree, elm, hickory, white oak and gum.

By Aneroid's barometer, the top of the mountain was found to be six hundred feet above the waters of Cove creek. On the north side of the mountain there is a large rock house or cave. It is four hundred yards above the creek, and extends into the mountain over one hundred yards. The mouth is six feet high and ten feet wide. Bottom, sides and roof are covered with sparry lime, which by the action of water has been formed into various shapes. In some places it is in waves, cups and pockets, and in other places stalactites and stalagmites. On a level with the cave, a spur of the mountain which is four hundred feet high, extends a mile south. On the top and part of the base is encrinital crystalline lime rock, nearly one hundred feet thick, which rests on a gray fine grained rock, that is nearly one hundred feet thick, which rests on shale slate, and stratified ferruginous sand rock, which extends down to the cove. The disintegration of these rock have formed a fine rich soil, which is very productive.

The limestone of this region are of a light gray and dark gray hue, and often singularly withered into small furrows, radiating from the center, and often intersected with veins of calkspar.

Near Rocky Bayou, and at William Hinkle's, there is a

voluminous spring silently flowing out from the side of a hill, and affords water enough to propel a small grist mill. The sand rock beneath the encrinital lime-rock is one hundred and fifty feet thick. The light-gray lime-rock under the sand-rock is eighty feet thick. The fossiliferous cherty rock that caps the hills in this part of the county, taking the lithographical character and order of superposition as a guide, will probably be found to belong as the base of the subcarboniferous series of Izard and Marion counties, resting on limestones which belong probably to the devonian and silurian period.

On the tops of the hills near Rocky Bayou, in a cherty rock, there are brachiopods, orthis Missouriensis spiraphera, likewise some casts of imperfect fossils. Three miles down the creek there is a saltpetre cave, where some work has been done and some nitre made.

The summit of the mountains at the mouth of Silliman creek, according to Aneroid's barometer, is eight hundred feet high. Syldmore is a small town on a bluff of White river, at the mouth of Silliman creek. It has several houses, two stores, one grocery, one church, one masonic hall and chapter, a large cotton-gin, grist-mill and a ferry on White river.

On the road to Livingstone's creek and south of White river there is a high bluff of limestone, within fifty yards of the river. This is a very convenient place to burn lime. This lime-rock when calcined makes a good quality of lime. There is also plenty of timber handy. Further north, on the road, there are deep channels worn into the bluff by the action of water. At this place large heaps of tuffa have been found at the bottom of the bluff. Further on the road, and on Livingstone's creek, a large growth of cedar reposes on a stratified lime-rock.

High up on Jackson's creek there is a cave or cavern. After you pass through the first hoppers, there are several roomy chambers and antechambers, and quantities of stalactites hanging from the roof and stalagmites at the bottom. There has been saltpetre made here, but what quantity is not known.

On the road from the last mentioned place to Calico, there

is a bald knob called Sugar Loaf Mountain. It is a barren, high peak, standing in bold relief; a conspicuous land-mark in bygone ages; a guide for the Indian pedestrians and early settlers of the country. A measurement of the aforesaid mountain with Aneroid's barometer gave its highth twelve hundred feet above low-water on White river. Calico Rock, on White river, Izard county, is four hundred and sixty feet from the so-called saccaroidal sand-rock down to low-water mark. It is a perpendicular cliff, and forms a conspicuous landmark for navigators of the river.

Two miles from Calico the sandstone is one hundred and sixty feet in thickness, with perhaps some intercolated layers of limestone. Most of the beds of sandstone in this part of Izard seem to be white, or of a pale-yellow color, and soft. The dip is irregular and often undulating, and conforms to the general contour of the country. However, the prevailing dip is to the southwest.

The limestone of this region are of a light and dark gray hue, and often singularly weathered into small, regular furrows, radiating from a center, and often intersected with veins of calcspar. This rock very much resembles the limestone that was found on the top of a spar of the Blue Mountain in Night's Cove.

On the road from Calico to "Naked Joe," the white and yellow sandstone occupies for the first eight miles a position towards the summit of the ridge. Its upper layers are generally coarse grained and present glistening reflections. This limestone is underlaid by the cherty limestone which form the variegated cliffs on White river, known by the name of Calico Bluffs.

North and east of Naked Joe the sandstone becomes harder and more cherty; it may be designated there as a porous and cellular cherty sandstone. *En route* from Calico Bluffs to the mouth of the North Fork, the road passes around the northern broad base of Naked Joe, on a rock terrace, which is fifteen feet wide and nearly horizontal. The summit of Naked Joe is three hundred feet above the road, and a thou-

sand feet above the waters of White river, according to observation taken with Aneroide's barometer.

The ridges north of Naked Joe, and for four miles before reaching the north fork of White river, are composed of cellular buhr-stone chert.

The summit level of the mountain on the east side of the North Fork, and east of William Hall's, by barometer measurement, is found to be six hundred feet above low-water mark on White river.

From the top of Naked Joe, a high conspicuous mountain can be seen towering above the rest of the mountains, called Matner's Knob, which is said to be twelve hundred feet high.

The gray and variegated limestone occurs in the bluffs of White river, one mile above Big creek.

The cherty magnesian and other varieties of limestone, of which the base of the hills is composed, and which form bold cliffs on North Fork, appear to be of silurian date, but the sandstone, cherty and limestone towards the top of the ridges, must belong to the subcarboniferous group, judging from the fossils found.

On the North Fork, and not far from an old mill, there are very fine buhr rock in the ridges, also in the bluff of White river, below the mouth of Big Creek, there has been found ores of manganese.

The best quality of buhr stone, of any required dimensions, can be obtained either in Camp Creek hollow, or on the ridges two miles above the mouth of the north fork of White river, equal in quality to French buhr.

MAGNESIAN LIMESTONE.

As seen in this county, this formation presents a great diversity of appearances, not only in the thickness and arrangement of its layers, but in their character and composition. As a general thing it is distinctly and for the most part thickly stratified; though some of the lower portions, seen on the water courses, are more compact and heavy bedded. In color, varies

from a very light drab, through various shades of yellowish and bluish tints to a light gray. In composition, some of the layers and beds appear to be a pure, fine grained or compact magnesian limestone, while others contain a large proportion of silicious matter, but in the form of imbedded angular fragments and concretions of flint, as well as in fine particles generally disseminated through the whole mass. Alternating with these, there are often thin seams of bluish argillaceous matter, and sometimes, though rarely, we meet with thin layers and beds of sandstone. In a few instances, near the upper part, thin layers of very hard, compact sandstone, passing into quartzit, were seen alternating with the other beds.

Some of the beds have a fragmentary structure, as though partly composed of broken up materials of similar strata elsewhere; while others have a confused appearance, as though the layers had been bent and broken while in a yielding condition. Large concretionary masses are sometimes seen in some of the beds, around which the layers of the beds are variously bent and twisted, while those of the beds immediately above and below remain undisturbed.

In the more impure and porous layers and beds, as well as in the cherty masses imbeded in them, the oolitic structure is often observed, even in the most compact, flinty masses. When a fresh fracture is examined with a magnifyer, oolitic particles can be seen imbedded in the translucent base, and on weathered surfaces, they often present beautiful examples of this structure in relief. Sometimes these concretions when broken, present an agate like structure, being composed of concentric layers or coats of various colors. The upper part of the formation generally consists of the light drab colored, fine grained varieties of magnesian limestone, known among the country people by the appropriate local name of cotton rock. The surfaces of these layers are almost always covered with fucoids, very like those of the calciferous sandrock of New York. Sometimes beds of considerable thickness are made up entirely of layers of these cotton rock, while, in other instances, they alternate with other varieties of magnesian limestone. The

lower part of the formation consists of the coarser varieties of magnesian limestone, which are usually in thicker beds, and sometimes alternate with sandy limestone, which often contain enough calcarious matter to make tolerably good lime.

GEOLOGICAL RECONNOISSANCE.

FULTON COUNTY.

On the north fork of White river, and in the vicinity of Rapp's barrens, the strata of the lower part of the cliffs are composed of different varieties of magnesian limestone and silico calcarious rocks, which are remarkable for the great differences which they exhibit in the capabilities of resisting atmospheric vicissitudes; some layers being hard, compact and durable, stand out permanently in overhanging ledges; others crumbling away, recede even under the shelter and protection of more durable strata. Some of the layers possess a fine oolitic structure.

East of the north fork, and on the waters of Barney's creek, there is lead, zinc and green carbonate of copper. Six miles from the mouth of the north fork, there is a quantity of buhr rock. It is very silicious and plenty.

Four miles west of Salem there is a considerable bed of hydrated oxide of iron, in connection with an impure silicious ore exposed on a ridge one hundred feet above the general drainings of the country.

Varieties of chert, hornestone, and porous buhrstones, form

the most conspicuous rocks in the ridges of the northern part of Fulton county. These repose on limestones, mostly of a silicious character, with segregations and interpolations of chert, sandstone and calciferous sandrock.

Fulton county is well watered, and possesses many fine water-powers, even at the very fountain-head of its numerous limpid calcareous streams, which frequently burst forth from amongst the ledges of rocks. The land produces well, particularly oats, wheat, rye, wool and honey. The crops of maize may be considered average. The bluffs along the streams are most beautiful when clothed with the rich foliage and numerous flowers which adorn them. In the months of April, May and June these bluffs are beautified by a gaudy and delicate flora, the white and red wild roses, the magnficent pink, the fairy-like sensitive briar and wild sienna, and numerous others of the lovely sisterhood, profusely adorn the bluffs and broken grounds along the streams.

The flora of the prairies are still more gaudy and magnificent; bell-flower, rattle-cup, white and purple lilies, lark-spur, wild indigo, wild pink and sienna adorn the green carpet of these meadows.

This county is bounded on the north by Missouri, on the east by Lawrence county, on the south by Izard and on the west by Marion. It contains about twenty-five and one-half geographical townships, or an area of 818 square miles. The face of the country, in places, is hilly, and in other places level, or agreeably undulating, and diversified with timber and prairie. It is watered by several streams, which have cut out their beds much below the general level of the country, so that on their borders the strata have been so denuded as to present many ridges and rounded knobs, varying in height from 100 to 445 feet. Half a mile north of Salem is an isolated conical hill called "Pilot Knob." A measurement made with the Aneroid barometer gave its height five hundred feet above the town of Salem.

On the road from Salem to Bennett's river, the substratum is a white earthy limestone, resembling the "white rock" of

the Independence county section, alternating with a greenish marly shale, which weathers easily, and forms broad, grassy valleys between the hills, destitute of timber.

Bennett's Bayou, along which is a rich agricultural district, takes its way principally through this stratum.

In the western part of the county, on the north fork of White river, there are seen in the base of the hills, ninety feet, irregularly bedded, impure cherty limestone. The chert is very brittle, and has a tendency to break into cubes. This is overlaid by one hundred and eighteen feet of cherty limestone, alternating with a grayish-buff silicious rock.

On Pine creek the saccharoidal limestone of Independence county section forms the tops of the ridges, and is covered with a heavy growth of yellow pine.

GEOLOGICAL RECONNOISSANCE.

VAN BUREN COUNTY.

In passing from White Pine into the eastern portion of Van Buren county, you will find silicious soils that support a large pine forest. This soil was derived from the disintegration of sandstone, of the millstone grit series. The table-lands in the eastern part of this county are elevated from one hundred and fifty feet above the general drainage of this section, and three hundred and eighty feet above a group of dark shale, including carbonate of iron, which are well exposed near the foot of a descent *en route* to Sugar-Loaf springs. This part of the county is well supplied with mills. One belonging to J. W. Dardan is a steam saw and grist-mill and cotton-gin. Another belonging to John Hodges is a saw and grist mill, propelled by the waters of Cadron.

The soil of the mill-stone grit, though it has no limestone, is richer than could be supposed from the porosity of the sandstone. It is light, sandy, permeable, and produces from twenty-five to thirty bushels of corn, or ten or fifteen bushels of wheat per acre. It is still better for tobacco, giving on an average one thousand pounds per acre. This soil is soon exhausted, and should be carefully manured. In dry seasons the crop is very short. Good springs are found at the top of the mill-stone grit on hills of small extent.

The Sugar-Loaf mountain is a conspicuous land-mark, and has been a guide to the first settlers and hunters. It is an insulated hill cut off by dendation from the main range of the mountain. A measurement with the Aneroid barometer gave its height five hundred and fifty feet above low water mark a

Little Red river. This river sweeps around the north eastern broad base of the above mentioned hill.

The Sugar Loaf springs are situated three miles from the Sugar Loaf mountain, in a south-west course. There are several fine springs of mineral water. The main springs are saline, sulphuretted waters, possessing alterative, laxative, diaphoretic and diuretic effects, well adapted for the cure of eruptive complaints, as well as chronic diseases of the digestive organs. The properties possessed by the chalybeate are those of a tonic, suited to cases of constitutional or temporary debility in which preparations containing iron ore are indicated.

On the road from Sugar Loaf springs, in the direction of Miller's Ferry, on Little Red river, there is a high range of country that supports a forest of large pines. In this section there is a sand rock of the mill-stone grit, which reposes on ferruginous shales and slate. This sand rock has strata adapted to the various building purposes to which rock is applied.

Goff's Cove, in Little river valley, is a rich portion of the county. It is well watered and supports a large growth of timber. On the south of the river there is a bold inland promontory five hundred feet high. This mountain is called Lafferty Point, named after a well known gentleman by the name of Lafferty, who lived on a farm at the foot of the mountain.

Shilo, a handsome little town, situated in the north-east part of the county is founded on a stratified sand rock, which answers for pavements and side-walks. The west part of town rests on sand and clay, which reposes on a stratified sand rock. This rock is good building material. In the vicinity of the town there is an excellent chalybeate spring, which is a good antidote for dyspepsia and has cured several.

Three miles south of town a strata of coal four inches thick, is seen in the bluff; also eight miles west of the above mentioned town, in the south fork of Little Red river, a strata of coal crops out.

The bottom lands on the river are very productive, producing all kinds of grain; also cotton and tobacco. The growth

is sweet-gum, hickory, elm, ash, black-gum, maple, hackberry, white oak, black-oak, persimmon, pawpaw, linden, willow-oak, leather-wood, spice-wood and birch.

South-east of Shilo there is a large rock house, one quarter of a mile long and thirty feet wide; it contains nitre earth and alum.

Shilo is a thriving little town, it contains fifty inhabitants, two stores, two groceries, one school-house, a masonic hall and meeting house.

GEOLOGICAL RECONNOISSANCE.

INDEPENDENCE COUNTY.

On the road leading from John W. Ross' to Wallace's Cove, and on the top of the mountain, which is found to be, according to Aneroide's barometer, ten hundred feet above the waters of White river; in this elevated section of the country there are massive columns of ferruginous sand rock. Some of these columns are from six to fifteen feet in diameter and twenty feet high with capitals on the top, which are larger than the base. These columns are some distance from the main range of sand rock, and have been cut off from the cliffs by water and disintegration. The main range of these rocks that cap the top of the mountain is nearly east and west. In some places they are fifty feet wide, thirty feet high and four hundred yards long. This sand rock, millstone grit and thirty feet of shale forms a stratum three hundred feet thick, which reposes on archimides and encrinital lime rock, which forms the first terrace. This lime-stone is a fine crystalline stratified rock from six inches to two feet thick, and is well worthy of the name of marble. It is a variegated calcarious stratum one hundred feet thick and extends down to the second terrace. The second bench is forty yards wide and sixty yards in length. Fifty feet of stratified blue limestone, twenty-five feet of hard silicious sand rock and fifty feet of drab colored lime rock, repose on the third bench; dark colored cherty lime rock, shale and silicious sand rock, in all one hundred feet thick, which forms the stratum that reposes on encrinital lime rock, which forms the fourth terrace, or spur. The spur is capped with encrinital lime rock and extends out from the main mountain four hundred yards

in a northerly direction. Encrinital and dark colored lime rock, shale, sand rocks and other lime rocks form the stratum, which is two hundred feet thick and extends down to the cove.

This cove is partly surrounded by mountains. This conspicuous range of hills, lying in the southwest corner of Independence county, whose northren terminus bounds the White river bottom on the south, is composed of central flat-topped ridges, whose hight, according to Aneroide's barometer, is twelve hundred feet above the waters of White river.

The decomposition of the lime, shale, slate and sand-rocks, and the deposit from the upper White river that was carried down by the high waters of bygone ages, has formed a rich soil that is very productive, producing all kinds of grain, also cotton and tobacco. The growth is sweet-gum, cherry, walnut, hickory, sycamore, ash, alder, blackberry, spicewood, elm and dogwood.

In the western part of Independence county, a cherty limestone forms a perpendicular cliff on White river, above the mouth of Lafferty's creek, four hundred and fifty feet in highth, forming a conspicuous landmark for navigators of the river, and bears the name of Pinter's Bluff. Between this point and Batesville, it forms the substratum of extensive table-lands, well adapted for agricultural purposes. A cavernous or barren limestone group, capped with chert, prevails in the vicinity of Lafferty's creek, where it is underlaid in many places by very white sandstone, some of which is sufficiently hard to make grind-rocks, and also very good material for making glass. Four miles from the mouth of Lafferty creek, in a subcarboniferous limestone, there is a nitre cave that was worked at the time of the war between the north and south, and quantities of nitre made.

The most interesting locality of manganese ore is in the cavernous limestone on the west branch of Lafferty creek; two miles above its mouth, there are well defined walls containing the manganese ore. The space between the walls varies from eight to fourteen feet. At many other localities on the waters of Lafferty, in this section of the county, similar ores of man-

ganese have been found. Associated with the ores of manganse, there is some excellent red oxide of iron; it has the appearance of per oxide of iron.

Although the bottom and upland is very good in this county, sub-soiling would confer many advantages. It would furnish an additional amount of soil to receive the roots and prepare food for their nourishment; it permits the water to percolate through the soil and deposit fertilizing gases absorbed by it from the air; it so loosens the sub-soil that air and heat may permeate through it and elaborate the elements needed by plants; by it the excess of water passes through the soil instead of running over the surface and removing the fertilizing properties; by its influence the soil dries much quicker after a rain, and can be worked much earlier in the spring; it also provides against the injurious effects of drought, by enabling the roots to penetrate the moist earth below the influence of the sun's rays, and by so loosening the soil that the water will more rapidly rise to the surface by capillary attraction; and by it crops will ripen some two weeks earlier and escape the early frost.

The soil of a country is the great source of individual wealth and happiness; it should, therefore, receive the fostering care of the farmers. And, besides, there is no department of human industry whose profits have been more advanced by science than that of agriculture, and none upon which the future prosperity of a country so much depends.

Many kinds of fertilizing minerals have been tried, and have proven very good; but green manure, or crops plowed in while green, is best adapted to most of the deteriorated lands of our State, particularly those exhausted by corn, as they will be found deficient in potassa, soda and phosphoric acid, and vegetable matter, which clover or peas will restore. The long top roots of the clover will obtain the acid and alkalies from the sub-soil, and the leaves other needed elements from the air, and they will be restored to the soil. Many farmers have used them with great success. Buckwheat may be used to better advantage on lands exhausted by wheat, as it contains many times as much phosphoric acid as clover.

GEOLOGICAL RECONNOISSANCE.

JOHNSON COUNTY.

The greater portion of Johnson county is underlaid by two beds of semi-bituminous coal. The upper bed is from ten to eighteen inches thick. The lower bed is from three to four feet. In this county pits have been dug in many places, and at various depths, and in some places considerable quantities of coal have been taken out and used in the blacksmith shops of the county; also at Clarksville. It is said to be better and cheaper than charcoal. Several boat loads of this coal have been floated down the Arkansas river to Little Rock and sold at forty cents per bushel. At Spadra creek, is the only place that these coal beds have been mined to any extent, and the only place where the lithological character of the rock can be made out The shales covering this coal bear already, like those of Horse Head creek coal bed, traces of a metamorphism, which has hardened and split them contrary to the plan of stratification. This renders them brittle, and causes, under the stroke of the hammer, irregular fractures, which prevent the preservation of fossil plants. The shales are grayish or black, less micacious than at Horsehead creek, and more like those of Hale's coal bank. The few plants determinable in the broken pieces of shale are neuropteris, and abundance of leaves of Lepidodendron and Lepidophylum. The coal is overlaid by the same brash-coal as that of James' Fork, and other places, which contains, especially in abundance, calamites. These species, like the former, show the same geological horizon, for this coal, as for the other beds examined in Arkansas. At some places near the mouth of Spadra creek

the coal is three and a half feet thick, including a clay parting of three inches, and about six inches of brashy coal. It is still underlaid by the black, hard fire-clay, full of leaves of stigmaria. The same coal crops out above the town of Spadra, on the bank of the Arkansas river, where it is said to be four feet thick. It is thus probable that the same coal will be found of workable thickness all around the country, when the combustible mineral shall become valuable enough to encourage exploration by boring. Clarksville, the county seat of Johnson, is built on an eminence, just at the top of the black shales overlying the Spadra coal. To direct future researches it will be well to remember that the coal strata of Arkansas generally underlie, at a distance of fifty to one hundred feet, a bed of red ferruginous clay or red earth, which is easily distinguished wherever it appears in the counties mentioned as included in the coal-fields of Arkansas. It is also well to bear in mind that, although two beds of coal may have been found in Arkansas, it is the lowest only which up to the present time has been of workable thickness. The subcarboniferous measures generally underlie it at a short distance, and no coal can be expected to be found within them. This is semi-anthracite coal.

The existence of semi-anthracite coal in the west is somewhat surprising, since the formation in which it occurs, is comparatively level, undisturbed, and bearing little evidence of metamorphism or change by internal heat. The coals of similar compositions in Pennsylvania occur, as we are informed by Hayes and Rogers, only in coal-fields and isolated patches, in the most disturbed portions of the Appalachian chain, and are associated with some of the boldest fluxtures and greatest dislocations of the whole coal region of that State. The nearest rock of undoubted igneous origin to this coal, at present known to me in Arkansas, is situated in Hot Spring county, some sixty miles, in a direct line south of Spadra; yet, here we have a coal possessing all the chemical properties of the semi-anthracites, that are usually found in the midst of the most striking evidence of decided igneous action. The inference

which I draw from these facts is, that through granite and other hypogene (nether bon) rocks do not actually reach the surface in Johnson county, as far as at present known, they must be near enough the surface to have exerted an igneous action, sufficient to have permeated the strata now found on Spadra creek, with heated vapors or gasses, that have expelled the greater portion of the gaseous matter; or else this coal has been subject to some extraordinary chemical agency, by which carbonetted hydrogen has been removed.

Most of the coal which has been found in Johnson county, lies beneath the shales of that section, reaching often within a few feet of the surface. Some of the most important outcrops I shall here enumerate.

The Hardwick bank on the Arkansas river is a semi-bituminous coal, and its strata is four feet thick. It resembles the Spadra coal.

North-west of Clarksville, fifteen miles on the road leading to Ozark, commonly called the wire road, there is a strata of semi-anthracite coal three feet thick. It is used in the blacksmith shops in Clarksville, and is said to be very good.

The Morris coal bank is thirteen miles west of Clarksville, on the Little Rock and Fort Smith road, one mile south of the Little Rock and Fort Smith Railroad.

The Wilmot coal bank, one mile north of Little Rock and Fort Smith road, and within fourteen miles of Clarksville, and within four hundred yards of the railroad survey. This coal is semi-bituminous, rich in fixed carbon and coke, hard, and retains its original shape.

The Fleming bank is eight miles north-west of town and near the railroad survey; also Dr. Naylor's coal bank, eight miles north-west of town, and not far from the railroad survey.

The most noted coal bank is near the mouth of Spadra creek. It is a semi-bituminous coal remarkably rich in fixed carbon, and belongs to A. G. Meyers, Esq., who has erected various kinds of machinery to convey the coal to the boats, and the water from the mine. This strata of coal is three feet thick, and dips north from seven to ten degrees, strike line east and

west. It has been mined for the distance of eight hundred yards, and found to be continuous. Boatloads of this coal have been floated down Arkansas river to Little Rock, and sold at forty cents per bushel. I also learn that there are two boatloads of coal at the mouth of Spadra creek, that will be sent down the river whenever there is a sufficient quantity of water.

From the insight obtained into the chemical composition of this coal, by an approximate chemical analysis, I am led to believe that the valuable properties of this coal have been overlooked. It is superior, for manufacturing purposes, to any western coal at present known, where durability, intense heat, and reduction are required. It crops out close to the Arkansas river, above the mouth of Spadra creek, and extends back into the interior of Johnson county. This valuable article of commerce that warms our houses, that drives our steam engines, by which we navigate our rivers, lakes, and oceans; that propels the machinery by which we weave our fabrics, that reduces our iron, by which we cultivate our soil and carry on every conceivable mechanical operation, in various parts of the United States.

But few counties are so well watered as Johnson. A glance at the map will show how admirably every portion of it is intersected by rivers, creeks and branches. The Horsehead, Piney, Spadra, and Arkansas river, all abound in fish, particularly the Arkansas river. This part of the State is filling up very rapidly with an enterprising population; new dwellings meet our view in various places; while on one hand the forests are disappearing before the ax of the pioneer, on the other the prairie is yielding to the plow.

Wealth and all its attendant comforts and luxuries are also rapidly increasing, as is shown by the assessor's books of the county.

Still, with all these sources of wealth and permanent prosperity, and actual progress, the enterprise of this beautiful county is greatly paralyzed by the want of a good market.

The farmer finds no sale for his surplus produce, and the miner is compelled to sell his mineral at half price.

Complete the Little Rock and Fort Smith railroad, and the value of the farm and the mine, the timber and the water-power, will be greatly increased.

Clarksville, the county seat of Johnson county, is located in a fertile valley near Spadra creek, and four miles from Arkansas river. It controls the trade of that section, and is improving very fast. It contains one thousand inhabitants, nine stores, two churches, one steam grist mill and planing machine, one academy, and a masonic hall, also a king post bridge across Spadra creek, one hundred and fifty feet long.