THE MAKING OF SOUTHERN ILLINOIS.

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Sometime in the course of the ascent of man from his prehuman ancestors, the mental characteristic which we commonly call curiosity made its first appearance. With the entrance of curiosity into the makeup of animals the beginning of real intelligence made its appearance. This intelligence certainly originated among creatures of a lower order of development than man himself. Doubtless it is because of the keener sense of curiosity which appeared in the man animal that the human race has so outdistanced all competitors. When men began to wonder about the reasons for things and began to seek out the causes for the great variety of natural phenomena which surrounded him, he began the ascent of the intellectual ladder whose many steps he has already climbed, but from the top of which he is still much farther removed than from the bottom. In the early stages of this intellectual growth he had no perception of natural law, and of necessity he had to explain the phenomena of nature through supernatural agencies, and thus grew up the creation myths as well as other myths and stories to explain the movements of sun and moon and stars, and to account for all of the unexplainable phenomena about him. Many, many generations passed before man's intelligence began to give him some conception of the workings of the laws of nature. From time to time some great genius undoubtedly arose whose sense of curiosity was more intense than that of his fellows and who was capable of searching more deeply into the reasons for things and who was really able to make some addition to the exact knowledge of the human race. Comparatively few generations of men have passed since Newton formulated the law of gravitation, perhaps the most far reaching of all natural laws. Copernicus who founded all modern astronomy by his discovery that the earth was not stationary but revolved about the sun, was born less than 500 years ago. Even today the vast majority of human beings, and among them great numbers of our own people, have but little conception of the mean-

ing of science, and still hold to all sorts of supernatural explanations of phenomena which they observe every day.

Reduced to its last analysis Science is the search for the reasons for things. Every man of science knows that every phenomenon in nature has a cause, a reason, and just as truly every phenomenon has an effect. The search for the casual relations of all these phenomena is his task. If he is unable to discover a reason for the facts which he observes, he does not appeal to some supernatural explanation, he knows that his researches have not yet penetrated deeply enough into his problem. The men of science of our generation are those in whom the sense of curiosity concerning nature is most keenly developed. They are continually asking themselves the question "Why?" and are never satisfied until some reasonable and logical explanation is found for their questioning. Every child starts his career as an active researcher. He observes all sorts of strange and curious phenomena about him which arouse his curiosity, and he repeatedly asks the question "Why?". All too often his questioning soon surpasses the ability of his parents and teachers to make answer and he is told not to ask such foolish questions. Doubtless many an able man of science has been lost through the stifleing of childish questioning. Fortunately a few remain in whom this curiosity cannot be stifled, else the progress of our race would come to a standstill.

Among the phenomena which early attracted the attention of men were the features of the landscape which surrounded him, the hills and valleys, the mountains and the sea. Because of their apparent stability, explanations for these phenomena were not sought for as early as were the phenomena of the apparently moving heavenly bodies. If any thought at all was given to the subject, it was assumed that the hills and valleys and mountains and seas had always been there and would always remain. This conception is still with us, and not infrequently we see references made to the everlasting hills, although every geologist knows that neither the hills nor the highest mountains are everlasting. Another

group of objects which came to the attention of many early observers were the specimens of fossil shells observed in all sorts of situations. During the middle ages these objects aroused much discussion and numerous explanations were offered for them. Some thought them to be sports of nature, some believed them to be discards thrown aside by the creator of all things, but the final explanation which seemed to satisfy most men was that they were the remains of sea animals which were swept from the sea and were lodged upon the land through the agency of the Noachian Deluge. Of course the geologist today knows that these objects are the remains of once living animals and plants, many of them marine, that have once lived and flourished in the places where they are now found, at times when the ocean waters covered areas now dry land, but which were formerly parts of the sea bottom.

It was only a little more than a hundred years ago that students of geology began to realize that the present configuration of the earth's surface has been established through the agency of slowly acting processes which are in operation today, and which have been continually in operation for long periods of time, rather than through abrupt, cataclysmal revolutions which occurred at comparatively short intervals. We have come to realize that geological time is long, exceedingly long when measured by the scale of human existance, the duration of geological time being comparable, in a degree, to the vast extensions of space recognized by the astronomer. Furthermore, as we come to know more and more of the earth's history we have become convinced of the greater and greater duration of geologic time. In the history of the earth a million of years is as but yesterday, and forces and processes which seem to be but little effective when seen from day to day, are capable of tremendous effects when they are continued over long enough periods of time. The transfer of material from the hill tops to the valleys is of common observation to all of us who have been upon any of our hill roads during a Summer shower, and if time is long enough and enough showers fall upon the hill, the time will come when the hill

will be leveled to the plains. In the geologic past this very thing has happened repeatedly. Mountains as high as the highest upon the earth today have been worn down to the level of the sea. Other mountains have been raised up and these again have been leveled to the sea.

The geologist interprets the history of the earth's past, recorded in the rock strata of its crust, through an understanding of the processes which are active today. It goes without saying that in erecting a pile of lumber, the boards in the bottom of the pile were laid first. Likewise in the succession of rock strata in the earth's crust the lowermost beds in any given region are, axiomatically, the ones which were laid down first, and consequently are the oldest. If the solid rock formations were everywhere uncovered, and if they had never been disturbed, it would be a comparatively simple matter to trace the beds from place to place and so establish their true relationship. Such, however, is not the situation in most regions. The hard rocks are to a great extent covered with an unconsolidated residuum and soil. In parts of Illinois whole counties are without a single hard rock outcrop within their boundaries, and in many others the outcrops are so few and far separated that no tracing of the beds is at all possible. In other places the rock strata have been so broken into blocks which have been shifted to such an extent up and down and horizontally in relation to each other, through the agency of great deformative processes, that the several beds are discontinuous at frequent intervals. Under these conditions it has been necessary for the geologist to establish some means of tracing given rock beds from place to place, and long study has shown that the only reliable criterion for this purpose is found in the fossil organisms which are present in the rocks.

These organisms are really the record of the evolution of the life of our globe, the scattered remains of succeeding generations which exhibit the gradual changes through which living creatures have been passing. The life of no period of geologic time is the same as that of the preceeding or of the succeeding period, and conse-

quently a knowledge of the succession of living things upon the earth affords us a most reliable criterion for the determination of the relative ages of the rock strata which come under our observation. It must be recognized that knowledge of these long extinct living inhabitants of the earth is as yet but fragmentary, but every year adds to our information, and we can already make application of the accumulated facts in our interpretation of geological history in such a manner as to be of great service. With added information greater and greater refinements in our interpretations will become possible.

If the earth's crust had undergone no deformative changes during its long period of existence, all sediments which have accumulated under marine waters, and in which were buried the remains of marine organisms, would still be submarine in position and would be inaccessible for study. It is known, however, that crustal movements have taken place even in historical time. Certain portions of our shore lines are known to be rising relative to the ocean level, and other portions are sinking. Not infrequently violent earthquakes occur, in the course of which notable crustal changes take place. Rocks which are manifestly of marine origin because of the inclusion of the fossil shells of marine animals are now present in situations thousands of feet above sea level, and they must have been elevated to their present position or the sea level must have receeded. Both of these things doubtless have occurred. Rocks which must have been formed originally as nearly flat lying sediments deposited in water, are now steeply inclined in many places and are even folded and are crushed and broken, all of which shows the existence of tremendous forces which have been at work in the earth growing processes. By reason of such deformations rocks once beneath the sea have been raised far above sea level, and immediately the erosion processes of water falling as rain and always seeking a lower level, have started, and if continued long enough the elevated areas gradually have been worn down to sea level, just as the hills between Harrisburg

and the Ohio river are gradually being worn down by every rain.

Because of the almost universal deformation of the rocks of the earth's crust, and because of the varying degrees of erosion which have been accomplished, sedimentary rocks of all ages from the Proterozoic to the present, are exposed somewhere at the present earth's surface. In future geologic periods rocks which are now in existence at the surface will have been worn away and their materials will have been carried down the streams to the ocean, to be redeposited to form younger rocks such as are now accumulating in the delta of the Mississippi river.

Our present knowledge of the earth has progressed far enough to make it possible for geologists to recognize a number of distinct divisions of geologic time. Of course time is continuous and uninterrupted, and it is only by means of events which occur that we can divide time which has past into distinct periods. In our subdivision of time in human history we are likewise wholly dependant upon the occurrence of events. During the fifteenth century of the human era sea faring men began to grow more daring because of the discovery of the magnetic compass which made it possible for them to keep their direction when out of sight of land and when the stars of the heavens were hidden by clouds. As they became more daring and more confident one man at last sailed away to the west from Europe's shores and discovered a new continent which was wholly unknown to the European races. This event initiated a new period in human history of the utmost importance. The events which led to the declaration of war in Europe in 1914 initiated a period of human history which has changed and is changing the destiny of most of the nations of the world. Some well recognized periods in human history have been ushered in gradually, like the transition of our season of Spring into Summer, while others have been started abruptly and unexpectedly like the beginning of the great World War. Geological historical periods are not unlike those in human history. They are marked off by events such as the growth of great

mountain ranges, or the appearance of a new type of life. In some cases the transition from one period to another is abrupt, and is accomplished in an exceedingly short time, geogically speaking, at other times the transitions have been slow and it is difficult to set a precise boundary between successive periods, although the periods themselves are clearly distinct.

It has come to be the custom of geologists to base the larger eras in Earth history upon the character of the life existant at the time. Azoic time was an era during which no life existed. Eozoic was the era of the dawn of life with the introduction of unicellular organisms. Archaeozoic was the age of larval life, and Proterozoic the age of primitive invertebrates. All of Earth history to the close of Proterozoic time is so ancient that our information is most hazy, and for the Azoic and Eozoic times there are perhaps no rock records known. Following the Proterozoic we come to eras concerning which our information is much more complete, although still lacking immensely. The Paleozoic era is the time of ancient life, but still presenting life forms which are more or less remotely related to our contemporaneous life. The Mesozoic era is the time of medieval life having far more in common with the living creatures of the Earth today, although almost wholly different. The Cenozoic era is the time of modern life during which the inhabitants of the earth have been much like those which now exist. The last or Psychozoic era is the age of man.

Each one of these great eras is again divided into lesser periods which commonly have been named geographically from some district where rocks representing the period are well exhibited. One great period of the Paleozoic which holds the middle portion of the era has been named the Devonian because it was first studied, and its fossil life first described, from Devonshire, England. Following the Devonian is a great period known as the Mississippian, so named because the rocks comprising it are so fully and widely represented in the Mississippi Valley region of this country. Succeeding the Mississippian is the period during which the great coal formations of eastern North America were laid down,

which has been named Pennsylvanian because the rocks are so widely developed in the state of that name.

By reason of the action of the processes which have been described all too briefly, the hard rocks which are now exposed at this stage of the earth's history in southern Illinois, belong to the three periods of earth's history just mentioned, the Devonian, the Mississippian and the Pennsylvanian, which are the three closing periods of Paleozoic time. The Devonian rocks are now exposed only in a limited area in Hardin County, in what is known to the geologists as the Hicks dome. This is a structure which is comparable to a great bubble blown in the earth's crust, doming up the rocks towards the surface. Associated with this process of uplift, the action of the process of erosion in cutting away the overlying and higher strata, has permitted these older beds to become exposed at the surface. It must not be inferred that this suggested bubble is filled, and that the Hicks dome is supported by any gaseous material such as air, although it is not improbable that it was originally formed and that it is now supported by a mass of material which was injected into the crust beneath the present dome in the form of moulten rock or lava which is now completely cooled and solidified.

The southern slope of the range of hills to the south of Harrisburg is underlain by rocks of Mississippian age, while the higher parts of the hills are made up of rock strata of Pennsylvanian age. These Pennsylvanian rocks continue northward, dipping to a lower and lower position, until at Harrisburg the same strata which are exposed at the tops of the hills are here far beneath the surface. The coal beds which are so extensively mined in southern Illinois belong stratugraphically far above the sandstone ledges which form the tops of the hills. At one time, long before the birth of the Ohio river, the coal beds undoubtedly continued over the hills and across the Ohio river and joined up with the existing coal fields of western Kentucky. All of these strata have been removed by the slow processes of erosion, and not less than three thousand feet of hard rock strata have been worn away in this manner from the

southern border of Hardin County and from the adjacent portion of Kentucky.

The Devonian rocks exposed in Hicks dome continue in all directions from this limited area of outcrop, but they are covered and completely hidden by the younger strata. Occasionally a deep drill hole is sunk in the search for oil or for some other purpose, and these deeply buried strata are penetrated, and from such evidence much information has been derived by means of which the geologist has been able to draw conclusions concerning events in earth history. We know that these Devonian rocks are continuous beneath the surface from their area of exposure in Hardin County, across southern Illinois to Union County where they are again exposed at the surface, and in southeastern Missouri. In the eastern direction they are completely hidden beneath younger strata to southern Indiana and the adjacent part of Kentucky near Louisville. These oldest Devonian rocks are limestones in which are buried numerous fossil shells of marine animals, and we can assert with confidence that during this time this portion of southern Illinois formed a part of the bottom of a great, shallow sea, which extended as far to the northeast as New York State, as far to the north as Canada, and as far to the east as the Allegheny Mountains. This sea had great islands, one extending to the north from where the city of Cincinnati, Ohio, now stands, and another in central Tennessee about where the city of Nashville now exists. A study of the life of this great sea, preserved to us as fossils in the rocks which accumulated as sediments upon its bottom shows us that it did not extend west of the Mississippi river except in southern Missouri. To the south this great interior sea must have had connection with the open ocean.

The situation which has just been described existed in the middle portion of the Devonian period, and at the end of Middle Devonian time it is known that great crustal disturbances took place in southeastern Missouri. Great faults were formed there having a maximum dislocation of the beds as great as 1000 feet. There is no evidence to show that any similar deformative disturb-

ance took place in southeastern Illinois, but the great earthquake tremors which these Missouri disturbances must have created, certainly affected this portion of Illinois. In southeastern Missouri these disturbances left the ancient sea bottom well above sea level, and it is not improbable that southern Illinois also for a time was dry land, although it was certainly again submerged in late Devonian time, when it became a part of a widespread interior sea extending from the Appalachian Mountains on the east to Oklahoma on the west, and as far north as lake Erie at least. It likewise extended as far to the southeast as Chattanooga, Tennessee, but its southern extent is hidden beneath much younger sediments. From the character of the deposits which were accumulated in this late Devonian sea, we know that the waters must have been in a more or less stagnant condition. The sediments were fine muds with a large admixture of organic matter which has given to the consequent shales an intensely black color. Quantities of the minute spore cases of an ancient type of plant were buried in these muds and are now preserved in the fossil condition. Animal fossils are scarce, and those that are present show that the sea was not a typical body of marine water, and that it had only indirect communication with the ocean waters surrounding the continent.

This great interior sea with its more or less stagnant waters must have existed for a long time, humanly speaking, for no less than 400 feet of the characteristic black shales were accumulated in its bed at least locally. This period, however, was brief as geologic time is reckoned, and at its close the whole of southern Illinois was elevated above sea level for a considerable time, during which the surface was subjected to the tearing down process of erosion, which is always initiated as soon as any surface becomes emergent, the vigor of the erosional process being proportional to the amount of topographic relief above the sea.

When at last the region again became submerged beneath the sea because of local crustal deformation or because of a rise in the sea level on account of changes elsewhere, the conditions were vastly different from those

during which the great accumulation of Devonian black shale had taken place. At the time of this submergence, earth history had passed from the Devonian into the Mississippian period, and the early Mississippian sediments accumulated here were in the main limestones whose fossil contents consists of typical marine organisms. For a long period of time this early Mississippian sea continued to cover what is now southern Illinois. The earliest records of the existance of this sea in the region under consideration are in the exposures of limestone formations encircling the Hicks dome already mentioned, although in most of the region these rocks are more or less deeply buried beneath the younger sediments. A little later record of this same submergence, with its limestone depositing waters, is exhibited in the great limestone bluffs of the Ohio river which are more or less continuously exposed from Rosiclare to Cave-in-Rock, in Hardin County, and these limestones are likewise present in that portion of the same county that is now so thickly set with sink holes.

Several distinct limestone formations exist in the rock record of this period of our geological history, these formations being distinguished by the character of the rock strata themselves and in the differences in the assemblages of fossil animals whose remains are buried in the rocks. The changes which are mirrored in the several distinct formations, were occasioned through changes in the outlines of the sea, in the depths of the water, in the purity of the waters and their freedom from sand and silt. The more pure limestones are constituted largely of calcium carbonate which was first separated from solution in the sea waters through the agency of shell forming animals. In some cases such shells were buried with little or no injury in the lime muds of the sea bottom, others of them were broken up into fragments, even into fine powder, by the movement of the waters, to help form the lime muds. Doubtless many bacteria were present in many localities whose life processes caused large amounts of the lime to be separated from the sea waters to be accumulated in limestone forming sediments.

The sea which covered southern Illinois during this time was a widespread body of water over the interior of the continent. It spread northward in the present Mississippi valley at least as far as Iowa and northern Illinois, and doubtless at times it continued into southern Wisconsin. At the time of its greatest extent it spread as far to the northwest as Montana, and as far to the southwest as New Mexico. To the southeast it stretched as far as Alabama and Georgia, but it was limited on the east by a great land mass which occupied a position east of the present Appalachian Mountains, known as Appalachia. It doubtless had free communication with the open ocean by some southern route. During a portion of the time the Ozark region of Missouri constituted a great island, Ozarkia, from whose surface the processes of erosion were carrying rock forming materials to the sea to form shales, sandstones and impure limestones. At other times this island was entirely submerged when it was no longer a source of land derived sediments and consequently more pure limestones were accumulated. Another great low-lying island, Cincinnatia, extended northward from the Ohio river in the vicinity of Cincinnati, Ohio, to the east of which was an arm of the sea extending into Michigan, in which little limestone was formed because of the great Appalachian lands lying to the east, which was a continuous source of supply of non-calcareous rock forming materials. The shore lines of this great interior sea were shifting continuously by reason of the crustal movements of the earth, but there is no evidence that southern Illinois was raised above sea level before the close of the period. This great succession of limestone sediments formed during the first half of Mississippian time is known as the Iowa Series because of its great development and its first description in that state.

This Iowan sea was teeming with life in great variety of form, but instead of the clams and snails which make up so great a part of the faunas of our present oceanic waters, there were great numbers of brachiopods and crinoids, types of life which are only rarely met with in the seas today. Besides these there were a few trilo-

bites, a life form which is now wholly extinct, some snails and clams, and some corals. All these forms which have been mentioned are creatures which secreted hard, stony shells of some sort that were capable of fossilization. There were great numbers of fishes also, all of them related to the sharks, some of which must have grown to a large size, whose sole records are their fossilized teeth and fin spines. Besides all of these forms doubtless there were great numbers of entirely soft bodied animals, as there are in the seas today, wholly incapable of leaving a record of their existence, as well as numbers of sea weeds of various sorts.

Following the long period of limestone formation in southern Illinois during Iowa time, the entire area was raised above sea level, indeed it is not unlikely that the whole of the interior of the continent became a dry land surface. The processes of erosion at once became active, but because of the low relief of the land in the region under consideration, erosion did not progress rapidly, and no great thickness of the accumulated limestone was removed. This emergent condition of the region continued for a considerable period of time although it was not long enough to permit all of the forms of animal life which had inhabited the Iowa sea to become extinct before a new submergence took place. With the next period of submergence in southern Illinois, the conditions for the accumulation of sediments were greatly different from those during the making of the Iowa Series of limestones. The rock forming materials were no longer almost pure lime, but included also great quantities of sand and fine mud, which were built into the great succession of formations which are known as the Chester Series. At the present time these Chester formations constitute the surface rocks upon much of the southern slope of the range of hills south of Harrisburg, and in places they continue clear to the Ohio river bluffs and across the river into Kentucky. The basin in which this series of rocks were accumulated was much different from the widely spread interior sea where the limestones of the Iowa series were formed. So far as southern Illinois was concerned it was simply a great embayment

reaching northward between Cincinnatia on the east and Ozarkia on the west, the head of this bay being somewhere near the mid-length of the state of Illinois. Great rivers emptied into this embayment, doubtless having their source far to the north in what we know as Canada. These rivers carried much sand and fine mud which was dumped into the Chester embayment, and by the washing of the waves along the shores the materials were assorted and deposited in different places, the sands, representing the coarser materials settling near the shore, while the finer materials in the form of mud were held in suspension much longer and were carried out and finally settled in the deeper waters at a distance from the shores, to form the shale beds which are such a conspicuous feature of the Chester series. In places, in these deeper waters, conditions were favorable for the existance of a wonderful variety of living animals, and their calcareous remains were buried in the calcareous shale beds where they have been changed into fossils which may now be gathered in great abundance locally. There were places also in this Chester sea where the conditions were favorable for the accumulation of pure limestones, and these formations are now present in many of the exposures of the Chester rocks.

If the shore line of the Chester embayment had remained stationary throughout Chester time, there would have been formed one great sandstone formation near shore, which would have become finer and finer in an off shore direction, finally merging into shale beds formed from the fine muds which were held in suspension longer, and these shales in turn would merge into limestone still farther off shore. Such conditions, however, did not prevail. The shores of this embayment were constantly shifting, and areas which at one time were submerged became dry land at other times. In the main the changes which took place during this period consisted of a succession of withdrawals of the waters of the Chester embayment, either because of the rising of the region or because of the lowering of the general sea level, followed by readvances when the waters again occupied the territory which had previously been aban-

doned. At a number of intervals during the Chester epoch, the whole of southern Illinois must have been exposed above sea level, with the shore line somewhere to the south, doubtless across what is now Kentucky. Perhaps it was even farther removed than this. Because of these shiftings of the shore line, that portion of southern Illinois where the Chester rocks now form the surface, was successively within the zone of sand accumulation, and of shale and limestone formation, so that now the Chester rocks which have been built into the earth's crust consist of an alternating series of rocks of these different characters. The evidence afforded by the Chester section of this portion of the state shows us that there were no less than eight shiftings back and forth of the shore line. Some of the withdrawals were more extensive than others. Finally the Chester seas withdrew completely, not to return, and with this withdrawal the whole of the southern portion of the North American continent doubtless became dry land.

For a long time after the final withdrawal of the Chester sea from southern Illinois, this portion of the continent remained as dry land. It undoubtedly supported a rich vegetation which was far different from that which now covers the region. Instead of the usual types of forest trees and herbaceous and shrubby plants with which we are familiar, a large number of the trees and other plants were ferns or fern like in their habit, others were relatives of the little club mosses of the more northern portion of our country which now grow only a few inches in height, and do not occur at all in southern Illinois. Others were great tree like relatives of our little horse tails which now grow as slender plants only a foot or two high at the most, and still others were cone bearing trees with long and broad grass-like leaves. Nowhere in all of these forests was there a single representative of the plants bearing showy and sweet scented flowers which make our present landscapes so beautiful. The air breathing animals of these forests were also strange forms when compared with those we now encounter here. Doubtless there were numerous forms related to our living salamanders, lizard-like forms whose

early life stages were spent in the waters of ponds and swamps, just as the aquatic tadpole today is the early stage of the toad or frog. Perhaps there were a few reptiles, lizard-like creatures whose whole life was spent on land as air breathers. There may have been some land snails, and other fresh water molluscs both snails and clams. Flying about in these forests were numerous insects, mostly of the cock-roach and dragon-fly types, some of which were large compared with the ones we are acquainted with. One Carboniferous dragon-fly with wingspread of thirty inches is known, but not in Illinois, and some of the cock-roaches of the period are known to have been more than a foot in length.

This dry land period was the beginning of what we call Pennsylvanian time, and while the conditions which have been mentioned prevailed here, great accumulations of terrestrial deposits consisting of coarse sands and conglomerates and some coal beds were accumulating to the east along the border of old Appalachia, all the way from Pennsylvania to Georgia. Likewise to the southwest, in Oklahoma and beyond, great accumulations of aquatic sediments, part of which at least were marine in origin were in the course of accumulation.

How long this terrestrial condition continued in Illinois cannot be measured in years, but it was an immensely long time humanly speaking, and even from the standpoint of the geologist it was a notable interval. During this time the land surface was undergoing erosion and down-wearing, but the region was not highly elevated above sea level so that this erosion was not as vigorous as in more mountainous regions. Great river systems were doubtless developed, however, and some hundreds of feet of older sediments were removed, and in places perhaps much more.

Finally, probably with the accompanyment of sinking of the land surface, a great wash of terrestrial sediments, similar to those which had been accumulating for a long time farther east, overspread this region. They consisted of coarse sands and conglomerate beds which filled up the depressions of the uneven surface contour, with at times finer sands and sandy shales. Locally the

conditions were favorable for the accumulation of quantities of vegetable material in certain swamps, which first formed peat and later became consolidated into coal. These sediments constitute the record of the late Pottsville epoch of the early Pennsylvanian time, and they now form the crest of the so-called Ozark ridge extending east and west across the state south of Harrisburg. These same beds at Harrisburg are far beneath the surface, because of their northward dip brought about by later deformation in the region, but when they were originally laid down they must have been essentially horizontal.

After a time this region, extending to the position of the present Ohio river, and far to the south beyond this line, as well as extending northward well up into northern Illinois, and out across Iowa, Missouri and Arkansas to Kansas and Oklahoma, became stabalized at a level not far from that of the ocean surface. Upon this low, flat expanse, the drainage became more or less stagnant and great swamps came into existence, at times of great extent, in which the abundant remains of vegetation slowly collected. The conditions were such that this vegetable matter did not readily decay, and it accumulated first as great beds of peat. At times conditions about this great basin changed, perhaps by reason of a slight elevation of lands to the north, so that quantities of fine sands and muds were washed down, which buried the great peat beds under strata of sandstone and shale. At other times a slight depression of the area, or perhaps the elevation of the sea level for some reason, caused marine waters to overspread the basin in which thin limestone beds, some nearly pure and others more or less impure, including characteristic marine shells, were formed. At other times some of the muds were lain down under marine conditions, a fact that we know because of the presence of marine shells. Such conditions were followed by a recurrence of swamps in which more peat beds were formed. By a succession of changes of the sort mentioned above there was built up the great series of sandstones, shales, coals, and limestones which constitute the present section of the Illinois coal basin.

The great weight and consequent pressure of the superimposed strata upon the peat beds of the series, caused these layers gradually to be transformed into the coal beds which make the region about Harrisburg, and elsewhere in southern Illinois, so rich in this important mineral substance.

At the time when all this accumulation of materials was in progress, the several strata were laid down in an approximately horizontal position. The coal beds continued southward from the present Harrisburg region, across the area now occupied by the more southern counties of the state, and connected with the coal fields of western Kentucky. The existence at the present time, in this interval between the Illinois and Kentucky coal basins, of rock formations much older than the coal bearing strata, at elevations much higher than the present position of the Illinois coals, shows that some deformation of the earth's crust has taken place. It is a problem for the geologist to explain this condition, to find the reason why this portion of the earth's crust has been thus deformed, and if possible the time when it was accomplished. A significant fact concerning this uplifted area is its position directly east from the Ozark region of Missouri, which for some reason was uplifted repeatedly during the whole of Paleozoic and even later geologic time. It is not unlikely that this elevation in Illinois was due in part at least, to its proximity to and its connection with the Missouri Ozarkia, so that it is not at all improper to speak of this highland portion of the state as a continuation of the Ozarks. The popular recognition of such a connection is evidenced in the application of the name Ozark to a small town in this portion of Illinois.

The present elevation of the Illinois Ozarks is by no means equal to their original height. Some hundreds of feet, perhaps more than a thousand feet have been removed by erosion from the tops of these hills, and at one time they must have been much more formidable as a mountain range than they are now, although they never could have been really high mountains. The reason for the present elevation is not the fact that the area was

bowed up in some far distant time in the past, but because the older rocks which have been uncovered by erosion are harder and far more resistent to these processes than are the strata to the north. If it had happened that in the building of this portion of the earth's crust that the older rocks were soft and easily worn away, and the younger ones much harder, there would have been a depression or valley marking the belt of uplift at the present time, instead of a range of rugged hills.

In the more eastern portion of this elevated belt across Illinois, another factor than proximity to the Missouri Ozarks has entered into the reason for the elevation. As has been indicated already, limestones as old as the Middle Devonian are exposed in the Hicks dome in Hardin County. If all the rocks which have been eroded could be replaced over this dome, those strata which now form the highest portion of the Ozark ridge would occupy a far higher position over the dome. With this elevation as well as the added height of the still younger strata which have now been removed from the entire ridge, this Hicks Mountain must have been a towering peak standing well above its surroundings.

Another significant fact associated with this eastern portion of the Illinois Ozarks, is the existence of numerous dikes of igneous or volcanic rocks, and also of extensive faulting, or cracking with dislocation, of the strata. These dikes could only have been introduced when the material forming them was in an exceedingly hot, moulten, and plastic condition. These dikes, some of which are known in coal mines near Harrisburg, are known to be present at many localities between here and Princeton, Kentucky. They are all similar in character and must be connected at some unknown depth with a great mass of volcanic rock which underlies the whole region where the dikes are known. The depth of this igneous rock mass may never be known unless some excessively deep drilling should be undertaken in the region at some future time.

The intrusion of the igneous material deep in the crust of southeastern Illinois, was probably associated with the Appalachian Mountain disturbances towards

the eastern border of the continent. Its injection into this area was like the blowing of a huge bubble deep in the earth's crust and causing the elevation of the Hicks dome. All of the beds about it were domed up, and in the consequent stretching of the inelastic crust, innumerable cracks were formed. The wedge-shaped crustal blocks thus formed, slipped and slid upon each other, and in becoming adjusted they took up the slack produced by the stretching. The readjustments along these fractures form the complicated system of faults which exists over a large area in southeastern Illinois and western Kentucky. Along some of the faults the dislocation has been as great as 2,000 feet, elsewhere it is only a few feet, with every gradation between these two extremes.

The phenomena of igneous intrusion and faulting which have just been described, are believed to be responsible for the accumulation of the famed fluorspar deposits of southeastern Illinois and western Kentucky. Igneous rocks are known to be a source of fluorine, and nearly all of the important ore bodies of the district are present in veins located along fault lines. In a few cases the fluorspar is not associated directly with a fault, but such deposits are in close proximity to some fault with which they doubtless have had some genetic relation.

The determination of the time when all of the deformation which has been discussed and all of the accompanying phenomena took place, is a problem for the geologist to solve. We know certainly that it all occurred after the Pennsylvanian rocks had been formed, for these strata are involved in all of the deformations. The limits of time in the other direction are not so easy to establish because of the absence of any rock strata in the region representing a long period of time after the Pennsylvanian. In the extreme southern portion of Illinois there are Cretaceous strata, late Mesozoic in age, and so far as we know these beds are not deformed, while the deformed older rocks pass beneath them. With these data, which are all that we have at the present time, we can only say that the disturbances took place

after the last of the Pennsylvanian rocks of the region were formed, and before the deposition of the Cretaceous rocks, but this is a time interval representing many millions of years. The fault movements were probably distributed over a long period of time, for no geologist believes that such deformations were instantaneous in their occurrence. It is altogether probable that slight movements are still taking place along some of the fault lines. Scarcely a year passes without the record of one or more slight earthquake shocks in this portion of the Ohio Valley, which are more than likely the result of residual movements along some of these lines of deformation. A little more than one hundred years ago a severe earthquake occurred throughout the region, which may well have been caused by an adjustment of greater magnitude than usual along one of these fracture lines. It may be asserted with great certainty that during the active period of all this deformation, frequent earthquakes of great severity shook this portion of Illinois.

It is not at all unlikely that a preliminary uplift of the whole Illinois Ozark region, associated with adjustments in the Missouri Ozarkia, and not accompanied by any notable faulting, was accomplished a long time before the igneous intrusion and associated complex faulting in the more eastern portion of the region. All of the facts are not yet known, but every season of observation adds something to our understanding of the region.

Since the completion of the east-west Ozark uplift across the southern portion of Illinois, there is no evidence that the sea has ever entered that portion of Illinois north of the uplift. For an inconceivably long period of time it remained a portion of a widely extended land area. Throughout the whole of Mesozoic time doubtless it was the home for the successive generations of the faunas of gigantic reptiles which are known to have inhabited North America during this time, and these creatures doubtless were followed by the great mammalian hords that characterized all Cenozoic time. Through these millions of years the vegetation of the region also underwent profound changes, but none

of this record is preserved to us here. We have little knowledge of the topographic features of the region during this time, whether it was a plains country or hilly, or what were its drainage lines, although it is more than likely that it was a country of greater relief than the present Illinois prairies.

With the coming of Pleistocene time and the great ice age, the glaciers came down from the north and destroyed or drove out all of the animal and vegetable life, and the material accumulations from the glaciers filled up the depressions in the surface and evened it off, leaving it approximately as we know it today.

South of the Ozark highlands an arm of the sea did reach into the southern tip of Illinois from the Gulf of Mexico, in Cretaceous time, although the absence of any typical marine fossil shells in these beds may mean that typical marine conditions never invaded this state. There are also widely distributed deposits in the south, probably Tertiary in age, which reach up into southern Illinois, but it is not likely that they are marine, and they were formed when the topographic conditions were far different from those today, long before the Ohio river and its tributaries were features of the landscape.

In the preceding remarks I have attempted to outline in as brief a manner as possible, what we know concerning the manner in which southern Illinois has come to be as we know it. Much detail necessarily has been omitted, and much remains to be learned, but not a year passes without the acquisition of some new information which helps to complete the story. We look backward upon the many millions of years during which all of these events have come about. When we realize that the entrance of man into the history is the very latest event of all, we can only be amazed and overwhelmed by a glance into the future. There is every reason to predict that the continuation of this history into the future may be as long as the time which has past. Man is a mere infant, he has taken only the first step in his career, but he has learned to control his environment as no other animal has ever done. A geologist can only be an optimist. He is brought continually face to face

with the law of progress, with the evolution of all things, and he cannot help but feel the destiny of man to be such that in the distant future our descendants will look back upon us in much the same manner in which we look back upon the men of the old stone age.