THE GEOLOGICAL HISTORY OF THE MACOMB REGION

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There was a man sent from God whose name was Louis Agassiz. The same came to bear witness to the divine things in Nature; to open the eyes of men to her beauties rare which knowledge makes more charming, and their ears to voices sweet which speak of a long distant past; to quicken in the mind a deeper reverence for the revelations and the lessons which "half-revealed and half-concealed" are written over all the earth on which we live.

"All is holy ground,
And every flowering bush is aflame with God."

On the fiftieth birthday of this great teacher the poet Longfellow wrote some verses in which Nature is represented as taking the child Agassiz upon her knee, and saying:

"The earth is a story book
Thy father hath written for thee.

Come wander with me, she said,
Over hills so often trod;
And read with me what can be read
From the manuscripts of God."

It is a fragment of the story from these manuscripts of which I shall speak at this time; a story as beautiful as it is strange and wonderful, and as wonderful as it is true; facts which Nature is ever willing to tell to him who lends an attentive ear.

Our story will deal with little more than the latter third of the earth's history, the records of the earlier chapters being exposed in other parts of the continent. We will begin with the oldest rocks that have been penetrated in the deep wells in this area. These belong to the Ordovician period, and were laid down as sediments in a sea that covered this region something like 500 million years ago. At that time, over the place where Macomb now stands, was a great central sea which advanced from the

south and southwest across Illinois, and extended north as far as the highlands of central Wisconsin. The clear waters of such shallow seas were veritable gardens of marine life, in which there flourished a great number and variety of animals that were fixed to the sea bottom, and so secreted calcareous skeletons or shells as a protection from their predaceous enemies. As each generation of such animals lived and died, their more or less broken shells accumulated on the ocean bottom, and formed the floor on which their successors became established. These, in turn, at death gave up their shells to swell the deposit on the ocean bed. In this manner, throughout slow moving centuries, there was accumulated a thickness of more than 500 feet of sediments known as the Lower Magnesian or Prairie du Chien limestone.

Such deposition was brought to a close by the withdrawal of the sea from some cause, probably the down warping of some part of the ocean bottom. Into this deepened basin the waters drained from the lands, and the larger part of the Continent, including Illinois and the Macomb region, emerged from beneath the sea.

Concerning the life that peopled this ancient land, little is known. During millions of years in the early periods of the earth, almost all of the plants and animals lived in the water. Low forms of moisture nurtured plants had possibly succeeded in establishing themselves on the lands before this time, but no animals are known to have yet become adapted to terrestrial habitats.

After a long interval of land conditions during which the surface was gradually lowered by the slow but continuous processes of weathering and erosion, the sea again advanced over the trenched and denuded surface of Illinois. At this time the bordering lands were so high that the streams which drained them carried large quantities of sand into this part of the basin. These coarse sediments were spread widely by the waves, and accumulated in places to a thickness of 200 or more feet. They make up the St. Peter sandstone formation, which is the source of the water of the deep well at Macomb, and of many other deep wells in the upper Mississippi valley.

After a long time the bordering lands became reduced in height, the streams carried less sediment, and shelled animals again flourished in great profusion in the shallow sea of this region. Among these, bryozoa and brachiopods were abundant; the flower-like crinoids and delicate corals were in places common; and cystoids and trilobites were never so numerous before or since.

Giant cephalopods with straight, chambered shells several feet in length were easily the masters of those ancient seas. Here for the first time appeared the earliest fishes in small forms which showed slight promise of becoming the founders of the highest dynasty of animals.

Then, as now, life was constantly changing in adjustment to the changes in its physical environment. These animals were all different from those that lived during Prairie du Chien time. Not a single species of the earlier age continued to live unchanged in these later seas. The shells of unnumbered generations of animals accumulated on the sea bottom and make up the Plattin and Kimmswick, or so-called Trenton, limestone of this region.

At the end of this long submergence the sea again drained from this part of the Continent, and there followed another long interval of land conditions. These land conditions preserve less fully the history of a region than do the times of submergence. The records of the past are written mostly on the deposits of the successive ages and in the fossils that they contain. They were impressed upon the sediments as they were slowly spread out on the sea bottom. Land areas commonly leave scant history of the life that peopled them. Even the bones and hard parts of the animals that die on the surface, and the trees that fall in our forests completely disintegrate and decay when exposed to the air, and leave no trace behind. The chief record left on a land surface during a long lapse of time is in the erosion it has suffered, and other things being equal, the amount of denudation is a measure of the interval of time.

After a long emergence the sea again slowly advanced upon the lands, at first from the south, and later, also from the north. The greater part, or all, of Illinois was submerged, and with it the Macomb region. During most of this time the sea was muddy, and the sediments that make up the Maquoketa shale were laid down in this region to a thickness of 180 to 200 feet. This sea withdrew from Illinois somewhat earlier than from farther east in North America. The emergence brought the Ordovician period to a close, and in restricted tracts of shallow seas along the borders of the continents the intense crowding and competition among the animals adapted to living in shallow water resulted in the extinction of great numbers of Ordovician types. Others which possessed greater plasticity and powers of adjustment became changed into species characteristic of the Silurian period. Land

life was still rare and simple in this far-off time. No air-breathing animals are certainly known, and only the lowest types of plants were becoming weaned away from their ancestral aquatic habitats.

The streams that drained the land of this region in early Silurian time deposited sand along their channels, and these narrow belts of channel sand, called the Hoing sand, are the reservoirs from which the oil and gas is produced in this part of the state.

Early in Silurian time an oscillating sea advanced into this region from the south, and extended as far as the northern border of Illinois. Other invasions from the north and east occurred in places on the continent during this Alexandrian epoch. During the succeeding Niagaran epoch the Silurian flood reached its height. In the Mississippi valley the sediments of this time were mostly limestones which in places reach a thickness of 300 to 400 feet, but in McDonough County they are less than 50 feet thick.

In these seas both simple and compound corals were abundant in many places. Brachiopods, cephalopods, and trilobites continued in new species, and cystoids which were waning and crinoids which were increasing were common in the late Niagaran seas. The primitive sharks were also on the increase at this time.

Near the end of the Niagaran epoch the sea was again drained from this region and the Mississippi valley, and land conditions prevailed here for a few hundred thousand years. On the lands some animals began to develop the air-breathing habit, and forms like scorpions and centipedes appeared for the first time. Land plants were still of low types of algae and their relatives, but the time of their expansion was near at hand.

At the end of this long land interval an Arctic sea advanced southward over the Macomb area and as far south as Jersey and Calhoun counties in early upper Devonian time. These waters were generally so warm and clear that corals built reefs, and brachipods were so numerous that their shells formed beds of limestone all the way from Alaska and the Mackenzie River to central Illinois.

Another short sea withdrawal succeeded this limestone deposition and was followed in late Devonian time by the advance of a stagnant sea in which foul mud, black with organic matter, accumulated over the larger part of the state. These sediments make up the Sweetland Creek shale.

Besides the numerous invertebrate groups that flourished in the Devonian seas, fishes were at this time abundant. Among these, primitive armored forms were common, and sharks, ganoids, and lung fishes abounded in such numbers that the Devonian has been called the Age of Fishes.

Impelled by the arid climates of late Silurian and Devonian time, some of these fishes formed the habit of gulping air into their swimming bladder which thus became modified into a lung. Limbs were also developed from their lobed, paired fins as the fishes crept about on the land in search of new water bodies, when the pools in which they previously lived became dry, and thus Amphibia arose from the fishes in the Devonian period.

Land plants were also making rapid progress in the development of vascular tissue consisting of specialized cells for the purpose of efficiently conveying the liquids through the roots and stems. This tissue made it possible for the first time for plants to grow to a considerable height above the ground, and forests have covered portions of the lands from this time. During the Devonian, ferns, lycopods, and rushes were common trees of the lowlands, and Gymnosperms consisting of seed ferns, the ancestors of the cycads, and Cordaites, the fore-runners of the conifers, formed the forests of the more moist uplands.

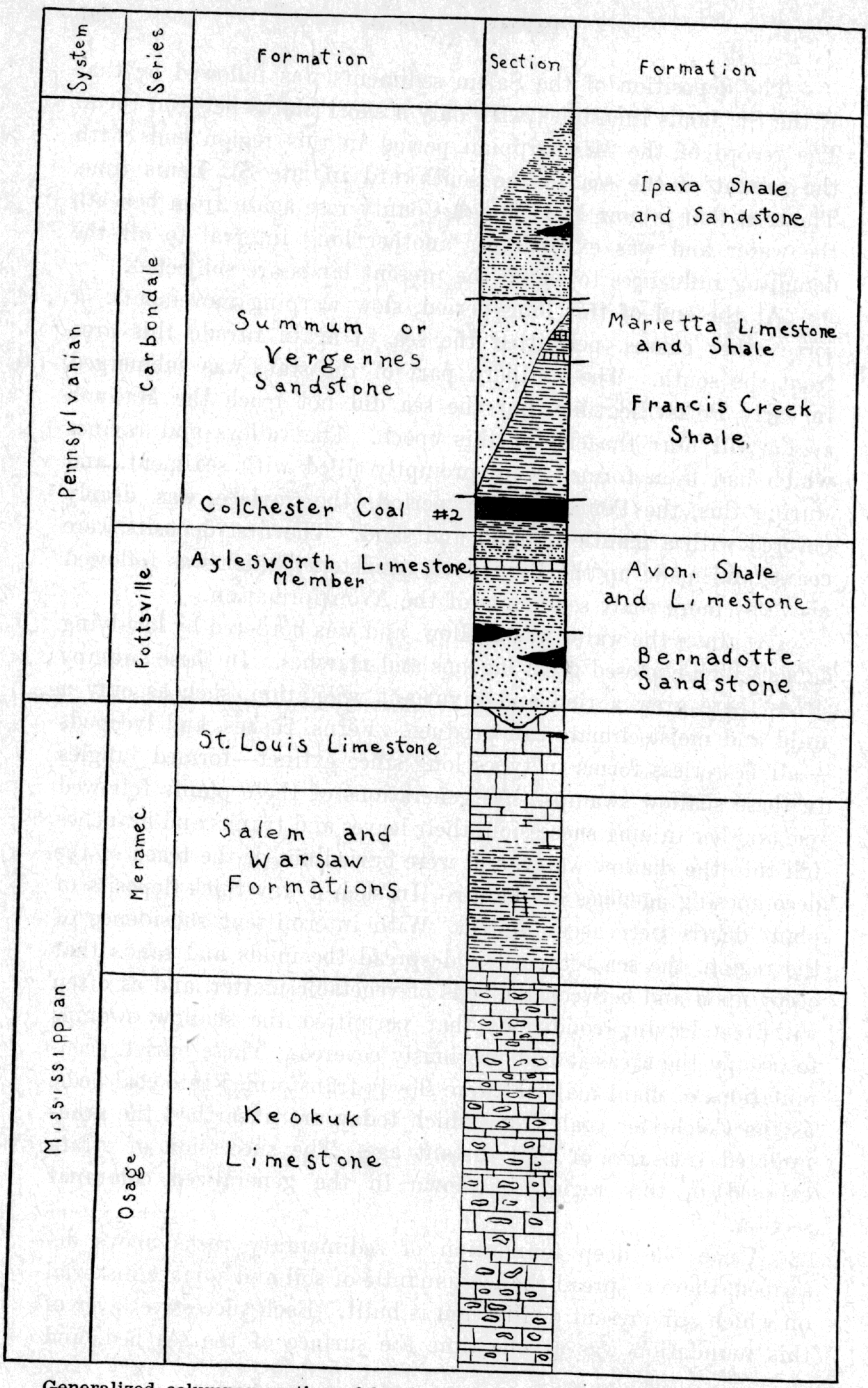
After a relatively short sea withdrawal, deposition of the Mississippian sediments in this region was initiated by the advance of a sea in which the muds of the Kinderhook shale were deposited on the earlier, darker shale of the late Devonian. The more or less weathered, upper portion of the black shale was reworked by the advancing Kinderhook sea and mixed with the muds brought to this basin by the streams. In this way there was developed in places what resembles a gradual transition from the black shale below into the greenish Kinderhook shale above. Towards the end of Kinderhook time the water became clearer, and the mud deposition gave place to the accumulation of shells and fragments of crinoids which make up the Burlington and Keokuk limestones. Near the end of Keokuk time the waters became more turbid and the calcareous shales of the Warsaw and Salem formations were deposited above the Keokuk limestone. No unconformity is clearly distinguishable in this region either between the Keokuk and the Warsaw, or between the Warsaw and Salem, although in Iowa a break in sedimentation is thought to have occurred at both of these contacts.

The deposition of the Salem sediments was followed by that of the St. Louis limestone, with only a short hiatus between them. The record of the Mississippian period in this region ends with the retreat of the sea to the southward in late St. Louis time. The area that is now McDonough County rose again from beneath the water and was exposed for another long interval to all the denuding influences to which the present lands are subjected.

At the end of this long period, slow warping movements, or some other causes, permitted the sea to again invade this area from the south. The southern part of the state was submerged in early Pottsville time, but the sea did not reach the Macomb region till near the end of this epoch. The valleys and ravines which had been formed were promptly filled with sediment, and during this, the Pennsylvanian period, the surface was deeply covered with a mantle of mud and sand. The first deposits were coarse and made up the Bernadotte sandstone, which was followed above by more shaly sediments of the Avon formation.

At times the water was shallow, and was bordered by low-lying lands which enclosed great lagoons and marshes. In these swampy areas there grew a rich and luxuriant vegetation, such as only a mild and moist climate can produce. Ferns, rushes, and lycopods —all flowerless forms in types long since extinct—formed jungles in these shallow swamps. As generations of these plants followed one another in long succession, their leaves and trunks and branches fell into the shallow water, and were buried out of the reach of the decomposing agencies of the air. In such a way thick deposits of plant debris were accumulated. With intermittent subsidence of the region, the sea returned and spread the muds and sands that occur upon and between the beds of vegetable matter, and as often withdrew leaving conditions that permitted the shallow swamps to occupy the areas it had previously covered. These buried accumulations of plant material were slowly transformed into coal beds, as the Colchester coal, from which today are unearthed the accumulated treasures of that distant age. The succession of strata exposed in this region is shown in the generalized columnar section.

Upon the deep foundation of sedimentary rocks above described, there is spread the loose mantle of soil and surface material on which our present civilization is built. Each successive layer of this foundation was at one time the surface of the sea bed, and



Generalized columnar section of hard rocks exposed in the Macomb region.

makes up a separate page in the history of the world's book of life. Each separate formation is a vast cemetery or mausoleum which contains the remains of the particular forms which constituted the life of the earth during each successive period.

These strata then can teach us many things. They tell us of time lapses inconceivable. They tell us of the myriads of strange forms that have appeared and played their part upon earth's stage, and disappeared behind the dim horizon of the past.

"Those that tread the globe
Are but a handful to the tribes
That slumber in its bosom."

They also tell us of continuous progress in the forms of life from age to age, and they reveal the slow and silent changes, "never hasting" but yet "never resting," by which the earth with all its richness and variety of living forms came to be as we find it today.

Deposition of the Pennsylvanian period in this region was brought to a close by a movement of the earth's crust which was connected with the beginning of the uplift of the Appalachian mountains in the east, and the Ozark dome to the south, and this area has never since been covered by the sea. As the land rose, the streams immediately began to carve new channels, and in the course of later centuries the surface of the land was dissected with valleys, and hills were left standing in bold relief above them.

During the long periods which followed this emergence, embracing all of the Mesozoic and the greater portion of the Cenozoic eras, the surface of this region was subjected to erosion rather than deposition. As a consequence, no record was here preserved of the monster reptile hordes that ruled the earth during the Mesozoic era, nor of the strange toothed birds that rivaled these winged reptiles for the supremacy of the air during that same period.

In order to read the history of the animals and plants that lived during this long interval, we must search farther westward for the later seas and find in their deposits, and in the sediments of the rivers that drained the lands, the more continuous record of the world's advancing life. From these we learn that during the Mesozoic era MacDonough County was a part of that great theater in which was displayed the scenes and actors of the wonderful drama of reptilian evolution. Here disported the largest reptiles that ever walked the earth, and here too, among their children were the strangest birds that ever found the empire of the air a refuge from

their enemies. During this same era also the highest offspring of that great reptile horde appeared, and primitive mammals took their place upon the earth—among the latest, yet destined to become the mightiest of all their mighty ancestors.

In the Cenozoic era the Placental mammals underwent a wonderful development, and became adapted to almost all the habitats the earth afforded. They soon became the dominant animals, and since that time have held undisputed sway.

During a long time in the Cenozoic era perpetual summer reigned in this region. Over the surface of McDonough County rich forests, many of the trees of tropical species, grew in great luxuriance. Birds of brilliant plumage lived and nested among those tree tops. Troops of monkeys found in those same forests a safe shelter and habitation, carnivores related to the cats and saber-toothed tigers crept stealthily through the jungles in search of food, and herbivores such as the camel, elk, horse, tapir, and rhinoceros found pasturage over the grassy prairies.

These happy conditions of the Cenozoic time were slowly brought to a close by an upward movement of the land, and some cause or combination of causes resulted in the lowering of the temperature over the greater part of North America. Immense quantities of snow accumulated far to the northward, and the warmth of the winter's sun sufficed only to compact it into more solid ice. As the quantity of snow increased, the pressure of the great weight pushed outward on all sides the edge of the mass of ice. Slowly from year to year the snow increased, and slowly the margins were crowded farther and farther outward. As this great mass of ice moved southward, the animals that here had lived and flourished were compelled to migrate farther south in search of a more genial climate, while desolation dreary and artic brooded over the region of McDonough County. Slowly the giant glacier moved forward with resistless force, unheeding alike the rocky point or rounded hill or river gorge. The surface of the ledges were ground off and polished by the stones that were carried along beneath the mass of moving ice, and these same stones, held fast beneath the ice, were planed and polished by the same friction. Year after year the depth increased, and for centuries our deserted land was locked in the embrace of ice.

After a long lapse of time the weakened rays of the sun increased in power, and causes combined to melt the ice from the frozen continent, and once more the pulse of Nature coursed along

the streams. Slowly this ice sheet, which was probably the Kansan, retreated in the direction from which it came, and around its retiring margin followed close a new influx of life into this region. On the surface over which it passed the ice sheet left a mantle of unsorted clay, sand, pebbles, and bowlders called drift or till. The gorges and valleys were buried deep beneath this load of drift, and slowly this new surface became clothed with a garment of vegetation.

For another long interval, known as the Yarmouth interglacial age, this region was subjected to the wasting effects of weathering and erosion, during which soils and beds of dust and organic material developed over the more level areas. The climate of this time was not so warm as it had been before the glacial epoch, but horses, tapirs, bison, deer, mastodons, and saber-toothed tigers still found congenial conditions for existence in this region.

Gradually there was a return of the causes that favored the accumulation of snow in the north, and another great glacier crept slowly southward and buried this region once more under a thick mass of ice. This was no sudden calamity burying all of the life beneath its ruins, but the animals had ample time to escape southward before the advancing destruction. This is known as the Illinoian ice sheet. It extended nearly to the southern border of Illinois, and pushed a lobe across the Mississippi River between Clinton and Keokuk for a distance of a few miles into Iowa. After a long stay this glacier, like the former one, slowly melted backward towards the north, and left another sheet of glacial till over the surface which it had covered.

To these glaciers we are indebted for two very important results. First, their load of drift filled up and completely covered the preglacial valleys, so that today we plow our fields and build our roads over those ravines, without suspecting the presence of the buried valleys over which we ride. Second, it is to the till that we owe the depth of the fertile soil which covers the bed rock over all of this region.

The influence of yet another ice sheet was felt in this region. The Iowan glacier, which succeeded the Illinoisan, did not extend so far south as the Macomb region. However, as this ice sheet melted, and before the surface of the drift became covered with vegetation, conditions favored the carrying and depositing of unusual quantities of dust by the wind. In this way the fine-grained

loess deposits that cover the glacial till in this region were laid down.

At some time during the glacial period, in the early part in Asia, and somewhat later in this country, man crossed the threshold of the temple of life which was being built through all the preceding ages. Since that time, so recent that over the surface of the latest drift a drainage system has scarcely become developed, man has grown from a fear into a knowledge of Nature and her laws, and through that knowledge into power, until he gained the dominant place which he holds today.

Since the retreat of the glacier, the changes of the earth's surface produced by the slow action of the natural forces have impressed upon this region the features with which you are all familiar. But these features are not the same as those the area will present during a future age.

We are introduced on the earth at this particular stage of creation, and because the changes take place so slowly that we can not note or measure their progress from day to day or from year to year we are prone to think that there is no change and that the present order of things is the same as it has been throughout the past. However, the Geology of our own region teaches us far different views of Nature and of life. Nature is always active, is ever changing. We are just now in the midst of one of God's creative days. At the present time man, too, has become a potent agency of change. With a fuller knowledge of Nature's laws, and an increased application of her forces his power is certain to increase more and more. To what he may accomplish or become before the end of the present geological age the highest stretch of the imagination would hesitate to limit or set the bounds.