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A GEOLOGICAL SKETCH, WITH NOTES ON THE GEOLOGY OF THE MANITOU ISLANDS OF LAKE NIPISSING, ONTARIO.

BY J. M. GOODWILLIE, OTTAWA, CANADA.

GEOLOGY is that particular branch of scientific study which treats of the history of the earth; its organization and structure, the materials of which it is composed and the various processes by which it has attained its present constitution.

The term Geology is derived from two Greek words: ge, the earth, and logos, a history or description.

As history, we must consider it apart from the records of human action and human progress,—a history disclosed to us by the record and study of the rock masses which lie around us and beneath us, and by comparing the results of the natural phenomena of the past with the numerous forces and agencies at present in operation, in modifying the surface of the globe.

By the term *rock*, in geology, is not to be understood merely that hard material which we commonly call stone, but it is employed to include everything of which the earth's crust is composed. The sand and gravel of our lake shores, the clays employed in the manufacture of brick and earthenware, the limestone and marble and sandstone of our provincial quarries, the pebbles and bowlders by the roadside, and the soil of which our gardens and farms are composed are all, geologically speaking, rock, equally with the granite of our hills and mountains.

The determination of the materials of which rocks are composed belongs to the department of mineralogy and which, although not identical with geology, is closely allied to it.

Geology endeavors to account for the rock masses and various materials of which the earth is constructed. It aims at answering the enquiry, how have these things been formed and what are the processes by which they exist? Mineralogy examines into the nature and character of the materials, and analyzes and resolves into its component parts the various ingredients of which a rock is composed.

The study of geology reveals the fact almost everywhere patent in our surroundings, that we live in the midst of a rocky area, which upon investigation, proves to belong to the oldest known rocks in existence, and forms what we might term the foundation stones of the superstructure of our world.

Mineralogy shows us what the rocks contain, whether iron, or copper, or galena, or nickel, or silver, or gold, or platinum, and the modes of their occurrence; so that by a careful study of the conditions in which they are usually found, the investigator and prospector may be saved much unnecessary expenditure of time and labor in searching after the concealed wealth which lies hidden from the easy observation of man.

Geology does not attempt to account for the origin of the world, but the careful study of it gives us the only intelligible solution that can be entertained of the causes which must have operated in producing its present appearance, and the diversity everywhere apparent in its structure.

To a higher than any human source must we look for an answer to the inquiry into the origin of the world. In the sublime and indisputable declaration with which the book of Divine Revelation opens, there is given us the only satisfactory answer that can anywhere be found and which must forever prove sufficient, not only as it relates to this terrestrial sphere, but also to the universe of unenumerated worlds of which this earth is, comparatively speaking, only an insignificant part: "In the beginning God created the heavens and the earth."

In that opening announcement of the book of God we are not only carried back to an indefinite, and it might be said an almost unlimited period, but we are also reminded that He who by his own almighty word "spake and it was done," and "commanded and it stood fast," did not then create the world as it at present exists. We are reminded that there was a time when the earth was without a human inhabitant, when no rain had yet fallen upon it, and when "there was not a man to till the ground." There was a time, further back, when our forests were uninhabited by wild beasts, and our marshes and lowlands untenanted by the almost numberless creeping things which make these resorts their abode. There was a time, still further back, when our streams and lakes and seas were without inhabitant, when there were no monarchs of the deep to engage in bloody encounters, and contest with each other the right of occupancy, and when there was no fowl of any kind to fly in the heavens, nor songsters to awaken the morning with notes of rejoicing and triumph.

There was a time, yet more distant, when the earth was destitute of vegetation of any kind, when no forests clothed our hills and mountains, when no grasses grew upon our plains, nor made verdant the valleys of our water courses, and when herbs, and fruits and flowers had not yet begun an existence preparatory to the introduction of animals and of man in particular.

There was a time, still more remote, when no mountain chains existed, with here and there lofty peaks penetrating the clouds and towering high towards heaven, and when there were no hills with accompanying valleys hollowed out among them.

There was a time, more distant still, when the earth appeared as one vast expanse of boundless sea, when islands and continents had not appeared above the surface of the great and mighty ocean, when "darkness was upon the face of the deep," and when, in all the illimitable dreary waste of waters, life and animation were entirely unknown.

Step by step the Creator was gradually preparing the earth to be the residence of the human race. Slowly and deliberately He brought about the necessary changes, all of whose workings are particularly distinguished by the absence of that spirit of haste and restless impatience so commonly manifested in the undertakings of man.

The time occupied in bringing about the present condition of things, as apparent throughout the world, must have been an indefinitely long period. Sacred science,

as held and interpreted by the early Fathers, taught that the world was of a comparatively recent origin, and did not date beyond four or five thousand years before the Christian era, and that the time occupied in the act of creation comprised six ordinary days.

Geological investigation, however, constrains us to assign to the earth an antiquity much more remote than the six or seven thousand years which it is commonly supposed to have existed, and to give to the several stages which marked its gradual development a limit beyond the twenty-four hours included in each of the successive days of creation.

It is impossible, however, for us to arrive at any definite conclusion as to the age of the world. Scientists, anxious and zealous in the maintenance of truth, differ among themselves as to the exact time occupied in the various modifications which the world must necessarily have undergone previous to its being occupied as the temporary abode of man. Instead of a few thousand, the space included comprises tens of thousands of years; some estimating the time at fifty thousand, others at two hundred and fifty thousand, and half a million of years as being necessary to the production of the present condition of things. But in one particular they all agree, and unite in giving to the earth a place in history many thousands of years anterior to the creation of man.

The rocks of which the earth's crust is composed are divided into 1st, igneous, or eruptive and unstratified rocks, and 2d, aqueous, or sedimentary and stratified rocks.

A third division is sometimes made and designated as metamorphic rocks, or rocks of a stratified crystalline formation, which in reality are only sedimentary rocks which have been changed by the action of steam or heat without destroying their stratified appearance.

By far the largest proportion of the earth's crust with which the geologist has to do is composed of aqueous or sedimentary and stratified rocks, and to the study of these, principally, must we look for those facts and data which, without doubt, prove our world to have a history of very great and undetermined antiquity.

By the crust of the earth is to be understood the materials of these several great sub-divisions of which the earth's surface is composed. It is by no means to be regarded as a solid mass throughout. Different theories have been advanced by scientists in reference to the internal condition of the earth. Some consider the centre of the earth to be composed of rock matter solidified by pressure with liquid fiery matter between this central area and the crust on the surface.

Others regard the earth as more or less solid, with lakes and seas of fire internally alternating throughout, while many others, and the commonly received opinion, hold that beneath the surface, of which we are accustomed to speak as the crust of the earth, and which extends to only a very limited depth, the whole of the internal portion of the earth consists of a molten sea of liquid fire.

The evidence in favor of this is confirmed by the following observations: In various parts of the world and at certain depths below the surface, an even temperature is found to exist throughout the year. At greater depths the temperature invariably increases, and although in all places it is not uniform, owing to the different kinds of rock penetrated, the average rate of increase is one degree for every sixty feet. And, as we may reasonably suppose the ratio to increase the greater the depth attained, we might expect comparatively soon to reach a temperature sufficiently high to sustain most minerals in a vaporous or molten condition.

Another evidence is found in the fact, that water brought at great depths from beneath the surface is found to possess a higher temperature than the temperature of the surrounding locality, and if the depth be extended the temperature of the water is increased with it.

Another and more convincing argument in proof of the molten condition of the interior of the earth is afforded us by the numerous volcanoes which occur throughout the world, some of which have been in active operation for hundreds, and even thousands, of years. They are generally regarded as constituting the principal channels of communication between the interior parts of the earth and the surface; and from unfathomable depths are more or less constantly pouring forth immense volumes of molten rock and liquid streams of living fire. More than two hundred and fifty volcanoes are now known at different times to be in a state of eruption, and many others have long since ceased to exhibit any degree of activity.

The thickness of the earth's crust has been variously estimated at from ten to twenty miles and upwards, but there is no means by which the exact depth of rock matter upon the surface can be accurately determined.

From the above considerations we are led to the conclusion that the interior of the earth consists of a mass of igneous incandescent matter, and which may have been, originally, the condition of the material now forming the crust of the earth, and that the gradual cooling of the surface by radiation, accompanied by the shrinkage and contraction attending the cooling process, together with the enormous pressure from within, produced immense crackings and bulgings of the earth's crust, which resulted in the many groups and chains of mountains, and associated valleys, to be seen upon the surface.

The rocks surrounding Lake Nipissing belong to the oldest known rocks in existence. They are the lowest and first in the order of sequence, and with but one exception, so far as is known, are almost entirely of an eruptive or metamorphic origin. They belong to the great Laurentian formation which extends over all the northern portions of the provinces of Quebec and Ontario, and continues west and northward to the Arctic Ocean. They are usually distinguished by their inclination at high angles, and by presenting in many places a variously folded and contorted appearance, and by the absence of organic remains. Here and there they are broken through by fragments and hugh masses of granite, which in some instances appear to have become the centres of eddies or whirlpools of molten rock. Some very interesting examples of these may be seen on the high, rocky portion crossed by McIntyre Street in the southeast part of the town of North Bay.

During some period of the world's history this whole region has undergone a most terrific convulsion of upheaval and depression, during which streams and lakes of fire appeared upon the surface, liquefying and changing the condition of the rock masses with which they came in contact.

To this same period, and to the operation of these same agencies, must we trace the origin of the extensive mineral deposits which occur throughout this northern region. The various metals being more fusible than the rock masses in general, found a ready exit in the cracks and fissures formed by the breaking of the earth's crust, and filling these became subsequently cooled, forming veins of various depths and thicknesses, and sometimes extending for miles in length, imparting to this part of our dominion, in outward appearance so uninviting, an attractiveness of wealth, in mineral resources, unrivalled, and perhaps it would not be an exaggeration to say, unequalled by any country in the world.

The rocks forming the second great sub-division into which the crust of the earth is divided are called aqueous, or sedimentary rocks. They are essentially formed by the ac-

tion of water, the strata or layers of which they are composed varying in composition and thickness according to the mineral character of the water and sediments, and the length of time engaged in forming them. They are readily distinguished from igneous, or eruptive rocks, by their horizontally stratified appearance, and by the occurrence of organic remains, of which some strata are almost wholly composed. These remains, which we commonly call fossils, comprise almost every variety of vegetable and animal life of the past, from the lowest fungus to the highest form of animate creation, including also many extinct species of both plants and animals, and which have no living representatives in the types and genera of the present day.

An examination into the nature and character of these fossil remains, both of vegetables and animals, which have inhabited the globe during the periods of its past history, constitutes the science of palæontology.

The sedimentary rocks, which enter so largely into the formation of the earth's surface, comprise a number of great divisions, distinguished by special and characteristic collections of plants and animals, and these again are further sub-divided, each sub-division having fossils peculiar to itself, and which may easily be recognized by those skilled in palæontology.

We shall have a clear understanding of the manner in which sedimentary rocks were formed by observing the various natural processes in operation at the present time in modifying the surface of the globe.

Sediments of various kinds, such as sand and gravel, and clays in solution, are constantly being carried down by streams and rivers and deposited on the bottom of lakes and seas.

Portions of banks and cliffs on the sea coast are continually breaking away, and, by the action of the water, disintegrated and spread over the bottom. The sediment deposited in this way is generally found to be disposed in horizontally arranged beds or layers, often enclosing shells and bones, weeds, leaves and branches from trees, and other organic bodies, drifted from the land or carried by the various streams into the sea. In process of time the sediments so deposited become solidified, partly by means of the calcareous and silicious matter contained in them, and that derived from the decomposition of the enclosed organic remains, and partly by the pressure of the superincumbent layers and strata of sedimentary matter.

In this and similar ways, all the stratified rocks on the surface of the globe have at different periods been built up, enclosing within the various formations the almost innumerable forms of vegetable and animal life peculiar to each successive period.

The time occupied in the deposition and solidifying of stratified rocks must necessarily have been enormously great.

It would not be an exaggeration to say that tens of thousands of years would be requisite to bring about the results which are so apparent in all our stratified rock formations.

The coast line of the Gulf of Mexico, at the mouth of the Mississippi River, has been known for more than three hundred years; and notwithstanding the immense alluvial deposits annually conveyed to the sea by that river and its tributaries for more than three centuries, comparatively little change has been made by the encroachment of the land upon the sea, and yet there was doubtless a time when the delta of the Mississippi was at St. Louis, nearly eight hundred miles from its present position.

Another and more forcible illustration may be seen in the various coal fields of the present day. They appear to have consisted, originally, of primeval forests, situated in low or marshy ground, which by a sinking of the earth's crust, or some similar natural phenomenon, gradually became submerged, and eventually covered with organic sediment of a vegetable kind, and in this condition have been gradually consolidated. In process of time fresh forests appear to have grown up, covering the same area, and in turn have in a like manner disappeared beneath the surface. In the coal-bearing strata of Nova Scotia, which have attained a thickness of 14,570 feet, no less than seventeen successive forests have been counted in less than one-third of that depth. Trees four feet in diameter have been found standing erect and almost entire, as they originally grew upon the surface. In the coal field of Sydney fifty-nine fossil forests have been distinctly traced, one above another.

When we take into consideration the time necessary to mature the growth of a forest, the gradual subsidence of the area on which it grew, until the whole was completely submerged, the filling up of the area with decomposed organic matter, the formation and growth of a second forest similar to its predecessor, and so on until fifty-nine such forests have matured and in turn disappeared, we can form some idea, though very vague at best, of the vast extent of time occupied in fitting up this world as an abode for man.

Again, when we consider that many stratified rocks lie hundreds and thousands of feet above the level of the sea, that the various strata of which they are composed abound in the fossilized remains of marine shells and animals, that there was a time when these same rocks must have formed the bed of the ocean, and the substratum of numerous other strata ages since abraded from their surface, not only will our conceptions of the length of time the earth has existed be greatly enlarged, but rightly considered, we shall also be led to adore the unsearchable wisdom and mighty power by which all these things were made.

A study of the geology of the Manitou Islands lying in front of North Bay reveals the only exceptional break in all the Laurentian monotony of this district. There, side by side with rocks of the Laurentian sea, we have presented, in clearly defined outlines, substantial evidences of stratified rock formation belonging to what is commonly known as the Trenton period, which is only one of the great sub-divisions of the Palæozic age of the earth's history.

At some time very remote, when this whole region was in the throes of convulsion, when livid streams of molten rock broke forth from beneath, and fire and heat and steam acting in concert aided the work of disintegration, when huge masses of metamorphosed and igneous rock matter were heterogeneously piled into the hills and mountains round about, and when by an unevenly formed subsidence of the earth's crust an immense valley was constituted, now occupied by the waters of Lake Nipissing, amid the wreck of matter and the chaos and confusion that reigned on every hand, a portion of Little Manitou remained undisturbed, retaining in an unchanged condition, in its argillaceous and bitumenous shales and calcareous strata, abundant organic remains of both animal and vegetable life, the internal evidence of its own antiquity.

On Great Manitou Island similar evidences exist, but under somewhat changed conditions. There are outcroppings of stratified rock on both the eastern and the western divisions of the island. That on the eastern part of the island apparently corresponds in strike with the exposure on Little Manitou, but appears to have a slight dip to the south or southwest. The whole area, however, is so obscured with drift and bowlders that neither dip nor strike can be determined with any degree of accuracy.

On the western part of the island, where the principal exposure occurs, the strata have a dip of twenty-two degrees to the southwest, reminding us that during the period of upheaval through which this district passed, Great Manitou by no means fared so well as its sister island.

On the third largest island of the group there are also indications of a stratified formation, but in this case, as in the other referred to, the whole is so covered with drift and rubbish and densely wooded as to render it at present practically indeterminable.

The islands are not only conveniently and pleasantly situated, but are also one of the most delightful and healthful summer resorts in this whole northern region. The student of geology will always find a seasonable visit to these islands a delightful pastime, and will be amply rewarded in being afforded an opportunity of studying some features of geological science seldom experienced, and which assist us materially in correctly interpreting the past history of the earth. Some of the fossils found on the islands are in themselves interesting objects of study, and beautiful illustrations of that wisdom and skill everywhere to be seen in the Creator's work. And while they are important as evidences of past history and assist in determining to some extent the very great age of our world, they are also no less significant in demonstrating the eternity of Him who "before the mountains were brought forth, or ever the earth and the world were formed," from everlasting to everlasting is God.

In contemplating the glory and grandeur of the Creative handiwork, and considering the great antiquity of the world on which we dwell, may we not well adopt the language of inspiration and say: "Great and marvellous are thy works, Lord God Almighty;" "Of old hast thou laid the foundations of the earth."

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE 42nd meeting of the American Association opened at Madison, Wisconsin, on August 17th. The following were the officers of the meeting, new secretaries having to be elected in the case of Sections E and G, Messrs. Hill and Coville being absent on the opening of the meeting: President, William Harkness, Washington, D. C.; Vice Presidents.—A. Mathematics and Astronomy—C. L. Doolittle, South Bethlehem, Pa. B. Physics—E. L. Nichols, Ithaca, N. Y. C. Chemistry—Edward Hart, Easton, Pa. D. Mechanical Science and Engineering—S. W. Robinson, Columbus, O. E. Geology and Geography—Chas. D. Walcott, Washington, D. C. F. Zoölogy—Henry F. Osborn, New York, N. Y. G. Botany—Charles E. Bessey, Lincoln, Neb. H. Anthropology—J. Owen Dorsey, Tacoma Park, Md. I. Economic Science and Statistics—William H. Brewer, New Haven, Conn. Permanent Secretary, F. W. Putnam, Cambridge (office Salem), Mass. General Secretary, T. H. Norton, Cincinnati, Ohio. Secretary of the Council, H. L. Fairchild, Rochester, N. Y. Secretaries of the Sections. A. Mathematics and Astronomy—C. A. Waldo, Newcastle, Ind. B. Physics—W. LeConte Stevens, Troy, N. Y. C. Chemistry—H. N. Stokes, Chicago, Ill. D. Mechanical Science and Engineering—D. S. Jacobus, Hoboken, N. J. E. Geology and Geography—W. H. Hobbs, Madison, Wis. F. Zoölogy—L. O. Howard, Washington, D. C. G. Botany—B. T. Galloway, Washington, D. C. H. Anthropology—Warren K. Moorehead, Xenia, O. I. Economic Science and Statistics—Nellie S. Kedzie, Manhattan, Kan. Treasurer, William Lilly, Mauch Chunk, Pa.

The addresses of the Vice Presidents were delivered before their respective sections in the afternoon, and they were as follows: Vice President Nichols, before Section of Physics; subject, "Phenomena of the Time Infinitesimal." Vice President Dorsey, before Section of Anthropology; subject, "The Biloxi Indians of Louisiana." Vice President Walcott, before Section of Geology and Geography; subject, "Geologic Time as Indicated by the Sedimentary Rocks of North America." Vice President Brewer, before Section of Economic Science and Statistics; subject, "The Mutual Relations of Science and Stock-Breeding." Vice President Osborn, before Section of Zoölogy; subject, "The Rise of the Mammalia." Vice President Doolittle, before Section of Mathematics and Astronomy; subject, "Variations of Latitude." Vice President Bessey, before section of Botany; subject, "Evolution and Classification." Vice President Hart, before Section of Chemistry; subject, "Twenty-five Years' Progress in Analytical Chemistry." Vice President Robinson, before Section of Mechanical Science and Engineering; subject, "Training in Engineering Science."

Vice President Walcott in his address before Section E, Geology, referred to the various estimates that had been made as to the length of geological time, these varying from a minimum of 3,000,000 to a maximum of 1,200,000,000 years. His own studies, based largely upon the Paleozoic sediments of the Cordilleran area, gave a mean between these. The following table gives the estimated time for each of the larger geological eras:

Cænozoic,	2,900,000
Mesozoic,	7,240,000
Paleozoic,	17,500,000
Algonkian,	17,500,000
Archean,	?
Total,	$45,140,000

He stated his belief in the theory that the deep seas and the continental areas are permanent, and thought that the main outlines of the North American continent were laid down as far back as Archean time. Cambrian sediments on either side of the continent are of such extent as to justify the belief, or rather necessitate the belief, that extensive continental masses were near at hand. Thirty thousand feet of sediment in the Rocky Mountain area, and nearly as much in the Appalachian, were indicative of long lapses of time. The sediments of the Rocky Mountains were deposited over an area of at least 400,000 square miles and probably of 800,000. This area extended from the Gulf of Mexico to the Arctic Ocean.

Many statements were made as to the rate of denudation and deposition of calcareous and mechanical sediments. Estimated at the rate of deposit of calcareous sediments now being formed, it was calculated that about 600,000 years would be required to form a deposit of limestone twenty-two feet in thickness. It was estimated that about 47,000,000 years would be required, at this rate, to form the deposit of calcium carbonate in the Cordilleran area. But reducing this fifty per cent for any possible change of conditions, and then taking off a further twenty-five per cent for special conditions affecting deposition, 16,000,000 years would remain for the accumulation of the calcareous sediments. To this must be added time for mechanical deposits, and putting this at its lowest possible term of 1,500,000 years, we have the 17,500,000 years for the Paleozoic time given above.

Professor Osborn, in addressing Section F upon the rise of the mammalia, dwelt especially upon the methods employed by paleontologists, and upon the broad generalizations that had been made by students of fossil mammals. Among these was the generalization of Marsh, that all early types of mammalia had small brain cavities.

Cope had shown by the growth of the feet that all early types had five toes upon both the fore and hind feet and