

Historic Geology.

HISTORIC Geology builds up a history of the earth, showing the succession of its rocks, the origin of its lands and especially tracing the progress of living creatures from remote ages until our time. The present article does not purpose to give such an account of the whole earth but will deal particularly with the Geological history of North America.

Much that pertains to this account of the earth can be told by the astronomer and the physicist but by far the greater part of our information is obtained from rocks and the remains of living things. For by examining rocks the Geologist can tell whether they were made in deep water or along the shore, whether they were formed by organic or mechanical means or whether they have had a volcanic origin.

From fossils or organic remains Geologists can know much about the lives of ancient creatures. They can tell whether they lived on land or in the water either fresh or salt. Likewise the occurrence of fossils tells us what kind of a climate existed here or there on the surface of the earth during former ages.

Land fossils are few because the oxygen of the air is always destroying organic bodies. But sometimes trees, plants, bodies of men and other animals become immired in swamps or are buried in flood deposits where the oxygen cannot reach them and thus are preserved for future ages. But sea fossils are numerous, for the vast majority of such creatures, particularly those having skeletons, sink to the sea bottom and are there covered by silt and mud. In the course of time the places where they lie become rocks and eventually dry land, and may then be removed.

When we have seen what data the geologist has we shall now see how he uses them to trace out the earth's history. The first means by which he knows to what period certain rocks belong is called the law of Superposition and this depends on the principle that younger rocks or formations overlies the older. But this law will not enable us to connect the history of a region with that of another place very distant. The rocks of

Ontario and those of the same age in British Columbia are vastly different in appearance.

The most important factor in the making of geological history is the Law of Included Organisms—that is, that formations, however widely separated, which contain a similar assemblage of fossils, belong to the same geological epoch. By study and comparison Geologists have found that certain kinds of creatures lived at the time when ancient rocks were being formed. Other kinds more resembling modern animals and plants lived in later ages and so on until we meet with the animals and plants of today. Thus a standard series from the earliest to present types has been made out; so that any new fossil can soon be referred to its place in the list and thus determine the relative age of the rock in which it was imbedded.

By means of these two laws, the formations of different regions and continents are co-related and arranged in their natural order. The Geological record so made out is used as a universal time scale for geological history. Such history is generally divided into five great eras—the Eozoic, including the Archean and Algoquian, the Paleozoic, the Mesozoic, the Cenozoic and the Quaternary. The last four of these are subdivided many times but the divisions given above will suffice for a brief sketch such as this.

The beginning of the history of the globe cannot be known from any geological record or fact. Consequently, among Geologists how the world began is as yet an unsettled question. There are two theories most followed today—the Nebular Theory of Laplace, and the Accretion Theory, which has in late years won many supporters. But both these unproved speculations agree in showing how immense is the age of the earth—how many millions and millions of years must have passed since the earth began to take its present form. Behind the history recorded in the rocks, which tells of countless centuries, lies the unrecorded history of the beginnings of our world which stretches back for aeons practically numerless.

According to both of these theories the earth was glowing and molten for a long period before an outer

crust could be formed. But as the fiery mass lost its heat the surface gradually became hard and so was formed the first land. In that age of high temperature there could not have been any life—at least any such forms as are now known.

The oldest known sedimentary strata, wherever they are exposed, are found to possess the same characteristics in all parts of the world. They consist of gneisses and schists of various kinds which have been cut with dykes and such intrusions of molten rocks, broken crumbled and crushed and left in masses so confused that their true arrangement is made out only with great difficulty. No thickness can be assigned to them, but they underlie later rocks everywhere and form the surface of many irregular areas where they have been uncovered by denudation. Most of these rocks are of igneous origin but some may be sedimentary. In them no evidence of life have been found.

Next in time order come the Algonquian rocks, younger than the Archean and largely sedimentary. They have been greatly disturbed and broken. The greater part of the provinces of Quebec and Ontario are of this formation. So also are most of the New England States. In them are found deposits of iron, copper, nickel, cobalt, marble, slate, limestone and graphite. Since this last is of organic origin we infer that life existed during this period.

The next era, the Paleozoic is comparatively full of records and thus is much easier to be told about. This age also was very long: it must be reckoned in millions of years. This period is subdivided into five great systems—Cambrian, Ordovician, Silurian, Devonian and Carboniferous. Paleozoic rocks consist of shales, sandstones and limestones. The whole of Canada except those parts mentioned before and the provinces of Manitoba and Saskatchewan was laid down in this period. During this epoch life developed very much, for at its close all the great types except the vertebrates were present. In the first centuries of the Paleozoic era there were only forms of sea life and these were all shelled creatures such as Brachiopods Trilobites which are the ancestors of our "lobsters."

Very many species of these latter have been discovered in the rocks of the Cambrian period. In the Ordovician epoch are found Crinoids—relatives of our star-fishes and sea urchins—Graptolites—a family now extinct and many great coral growths. In the Silurian epoch these same kinds of fossils are found as well as a few land plants and some fish. But it was in the Devonian epoch that the fishes reigned supreme. They were very fierce strange creatures generally covered with an armor of bony plates and often of great size. In this epoch land plants became abundant. There were great forests of ferns and horsetails and these forests swarmed with large sized insects. The Carboniferous epoch is so called because of the immense quantities of coal found among the rocks of this period. That was the age when ferns and horsetails grew two to four feet in diameter and forty to sixty feet high. These after falling and being buried and pressed for millions of years are now being dug up as coal. Natural gas and petroleum were also formed in the same way. The animal life of this period was similar in the main to that of the Devonian; but locusts and spiders and amphibians are the new species found.

The next great era—the Mesozoic is the great natural division of Geological history. As there are but few parts of Canada of this formation we shall treat it briefly. Its life forms are intermediate between the ancient and modern forms. It is often called the age of Reptiles because of their number and great size. They ruled every-where for they lived both in water and on the land, while some of them could fly. The plants were pretty much the same as in the preceding era. But there are many new ones of importance. Some of these are our hard wood trees such as Maple, Beech, Birch, Oak and Willow. The shell bearing creatures were very numerous and of many forms. This is the time when vertebrate animals are first found. The economic products of this epoch are building stone, coal, salt and gold.

In the Cenozoic era the great reptiles have disappeared and Mammals are the leading species. In North America the Tertiary formations are few espec-

ally so in Canada. But it was in this era that some of the loftiest mountains of the world such as the Himalayas, Alps, Caucasus and Atlas received the uplift to which they owe most of their colossal bulk and height. The plants of the time were similar to those of today, and the animal forms were becoming more and more like those of our time. All our domestic animals, rats and mice, rhinoceroses and monkeys lived then, but there are no certain traces of man. A warm climate then prevailed all over North America as may be proven by fossils of tropical flora and fauna which have been found up to within a few degrees of the pole. This was the age when the coal beds of California and Oregon were laid down and many of the salt mines and gypsum beds of the world belong to the same period.

The fifth and last geological epoch—the Quaternary may be said to begin with the great glacial invasion. This is a period of unusual interest because of its difference from preceding epochs and present conditions. The whole of Canada, the New England States, the Northern half of the Mississippi valley and the north-western States were all covered by an immense ice sheet which in some places was over a mile thick. It was so thick that the Adirondock and White mountains seem to have been covered. Great boulders, weighing tons were carried long distances and over mountains and then left thousands of feet higher than their former place. This filled the river valleys with drift rock and clay and as in many cases the drift is a hundred or more feet in depth these rivers were compelled to cut new channels. As the ice sheet retreated great bodies of water were formed wherever the ice front dammed the natural drainage. Thus Lake Agassiz covered an area of one hundred and ten thousand square miles, where now are the praries of Manitoba and Dakota. The mud deposited in it now forms the great wheat-growing soil of our continent. There are many theories about the climate changes which caused the glacier and which after thousands of years caused it to me't back to the region of the North Pole, but none seem entirely satisfactory. After it had receded the land of Eastern North America sunk so much that the sea extended up

the St. Lawrence valley and down the Champlain and Hudson Rivers, thus forming an Island of the New England States and the Maritime Provinces. But these regions soon again rose and the country appeared pretty much as it is today.

The flora and fauna of the Quaternary were about the same as that of the present day but there were several great mammals such as the Mastodons and Mammoths which are now extinct. In the glacial epoch some of these were killed out by the terrible cold. During that time the distribution of plants and animals was very different from now. Arctic species, as may be proved by the finding of fossils, roamed over what are now temperate climes, but followed the receding ice-sheet back to where they now live.

It was at the end of the Glacial period that man—the lord of creation—came forth, created immediately by the hand of God. For otherwise it is impossible to explain his intellectual faculties. He is not, as the evolutionists claim, a perfected ape—the last link in an indefinite series of forms through which living beings have passed in obedience to the great law of perfection which they say, rules all animated creation. Even the evolutionists themselves, admit that the most ancient human skulls are altogether different from those of the ape. There is no evidence to prove that man was created in a savage state; where Barbarism is found among certain people it is a product of degeneracy. The antiquity of man is a question of research for the science of History, and if at any time Geology contradicts documental proven facts of history, it must be admitted that Geology has erred. And as to the relation between Geology and the Bible, we shall say that God is the author of both Geological records and the Bible. They are two wonderful books which cannot contradict each other. If in reading them we seem to find contradictions let us rest assured that we are interpreting wrongly one or the other. Let us respect both and study both but with submission to the decisions of competent authority. For we may confidently believe that each in its own way proclaims the glory of their common author—the God of all truth.

F. L. M.—18.