The Glacial Epoch.

by

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A remarkable and stupendous period which followed that one in which the solid portion of the earth was formed was the glacial period. Nothing in geological researches has been more fully proved than the existance of this period, which left its traces in unmistakable monuments over the face of the earth, and written its history upon their rocks. It was an epoch of arctic rigidity when the temperature of that portion of the earth in which it existed had become so lowered that the cold regions around the poles were permitted to extend their previously contracted

circles over the temperate latitudes, and to envelop with a prodigious mantle of ice the land which once, beneath a milder sun had been the home of an abundant and tropical vegetation.

Ice came the podigious monster until its frigid folds hid the surface of the earth down to 39° North latitude. During the same great period, but at a different time, a like deluge of ice left its unmistakable traces amid the forests and pampas of South America and other southern lands.

Agassiz was the first who insisted that central Europe, England, Scotland, and Ireland, and Iceland, also, had been buried beneath thousands of feet of solid ice, and that from

the mountain tops of Scandinavia, the Lake hills of England, and from the summits of the Alps had proceeded vast rivers of ice whose confluent seas had swept over Europe, and beneath their restless, ceaseless, and perpetual advance, grooved it with valleys, engraved its rocks, scalped out its lakes, and scattered its burden of debris far and wide over its plains.

This theory was long looked upon with doubt, but Forbes, Hopkins, and Tyndell, succeeded Agassiz and after careful study of glacial movements, formations, and other phenomena associated with them, added confirmation to the theory which Agassiz had advanced.

Numerous are the things which go to prove that a glacial epoch existed. Theories, many and various, have been advanced, by men of world wide fame, to account for the strange phenomena which exists over more or less of the entire surface of the globe. To account for the fact that huge boulders are found many miles from their native homes, has called forth the most varied opinions. Rocks of various sizes and kinds are scattered promiscuously over the greater part of the Northern hemisphere. Specimens from Greenland have been found hundreds of miles southward on the plains of North America. Some

immense rocks to have been wrenched from their firm hold upon the summits of mountains and have been transported by unseen powers miles from their native homes. Some of the largest and most remarkable instances should be mentioned, but I will only mention one; Pierre-à-Bot a bowlder of fine-grained granite, mentioned by Agassiz, "has been traced to the vicinity of Martigny in the Valais; it measures fifty feet in length, forty feet in height, and twenty feet in width, and contains 40,000 cubic feet. To reach its present locality it had to traverse a distance of from sixty to seventy geographical miles, and to cross the basin of Neu-

de châtel." Others larger than this one are found long distances from their homes in Alpine ranges.

Other phenomena besides the displacement of huge boulders is to be associated with the glacial epoch. Rocks as they lie in place ~~in place~~ upon the flanks and summits of mountains to the hight of 5,000 to 10,000 feet are all grooved in long, straight channels which diminish in size and depth from several feet deep and as many wide, to the faintest striae. These marks score the rocks over the United States, and Canada, throughout Europe and South America. On the top of Mt. Washington at 5,000 feet above the sea,

is cut with these strange furrows; the rocks polished and the whole surrounding country still bears the evidence of past erosions wherever the naked rocks meet the eye. Over the New England states may be traced these furrows for great distances running in parallel courses. Still farther and farther they extend; now appearing in bold characters on the hills of Ohio, Indiana, Iowa, and finally are lost from sight among the rocks and ledges of eastern Kansas. Not content to cross and evade the high plains and rugged steeps of the inland, we find the same phenomena presenting themselves, grooving and corrugating

the borders of innumerable bays and finally loosing themselves in the deep sea beyond.

To account for this, numerous theories have been advanced. Theories which only prove certain phases of the phenomena, and some which do not prove any of them. The first I will mention is the theory of Agassiz, who advocated that at the time when the mountains were thrown up by a great upheaval of the earth, these huge rocks were rolled and tumbled everywhere. Second:- Mr Bush and Esther imagined that an immense deluge swept the boulders along its surging course and landed them promiscuously over the land-scape.

Another theory was a change in the axis of rotation. Another ingenious man advocated the theory that the Noachian deluge was burdened with the responsibility of their dispersion. Still another advocated the possibility of a collision with a comet, which loosened the rocks from the mountain peaks and sent them rattling and thundering to the plains below.

These theories are good as theories but when we come to test them they fail in many respects. The up-heaval of the earth's surface or the collision with the comet would have a tendency to rattle the stones loose and send them down the mountains

with an immense velocity, but with a velocity which could not in any way carry them over hills and through lakes, and to the distance which they have traveled. Nor does the theory in any way account for the grooving of the rocks which is one of the main proofs of an epoch of this sort.

The deluge idea may sound plausible but a current of water was never produced which possessed the power it would require to move these immense boulders. Also the grooves which water makes are smooth, rippling and uneven in depth, while these grooves possess the character of being of an even depth and shape throughout.

Another theory was the elevation of the Arctic seas, or the shrinkage of the earth at the equator, which caused a flow of water from the polar regions, carrying immense ice-bergs laden with rocks and gravel southward. Upon this theory has been based the only true aspect of the phenomena. As it has long been proven that the actions of water and those actions which employ the agency of ice, either in the form of ice-bergs or glaciers, or both, are the only possible means by which such work could be performed.

At the present time in Greenland there extends northward for over 1,300 miles, far beyond where the human foot has ever

trod, a rigid sea of ice which sweeps its appalling and silent surface. As snow and ice accumulates inland it is pushed down the slope and forces itself forward in vast sheets and icy currents to the shore where huge ice-bergs break themselves loose and float seaward, burdened with an accumulation of rocks and soil, which are dropped to the bottom of the sea as the ice-bergs is slowly melted by warmer waters and a still warmer sun. Glaciers are not confined to the Alpine wastes of Greenland and other polar lands, for in the Alps, we may stand amid luxuriant vegetation and cast our eye up-

ward towards the gorges of eternal snow, and there behold a glacier winding its way down the rugged steeps, only a few inches a day. Tho they are small affairs compared with those of previous ages, but they prove by their actions beyond a doubt the phenomena which we associate with the former glacial epoch.

The Glacial Duration.

At an uncertain date in the history of this earth, probably 160,000 years ago the climate was not the same as now, for geological researches go to prove that during certain ages, warm periods existed first in

one hemisphere and then in the other; while it was warm at the north pole a sea of icy rigidity covered the south, and vice versa. It follows that as the cold periods become more and more severe, the warm intervening periods would become more and more warm. And that while the southern hemisphere was engulfed in a stupendous sea of ice, Greenland and the Arctic regions would be free from ice, and enjoying a mild and equable climate. Then at the end of the cycle the reverse would take place. And so during these periods of intense cold, the accumulation of ice and snow pushed its frigid folds far from their now limited circle, and carried with it

the debris which are now scattered broad-cast over the temperate zones; and with this some burden of rocks it grooved and scratched imperishable lines upon rocks of a more imperishable nature for a period of 50,000 years.

Phenomena in America.

The New England states present to the Geologist great opportunities for the study of the glacial epoch. nor are the evidences limited to the New England states alone, for unmistakable traces have been found in Ohio, and still farther south and west; even Kansas comes in for a share.

Agassiz, in his study of Maine says, that "nearly its whole width, and between latitude 44° and 45° bears all the characteristic indications of glacial action on its surface." Here the markings run north and south. Of course it is impossible to trace the same markings continuously, for in places the rocks are covered with many feet of earth, and again they are intercepted by streams of water of various sizes, through which it would be impossible to trace the grooves and scratches. But in taking a general view of the whole, we can say with comparative accurateness that the same markings continue from one ledge to another, and from

one bank of a river to the opposite one.

Those rocks which have been exposed to a more vigorous action of the glacier are polished to a high degree. Of course they do not glisten in the sunlight like a tombstone; but to such an extent are they polished that no other means could have accomplished the work except the external rubbing, grinding, scouring action of the glacier.

Over this portion of the United States are scattered boulders which are in no way similar to the other rocks deposited. Moraines are easily traced upon the hill-sides. In Ohio the glaciated surface consists of a rolling

surface essentially like the prairies of farther west, except that it was originally covered with timber. The pre-glacial channels have nearly all been buried out of sight, and it is rare that the rocks anywhere emerge above the till. Here the till itself contains glacial fragments of a great variety of rocks, all of which are from the north. Along the very edge of the glacial region are found immense boulders of granite, too numerous to mention. So thickly are they distributed here that it can be accurately determined how far the glacier reached.

Many may not see that an epoch of this sort has been of any

value to the area over which it extended. But it has been ably proved and is easily understood if we but think for a moment. The soil is composed of rock. Rocks which have been broken down by the actions of rain, frost, erosion, etc, and have been deposited over the surface of the earth. The action of the glacier is to transport rock which has been gathered up by its icy fouldo, and during transportation to crumble them into powder and deposit it broadcast over the surface of the earth. By this action has the glaciated portion of the earth been enriched, and to such an extent that in Ohio, where com-

parisons have been made, we find a ratio of 14:9 in favor of the glaciated area.

We might follow the action and compare notes in each of the states traversed by the glacier, but we will turn our attention for a time to Kansas.

Glacial actions here are not as easily recognized, in that limited area over which it extended, as they are the oldest glacial phenomena in America. Great moraine deposits in Brown, Leavenworth, and Douglas counties are hidden by vegetation, which has covered the largest boulders, and deposits of gravels and clay, which had been assorted and

arranged, and "even the hills have been rounded to the angle of conservation". All of northeastern Kansas, from the Missouri to the west of the Little Blue river, and as far south as the mouth of the Big Blue had a share in this great epoch that affected all the northeastern and northcentral parts of the North American continent.

If we bear in mind that the glacier returned toward the north, whence it came, it goes without saying that the glacial phenomena will be newer as we go in that direction from the southern border of the glaciated area, and if the retreat of the ice was very slow, as in the case of some of the small Alpine glaciers,

the southern parts of the area would have had a much longer time to be exposed to the weathering and denuding agencies of post-glacial times.

One of the most common signs of glacial action is the presence of striae, grooves in the surface of rock beds, done by the ice and hard rocks mixed in with it. This phenomena is largely missing in Kansas on account of the weathered condition of the rocks. In Nemaha county a small striated area has been observed, and fully examined by many. Coming still closer home the phenomena known as moraines, recognized by

agglomerations of foreign boulders, are observed in Washington County. Another a short distance south of Topeka has been observed. Here the boulders are strung out north and south for more than a mile. Still another is located south of Lawrence. This one runs east and west. This is evidently where the glacier rested, and dropped on its southern edge these heavy bodies of transported boulders; and leaves as a monument, this terminal moraine to mark the boundry of one of the greatest epoch in all times.

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