
IGNATIUS DONNELLY
RAGNAROK : THE AGE OF FIRE AND GRAVEL

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PART I.

The Drift

CHAPTER I.

THE CHARACTERISTICS OF THE DRIFT.

READER,--Let us reason together:--

What do we dwell on? The earth. What part of the earth? The latest formations, of course. We live upon the top of a mighty series of stratified rocks, laid down in the water of ancient seas and lakes, during incalculable ages, said, by geologists, to be from *ten to twenty miles in thickness*.

Think of that! Rock piled over rock, from the primeval granite upward, to a height *four times greater than our highest mountains*, and every rock stratified like the leaves of a book; and every leaf containing the records of an intensely interesting history, illustrated with engravings, in the shape of fossils, of all forms of life, from the primordial cell up to the bones of man and his implements.

But it is not with the pages of this sublime volume

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we have to deal in this book. It is with a vastly different but equally wonderful formation.

Upon the top of the last of this series of stratified rocks we find THE DRIFT.

What is it?

Go out with me where yonder men are digging a well. Let us observe the material they are casting out.

First they penetrate through a few inches or a foot or two of surface soil; then they enter a vast deposit of sand, gravel, and clay. It may be fifty, one hundred, five hundred, eight hundred feet, before they reach the stratified rocks on

which this drift rests. It covers whole continents. It is our earth. It makes the basis of our soils; our railroads cut their way through it; our carriages drive over it; our cities are built upon it; our crops are derived from it; the water we drink percolates through it; on it we live, love, marry, raise children, think, dream, and die; and in the bosom of it we will be buried.

Where did it come from?

That is what I propose to discuss with you in this work,--if you will have the patience to follow me.

So far as possible, [as I shall in all cases speak by the voices of others] I shall summon my witnesses that you may cross-examine them. I shall try, to the best of my ability, to buttress every opinion with adequate proofs. If I do not convince, I hope at least to interest you.

And to begin: let us understand what the Drift *is*, before we proceed to discuss its origin.

In the first place, it is mainly unstratified; its lower formation is altogether so. There may be clearly defined strata here and there in it, but they are such as a tempest might make, working in a dust-heap: picking up a patch here and laying it upon another there. But there

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are no continuous layers reaching over any large extent of country.

Sometimes the material has been subsequently worked over by rivers, and been distributed over limited areas in strata, as in and around the beds of streams.

But in the lower, older, and first-laid-down portion of the Drift, called in Scotland "the till," and in other countries "the

hard-pan," there is a total absence of stratification.

James Geikie says:

"In describing the till, I remarked that the irregular manner in which the stones were scattered through that deposit imparted to it a confused and tumultuous appearance. The clay does not arrange itself in layers or beds, but is distinctly unstratified."[1]

"The material consisted of earth, gravel, and stones, and also in some places broken trunks or branches of trees. Part of it was deposited in a pell-mell or unstratified condition during the progress of the period, and part either stratified or unstratified in the opening part of the next period when the ice melted."[2]

"The unstratified drift may be described as a heterogeneous mass of clay, with sand and gravel in varying proportions, inclosing the transported fragments of rock, of all dimensions, partially rounded or worn into wedge-shaped forms, and generally with surfaces furrowed or scratched, the whole material looking as if it had been scraped together."[3]

The "till" of Scotland is "spread in broad but somewhat ragged sheets" through the Lowlands, "continuous across wide tracts," while in the Highland and upland districts it is confined principally to the valleys.[4]

[1. "The Great Ice Age," p. 21.

2. Dana's "Text-Book," p. 220.

3. "American Cyclopædia," vol. vi, p. 111.

4. "Great Ice Age," Geikie, p. 6.]

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"The lowest member is invariably a tough, stony clay, called 'till' or 'hard-pan.' Throughout wide districts stony clay alone occurs."[1]

"It is hard to say whether the till consists more of stones or of clay."[2]

This "till," this first deposit, will be found to be the strangest and most interesting.

In the second place, although the Drift is found on the earth, it is unfossiliferous. That is to say, it contains no traces of pre-existent or contemporaneous life.

This, when we consider it, is an extraordinary fact:

Where on the face of this life-marked earth could such a mass of material be gathered up, and not contain any evidences of life? It is as if one were to say that he had collected the *detritus* of a great city, and that it showed no marks of man's life or works.

"I would reiterate," says Geikie,[3] "that nearly all the Scotch shell-bearing beds belong to the *very close of the glacial* period; only in one or two places have shells ever been obtained, with certainty, from a bed in the true till of Scotland. They occur here and there in bowlder-clay, and underneath bowlder-clay, in maritime districts; but this clay, as I have shown, is more recent than the till--fact, rests upon its eroded surface."

"The lower bed of the drift is entirely destitute of organic remains."[4]

Sir Charles Lyell tells us that even the stratified drift is usually devoid of fossils:

"Whatever may be the cause, the fact is certain that over large areas in Scotland, Ireland, and Wales, I might add

throughout the northern hemisphere, on both sides of the Atlantic, the stratified drift of the glacial period is very commonly devoid of fossils."[5]

[1. "Great Ice Age," Geikie, p. 7.

2. Ibid., p. 9.

3. Ibid., p. 342.

4. Rev. O. Fisher, quoted in "The World before the Deluge," p. 461.

5. "Antiquity of Man," third edition, p. 268.]

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In the next place, this "till" differs from the rest of the Drift in its exceeding hardness:

"This till is so tough that engineers would much rather excavate the most obdurate rocks than attempt to remove it from their path. Hard rocks are more or less easily assailable with gunpowder, and the numerous joints and fissures by which they are traversed enable the workmen to wedge them out often in considerable lumps. But till has neither crack nor joint; it will not blast, and to pick it to pieces is a very slow and laborious process. Should streaks of sand penetrate it, water will readily soak through, and large masses will then run or collapse, as soon as an opening is made into it."

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TILL OVERLAID WITH BOWLDER-CLAY, RIVER STINCHAR.

r, Rock; *t*, Till; *g*, Bowlder-Clay; *x*, Fine Gravel, etc.

The accompanying cut shows the manner in which it is distributed, and its relations to the other deposits of the Drift.

In this "till" or "hard-pan" are found some strange and characteristic stones. They are bowlders, not water-worn, not rounded, as by the action of waves, and yet not angular--for every point and projection has been ground off. They are not very large, and they differ in this and other respects from the bowlders found in the other portions of the Drift. These stones in the "till" are always striated--that is, cut by deep lines or grooves, usually running lengthwise, or parallel to their longest diameter. The cut on the following page represents one of them.

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Above this clay is a deposit resembling it, and yet differing from it, called the "bowlder-clay." This is not so tough or hard. The bowlders in it are larger and more angular-sometimes they are of immense size; one at

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SCRATCHED STONE (BLACK SHALE), FROM THE TILL.

Bradford, Massachusetts, is estimated to weigh 4,500,000 pounds. Many on Cape Cod are twenty feet in diameter. One at Whitingham, Vermont, is forty-three feet long by thirty feet high, or 40,000 cubic feet in bulk. In some

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cases no rocks of the same material are found within two hundred miles.[1]

These two formations--the "till" and the "bowlder-clay"--sometimes pass into each other by insensible degrees. At other times the distinction is marked. Some of the stones in the bowlder-clay are furrowed or striated, but a large part of them are not; while in the "till" *the stone not striated is the rare exception*.

Above this bowlder-clay we find sometimes beds of loose gravel, sand, and stones, mixed with the remains of man and other animals. These have all the appearance of being later in their deposition, and of having been worked over by the action of water and ice.

This, then, is, briefly stated, the condition of the Drift.

It is plain that it was the result of violent action of some kind.

And this action must have taken place upon an unparalleled and continental scale. One writer describes it as,

"A remarkable and stupendous period--a period so startling that it might justly be accepted with hesitation, were not the conception unavoidable before a series of facts as extraordinary as itself."[2]

Remember, then, in the discussions which follow, that if the theories advanced are gigantic, the facts they seek to explain are not less so. We are not dealing with little things. The phenomena are continental, world-wide, globe-embracing.

[1. Dana's "Text-Book," p. 221.

2. Gratacap, "Ice Age," "Popular Science Monthly," January, 1878.]

CHAPTER II.

THE ORIGIN OF THE DRIFT NOT KNOWN.

WHILE several different origins have been assigned for the phenomena known as "the Drift," and while one or two of these have been widely accepted and taught in our schools as established truths, yet it is not too much to say that no one of them meets all the requirements of the case, or is assented to by the profoundest thinkers of our day.

Says one authority:

"The origin of the unstratified drift is a question which has been much controverted."[1]

Louis Figuier says,[2] after considering one of the proposed theories:

"No such hypothesis is sufficient to explain either the cataclysms or the glacial phenomena; and we need not hesitate to confess our ignorance of this strange, this mysterious episode in the history of our globe. . . . Nevertheless, we repeat, no explanation presents itself which can be considered conclusive; and in science we should never be afraid to say, *I do not know*."

Geikie says:

"Many geologists can not yet be persuaded that till has ever formed and accumulated under ice." [3]

A recent scientific writer, after summing up all the facts and all the arguments, makes this confession:

[1. "American Cyclopædia," vol. vi, p. 112.

2. "The World before the Deluge," pp. 435, 463.

3. "The Great Ice Age," p. 370.]

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From the foregoing facts, it seems to me that we are justified in concluding:

"1. That however simple and plausible the Lyellian hypothesis may be, or however ingenious the extension or application of it suggested by Dana, it is not sustained by any proof, and the testimony of the rocks seems to be decidedly against it.

"2. Though much may yet be learned from a more extended and careful study of the glacial phenomena of all parts of both hemispheres, the facts already gathered *seem to be incompatible with any theory yet advanced* which makes the Ice period simply a series of telluric phenomena, and so far strengthens the arguments of those who look to extraneous and cosmical causes for the origin of these phenomena."[1]

The reader will therefore understand that, in advancing into this argument, he is not invading a realm where Science has already set up her walls and bounds and landmarks; but rather he is entering a forum in which a great debate still goes on, amid the clamor of many tongues.

There are four theories by which it has been attempted to explain the Drift.

These are:

I. The action of great waves and floods of water.

II. The action of icebergs.

III. The action of glaciers.

IV. The action of a continental ice-sheet.

We will consider these several theories in their order.

[1. "Popular Science Monthly," July, 1876, p. 290.]
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CHAPTER III.

THE ACTION OF WAVES.

WHEN men began, for the first time, to study the drift deposits, they believed that they found in them the results of the Noachic Deluge; and hence the Drift was called the Diluvium, and the period of time in which it was laid down was entitled the Diluvial age.

It was supposed that--

"Somehow and somewhere in the far north a series of gigantic waves was mysteriously propagated. These waves were supposed to have precipitated themselves upon the land, and then swept madly over mountain and valley alike, carrying along with them a mighty burden of rocks and stones and rubbish. Such deluges were called 'waves of translation.'"[1]

There were many difficulties about this theory:

In the first place, there was no cause assigned for these waves, which must have been great enough to have swept over the tops of high mountains, for the evidences of the Drift age are found three thousand feet above the Baltic, four thousand feet high in the Grampians of Scotland, and six thousand feet high in New England.

In the next place, if this deposit had been swept up from or by the sea, it would contain marks of its origin. The shells of the sea, the bones of fish, the remains of seals and whales, would have been taken up by these great deluges, and carried over the land, and have remained

[1. "The Great Ice Age," p. 26.]

mingled in the *débris* which they deposited. This is not the case. The unstratified Drift is unfossiliferous, and where the stratified Drift contains fossils they are the remains of land animals, except in a few low-lying districts near the sea.

I quote:

"Over the interior of the continent *it contains no marine fossils or relics*."[1]

Geikie says:

"*Not a single trace of any marine organism has yet been detected in true till*."[2]

Moreover, if the sea-waves made these great deposits, they must have picked up the material composing them either from the shores of the sea or the beds of streams. And when we consider the vastness of the drift-deposits, extending, as they do, over continents, with a depth of hundreds of feet, it would puzzle us to say where were the sea-beaches or rivers on the globe that could produce such inconceivable quantities of gravel, sand, and clay. The production of gravel is limited to a small marge of the ocean, not usually more than a mile wide, where the waves and the rocks meet. If we suppose the whole shore of the oceans around the northern half of America to be piled up with gravel five hundred feet thick, it would go but a little way to form the immense deposits which stretch from the Arctic Sea to Patagonia.

The stones of the "till" are strangely marked, striated, and scratched, with lines parallel to the longest diameter. No such stones are found in river-beds or on sea-shores.

Geikie says:

"We look in vain for striated stones in the gravel which the surf drives backward and forward on a beach,

[1. Dana's "Text-Book," p. 220.

2. "The Great Ice Age," p. 15.]

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and we may search the *detritus* that beaches and rivers push along their beds, but *we shall not find any stones at all resembling those of the till*."[1]

But we need not discuss any further this theory. It is now almost universally abandoned.

We know of no way in which such waves could be formed; if they were formed, they could not find the material to carry over the land; if they did find it, it would not have the markings which are found in the Drift, and it would possess marine fossils not found in the Drift; and the waves would not and could not scratch and groove the rock-surfaces underneath the Drift, as we know they are scratched and grooved.

Let us then dismiss this hypothesis, and proceed to the consideration of the next.

[1. "The Great Ice Age," p. 69.]

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CHAPTER IV.

WAS IT CAUSED BY ICEBERGS?

WE come now to a much more reasonable hypothesis, and one not without numerous advocates even to this day, to wit: that the drift-deposits were caused by icebergs floating down in deep water over the sunken land, loaded with *débris* from the Arctic shores, which they shed as they melted in the warmer seas of the south.

This hypothesis explains the carriage of enormous blocks weighing hundreds of tons from their original site to where they are now found; but it is open to many unanswerable objections.

In the first place, if the Drift had been deposited under water deep enough to float icebergs, it would present throughout unquestionable evidences of stratification, for the reason that the larger masses of stone would fall more rapidly than the smaller, and would be found at the bottom of the deposit. If, for instance, you were to go to the top of a shot-tower, filled with water, and let loose at the same moment a quantity of cannon-balls, musket-balls, pistol-balls, duck-shot, reed-bird shot, and fine sand, all mixed together, the cannon-balls would reach the bottom first, and the other missiles in the order of their size; and the deposit at the bottom would be found to be regularly stratified, with the sand and the finest shot on top. But nothing of this kind is found in the Drift, especially in the "till"; clay, sand, gravel, stones,

and bowlders are all found mixed together in the utmost confusion, "higgledy-piggledy, pell-mell."

Says Geikie:

"Neither can till owe its origin to icebergs. If it had been distributed over the sea-bottom, it would assuredly have shown some kind of arrangement. When an iceberg drops its rubbish, it stands to reason that the heavier blocks will reach the bottom first, then the smaller stones, and lastly the finer ingredients. There is no such assortment visible, however, in the normal 'till,' but large and small stones are scattered pretty equally through the clay, which, moreover, is quite unstratified."[1]

This fact alone disposes of the iceberg theory as an explanation of the Drift.

Again: whenever deposits are dropped in the sea, they fall uniformly and cover the surface below with a regular sheet, conforming to the inequalities of the ground, no thicker in one place than another. But in the Drift this is not the case. The deposit is thicker in the valleys and thinner on the hills, sometimes absent altogether on the higher elevations.

"The true bowlder-clay is spread out over the region under consideration as a somewhat widely extended and uniform sheet, yet it may be said to fill up all small valleys and depressions, and to be thin or absent on ridges or rising grounds."[2]

That is to say, it fell as a snow-storm falls, driven by high winds; or as a semi-fluid mass might be supposed to fall, draining down from the elevations and filling up the hollows.

Again: the same difficulty presents itself which we found in the case of "the waves of transplantation." Where did the material of the Drift come from? On what sea-shore, in what river-beds, was this incalculable mass of clay, gravel, and stones found?

[1. "The Great Ice Age," p. 72.

2. "American Cyclopædia," vol. vi, p. 112.]

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Again: if we suppose the supply to have existed on the Arctic coasts, the question comes,

Would the icebergs have carried it over the face of the continents?

Mr. Croll has shown very clearly[1] that the icebergs nowadays usually sail down into the oceans without a scrap of *débris* of any kind upon them.

Again: how could the icebergs have made the continuous scratchings or striæ, found under the Drift nearly all over the continents of Europe and America? Why, say the advocates of this theory, the icebergs press upon the bottom of the sea, and with the stones adhering to their base they make those striæ.

But two things are necessary to this: First, that there should be a force great enough to drive the berg over the bottom of the sea when it has once grounded. We know of no such force. On the contrary, we do know that wherever a berg grounds it stays until it rocks itself to pieces or melts away. But, suppose there was such a propelling force, then it is evident that whenever the iceberg floated clear of the bottom it would cease to make the strive, and would resume them only when it nearly stranded again. That is to say,

when the water was deep enough for the berg to float clear of the bottom of the sea, there could be no striæ; when the water was too shallow, the berg would not float at all, and there would be no striæ. The berg would mark the rocks only where it neither floated clear nor stranded. Hence we would find striæ only at a certain elevation, while the rocks below or above that level would be free from them. But this is not the case with the drift-markings. They pass over mountains and down into the deepest valleys; they are

[1. "Climate and Time," p. 282.]

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universal within very large areas; they cover the face of continents and disappear under the waves of the sea.

It is simply impossible that the Drift was caused by icebergs. I repeat, when they floated clear of the rocks, of course they would not mark them; when the water was too shallow to permit them to float at all, and so move onward, of course they could not mark them. The striations would occur only when the water was; just deep enough to float the berg, and not deep enough to raise the berg clear of the rocks; and but a small part of the bottom of the sea could fulfill these conditions.

Moreover, when the waters were six thousand feet deep in New England, and four thousand feet deep in Scotland, and over the tops of the Rocky Mountains, where was the rest of the world, and the life it contained?

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CHAPTER V.

WAS IT CAUSED BY GLACIERS?

WHAT is a glacier? It is a river of ice, crowded by the weight of mountain-ice down into some valley, along which it descends by a slow, almost imperceptible motion, due to a power of the ice, under the force of gravity, to rearrange its molecules. It is fed by the mountains and melted by the sun.

The glaciers are local in character, and comparatively few in number; they are confined to valleys having some general slope downward. The whole Alpine mass does not move down upon the plain. The movement downward is limited to these glacier-rivers.

The glacier complies with some of the conditions of the problem. We can suppose it capable of taking in its giant paw a mass of rock, and using it as a graver to carve deep grooves in the rock below it; and we can see in it a great agency for breaking up rocks and carrying the *detritus* down upon the plains. But here the resemblance ends.

That high authority upon this subject, James Geikie, says:

"But we can not fail to remark that, although scratched and polished stones occur not infrequently in the frontal moraines of Alpine glaciers, yet at the same time these moraines *do not at all resemble till*. The moraine consists for the most part of a confused heap of rough *angular* stones and blocks, and loose sand and *débris*; scratched

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stones are decidedly in the minority, and indeed *a close search will often fail to show them*. Clearly, then, the till is

not of the nature of a terminal moraine. *Each stone* in the 'till' gives evidence of having been subjected to a grinding process. . . .

"We look in vain, however, among the glaciers of the Alps for such a deposit. The scratched stones we may occasionally find, *but where is the clay?* . . . It is clear that the conditions for the gathering of a stony clay like the I till' do not obtain (as far as we know) among the Alpine glaciers. There is too much water circulating below the ice there to allow any considerable thickness of such a deposit to accumulate."[1]

But it is questionable whether the glaciers do press with a steady force upon the rocks beneath so as to score them. As a rule, the base of the glacier is full of water; rivers flow from under them. The opposite picture, from Professor Winchell's "Sketches of Creation," page 223, does not represent a mass of ice, bugging the rocks, holding in its grasp great gravers of stone with which to cut the face of the rocks into deep grooves, and to deposit an even coating of rounded stones and clay over the face of the earth.

On the contrary, here are only angular masses of rock, and a stream which would certainly wash away any clay which might be formed.

Let Mr. Dawkins state the case:

"The hypothesis upon which the southern extension is founded--that the bowlder-clays have been formed by ice melting on the land--is open to this objection, that *no similar clays have been proved to have been so formed*, either in the Arctic regions, where the ice-sheet has retreated, or in

the districts forsaken by the glaciers in the Alps or Pyrenees, or in any other mountain-chain. . . .

The English bowlder-clays, as a whole, differ from

[1. "The Great Ice Age," pp. 70-72.]

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the *moraine profonde* in their softness, and the large area which they cover. Strata of bowlder-clay at all comparable to the great clay mantle covering the lower grounds of Britain, north of the Thames, are conspicuous by their absence from the glaciated regions of Central Europe and the Pyrenees, which were not depressed beneath the sea."

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A RIVER ISSUING FROM A SWISS GLACIER.

Moreover, the Drift, especially the "till," lies in great continental sheets of clay and gravel, of comparatively uniform thickness. The glaciers could not form such sheets; they deposit their material in long ridges called "terminal moraines."

Agassiz, the great advocate of the ice-origin of the Drift, says:

"All these moraines are the land-marks, so to speak, by which we trace the height and extent, as well as the

[1. Dawkin's "Early Man in Britain," pp. 116, 117.]

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progress and retreat, of glaciers in former times. Suppose, for instance, that a glacier were to disappear entirely. For ages it has been a gigantic ice-raft, receiving all sorts of materials on its surface as it traveled onward, and bearing them along with it; while the hard particles of rocks

set in its lower surface have been polishing and fashioning the whole surface over which it extended. As it now melts it drops its various burdens to the ground; bowlders are the milestones marking the different stages of its journey; the terminal and lateral moraines are the frame-work which it erected around itself as it moved forward, and which define its boundaries centuries after it has vanished."[1]

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TERMINAL MORAINE.

And Professor Agassiz gives us, on page 307 of the same work, the above representation of a "terminal moraine."

The reader can see at once that these semicircular

[1. "Geological Sketches," p. 308.]

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ridges bear no resemblance whatever to the great drift-deposits of the world, spread out in vast and nearly uniform sheets, without stratification, over hills and plains alike.

And here is another perplexity: It might naturally be supposed that the smoothed, scratched, and smashed appearance of the underlying rocks was due to the rubbing and rolling of the stones under the ice of the glaciers; but, strange to say, we find that--

"The scratched and polished rock-surfaces are by no means confined to till-covered districts. They are met with *everywhere* and *at all levels* throughout the country, from the sea-coast up to near the tops of some of our higher mountains. The lower hill-ranges, such as the Sidlaws, the Ochils, the Pentlands, the Kilbarchan and Paisley Hills, and others, exhibit polished and smoothed rock-surfaces *on their*

very crest. Similar markings streak and score the rocks up to a great height in the deep valleys of the Highlands."[1]

We can realize, in our imagination, the glacier of the mountain-valley crushing and marking the bed in which it moves, or even the plain on which it discharges itself; but it is impossible to conceive of a glacier upon the bare top of a mountain, without walls to restrain it or direct its flow, or higher ice accumulations to feed it.

Again:

"If glaciers descended, as they did, on both sides of the great Alpine ranges, then we would expect to find the same results on the plains of Northern Italy that present themselves on the low grounds of Switzerland. But this is not the case. On the plains of Italy there are no traces of the stony clay found in Switzerland and all over Europe. Neither are any of the stones of the drift of Italy scratched or striated."[2]

[1. "The Great Ice Age," p. 73.

2. Ibid., pp. 491, 492.]

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But, strange to say, while, as Geikie admits, no true "till" or Drift is now being formed by or under the glaciers of Switzerland, nevertheless "till" is found in that country *disassociated from the glaciers*. Geikie says:

"In the low grounds of Switzerland we get a dark, tough clay, packed with scratched and well-rubbed stones, and containing here and there some admixture of sand and irregular beds and patches of earthy gravel. This clay is quite unstratified, and the strata upon which it rests frequently exhibit much confusion, being turned up on end

and bent over, exactly as in this country the rocks are sometimes broken and disturbed below till. The whole deposit has experienced much denudation, but even yet it covers considerable areas, and attains a thickness varying from a few feet up to not less than thirty feet in thickness." [1]

Here, then, are the objections to this theory of the glacier-origin of the Drift:

I. The glaciers do not produce striated stones.

II. The glaciers do not produce drift-clay.

III. The glaciers could not have formed continental sheets of "till."

IV. The glaciers could not have existed upon, and consequently could not have striated, the mountain-tops.

V. The glaciers could not have reached to the great plains of the continents far remote from valleys, where we still find the Drift and drift-markings.

VI. The glaciers are limited in number and confined in their operations, and were utterly inadequate to have produced the thousands of square miles of drift-*débris* which we find enfolding the world.

[1. "The Great Ice Age," p. 373.]

CHAPTER VI.

WAS IT CAUSED BY CONTINENTAL ICE-SHEETS?

WE, come now to the theory which is at present most generally accepted:

It being apparent that glaciers were not adequate to produce the results which we find, the glacialists have fallen back upon an extraordinary hypothesis--to wit, that the whole north and south regions of the globe, extending from the poles to 35° or 40° of north and south latitude, were, in the Drift age, covered with enormous, continuous sheets of ice, from one mile thick at its southern margin, to three or five miles thick at the poles. As they find drift-scratches upon the tops of mountains in Europe three to four thousand feet high, and in New England upon elevations six thousand feet high, it follows, according to this hypothesis, that the ice-sheet must have been considerably higher than these mountains, for the ice must have been thick enough to cover their tops, and high enough and heavy enough above their tops to press down upon and groove and scratch the rocks. And as the *striæ* in Northern Europe were found to disregard the conformation of the continent and the islands of the sea, it became necessary to suppose that this polar ice-sheet filled up the bays and seas, so that one could have passed dry-shod, in that period, from France to the north pole, over a steadily ascending plane of ice.

No attempt has been made to explain where all this

ice came from; or what force lifted the moisture into the air which, afterward descending, constituted these world-cloaks of frozen water.

It is, perhaps, easy to suppose that such world-cloaks might have existed; we can imagine the water of the seas falling on the continents, and freezing as it fell, until, in the course of ages, it constituted such gigantic ice-sheets; but something more than this is needed. This does not account for these hundreds of feet of clay, bowlders, and gravel.

But it is supposed that these were torn from the surface of the rocks by the pressure of the ice-sheet moving southward. But what would make it move southward? We know that some of our mountains are covered to-day with immense sheets of ice, hundreds and thousands of feet in thickness. Do these descend upon the flat country? No; they lie there and melt, and are renewed, kept in equipoise by the contending forces of heat and cold.

Why should the ice-sheet move southward? Because, say the "glacialists," the lands of the northern parts of Europe and America were then elevated fifteen hundred feet higher than at present, and this gave the ice a sufficient descent. But what became of that elevation afterward? Why, it went down again. It had accommodatingly performed its function, and then the land resumed its old place!

But *did* the land rise up in this extraordinary fashion? Croll says:

"The greater elevation of the land (in the Ice period) is simply assumed as an hypothesis to account for the cold. The facts of geology, however, are fast establishing the opposite conclusion, viz., that when the country was

covered with ice, the land stood in relation to the sea at a lower level than at present, and that the continental periods or times, when the land stood in relation to the

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sea at a higher level than now, were the warm inter-glacial periods, when the country was free of snow and ice, And a mild and equable condition of climate prevailed. This is the conclusion toward which we are being led by the more recent revelations of surface-geology, and also by certain facts connected with the geographical distribution of plants and animals during the Glacial epoch."[1]

H. B. Norton says:

"When we come to study the cause of these phenomena, we find many perplexing and contradictory theories in the field. A favorite one is that of vertical elevation. But it seems impossible to admit that the circle inclosed within the parallel of 40°--some seven thousand miles in diameter--could have been elevated to such a height as to produce this remarkable result. This would be a supposition hard to reconcile with the present proportion of land and water on the surface of the globe and with the phenomena of terrestrial contraction and gravitation."[2]

We have seen that the surface-rocks underneath the Drift are scored and grooved by some external force. Now we find that these markings do not all run in the same direction; on the contrary, they cross each other in an extraordinary manner. The cut on the following page illustrates this.

If the direction of the motion of the ice-sheets, which caused these markings, was,--as the glacialists allege,--always from the elevated region in the north to the lower