Undertaking to deal with ice age, subject well fitted for course thus signed evening with third attention by Sketch.

Lecture in Victoria P.S.
1876.

At a time not very remote in human history, or even in the progress of that modern civilization of which we are all proud, when many of the sciences had emerged from mediaeval darkness, & made considerable progress in the paths of legitimate enquiry in which they have since achieved so great success; that department of knowledge now known as geology did not exist, & the few facts in the physical history of the globe which had come to light were not grouped together under any common name, & received little attention. People were content still to look upon a rock as so much hard stuff, suitable perhaps for building, but perhaps only standing in the way of some road or needed improvement; or earth merely as soft stuff interesting if capable of yielding potatoes, but otherwise undeserving ~~attention~~ notice. It was

also imagined that things had always been much as they now appear since some period vaguely known as the 'beginning of the world', & it had hardly dawned upon the minds even of the most thoughtful men that the physical geography of our earth of today ~~was~~ is only one view in a great succession, which under the influence of supreme law, had passed over this our earth. The miner in pursuit of ore groped, it is true in the rocky substratum of the earth, but he was only guided by certain empirical rules, the result of tedious experience, & the structure of the crust of the earth only presented itself to him as a question of easy or difficult penetration. If occasionally he should turn out of the solid rock the print of some shell, or marine animal, or plant, or if such should be found on the surface, high above the sea,

perhaps somewhere on the summit of a mountain range, men of learning were content to call it a lusus naturae, or freak of nature, & not enquire further about it. As long ago as 1688, however, Robert Hooke, an English physician wrote as follows, showing that the spirit of enquiry once awakened would not be debarred even from this field of knowledge — "However trivial a thing a rotten shell may appear to some, yet these monuments of nature are more certain tokens of antiquity than coins or medals, since the best of these may be counterfeited or made by art or design, as may also books, manuscripts, & inscriptions, as all the learned are now sufficiently satisfied has often been actually practised" "& though it may be granted that it is very difficult to read the records of

nature, & to raise a chronology out of them, & to state the intervals of the time wherein such & such Catastrophes & mutations have happened, yet it is not impossible"

A new light dawned when it was discovered that certain shells & other animal remains found in the rocks ~~could~~ do not now inhabit any part of the world; that they are in fact extinct & further that among the great diversity of these old remains or fossils as they are generally called, some only occur in certain beds of rock. Thus it was found in England that where certain kinds of fossils occur in the rocks, coal was pretty sure to be found there also, while other rock formations however much they resembled the coal bearing rocks, could be distinguished from them by holding the remains of animals & plants of

of a different kind. This knowledge directed the miner in his search, & showed him where it would be useless to spend time & money in looking for what did not exist. This application of the 'Medals of Creation' as these organic remains may be called, is due to an English engineer with the very ordinary name of William Smith, who published the result of his studies in 1790, & has been called the Father of English Geology. He showed that where the different rocks are well seen they can be divided into series, & that where they have not been too much broken & bent, those which are deepest are also oldest, that other beds of rock lie upon these, & others again on these, & that each great layer held fossils of a kind peculiar to itself, & also that as we ~~went~~ go further & further down into the rocks we find

pile of books | +

forms of animals more & more unlike those now living. Thus, what is called the succession & progress of life in time was discovered, & it became possible when in some altogether ~~xxx~~ unknown locality, where perhaps the rocks are not well shown, to judge their age pretty nearly if only fossils can be found.

Thus the science of Geology arose, but for a long time attention was confined to the hard masses which we usually call rocks, & naturally so, for with them the valuable deposits of coal & the various metals are usually found. The clays, sands, gravels, & soils now covering the surface of the older rocks, were little investigated; but when at last they too were carefully examined, it was found that in these newest deposits of all there were problems of no ordinary difficulty.

It might appear reasonable to suppose that these soft deposits, formed as they are from the decay of harder rocks, would generally be found to be composed of crumbled fragments of rocks in their immediate neighbourhood, & bear some more or less close resemblence to them. But this is ~~[illegible]~~ not always the case, for we find gravel & sand perhaps still distinguishable as having come from some rocks which are only found in the solid state at a great distance, we see also in some places not only pebbles, but great boulders, & blocks of stone upon the surface which do not resemble any rocks found near at hand. Then, removing the sand or clay, or examining localities where ~~[illegible]~~ these have been naturally carried away, it may appear that the surface of the solid rock below is hard & smooth, &

does not show any sign of rotting away to add to the soil. On a closer examination it may also be observed in some localities that the rock is not only smooth & rounded, but has apparently been scratched & scored as though some very rough polishing powder had been applied to it.

Sq. Victoria

Similar sand & gravel beds are in many places found forming old beaches, or as they are sometimes called terraces, or benches, far above the present level of the sea, upon the hillsides, & in some of these marine shells may be observed, not in all cases scattered about near the surface as though birds might have carried them up, but often buried like clams in the old mud with both valves, & in the position in which they lived. These benches or ancient sea beaches also in many places

stretch far inland, surrounding lakes, rivers, & valleys in which now no water lies, & evidencing the great former extent of the sea.

The ~~[illegible]~~ surface materials of the land, when it became evident that they were in many cases derived from other regions than those they now occupy were called drift deposits, & when those of different localities were closely compared with the parent rocks, it became evident that the general direction in which most of this drift has travelled was from north to south, & then it was put forward as a plausible hypothesis that the drift deposits were the result of a great diluvial wave, supposed to be something like those now occasionally produced by earthquakes, but on a vastly greater scale, which, resulting from some great natural convulsion, swept

e.g. mountain of granite with long train of boulders

from north to south, bearing everything before it. This great wave thick with mud & sand, & charged with stones, shells, & everything else that could be gathered up from the bottom of the sea or surface of the land, was ~~[illegible]~~ thought to have submerged the greater part of the present continents. The smoothing & scratching of the solid rocks was explained by the pushing forward of stones by the rush of water, & the loose materials of the surface were said to have been left behind when it subsided.

This however did not long serve as an explanation of the phenomena. It did not very well explain the facts themselves, & was besides soon found to be at variance with what was known of the ~~[illegible]~~ other changes in the history of the earth, which it became more & more clearly evident were the result of the long continued action of such forces as we see around

as today, rather than of sudden natural convulsions & cataclisms. The theory however was false, as most theories are, for it lead to research, & the discovery of new facts, which, while tending to controvert it, added allways to our general knowledge of the subject. ~~It at last became~~ at length however it became evident that only ice action on a great scale would explain the facts as we find them, & as is always the case when the true explanation is at last reached, a thousand facts before anomalous at once fall naturally into their places to support it.

It was found in fact that a great part of the northern hemisphere had been acted upon by glacier or iceberg ice on a prodigious scale, at a date subsequent to nearly all the other events of geological history.

Having arrived at this conclusion it will be

desirable to take a brief review of our knowledge of modern glaciers & icebergs that we may see which of the agents best serves to explain the facts, & how they may be supposed to have acted; without however entering into details, & necessarily passing over many interesting points which might alone occupy several evenings. We know that in temperate regions snow falling on mountains above a certain level never entirely melts, & even in the tropics some peaks are so high as to be permanently snow-clad, & were there no natural provision for its removal, the snow in great mountain ranges, except where able to remove itself by slides & avalanches, would accumulate till the tops of the mountains were completely buried & the high peaks would increase indefinitely in height. This is not the case however, for it is found that the great snow-drifts

collected in the upland valleys, by the pressure of its own mass, & the alternate action of frost & thaw, turns little by little to solid ice; & that this ice instead of accumulating indefinitely, moves slowly away by the lower valleys, taking the same course that a river would, but very much more gradually, flowing something like very thick glue or treacle, but still flowing. These rivers of ice or glaciers are found in many places coming far down the slopes below the normal line of perpetual snow, pushing their way sometimes among forests, or even near cultivated fields, but growing always less by liquefaction, till at last they are seen to terminate where the heat becomes too great for them to exist any longer, forming streams & rivers of running water. They may push a little further forward in winter, ~~[illegible]~~ ~~[illegible]~~ or may not be able to advance

quite so far in summer, but the average climate remaining the same, they are not generally much affected from year to year. The rate of movement of glaciers is found on careful examination to differ during winter & summer, being greatest in the warm season, & is also affected by local circumstances, but perhaps 12 inches a day may be about the average, corresponding to 1 mile in about 14 ½ years, showing that even in the ~~[illegible]~~ glaciers of the European alps hundreds of years may be occupied in the descent of a mass of ice from the source. The surface of the glacier is usually covered with stones & rubbish which have fallen on it from the neighbouring hills, & these are carried along with it, just as the chips & straws move on the waters of a river. ~~[illegible]~~

In moving over its rocky bed great cracks or crevaces are formed in the ice of the glacier, & into these too adventurous travellers have at times fallen, & being carried with the slow movement of the ice, their bodies have appeared many years afterwards at the lower levels on its dissolution. The stones covering the surface also fall into these openings from time to time, & making their way to the bottom of the glacier, become sometimes fixed in the ice like a ~~gem~~ diamond in its setting, & are pushed along the rock's surface, rasping & groving it. We find that these stones grind the bottom, & are themselves ground into sand & mud, which becomes evident when we examine the stream flowing away from the end of the glacier, which is always turbid & milky with this flour of rocks as it has been called. When at last the ice melts, the remaining stones & earth,

C.g. stone from glacier. scratched &c. ×

Carried so far, are dumped off at the end & piled up into mounds & ridges called end moraines, some of them stranded against the sides of the valley form side moraines.

This description applies to glaciers like those of Switzerland, or the Cascade Mountains here, ~~but~~ where the ice may perhaps be 200 or 300 feet thick. Had we never heard of glaciers thicker than these we could hardly credit that in Greenland they are actually from 2000 to 3000 feet thick, but this is the case. In that northern latitude the limit of perpetual snow instead of being 6000 or 8000 feet above the sea, comes nearly down to the ocean level, & the supply is very great. We find the glaciers here not ending on the land, but pushing out to sea & finally buoyed up by the water, being broken off in large pieces, & these are the conditions which give rise to icebergs. Nor

are the glaciers of Greenland mere icy ribbands stretching down among the hills, the great Humboldt glacier enters the sea with a breadth of forty-five miles, & it is but one among many. There is further every reason to believe that the interior of the Continent of Greenland is covered with one great confluent glacier, by which term is meant a mass of ice so great that it not only fills the valleys, but passes up over ~~the hills~~ most of the hills, so that one continuous ice sheet covers the entire country. Of this form of glacier, vastly more powerful than anything existing in temperate latitudes, we know very little, but hear what Dr Hayes one of the very few explorers who has penetrated at all beyond the coast of Greenland, has to say.—

On the first day he & his party reached the foot of the great glacier, the second day's journey

carried them to its upper surface. On the third day they travelled 30 miles, & the ascent which had been about 6°, diminished gradually to about 2°. They advanced on the fourth day about 25 miles; the temperature being 30° below zero. "Our station at the camp" he says "was sublime as it was dangerous. We had attained an altitude of 5000 feet above the sea level, & were 70 miles from the coast in the midst of a vast frozen Sahara immeasurable to the human eye. There was neither hill mountain nor gorge anywhere in view. We had completely sunk the strip of land between the Mer de Glace & the sea, & no object met the eye but our feeble tent, which bent to the storm. Fitful clouds swept over the face of the full-orbed moon, which, descending towards the horizon, glimmered through the drifting snow that scudded over the icy plain — to the eye in undulating lines

of downy softness, to the flesh in showers of piercing darts."

It has proved almost impossible to explore the South polar region, but where the land has been reached by various voyagers, it has been seen to present a nearly continuous front of huge icy cliffs, & we may judge to some extent of the development of the glaciers of the South pole, from the ~~glaciers~~ icebergs which break from them, & float northward into warmer latitudes. These far transcend the bergs of the Greenland glaciers, vast though they are, & a few instances ~~[illegible]~~ will tend to show ~~[illegible]~~ what icebergs really ~~[illegible]~~ may be when developed under favourable circumstances.

Feb. 1860. Capt. Clarke of the "Lightning" when in lat. 55° 20' S., long. 122° 45' W., found an iceberg 500 feet high & 3 miles long.

Decr. 1. 1859. An iceberg 580 feet high, & from 2 1/2

to 3 miles long was seen by Capt. Smithers of the 'Edmond' in lat. 50°52′ S., long 43°58′ W., This berg was at first taken for an island

May 23. 1853. The 'Agneta' passed an iceberg in lat. 53°14′ S., long 14°41′ E., 960 feet high

Aug. 16. 1840. The Dutch ship "General Baron von Geem" passed an iceberg 1000 feet high in lat. 37°52′ S., long. 14°10′ E.,

Many instances might be given, but from these it seems that we may safely conclude that even the glacial phenomena of Greenland are small as compared with those of the great unknown Southern Continent, & that it ~~also~~ also is covered by a Continent Glacier, but one almost continental in size, ~~its probable diameter being~~ its surface being probably 2800 miles across. What smoothing grooves & transporting of stones & rubbish may not such an ice sheet as this accomplish.

The icebergs ~~at~~ just described though but fragments are by no means insignificant, especially when it is remembered that in a floating ice-block about 8 1/2 times as much ice is below the surface ~~than~~ as appears above. When icebergs become weathered & broken they take very irregular forms, & pinnicles may rise to a great height above the sea, from a broad base which may not be very deep, & yet ~~contain~~ amount to 8 1/2 times the bulk of the ice which is seen. When however ~~[illegible]~~ as in some of these huge bergs the ice-mass is several miles in length, this cannot be the case, & the height above water must bear an exact proportion to that below,— that is to say that an iceberg 500 feet high out of water, would be altogether 4250 feet thick, while one like that seen by the "Agneta" 960 feet high, would have a total thickness

of 9312 feet! which is upwards of a mile & three quarters. When a body like this moving along under the influence of some deep ocean current chances to strike on a shoal or rock, the bottom may be ploughed up, & rock surfaces smoothed & striated for miles.

Such, then, are glaciers & icebergs, the tools by which all are agreed the last great shaping of the earth, during the ice age, has been accomplished. Geologists are not however perfectly agreed as to the relative share which the two agents have borne in the work, some attributing all, or nearly all, to glaciers; others, to icebergs, just as at a former time one school of thinkers explained nearly all the changes which have taken place in the world to subterranean heat, another to the waters of the surface. In this case, as in that, the truth will probably be found to lie between the two extremes,

especially as to have icebergs we must suppose glaciers, & large glaciers would not probably exist without the formation of icebergs.

Now taking with us such light as we have been able to obtain from a study of the phenomena presented to us in the living world, let us journey away into the "far backward & abysm of time" — though dealing always with a period which compared with the antecedent eternity of geology is a very modern one, — & try to fit together the different facts & relics in their sequence, & arrive at some intelligent & connected account of the great ice age.

Altogether previous to the glacial epoch, we find that ~~[illegible]~~ a climate warmer than the present, had for a long time spread over both the western & eastern hemispheres. Taking as an example the great interior region of this continent, we see broad plains

with luxurient forests, including even palms, & lakes larger than the present great lakes of America. Animals resembling those of warm climates, but of forms which are extinct, roam in countless numbers & of many kinds. Even as far north as Greenland & Spitsbergen forests including the fig, magnolia, & vine grew. Many of the great rivers of today then ran in nearly the same courses, & the surface of the land was diversified by hill & dale & mountain, & looked quite as fixed & permanent as that now around us. Turning up Nature's old store houses & rubbish heaps, we find in later deposits, fragments which still remain in some places, proof that a change was coming on. The so called Cromer forest bed, of England is one of these, here with remains of insects & shells of living species, are plants indicating a temperate climate, & animals some of which yet exist

while others are extinct. Among these are the beaver, wolf, fox, stag, Auroch, mole, the Mammoth, & great Irish Elk etc. (but not man.) The land in the northern hemisphere also appears to have been before the Glacial period at a higher level than now, with broader continents. England in all probability was joined to the rest of Europe, giving these animals free access to it.

There is no reason to think that the Cromer Forest Bed is exceptional or local in its character on the contrary we have every reason to believe that the process of refrigeration, one of the stages of which it represents, was a very gradual one, & that though deposits made at this intermediate period are now rarely found, it is only because they have been covered up by newer beds, or swept away.

Shortly after that stage of which we have taken the Cromer beds as a representative

the lands of the Northern hemisphere began to be depressed, & the sea to flow upon them. Just about this time, but whether ~~&~~ while the land was still at its highest or after it had sunk somewhat we cannot yet tell, glaciers began to appear in temperate latitudes, the climate having now changed so much that it became possible ~~&~~ for them to do so.

It is very difficult to trace the progress of events during the early part of the glacial period, for the simple reason that the subsequent action of the ice, ~~[illegible]~~ when at its greatest development, was such as to rub out & destroy the traces of the earlier glaciers & icebergs. We find the waters however slowly gaining upon the land, & at last that glaciers had attained an enormous development, while the whole northern part of America, & Europe ~~[illegible]~~ were submerged, & the

sea above them full of floating ice. All the mountains & elevated tracts rising above the water had their glaciers, & these not only filled the valleys, but became in many places confluent, & exposed to conditions of modern greenland or regions far to the south. At this period of greatest severity of climate, & greatest depression of the land, the deposit known as Boulder Clay was formed. ✱ Remains of shells are very seldom found in the boulder clay, & we may suppose that in most cases the water was too turbid, or too much mingled with fresh water from melting ice, for marine life; yet in a few places where the sea of those days must have been deepest shells are found, & the boulders dropped from icebergs have afterwards been crusted over coralline.

describe ✱

In Europe, when the Arctic sea spread furthest, it covered Denmark, Scandinavia, Russia, Poland,

North Germany, & the greater part of Britain; In America it stretched to Ohio, Indiana, Illinois, & Iowa. The depth of water over a part at least of England was 1500 feet, for we find sand & clay beds with sea shells at that height on the mountains. In America boulder clay without shells, but with stones which have been transported from ~~[illegible]~~ distant localities ~~[illegible]~~ is found on Mount Washington, & other New England peaks at various heights between 4,000 & 6000 feet. Along the Eastern slopes of the Rocky Mountains terraces, or old sea margins ~~[illegible]~~ exist at different elevations to nearly 5000 feet, & in the Cascade Mountains they probably occur to a similar height.

Taking North America as a type, let us try to picture ~~[illegible]~~ the condition of affairs when the period of cold was at its greatest, or had not

Land & water areas on the map. ×

yet much declined. The great source of ice was the Laurentian region as it has been called. This elevated rocky plateau was covered with a huge confluent glacier, descending southwards & westwards, & launching from time to time great ~~glaciers~~ icebergs from its whole front. There floating away under the influence of currents & the wind scattered their debris as they went, or grounding on some shoal or bank, slowly decayed, & left a piled up mass of stones & clay. It can be proved that some pieces of granite & other kinds of rock travelled at this time two or three hundred miles southward from the Laurentian range, & that others were carried 700 miles westward over the ocean which then covered the great plains. All the peaks of the Rocky Mountains, Cascade mountains, & hills of New England which projected above the waters also had their glaciers, but-

Section of sheet ×

missouri Coteau?

the gathering grounds for snow were not so extensive as those of the Laurentian region, & the ice streams smaller. Still we find that rocks only occurring in the Rocky Mountains have been drifted in ice several hundred miles eastward, & scattered over the plains to mix with those coming from the east. What the state of the region northward, within the Arctic Circle was at this time we have little means of knowing, but it may probably have been covered with a great ice-cap like that ~~[illegible]~~ covering the South polar region at present. (What a change now when compared with the former period of warmth!) But it is probable that this period of greatest severity did not last very long. Little by little the land began to rise, & at the same time the extreme of cold to pass away. The reelevation

was probably quite gradual. There is certainly no appearance indicating that it was sudden. There were no doubt occasional halts when the shore line remained for some time at a certain level & perhaps relapses to extreme cold, there may have been times when the land even sunk again slightly; but on the whole, the result was elevation & greater warmth. The sea becoming shallower, & less encumbered with ice, currents began to act on the bottom, & the waves on the shore lines making deposits of rounded pebbles, & sand, distinctly bedded, which are almost always found resting on the Boulder Clay, & which have been named Modified Drift. In some places too are thick beds of Clay of different kinds, often with very few stones in them, showing that ice had almost ceased to occur in these regions. Many of these

see section.

Modified drift deposits contain sea shells & other marine animals, & in some places thick beds & banks of shells show that generation after generation lived & died while this period was in progress. On examining these shells it is found that they are not as a rule living now in seas so far to the south, but are of species characteristic of the cold ~~seas~~ waters of the arctic ocean. Far up the Ottawa River sea fish called Capelins, & much like the Eulachon of this coast are found imprinted on clay which has turned to stone around them. They must have swarmed in the Ottawa when it was an estuary of the sea. In a hill near Montreal sea shells are found in abundance & of arctic forms at a height of 470 feet above the present sea level. Similar shells are found at heights of about 500 feet in Labrador, & at

In other places to 365 feet above sea

Beachy Islands in the Arctic Regions up to 1000 feet.

As the Arctic waters slowly left the land, the rivers again began to flow, & in most cases resumed very nearly the courses they had formerly taken, though their channels had been blocked up by boulder Clay & drift, which they now began to carry away. To this rule however there are some remarkable exceptions. It has been discovered that some of the great Lakes before the glacial period flowed Southward, probably into the Mississippi, but the old channels were here so completely blocked that when the land again emerged the water found for itself a new course, forming the St Laurence River. I have found a similar case in the Red River of Manitoba, which there can hardly be any

doubt formerly joined the Mississippi Also, & carried with it the waters of the great Saskatchewan River. The great trough-like valley by which it flowed still exists, but is heaped full of drift material in many places.

Thus ended the ~~glacial~~ age of ice, but in most cases the land was not again elevated to its former level, great tracts still remaining submerged; & we have never since regained the glacial climate of the preceding age. Into the evidence of all these things it is at present impossible to go, though many points of interest offer. —

One more point in connection with the glacial period, however, claims attention. We have seen that ~~this~~ previous to the advent of cold, animals & plants of warm climates lived far to the north. In the Cromer Beds we have ~~an example~~ a

Collection of animals indicating a pretty temperate climate, but as the cold increased, & the land became submerged, even these were driven southward, & a great part of the northern hemisphere must have been a barren lifeless waste. It is thought by some that man existed ~~later~~ at this early time & was also ~~driven~~ forced southward, but the evidence does not appear to be conclusive. We know, however, that as the ice crept back again to the north, & the water subsided, animals similar to those of the Cromer beds followed its retreating margin ~~&~~ occupied their old haunts. The mammoth, wild boar, auroch, stag, cave bear, grizzly bear, cave lion, & hyena, again appear, but now accompanied by man who hunts & preys upon them. Savage man as we first know him in the records of the earth, with

rude stone implements battling with nature, & leaving his tools & his bones only as a record of his presence. At a time when the Reindeer now confined to the extreme north of Europe, roamed in Southern France, human inhabitants killed them for food, cracked the bones to extract the marrow, & roasted the flesh. In Britain also old dug-out canoes have been found buried in gravel & clay ~~[illegible]~~ many feet above the present water line, in such a manner as to show that they were lost or sunk by accident while the sea still covered a part of the modern land. x

Another interesting fact with regard to migration brought about by the ice age, refers to the plant world. The migration of plants may seem rather ~~incomprehen~~ incomprehensible in the ordinary sense, but by this term it is only meant

rude stone implements battling with nature, & leaving his tools & his bones only as a record of his presence. At a time when the Reindeer now confined to the extreme north of Europe, roamed in Southern France, human inhabitants killed them for food, cracked the bones to extract the marrow, & roasted the flesh. In Britain also old dug-out canoes have been found buried in gravel & clay ~~[illegible]~~ many feet above the present water line, in such a manner as to show that they were lost or sunk by accident while the sea still covered a part of the modern land. x

x

Man, as Dana says "the first being that was not finished on reaching adult growth, but was provided with powers for indefinite expansion, a will for a life work, & boundless aspirations to lead to endless improvement. He was the first being capable of an intelligent survey of nature, & comprehension of her laws; the first capable of augmenting his strength by bending nature to his service, rendering thereby a weak body stronger than all possible animal force; the first capable of deriving happiness from truth & goodness; of apprehending eternal right; of reaching toward a knowledge of self & of God; the first therefore, ~~[illegible]~~ capable of conscious obedience or disobedience of a moral law, & the first subject to debasement through his appetites, & a moral nature!"

that a slow movement, occupying many generations took place, all those seeds falling too far to the north not coming to maturity, while others carried southward grew & thrived. We have evidence that in this way plants now only living in very cold regions grew far to the South. On the high summits of the New England mountains which are completely isolated to the north, many species of arctic plants still grow. These are the survivors of those covering the surface of the country at one time, but have only continued to maintain their ground on the high, cold, mountain peaks. Their relatives now inhabit the shores of Hudson's Bay & Greenland.

Wearing down of Hills. distribution of soil

Causes?

These events at which we have glanced hastily & I fear imperfectly this evening are not the mere imaginings of a fairy tale. There may be some uncertainty as to the precise order in which some of them have happened, & even those who have given most attention to the facts still differ among themselves in some points with regard to the succession & cause of the phenomena. This necessarily arises from the imperfect nature of the evidence now remaining, which ~~must~~ can only be circumstantial, & yet more perhaps from our still imperfect, though daily improving knowledge of the relics of this epoch in the earth's history. Yet the main facts are true & must stand.

From the difficulty which we have experienced in picturing to ourselves some of these last phases

P

in the preparation of the earth for man, it may be imagined how much greater the task is when we attempt to read the half effaced hieroglyphics of yet anterior ages. We learn too that the apparent stability of mundane things is an idea only arising from the shortness of the time allotted to us for observation, & the brief span which even our histories coming down from the past can cover.

It is a subject for wonder, & is looked upon as enabling us to realize a great lapse of time, that certain harbours mentioned by Classical writers are now dried up & useless, certain cities partially or entirely submerged along the borders of the sea. How much greater must have been the time occupied by the events to an examination which

we have devoted this evening. Attempts to measure in years the period since the later changes of the ice age, have been made in various ways e.g. By the cutting back of the Niagara falls in its gorge, & by the rate of deposit of the delta of the Mississippi. Into the particulars of these we cannot enter, but the results are yet uncertain & range all the way from a few thousand to a few hundred thousand years. We can only say that so far these attempts have failed, & this being the case how useless it is to try to measure in years the time occupied by the long succession of previous changes to which even this is modern but of which records more or less perfect, but most of them still buried, remain.

Tennyson who sometimes shows a quick

appreciation of the results of modern research, & embodies them in his poetry, writes—

There rolls the deep where grew the tree. O earth what changes hast thou seen! There where the long street roars, hath been the stillness of the central sea.

The hills are shadows, & they flow from form to form, & nothing stands; they melt like mist, the solid lands, like clouds they shape themselves & go.