so. Arriving in June, and choosing the pleasantest retreats in copses, by picturesque intervales, and generally preferring the neighborhood of man, the plaintive song of this bird is strongly associated with the pleasantness of a summer's evening in the country. Occasionally, however, the white throated sparrow, or the common peabiddy bird, (*F. Pennsylvanica*) strikes up his piping note at various times of the night, and is often heard when the surrounding woods are suddenly lighted up by the application of fresh fuel to the camp fire. Still, as a general rule, the pleasing notes of song birds are foreign to the solitudes of the large fir forest whose gloom is appropriately increased by the wilder voices of predatory birds and animals. With these imperfect remarks, I close the present sketch of the night life of animals in the woods.

Art. III.—*Some recent movements of the earth's surface.* By Thos. Belt.

(*Read before the Institute, Feb.* 2, 1863.)

I have thought it well, in the first geological paper read before our Institute, to take a subject of general interest and to treat it in a less technical manner than is usual before scientific societies. To address rather my non-geological hearers, who must in a young society like ours, form the large majority; and to ask the indulgence of my more scientific friends.

I well recollect the interest with which I first saw sea shells encased in hard rocks, hundreds of feet above the sea, and how that interest was increased, when proof upon proof showed that nearly every sandstone had been a sea beach—nearly every limestone had been deposited in the deep ocean,—and yet, there they were, hundreds of feet above that ocean, beneath which they had all been accumulated, and where the various animals whose remains were now imbedded in their hard casing had lived and died. It was easy to understand how corals could build up, in the course of time, great masses of limestone, and how the hard casings of shell fish might be imbedded and preserved in sediments at the bottom of the sea. The difficulty was to account for the breaking up of these ancient sea bottoms and for their upheaval.

Further examination shewed that a simple or a single upheaval would not account for the phenomena. That there must have been oscillations

of level. Fathoms deep, over the sandy bottom, mailed fish had pursued their feebler brethren. Then palm trees and ferns waved in the breeze over wide mud flats, and then again the ground on which they grew was submerged, and the finny tribes resumed their sway.

As we examine the geological records of the earth's surface, no truth is more apparent than this: that every where the sea and the land have held alternate dominion—where we have now broad continents or rocky islets, the sea once flowed, and where the unfathomed deep now rolls, rocky coasts once defied the ocean's roar, and reared their crested peaks, apparently immutable. Are these upheaved and shattered rocks the monuments of mighty convulsions to which the earth was once subject, but from which it is now free? of stupendous forces once active, but now quiescent? Thirty years ago these questions would have been answered unhesitatingly in the affirmative, for it was then usual for geologists to construct ingenious theories, by which, according to some, the world at one time was in a state of complete fusion,—a ball of igneous molten matter,—whilst others jumbled up water, earth and metals, and allowed them to sink down according to their specific gravities.

The theory of primeval chaotic fluidity is almost abandoned; that of universal fusion still finds many able advocates; but there is a large and increasing school of geologists, headed by the illustrious LYELL, who teach that nature is working now as ever. Slowly, almost imperceptibly remodelling continents, raising some, lowering others, and that the forces that raised the ancient sea beds are still at work, busy as ever, at their ceaseless toil.

Geology is not merely a dry catalogue of names of minerals and shells, but a study of vast changes, both of the animate and inanimate world, extending over long ages; the key to explain which is to be found in the attentive observation of natural phenomena now going on around us. The same agencies existed in the earliest geological periods as at present. In the oldest rocks we have slabs of sandstone marked with the ripples of a retiring tide, and there recognize, not only the presence of the ocean, but the influence of the moon,—whilst the impressions of rain-drops, slanting as they were driven by the wind, attest meteorological conditions similar to the present. And on the other hand, in the sediments accumulating around the mouths of our large rivers—in the coral reefs building up in tropical seas, and in the lava flows of modern volcanoes, we have limestones, slates, sandstones and whins, in course of formation.

I purpose to night to draw your attention to a few instances where the forces that have raised the mountain chains of the world may be detected

still at work, and to pourtray some oscillations of level of different parts of the earth's surface in recent geological times.

It has been my fortune to reside for some years in a country slowly and gradually rising from the sea, and near to another, also rising, not gradually, but by sudden jerks, that every half dozen years is lifting it bodily and at once from one to six feet.

The first of these countries is Australia. There it has been known for several years that the whole southern coast is slowly but surely rising. In South Australia, the railway between Adelaide and the port, is said to have risen four inches in twelve months—the height being measured from the mean level of the sea,—other observers have also stated the average rate of elevation for the whole coast to be four inches yearly. I do not think that the rate has been satisfactorily determined; but there is no doubt that the coast is really rising, and at a very rapid rate. At Williamstown, near Melbourne, land is now in cultivation, that in 1854 was covered by the tide, and as similar evidences of elevation have been noticed hundreds of miles apart, it can be due to no local cause. It has been in operation for a long period; shells of species of mullusca now living on the coast are common in marine deposits at various heights up to three hundred feet above the level of the sea. The elevation is participated in by all the neighbouring islands. At Green Island, in Bass' Straits, and in Tasmania, there are old sea beaches, one hundred feet above high water mark. One of the most remarkable and suggestive facts connected with this recent elevation, is that the movement is so comparatively rapid, that bones of sheep and oxen and pieces of pottery thrown out of the first emigrant ships are raised above the reach of the tide, mixed amongst sea shingle and shells. In one of these deposits I found bones of the sheep along with sea shells three feet above high water mark.

The rise of the southern coast of Australia is a slow continuous one, without tremblings or quakings or sudden shocks. Silently, imperceptibly (for although the effect of the movement is seen, the motion itself is unseen, unfelt, unheard,) this elevation has been progressing so long that it has raised the coast at least three hundred feet in very recent geological times, or since the present species of mollusca lived upon the coast. The only change of species is, where the deposits last formed chronicle the arrival of the European with his domestic animals—where the bones thrown out of the ships conveying the gold seekers of 1850–51, are slowly being upraised to form future "old sea margins." Supposing this upheaval to continue as far into the future as it has progressed during the past,—future geologists in marine deposits raised hundreds of feet above the

sea, may point to geological records of the advent of the European on the shores of Hobson's Bay, as they now point to the advent of a shell, a fish, or a reptile in older strata.

I have here shewn you a movement of the earth's surface extending over several degrees of latitude and longitude, continuous and regular—let me now take you to another part not far removed from the last, where the land is being raised by successive sudden jumps. On the 23rd of January and succeeding days, violent earthquakes were experienced in both islands of New Zealand, which shook down many houses in Wellington, in the north island, and injured others at Nelson, on the south side of Cook's Strait. After the shocks, it was found that the southern part of the north island had been bodily upraised, in some parts two, in others as much as eight feet vertically, and shells attached to the rocks near tide mark were raised above the reach of the sea, and soon died. The Bally rock, off Point Jerningham, which was formerly eighteen inches below low water, was found to rise two feet above it. At Wellington, they were celebrating the anniversary of the foundation of the settlement, and the amusements were brought to a sudden termination by the overthrow of every brick and stone building in the town. Fortunately most of the houses were of wood and only one storey high, for the inhabitants had been warned by similar disasters in former years.

In 1848 a similar shock had been felt, and it was then also noticed that the country was bodily uplifted a few feet, and I have been assured by New Zealand colonists that all around the coast there is evidence at various heights of the successive jerking up of the country.

Alongside of, and probably in connection with this immense area of upheaval, is a corresponding area of subsidence. Whilst New Zealand, Tasmania, and the south western side of Australia, is being raised, Mr. Darwin has shewn that immense areas in the adjoining South Pacific and the Indian Ocean are slowly sinking. The north eastern side of Australia is included in the area of subsidence, so that whilst new land is being gained on the south western side of the continent, the north eastern is being gradually submerged, and the whole continent must be slowly moving towards the south west, the movement being exactly similar to a great wave of the sea, which is always rising in front and sinking behind.

The western coast of South America is being jerked up in a similar manner to New Zealand. In November, 1837, a violent earthquake threw down the town of Valdivia, in Chile, and afterwards, most, if not the whole of the coast, was found to have been raised about eight feet above

its former level. Only two years before this, in 1835, a violent earthquake (or rather a series of earthquakes) had destroyed the town of Conception in the same country. Fortunately for the interests of science, Capt. FITZ ROY, R.N., (who was surveying the coast), was at the time in Conception bay, and with him, the celebrated naturalist, DARWIN. These gentlemen have published a minute account of the catastrophe, and of its effect upon the coast line. They found that the whole of the land around Conception Bay had been permanently raised from two to four feet. Thirty miles from the bay, the elevation was much greater; for, at the island of St. Maria, Capt. FITZ ROY found beds of putrid mussels, still adhering to the rocks, ten feet above high water mark. If it had not happened that Capt. FITZ ROY and Mr. DARWIN were present at the time of this earthquake, we might indeed have heard of the overthrow of the town and the loss of life and property; but it is probable that we would not have heard of this permanent upheaval of a considerable tract of country.

Mr. DARWIN satisfied himself that the country had been subjected to a long series of such upheavals. He found shells of recent species 600 feet above the sea, and at Valparaiso even up to a height of 1300 feet.

Whilst the western coast of South America is thus rising, there is strong evidence that the eastern coast of North America is sinking, although at an exceedingly slow rate, the movement being a much slower one than any of those we have been considering. As Nova Scotia has participated in this depression, I will confine myself to the proofs that this country afford—merely premising that American physicists have arrived at similar conclusions for the whole eastern sea-board.

In several places in Cumberland Basin and in Coquebid Bay, there are found stumps of trees standing as they grew, but now far below high water mark. Mr. DAWSON, in his Acadian Geology, has described one of these submerged forests at the mouth of La Planch River in Cumberland county. The stumps are found irregularly scattered over a considerable space, some of them as much as thirty feet below high water mark. On digging around one of them, DAWSON found it rooted in what appeared to be forest soil. All these stumps were entire and retained their bark. They belonged to two species—the beech and the pine. There is here a direct proof that part of Nova Scotia has been depressed in very recent times, and that the movement is still going on may be inferred from the fact which I have on the authority of Dr. GILPIN, that several hundred acres of dike land in Annapolis, formerly in cultivation, are now given up to the sea, and the farmers say that the tide rises righer now than it used to do.

The subsidence of the eastern coast of North America attains its maximum amount on the west coast of Greenland. For a space of six hundred miles from north to south, ancient buildings on the sea shore have been submerged, "and the Moravian settlers have had to move inland more than once the poles on which their large boats are set." * In Australia, the elevation of the land is bringing up from the deep. articles cast into it by man,—in Greenland, on the contrary, his handiwork is being gradually carried beneath the waters. It is a remarkable and suggestive fact that on the other side of the Atlantic, opposite to this great area of subsidence, there is a corresponding great area of elevation on the coasts of Sweden and part of Norway, and there likewise the greatest amount of movement is towards the pole. Perpendicular cliffs of gneiss, mica schist and quartzite confront the sea and resist decomposition for ages. On these rocks permanent marks have been made, and from them the rate of elevation ascertained. The movement has been proved to extend from Cape Cod, in the north, where the elevation is at least four feet in a century to Gottenberg, in the south, where it only amounts to a few inches in the same time.

I have thus shewn you that immense areas of the earth's surface do not possess that stability we are accustomed to associate with the idea of *terra firma;* but that movements are in progress which must, in the course of ages, modify in a great degree the relative positions of land and water. I have confined myself to the larger of these movements, for the limits of this paper will not allow me even to glance at the numberless instances of local changes that have taken place in recent times; but before passing to another branch of my subject, I may remark that although many earthquakes are considered mere vibrations of the earth's surface, we must remember that all vibrations are the result of some direct movement, and whenever any part of the earth's surface vibrates, we may be certain that somewhere a blow has been struck; somewhere a portion of the solid earth has been suddenly let down or raised up.

I now pass on to the consideration of another class of phenomena, of which the earth movements we have been considering, afford an easy and complete solution.

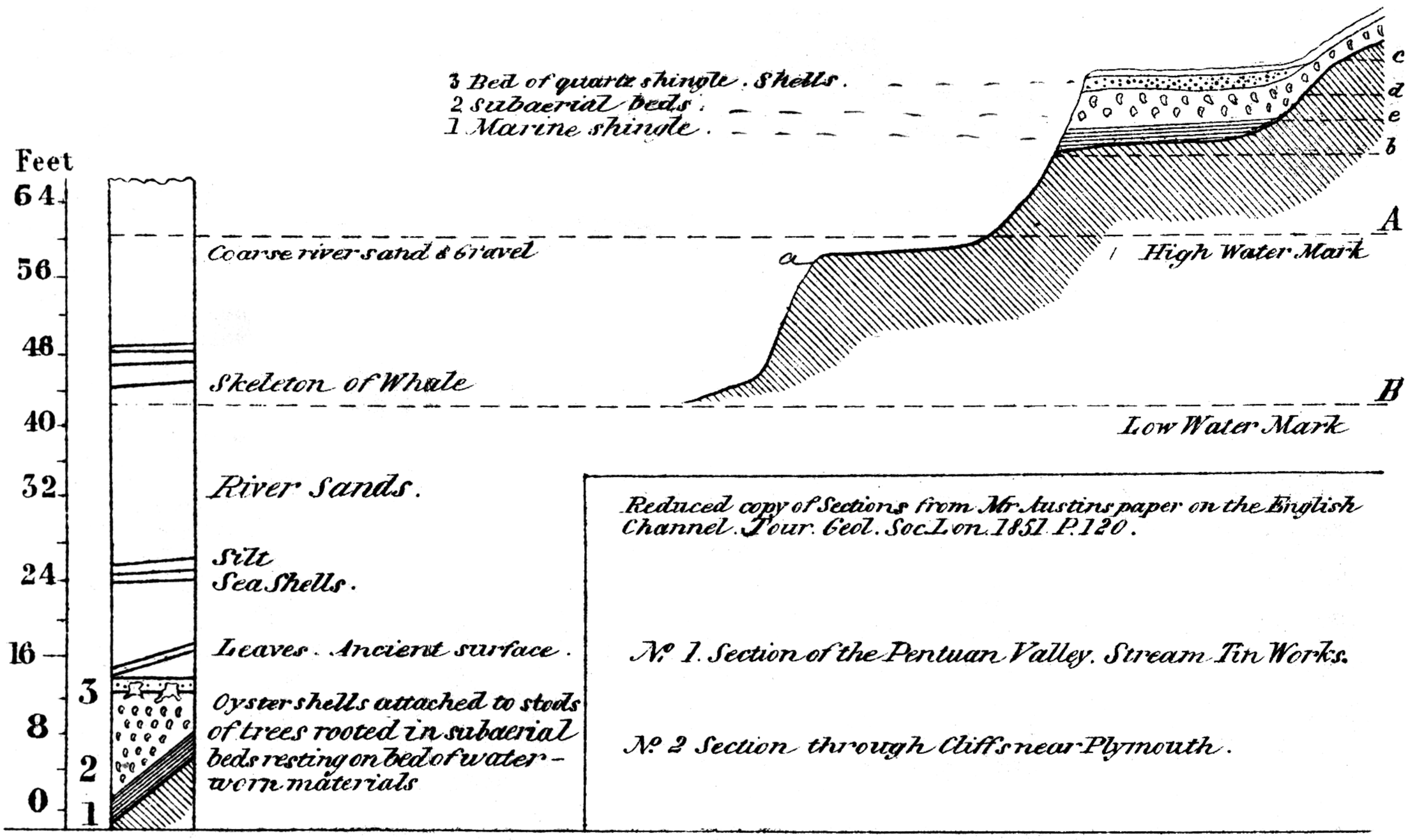
When we leave historical for geological records, we soon find that there is no land, however stable it might now seem, that has not alternately been above and below the sea.

On my return to England, in 1860, my attention was directed to those superficial deposits of sand, gravel and clay, that are spread over the

* Lyell's Principles of Geology—page 531.

SECTION Nº 1

SECTION Nº 2



Reduced copy of Sections from Mr Austins paper on the English Channel. Jour. Geol. Soc. Lon. 1851. P. 120.

Nº 1. Section of the Pentuan Valley. Stream Tin Works.

Nº 2 Section through Cliffs near Plymouth.

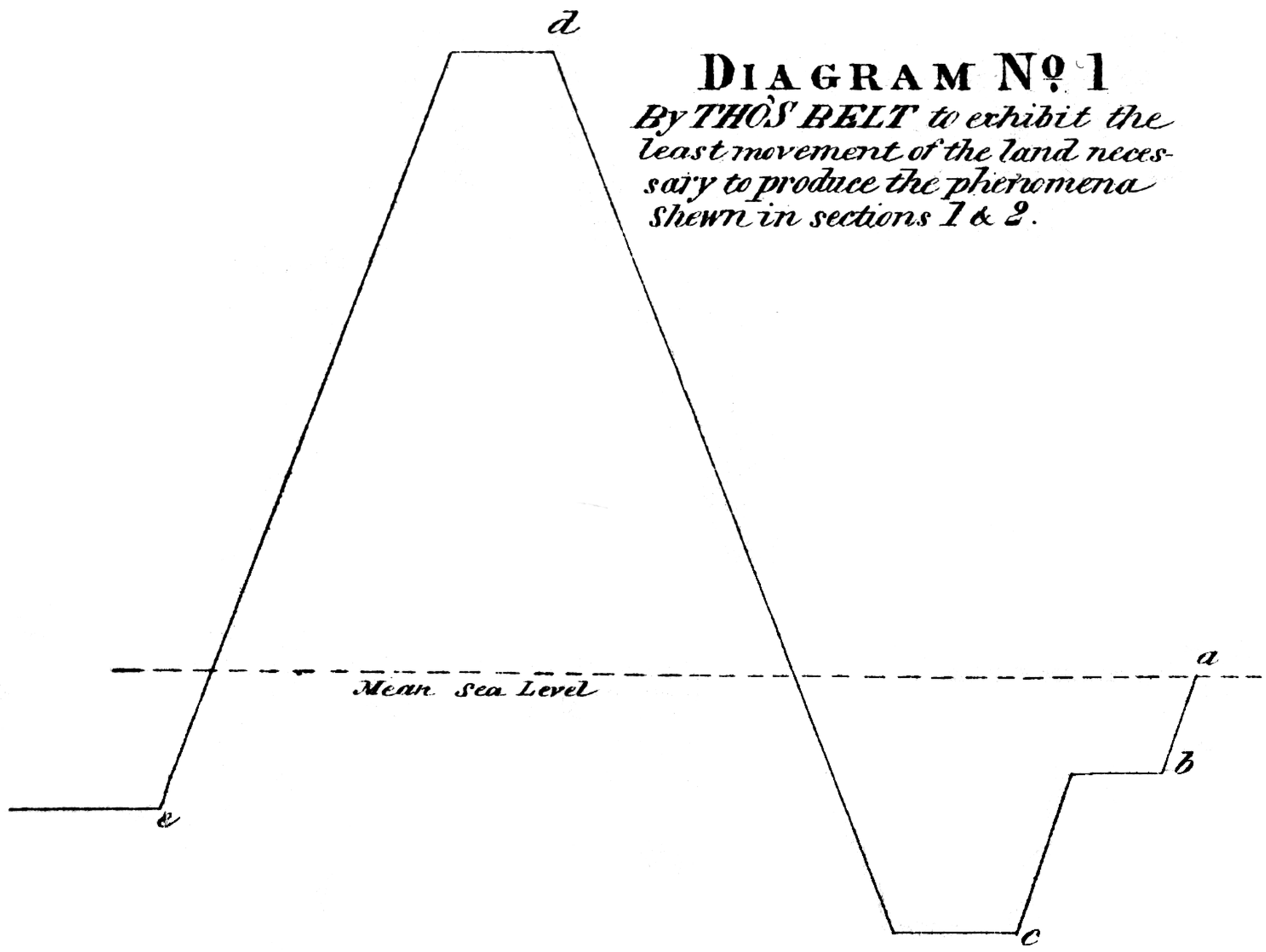


DIAGRAM Nº 1

By THOS BELT to exhibit the least movement of the land necessary to produce the phenomena shewn in sections 1 & 2.

C. & A. Clarke, Litho.rs Bedford Row, Halifax, N.S.

greater part of Great Britain. The evidence that they afforded seemed at first most contradictory and puzzling. In some places there seemed to have been upheavals, in others, depressions.

But convinced that some general law must govern the movements, I collected and collated from various sources, sections of the deposits from different parts of England and Scotland. It occurred to me that I might make the movements more intelligible, if I depicted them by means of curved lines in a similar manner to that by which meteorologists shew the rise and fall of the barometer.

Taking the land now at the mean level of the sea, as my starting point, I drew a series of diagrams, shewing the least changes of level that would account for the formation of the deposits. A few instances will best illustrate this:

Figures 1 and 2 are sections taken from a paper read before the Geological Society of London, by Mr. AUSTIN, on the English Channel, and I have constructed diagram No. 1 to shew the least necessary amount of oscillation of the land now at the mean level of the sea to produce the phenomena shewn in the sections. To explain this, I must first direct your attention to section 2, which represents the cliffs near to Falmouth, capped with beds of shingle. The limits of the tide are shewn by the dotted lines A and B. Between high and low water the sea is slowly wearing back a beach a. into the hard fundamental rocks. A few feet above high water mark we come to an older sea beach b. exactly similar to that now forming between high and low water mark, but removed beyond the reach of the sea. To allow the sea to wear out this old beach we must suppose the land stood once at least ten feet lower than it now does; and I represent this, the latest movement that we have any evidence in these sections, in diagram No. 1 at b., where the dotted line A. B. represents the mean level of the sea, and the point a. shews the land now standing at that mean level, and which must have stood during the formation of the beach b. ten feet lower than now, or as shewn in the diagram at b.

The cliff b. is capped by a series of beds of shingle, of which the topmost and least formed, No. 3 is a bed of rolled pebbles of quartz, and gneiss with fragments of shells. The shells all of species now living on the coast. This deposit is evidently a marine one, and when it was formed the sea must have stood at a relative level, twenty-four feet higher than it now does, or rather the land must have stood that much lower, or as shewn in the diagram at c.

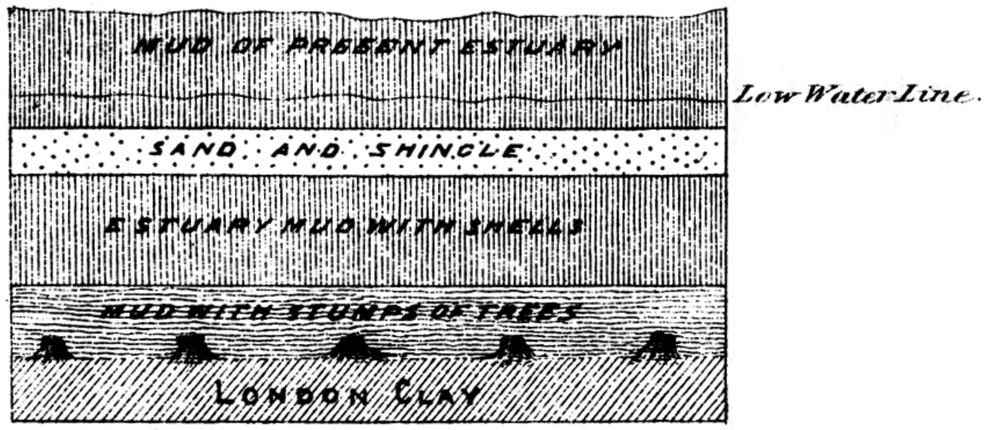
Beneath the bed of sea shingle No. 3, is a bed of angular fragments of rock without any rolled pebbles amongst them, or sea shells. It is com-

posed of fragments of the adjoining rocks, and as there are other evidences of the prevalence of an extremely cold climate at this period, it has been suggested that this bed has been formed under subaerial conditions, and that the severe winters of that period caused the breaking up of the rocks of which it is formed. Fortunately we have other evidences of the existence of a land surface at this period. This subaerial bed is found at various levels around the coast, down to fifty feet below high water mark, at which level it has been cut through at Pentuan Valley stream tin works, as shewn in section No. 1, and its subaerial character fully confirmed by finding stools of trees rooted upon it. To admit of the formation of the subaerial bed in section 2, the land must have stood at least as high as it now does, whilst to allow of the growth of the trees shewn in section No. 1, it must have stood at least sixty feet higher than it now does; and we thus arrive at the stage d. in diagram, at which the land stood much higher than now. Beneath the subaerial bed is an old sea beach with a bed of marine shingle and shells, No. 1 in section, and from it we learn that the land now at the mean level of the sea (and which we have just seen, had stood sixty feet higher than it now does) must at some still earlier time, have stood at least twelve feet lower, or as shewn in the diagram at e. Such is the story told to the geologist by the rocks and beds of pebbles, and angular stones of which we have here a section. Before leaving it, there is one other remark may be made concerning it. When the beach now being worn between high and low water mark, reaches the base of the second or higher beach, all traces of the latter will be merged in the former, and if the rocks had not been of a very hard nature, this would have been accomplished before now. It is probable that this result has been achieved by the waves around the greater part of the coast of England, as most of the shore rocks are of a much softer nature than those of Cornwall and Devon.

The movements of the earth's surface above depicted have taken place at the most southern point of the English coast. At the other extremity of the island there are many proofs of similar oscillations. Thus a careful consideration of the raised beaches, buried forests, ice scratchings and boulder drift of Scotland, has demonstrated that immediately anterior to the present period, there was a time when the land stood thirty feet lower than it now does; that this was preceded by a period when it stood at least one hundred feet higher than now; and that that again was preceded by a geological period when the whole country (Scotland) stood at least five hundred feet lower, and the stratified gravels with sea shells of the boulder period were deposited. These oscillations are shewn in diagram No. 2,

Section No 4

NEAR PORTSMOUTH.



Section No 3

TEAM VALLEY, DURHAM.

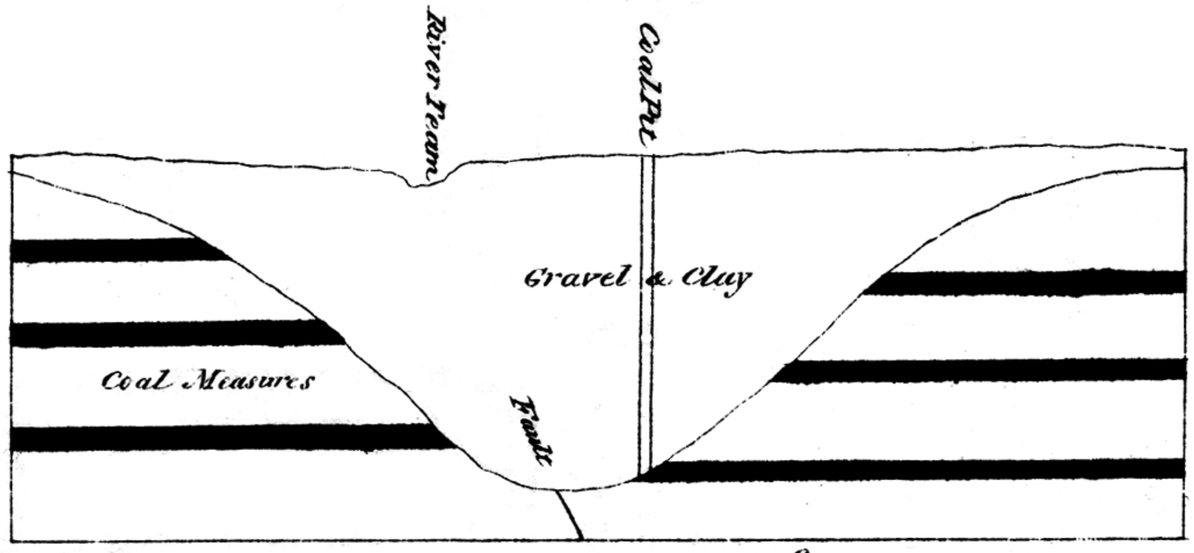


DIAGRAM No 3

To illustrate changes of level in Nova Scotia during Post tertiary times.

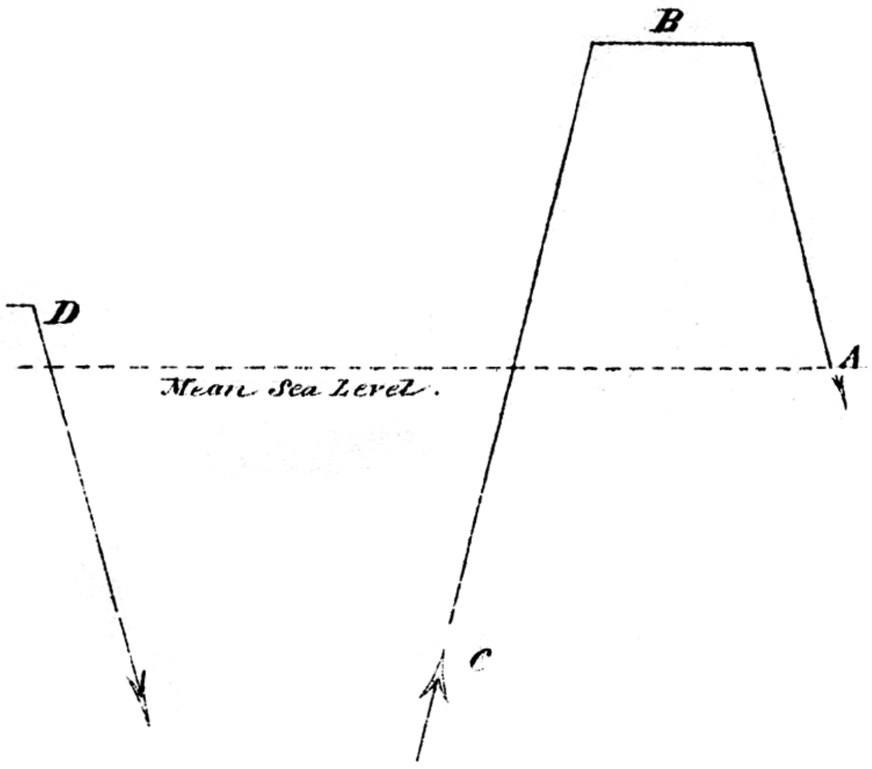
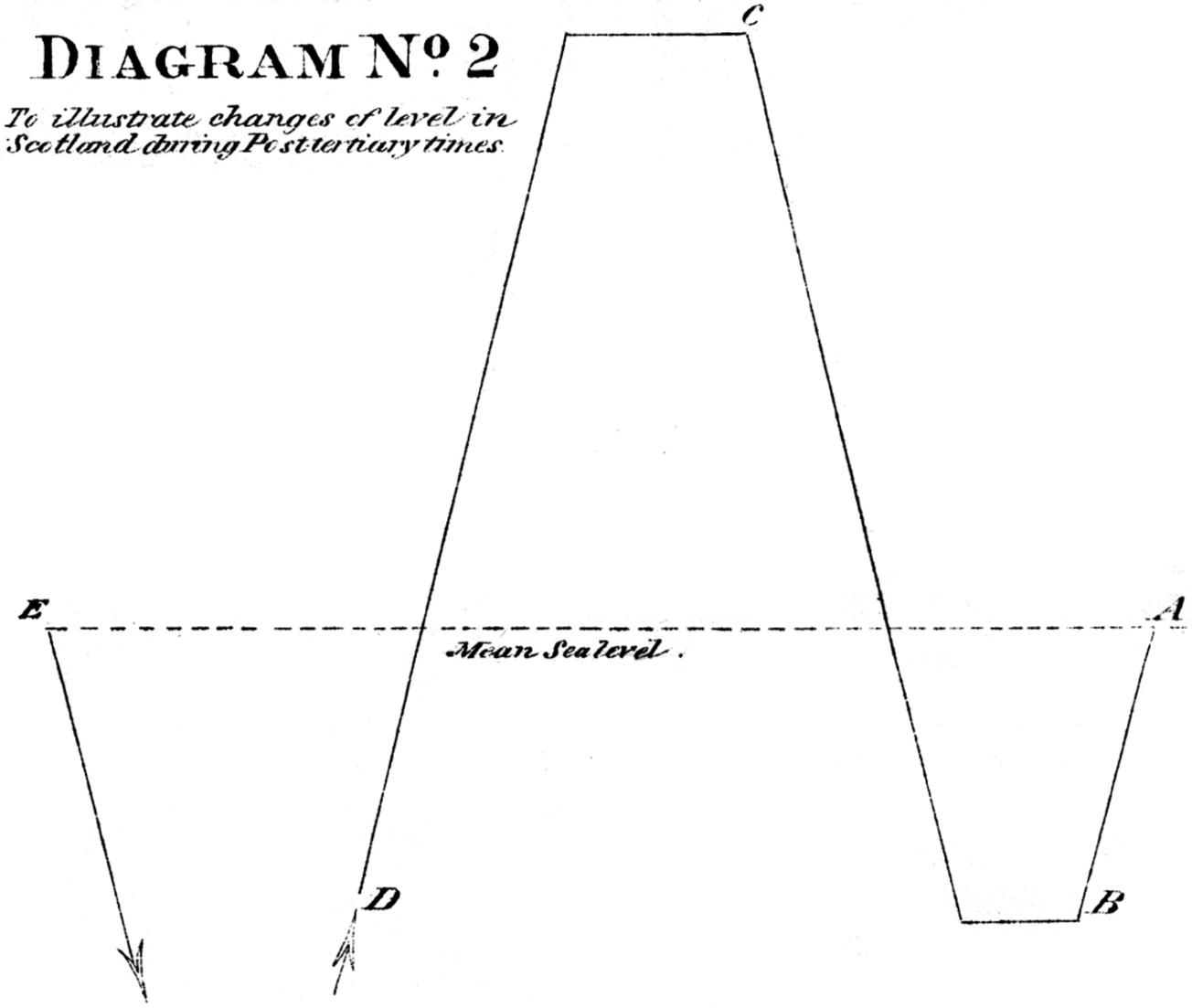


DIAGRAM No 2

To illustrate changes of level in Scotland during Post tertiary times.



and have a remarkable resemblance to those of the extreme south of England.

Of the first of these stages, going backwards from the present, that at which the land stood thirty feet lower than it now does, we have the most evidence, because the last action of the sea tends to obliterate the records of preceding events. This stage must have been of very long duration, for all around the Mull of Cantyre, the former sea level is marked by long caves now high above the reach of the tide. From the length of these, it has been computed that the sea must have stood much longer at that level than it has at the present. Beneath the gravels and clays of this period, lie buried peat beds and forests, speaking to us of that earlier period of elevation; whilst these, in their turn, are underlaid by the northern drift of the great submergence.

I have purposely drawn my illustrations from two points three hundred and fifty miles apart, to shew how general these movements have been; but from almost any part of the British islands I might have drawn similar conclusions, or I might say on the other hand, facts for the explanation of which our diagrams would afford the key. Take for example the section of the valley of the Team, a small tributary of the Tyne (section No. 3.) We have here a stream cutting its way through beds of gravel and clay raised twenty feet above high water mark, and these beds being sunk through at a. for a coal pit, are found to occupy a deep valley cut through the old rocks of the coal measures. The bottom of this old valley is sixty feet below high water mark, and must have been excavated when the whole country stood much higher than now. We have now an insignificant stream, but when this valley was scooped out a large river must have rolled down it, and this is curiously confirmed by other evidence that at one time the river Wear once joined the Tyne by way of the Team valley. This old valley was probably scooped out, at a period anterior to the great submergence of the northern drift and re-excavated during the elevation that succeeded it. By the last depression shewn in diagram No. 2, it was filled up with gravels and clays, and by the last elevation, these beds have been raised twenty feet above the tide, and are being cut into by the present stream. There is not a tidal river in all England that does not afford some evidence of a former elevation and of this last depression.

Section No. 4 was obtained during some excavations in Portsmouth harbour, when remains of an ancient forest were found beneath estuary mud and sand. The forest probably grew during the elevation shewn in the diagram at c. As the land was gradually carried downwards, it was

covered with estuarine mud, similar to that forming at present. At the lowest point, reached by the depression, the sand and gravel of the section was deposited by the action of a more open sea, whilst the last elevation has brought it to a similar stage to that at which the old estuarine mud was formed.

Whatever part of the world we visit we find similar proofs of elevation and submergence—some countries are slowly rising, others slowly sinking, others now stationary; but all without exception in their raised marine beds and buried forests, shew that they have been alternately above and below the waters.

I have constructed diagram No. 3 to shew changes of level which Nova Scotia has experienced in very recent geological times. We have first, a bed of peat uderlying the boulder clay at the River of Inhabitants, Cape Breton, which gives us a land surface (d. in diagram) anterior to the period of the deposition of the boulder clay, or the glacial period. During the glacial period there is proof in the shells of the St. Lawrence and other parts of North America, that the land stood at least five hundred feet lower than it now does, as shewn in the diagram at c. Next we have the period when the land stood at least thirty feet higher than now, and the submerged forest at La Planche river flourished, and then the subsidence that has continued to the present time and is still in progress.

The illustrations I have given are sufficient to convince the most sceptical that the general opinion respecting the stability of the earth's surface is illusive and unreal, and that the upheavals and depressions, shewn in geological records, do not speak to us of convulsions and catastrophes to which the earth was once subject, and from which it is now free, but are part of a general law still in operation.

The right appreciation of these oscillations of level, lie at the foundation of geological knowledge. The upheaval of sea sediments—the submergence of land surfaces—the carrying down into the very bowels of the earth, beds of sand and shingle and their metamorphism by electrical, chemical, or igneous agencies, are but a part of the phenomena on which a flood of light is thrown. Whilst the superficial deposits are being reconstructed or covered up by those later formed, we must suppose the movements we have been considering, extending far below those, to, and through the older and solider rocks, which are rent and fissured and contorted. The rents so formed are filled with foreign materials, and we are thus led to the origin of mineral veins, and their subsequent upheaval and exposure by denudation.

The oscillations I have portrayed in the diagrams, have taken place in the most recent geological times, they lie indeed at the very threshold of geological enquiry,—and yet so slow are these movements, that the whole of man's existence, on the earth, that we have any trace of, does not extend beyond the first depression. The flint implements found at Amiens and at Biddenham, near Bedford, are found in the reconstructed drift of this period, and the ancient canoes found in raised beds of silt, near Glasgow, cannot be older than the commencement of the last elevation.

Whilst ethnologists are pushing back the creation of man to a much earlier period than was once supposed,—geologists shew how brief was even that extended time compared with the long roll of ages during which the world has existed in subjection to the natural laws that now prevail. What the astronomer has done for space, the geologist has done for time. We find space so vast (and I speak not of space in the abstract, which is illimitable, but of space that the astronomer has measured and shewn to be studded with shining globes), that to give an idea of the distance of some of these worlds, we have not expressed it in millions of miles, but in the number of years that light, travelling at the rate of 12,000,000 miles per minute, takes in reaching us from these remote orbs. We stand in the clear night, looking at the firmanent studded with a thousand gems, and we can scarcely realize the fact, that we are not looking at the stars themselves, but at rays of light that left their surfaces in some cases, hundreds of years ago—so vast is space.

And in regard to time, not in the abstract, but during which the geologist has shewn the world to have been peopled with animal and vegetable life, I think no one who has examined the evidences, will accuse the geologist of exaggeration, when he speaks of millions of years, of the roll of uncounted ages. Man's history—his whole existence on the face of the earth, does not fill up a single beat of the oscillations we have been considering—scarcely bridges across the last small depression in the diagrams. We have depicted in the diagrams the commencement of a series of curves that run back to the earliest Silarian times, and only at the end of the last of these do we find any trace of man; like a little skiff, borne on the last wave next the shore and beyond an ocean extending to the horizon, and how far beyond our ken cannot reach.

I know there are those who are startled at these assertions of the extreme antiquity of the world, who think that they tend to sap the foundations of religion—that they are opposed to the teaching of the Scriptures. To those I would say—There was once an island in the midst of the ocean, around it next the sea shore were extensive sand banks, and

the islanders, fearing that in some storm, the angry sea might overwhelm their island, had erected wooden bulwarks, fixed in the sand, to stem the force of the waves; but one by one these had been washed away until only a few remained. And then came a mighty storm, such as they had not before known. The crested billows, mountains high, dashed against the shore; and as night closed around them, the fear-stricken islanders, saw that the sand banks were undermined, and the last of the buttresses were tumbling into the flood. All through the long night they listened to the howling of the storm, and trembled lest the whole island should be swallowed up. But when morning came, they found that the sea had washed away the sand banks that had accumulated through long centuries, and had exposed a bed of solid granite, that, before unknown to them, had formed the foundation of their island, and against which the angry sea raged in vain. And is not so with religion? have we not reared bulwarks and buttresses, which we, puny mortals, think are necessary for its support? The sea of knowledge ever spreading, sweeps them away, but exposes the eternal rock of truth on which religion is built.

Art. IV.— *On the characteristic Fossils of different Coal seams in Nova Scotia.* By Henry Poole.

[*Read March* 2, 1863.]

At a late meeting of one of the Scientific Societies in England, I noticed that the question had been asked, whether any law governed the position of fossils in the Coal Formations, and if any attempts had been made to classify or tabulate the *loci* or places in which certain fossils were found, above, or below coal seams, so as to guide explorers in their search for workable seams of coal.

In reply, it was regretted that much attention had not been paid to the subject; and, with the exception of the fact observed by Sir William Logan, that the Stigmaria ficoides, when found in an underclay, always indicates a seam of coal, even if only half an inch in thickness, I am not aware of any other general law having been established.

I am inclined to believe that further research will shew that the difference in quality of the different coal fields is owing to the difference of the vegetation that produced them. That this vegetation varied, according to the nature of the subsoil in which it grew; whether arena-