On the formation of Peat Bogs and Turbaries, which extend from the Bristol Channel into the central parts of Somersetshire.

BY REV. W. PHELPS, F.S.A.

THE various changes apparent on the surface of the earth since the first creation, have attracted the attention of the philosopher from an early period of the history of the world ; whilst the more recent discoveries of the geologist, have developed the great disorganisation and derangement of the component parts of the outward crust of the habitable globe.

The effects of the general deluge are visible both on the surface of the earth and beneath it; and when we penetrate its superficial crust, or descend into the deepest mines, we find evident traces of the awful catastrophe consequent upon the breaking up of the "fountains of the great deep"; and the present state of the earth's surface is not such as could have been the result of its original formation, for it

bears everywhere the traces of great derangement and revolution. The lapse of time since the first constitution of our earth, must have occasioned great changes; the effects of climate, heat and frosts, being everywhere discoverable in rounding and smoothing the rugged character of the surface, and reducing the more elevated points.

Since the period of the universal deluge, these ever acting causes have been in operation; but there are others aiding and assisting in the same great changes, which are apparent on the earth's surface. The ocean, which received the Almighty fiat, "Hitherto shalt though come, and no further, nor turn again to cover the earth," by its constant agitation, and the flowing and ebbing of its tides, has also produced considerable changes on the shores exposed to its influence. On the eastern coast of Kent its inroads have overwhelmed immense tracts of land, which are now called the Goodwin Sands, from the name of their possessor, the Earl of Kent, and are now extensive shoals, dangerous to mariners.

In these changes we may observe something like a balanced and compensating effect between destruction and renovation by the powerful agency of the sea; headlands and promontories, whose component parts are of a soft and friable nature, yield to the constant action of the waves, and are washed away; but the soil thus torn from the heights is annually thrown back, and according to its quality forms extensive tracts of marsh land along the less exposed parts of the coast, or is accumulated in the sea, becoming shoals and sand-banks along the shore.

2. The extended marshes which border on the Bristol Channel, in Somersetshire, bear evident traces of having been, at an early period, æstuaries of the sea, and their boundaries may be easily traced along the base of the

elevated lands which surround them, at the level of high water. The tides of the Bristol Channel are remarkable for the great height to which they rise, compared with those on the south coast of Devon, arising from the peculiar form of the shores of that æstuary, being funnel-formed, and exposed to the full force and action of the tidal wave of the Atlantic ocean. The spring tides rise at the Holmes to the height of 40 feet or more, and to this cause we attribute the vast extent of marsh land on the borders of the Bristol Channel, whilst on the coast of the English Channel at Lyme, the rise is only 17 feet. The silty bottom is sometimes in the form of sand, as at Westhay in Meare ; at others, deposits of marine exuviæ, which have been driven up into banks in the interior of these marshes, and have also formed lines of a former shore, easily to be traced along many parts of the border of King's Sedgemoor, at Sutton-Mallet, Compton-Dundon, under Ham-hill, Othery, Middlezoy, and Weston-zoyland. The etymology of the latter villages indicates their situation in the "Sowey," or "Zoyland"—that is sea-land.

The subjacent clay does not contain shells, but the alluvial deposit abounds with both marine and fresh-water shells. At the present time the sea would overflow these moors, if it were not excluded by banks and tide sluices in the rivers ; as the ordinary level of spring tides is above the surface of the adjoining lands near Glastonbury, and the moors around Meare, Wedmore, Axbridge, and on the borders of the great Brent Marsh. There is a record in the church of St. Benedict, Glastonbury, of the height to which the water of an inundation of the sea, rose.

The substratum of these marshes is red marl, which occasionally rises up into ridges of moderate elevation,

running parallel with the Mendip hills, and is overlaid with beds of blue and white lias rock. This indurated marl is seen on the sides of the deep channels of the rivers Axe and Parret, near their exit into the sea.

3. The filling up of these marshes next claims our attention, and here we find natural causes operating in a variety of ways to effect it. The waters of the Bristol Channel are remarkable for their muddy appearance. This arises from the beds of clay over which they flow, situated at the entrance and along the bed of the river Severn, and other streams which flow into it from the clay soils of Somersetshire. The waters thus saturated with clay being kept in constant agitation by the tides, which here flow with great rapidity, and rise to the height of from forty to fifty feet perpendicular, necessarily leave a great deposit of alluvial matter, whenever its current becomes impeded, or its motion retarded and stopped. This sediment being exposed to the influence of the sun and wind, during the interval between the ebb and flow of the tide, becomes in a certain degree hardened, and receives the deposit of the next tide ; and so by repeated accumulations the whole becomes consolidated and in time fit for the purposes of vegetation. It may further be remarked, that the difference in the height of the spring and neap tides leaves a considerable space of its shore dry for several days. During this interval, aquatic plants and grasses grow up, and on the return of the next spring tides become a receptacle for the subsequent deposits, which increase so rapidly as soon to form banks above the level of the ordinary tides ; which in the course of time become the barrier against itself, so that the highest tides only pass over it. The consequence of this barrier was, it converted the low lands of the interior into a lake, or morass, covered during the

winter months with fresh water; and formed a lake of considerable extent, having a small outlet into the sea at the points, no doubt where the rivers Parret, Brue, and Axe, now discharge their waters. In this way we may readily conclude, the great barrier and ridge of sand banks running from Brean Down to Burnham and Huntspill were formed, the river Brue being the outlet on the south-west at Highbridge, and the Axe of the district lying at the foot of the Mendip range.*

4. We find the former æstuary blocked up by the barrier noticed above, converted into a lake, covering the extent of district previously overflowed by the tide, though now occasionally affected by its entering the level by the outlets or rivers which carried off the flood waters. At this period, we may presume the labours of man commenced; when by sluices erected at the mouths of rivers, and by banks thrown up along their course, the influx of the tide was prevented from inundating the low lands. In consequence of these works, the lands becoming partially dry in the summer, vegetation soon began and spread rapidly over the district, and was the origin of the rich pastures now to be seen in these situations. In the more morassy parts, aquatic plants soon covered the waters, and became the incipient ingredients in the formation of the Peat bogs.

It has been observed that no stream, whatever its size,

* The following observations made by Mr. De Luc, a foreign geologist who visited England some years since, are striking, and show the rapid accumulation of alluvial marine deposits. "When," says he, "the tide rises towards the coast, the whole moves together forward, and exercises its action on the bottom, agitating and raising the mud which it carries towards the shore, and there deposits it during the interval between the flowing and ebbing of the tide; but when the water retreats it flows back from the surface only, beginning from the shore, and exercising scarcely any action on the bottom."—*De Luc's Travels in England.*

from the smallest brook to the Mississippi or Ganges, flows onwards for any considerable distance in the direct line of its descent. Its bias continually oscillates from one side to the other, in proportion to the inequalities of the sides of its channel. From this oscillatory mode of advancing forwards, all streams have a tendency to wear themselves a channel in a serpentine form. Where the stratum is of a uniform character and density, the curves of the river are generally alternate on each side, and correspond with almost geometrical exactness; the angle of incidence equalling the angle of reflection.

It may not be irrelevant to our present subject, to notice in this place, the singular curvatures of the channels of the rivers Parret, Axe, and Brue, at a short distance before they enter the Bristol Channel. On casting the eye to the map of the county of Somerset, we discover each of these streams to make a curve of considerable extent near their embouchure, almost encompassing a large tract of alluvial land.

5. The filling up of these morasses, next claims our attention, and here we find two causes in operation at the same time; the one, the growth of aquatic vegetables, subsequently converted into peat; and the accumulation of alluvial matter brought down by the rivers in floods, and deposited on the lands within reach of their influence.

The action of running water is a powerful agent in carrying away the finer particles of the earth's surface, when rendered soft and friable by the effects of frosts, and by the descent of rain in sudden showers and storms, sweeping away a considerable portion of the softer strata. And we also find a volume of water rushing down an inclined plane, with a force increased by being confined between high banks, or contracted between projecting

rocks on points on each side of its course, carries with it large portions of coarser matter, as stones, gravel, and sands into the lower parts of a valley, and there deposits the larger bodies first, then the smaller, and lastly the finer, according to their respective densities, till a stratum of alluvial matter is spread over the surface of the adjoining land which in time becomes fertilized in so high a degree as to be almost inexhaustible; and to this cause also is to be attributed the level appearance of all these marshes, as nothing but the action of water could have caused their present level character.

The rapid accumulation of alluvial deposit in any situation open to the influx of the tides of the Bristol Channel, and not affected by a counter current, is demonstrated by the filling up of the original bed of the river Brue, at Highbridge. The old channel was abandoned in consequence of a new outlet being made, about fifty years since, to improve the drainage of the marsh above. This cavity was filled up in about 25 years, to a depth of nearly twenty feet, with the deposit of the tide, and became cultivated land, producing fine crops of corn. It was excavated again, and now forms the entrance to the Glastonbury Canal navigation.

The time required to effect these changes is as nothing in the calendar of nature, when measured by the standard of human calculation. Our own recollection is sufficient to have witnessed the great change which has taken place in these marshes in less than half a century. When, therefore, we refer these considerations to a period of two or three thousand years only, we see there has been ample time for effecting these changes on the earth's surface.

Our ancestors, aware of the vast importance of protecting this district from inundation by sea or land water,

which would fill the marsh low lands, obtained a Royal Commission (33 Edward I., 1304) to inquire into these important matters, when Robert de Clare, Earl of Gloucester, Gilbert de Bere, and John Gereberd, were appointed inspectors. Afterwards we find similar commissions issued to the possessors of lands, manors, and lordships bordering on these marshes, among whom are the names of Sir Matthew de Furneaux, John de Merriet, Richard de Rodenay, John de Godelee, Dean of Wells, John de Clevedon, Sir John St. Loe, and many other influential persons in the reigns of Edward II., Edward III., and subsequent sovereigns.

ON THE FORMATION OF MARSH PEAT.

1. Peat is a vegetable formation, which overspreads certain extensive tracts of land in various parts of the earth's surface. In Ireland, Scotland, and England we find it to a considerable extent; in the former portion of the united kingdom a vast portion of its surface is covered by this formation, even now almost in a state of nature, and unproductive to the use of man.

Peat is of two kinds, viz.,

I. Mountain-peat, a black mould, with numerous grains of quartz sand intermixed with it, and found on the top of mountains; and

II. Bog-peat, which is the subject of our investigation.

In Somersetshire we find extensive tracts of land provincially called Turbaries, filled with peat, and a short account of its natural history forms a necessary appendage to the observations which we have already addressed to your notice.

"Peat," according to the definition given by Mr. Parkinson, "is a congeries of various sorts of vegetables collected in water, which to the last degree of their decomposition, retain their combustible property, and may be deemed a secondary fossil."

"Peat," says Professor Brande, "is a superficial stratum of vegetable matter, which at different depths is undergoing, or has undergone various stages of change and decomposition. Its superficial appearance is that of a mass of half-decayed mosses, rushes, heath, and grass. The roots having successively died away, though the upper part of the plant continued to vegetate. The mass is ligneous, and imbued with humus and humic acid, among other products of slow decay; and the abundance of moisture pervading the bog reflects the character at once of the peat and of the district."

"The upper layers of the bog are usually loose and fibrous, and of a pale brown colour. Beneath the surface the density is found to increase, sometimes to a great extent. At length, the distinct characters of the vegetables cease to be discernible, and the mass appears nearly homogeneous, and of a dark brown or blackish colour. Trunks of trees, and some geological phenomena occasionally present themselves."

Peat may be rendered valuable either from the charcoal which may be obtained from it, and by the various products derivable from what is called its destructive distillation. The elements of peat are essentially those of wood and coal, viz., carbon, nitrogen, hydrogen, and oxygen; and when distilled in close vessels, the products obtained would, as might be expected, resemble the products of a similar operation on wood and coal. The efficiency of this charcoal in the manufacture of iron, in

consequence of the small quantity of sulphur it contains, is proved, and its deodorising and purifying qualities are extremely valuable.

In drying, peat fully decomposed loses one-third of its weight; the lighter surface turf, one-half. Four tons of dried peat will give about one ton of charcoal, and its products on distillation are:—1. Sulphate of ammonia. 2. Acetate of lime. 3. Pyroxylic spirit. 4. Naptha. 5. Heavy fixed oil. 6. Paraffine, a material to be used in making candles.*

The situation in which it is generally found has been either lakes of moderate depth, or hollows on the surface of the ground capable of retaining water at all seasons of the year; and the progress and growth of peat is thus described by an intelligent observer:—"Reeds constantly precede the other vegetables in lakes, because they are able to raise themselves above the surface of the water from a greater depth than most other aquatic plants; thus they advance forward in proportion as the bottom attains a sufficient elevation in their front; as soon as they gain a certain height, other aquatic plants begin to grow, and rise between their stalks, till they become so thick as, at the last, to occupy the place of the reeds before them. The reeds advance in front; the confervæ thicken the mass, which is soon overspread by the sphagnum tribe, lichens, rushes, grasses, and a variety of plants natural to such situations. These plants become so thickset that they consolidate on the surface on which they grow, and sink with it into the water. The mosses and confervæ rise again the next year, and cover the surface on which they grow, producing a new race of plants; these in turn decay, and sink from the surface, and at length reach the bottom

* Athenæum for February, 1852, p 221.

of the water, and by the pressure of the annually accumulating mass, become consolidated, whilst those on the surface also grow, decay, and drop in their turn ; so that in the course of years a spongy mass is gradually elevated above the circumjacent waters, and finally becomes so solid that heaths, willows, and other ligneous plants grow up and cover the surface with their beautiful foliage and flowers."

2. It seems requisite to the formation of peat that the waters of the morass should be stagnant and not exposed to the admixture with other water or currents, as the vegetable particles which compose peat being macerated in the water, the water wherein they grow becomes highly astringent and antiseptic, and congenial to accelerate the growth of peat vegetables. If, however, a current of water passes through it, the astringent juice is washed away, and the chemical agent for converting vegetable matter into peat is then lost.

This mass or congeries of plants, by the alternations of growth and decay, forms the bed of peat, and continues to increase rapidly, if undisturbed, soon rising above the adjoining lands, being kept in a buoyant state in the winter and summer by the water contained in the spongy matter. The mass of peat also rises in the winter, and in the summer, in proportion to the quantity of water accumulated in the basin on which it rests. This curious circumstance is noticed by the inhabitants living on the borders of these Turbaries, who see objects across the bog in the summer, which are intercepted by the elevation of the surface of the peat in winter.

The general thickness of the vegetable mass in the centre of the bog is from fifteen to eighteen feet. A common opinion prevails that the pits cut for fuel grow up

again in a few years, which is an error. The cause of these pits becoming filled with turfy matter is that the pressure on the particular spot having been removed by the excavation of the peat, the substratum being in a semi-fluid state is forced up into the pit, by the pressure of the surrounding mass. The surface by its buoyancy thus keeps out of the reach of floods, which would otherwise stop the further growth of the peat bog plants, and its alluvial deposit on the surface, would cause an almost immediate growth of pasture grasses.

This mass of decomposed vegetable matter becomes, at the depth of about three or four feet, an homogeneous semi-fluid and dark-coloured substance, and undergoes a fermentation, which developes the bituminous and inflammable property. In this state, when dug and dried for fuel, it affords a highly combustible substance, and produces, when in a state of ignition, hydrogen gas, ammoniacal liquor, and coal-tar, and seems to corroborate the opinion that coal owes its origin to vegetable matter.

The coffee-coloured water always found in the pits dug out for fuel, has an astringent taste, and is so highly antiseptic, that animal matter immersed in it may be preserved a great length of time, undecomposed. An attempt was made some years since, to apply it to the purposes of tanning leather. The tanning principle was however found to be too weak to effect any beneficial purpose. Dr. Rutty, in his Essay on the Mineral waters of the kingdom, observes, "Moss water is possessed of an antiseptic and embalming property, and not only remains pure and free from putrescency, but it retards the putrid fermentation both of vegetable and animal matter immersed in it ; that the ligneous shrubs, trees and parts of animals are found in a state of unusual preservation, as is seen in the oak

and other trees, constantly found embedded in it in a perfect state ; and," he adds, "the air of peat bogs is more salubrious in consequence."

Peat is impervious to water in a high degree, and retains it like clay. When dry it becomes a hard, tough, and ponderous mass, and is one of the most insoluble substances, and least liable to decay. In Holland it is frequently used to lay under the foundations of their houses, where it remains unchanged for ages, and when the building has been totally decayed by time, the peat remained entire. Peat contains, in 100 parts, from 60 to 80 parts of matter destructible by fire, and the residuum consists of earth, usually the same kind as the substratum of soil on which it rests, together with a portion of the oxide of iron. Kirwan, states "that a piece of dried peat was put into the boiler of a steam engine for three months, yet though exposed to heat greater than boiling water, it remained unchanged. The only appearance it exhibited, was that the surface of it was covered over with a kind of powder of iron which attracted the magnet ; the centre and all but the surface remained unchanged."

3. The accumulation of alluvial clay and other earthy matter over the peat formation is visibly ascertained in the excavations made in forming new channels for the draining of these marshes, and in digging foundations for bridges, as at Highbridge, in 1804. At the depth of seven feet in the alluvial deposit, the workmen came to a stratum of indurated peat,* lying beneath it, and on it a heap of Roman pottery in fragments, with pieces of small bricks, such as are used to separate vessels in the kiln when they are burnt; also, moulds for casting coins, we presume of zinc,

* This peat so compressed is called pill-coal, being nearly as ponderous as coal.

procured from the Mendip Hills, which much resemble silver, and formed the spurious coins. All these circumstances prove that the surface of the peat was at that time dry, when occupied by the Romans. The late Mr. Anstice, of Bridgwater, who superintended the building of the sluices of Highbridge, found a considerable collection of Roman fragments. He also discovered the traces of the Roman road across Brent-Marsh, (coming from "Trajectus," Portbury, by Banwell, and "Bomium," Cross,) six feet below the present surface of the land, shewing how much the marsh has been elevated since the time of the Romans.

The surface of the peat bogs in Somersetshire is generally covered with varieties of heath, willows, bog-myrtle, and numerous other ligneous plants; lichens, sphagnum, and mosses, all interesting to the botanist.

Since it has been drained, and subdivided by ditches and watercourses, the whole has become more consolidated, and large plantations of forest trees, fir, birch, alder, &c., have been made. The oak is still found in some parts, growing luxuriantly, and to a considerable size in the peat. When the surface of the bog has been broken by digging, a decomposition of the peat takes place, and in a little time becomes a black light vegetable mould, capable of producing grass, corn, potatoes, and turnips. To give it a proper stimulus, however, the application of lime and heavy earth of a tenacious quality, is necessary to consolidate its particles; when it becomes capable of bearing wheat and other white crops; and when laid down to grass affords excellent pasture, for the feeding of cows particularly. Large tracts have been dug up, and brought into cultivation.

The following vegetables enter into the formation of

peat—Schœnus mariscus, schœnus conglomeratus, arundo phragmites, juncus squarrosus, juncus articulatus, potamogeton of different kinds, myriophyllum, ceratophyllum, lemna, byssus, equisetum, eriophorum and polystachion-vaginatum, sphagnum, lichens. We find on the surface myrica gale, andromeda polifolia, narthecium ossifragum, drosera latifolia and rotundifolia.

In these peat bogs we also find oak and other forest trees lying prostrate, with their roots decayed, embedded in the peat, about two feet beneath the present surface. They are in such numbers as to leave no doubt but that a wood heretofore covered the bog. By what change of circumstances they became destroyed is a matter of speculation. Oak, and other trees of the kind we find there, do not grow in water; and at the period when these trees flourished on the spot, no water overspread the surface. Now, the tract of land on which they grew is below the level of the tide at high water; it therefore follows, that some barrier must have been erected at the mouth of the river to keep back the influx of the tide water.

The following is an attempt to account for this phenomenon. We learn from ancient documents, the whole of this tract of country was an extensive morass, and held by the Abbots of Glastonbury. At a period which we cannot precisely fix, a sluice was erected at the mouth of the river Brue, to keep back the tide from entering the river; but most probably when the Abbot of Glaston made a new channel for the river Brue, from Northover, to form a navigable communication with the Bristol Channel, a collateral channel was then dug to communicate with the Axe, called *Pilrow-cut*, of which the traces now remain, secured also by a tide sluice, against the influx of the tide at "New-bay," the point to which the Axe was at that

time navigable, and was the canal and port of the Abbot of Glastonbury. This produced a considerable effect in relieving the country from its waters, and it is probable during this period, and before the dissolution of the monastery, in 1545, the trees occupied the soil, and continued to grow there. On the dissolution of that monastery an interval elapsed, during which the property of the Abbot fell into the hands of the crown, and that attention to the canal and outlets for the water (which had been so carefully cleansed, under the positive injunctions of the Abbots to their tenants, and formed a part of the covenants under which they held their land), became neglected and choked up with weeds, so as to impede the course of the water into the Axe and Brue. The result of this negligence was, that the low lands became again covered with water, surrounding the trees which grew on the surface, which soon decayed at their roots, and were thrown down by storms. The plants which compose peat were again called into activity, and soon covered these prostrate trees to the depth of two or three feet, where they now lie, preserved from decay by the antiseptic quality of the peat.

On a subsequent drainage taking place, this marsh was reduced to a lake about 500 acres in extent, called Meare Pool, and in this state it continued till the year 1800, when an Act of Parliament was obtained for perfecting the drainage ; the effect of which has been to convert the lake and morass into fine pasture land during the summer, and it is annually enriched by the alluvial deposits brought down by the river Brue, which during the winter months is suffered to overflow the district.

By draining and dividing this bog into fields, by ditches, a consolidation has taken place, and the surface rendered capable of agricultural operations, and from the improve-

ments made during the last forty years, we may predict that before the end of the present century scarcely a vestige of the peat bog in this district will be discoverable, and the future botanist will seek in vain for those rare indigenous plants which now flourish in this district.

Such are some of the changes the surface of the earth is now undergoing, from natural as well as artificial causes.

The survey of the river Parrett and its tributary streams, with observations on King's Sedgemoor, and the extensive marshes bordering on the rivers Parrett, Tone, Ivel, and Ile, will form the subject of a future paper.