and that, on the contrary, in countries abounding with marble and hard ſtone, theſe ſcattered fragments, which have rolled down from the hills, are exceedingly rare. This phænomenon is owing to the different ſolidities of the baſes upon which theſe ſtones are ſupported, and to the extent of the banks of marble or lime-ſtone, which is always more conſiderable than that of free-ſtone.

PROOFS

OF THE

THEORY OF THE EARTH.

ARTICLE XVIII.

Of the Effects of Rains—Of Marſhes, Subterraneous Wood and Waters.

IT has already been remarked, that rains, and the currents of water which they produce, continually detach, from the ſummits and ſides of mountains, earth, gravel, &c. and carry them down to the plains; and that the rivers tranſport part of them to the ſea. The plains, therefore, by freſh accumulations of matter, are perpetually riſing higher; and the mountains, for the ſame reaſon, are conſtantly diminiſhing both in ſize and elevation. Of the ſinking of mountains, Joſeph Blancanus relates ſeveral facts which were publicly known in his time. The ſteeple of the village of Craich, in the county of Derby, was not viſible in 1572, from

from a certain mountain, on account of a higher mountain which intervened; but 80 or 100 years afterwards, not only the ſteeple, but likewiſe part of the church, were viſible from the ſame ſtation. Dr. Plot gives a ſimilar example of a mountain between Sibbertoft and Aſhby, in the county of Northampton. Sand, earth, gravel, and ſmall ſtones, are not only carried down by the rains, but they ſometimes undermine and drive before them large rocks, which conſiderably diminiſh the height of mountains. In general, the rocks are pointed and perpendicular in proportion to the height and ſteepneſs of mountains. The rocks in high mountains are very ſtraight and naked. The large fragments which appear in the valleys have been detached by the operation of water and of froſts. Thus ſand and earth are not the only ſubſtances detached from mountains by the rains; they attack the hardeſt rocks, and carry down large fragments of them into the plains. At Nant-phrancon, in 1685, a part of a large rock, which was ſupported on a narrow baſe, being undermined by the waters, fell and ſplit into a number of fragments, the largeſt of which made deep trenches in the plain, croſſed a ſmall river, and ſtopped on the other ſide. To ſimilar accidents we muſt aſcribe the origin of all thoſe large ſtones which are found in valleys adjacent to mountains. This phænomenon, as formerly remarked, is more common in countries where the mountains

mountains are compoſed of ſand and free-ſtone, than in thoſe the mountains of which conſiſt of clay and marble; becauſe ſand is a leſs ſolid baſis than clay.

To give an idea of the quantity of earth detached from mountains by the rains, we ſhall quote a paſſage on this ſubject from Dr. Plot's natural hiſtory of Stafford. He remarks, that a great number of coins ſtruck in the reign of Edward IV. *i. e.* 200 years ago, were found buried 18 feet below the ſurface: Hence, he concludes, that the earth, which is marſhy where the coins were found, augments about a foot in eleven years, or an inch and a twelfth each year. A ſimilar obſervation may be made on trees buried 17 feet below the ſurface, under which were found medals of Julius Cæſar. Thus, the ſoil of the plains is conſiderably augmented and elevated by the matters waſhed down from the mountains.

The ſand, gravel, and earth carried down from the mountains into the plains, form beds which ought not to be confounded with the original ſtrata of the globe. To the former belong the beds of tufa, of ſoft ſtone, and of ſand and gravel which have been rounded by the operation of water. To theſe may be added thoſe beds of ſtone which have been formed by a ſpecies of incruſtation, none of which derive their origin from the motion or ſediments of the ſea. In theſe ſtrata of tufa and of ſoft imperfect ſtones,

we find a number of different vegetables, leaves of trees, land or river-ſhells, and ſmall terreſtrial animals, but never ſea-ſhells, or other productions of the ocean. This circumſtance, joined to their want of ſolidity, evidently proves, that theſe ſtrata have been ſuperinduced upon the dry ſurface of the earth, and that they are more recent than thoſe of marble and other ſtones, which contain ſea-ſhells, and have been originally formed by the waters of the ſea. Tufa, and other new ſtones, appear to be hard and ſolid when firſt dug out of the earth; but they ſoon diſſolve after being expoſed to the operation of the weather. Their ſubſtance is ſo different from that of true ſtone, that, when broken down in order to make ſand of them, they change into a kind of dirty earth. The ſtalactites, and other ſtony concretions which Mr. Tournefort apprehended to be marbles that had vegetated, are not genuine ſtones. We have already ſhown, that the formation of tufa is not ancient; and that it is not entitled to be ranked with ſtones. Tufa is an imperfect ſubſtance, differing from ſtone or earth, but deriving its origin from both by the intervention of rain water, in the ſame manner as incruſtations are formed by the waters of certain ſprings. Thus, the ſtrata of theſe ſubſtances are not ancient; nor have they, like the other ſpecies, been formed by ſediments from the waters of the ocean. The ſtrata of turf are alſo recent and have been produced by ſucceſſive accumulations

tions of half corrupted trees and other vegetables, which owe their preſervation to a bituminous earth. No production of the ſea ever appears in any of theſe new ſtrata. But, on the contrary, we find in them many vegetables, the bones of land-animals, and land and river-ſhells. In the meadows near Aſhly, in the county of Northampton, for example, they find, ſeveral feet below the ſurface, ſnail-ſhells, plants, herbs, and ſeveral ſpecies of river-ſhells, well preſerved; but not a ſingle ſea-ſhell appears*. All theſe new ſtrata have been formed by the waters on the ſurface changing their channels, and diffuſing themſelves on all ſides. Part of theſe waters penetrate the earth, and run along the fiſſures of rocks and ſtones. The reaſon why water is ſo ſeldom found in high countries, or on the tops of hills, is, becauſe high grounds are generally compoſed of ſtones and rocks. To find water, therefore, we muſt cut through the rocks till we arrive at clay or firm earth. But, when the thickneſs of the rock is great, as in high mountains where the rocks are often 1000 feet high, it is impoſſible to pierce them to their baſe; and conſequently it is impoſſible to find water in ſuch ſituations. There are even extenſive countries that afford no water, as in Arabia Petrea, which is a deſert where no rains fall, where the ſurface of the earth is covered with burning ſands, where there is hardly the appearance of any ſoil, and where nothing but a few ſickly plants are pro-

* See Phil. Tranſ. Abridg. vol. iv. p. 271.

duced.

duced. In this miſerable country, wells are ſo rare, that travellers enumerate only five between Cairo and Mount Sinai, and the water they contain is bitter and ſaltiſh.

When the ſuperficial waters can find no outlets or channels, they form marſhes and fens. The moſt celebrated fens in Europe are thoſe of Ruſſia at the ſource of the Tanais; and thoſe of Savolaxia and Enaſak in Finland: There are alſo conſiderable marſhes in Holland, Weſtphalia, and other countries. In Aſia are the marſhes of the Euphrates, of Tartary, and of the Palus Meotis. However, marſhes are leſs frequent in Aſia and Africa than in Europe. But the whole plains of America may be regarded as one continued marſh; which is a greater proof of the modernneſs of this country, and of the ſcarcity of its inhabitants, than of their want of induſtry.

There are extenſive fens in England, particularly in Lincolnſhire, near the ſea, which has loſt a great quantity of land on one ſide, and gained as much on the other. In the ancient ſoil many trees are found buried under the new earth which has been tranſported and depoſited by the water: The ſame phænomenon is common in the marſhes of Scotland. Near Bruges in Flanders, in digging to the depth of 40 or 50 feet, a vaſt number of trees were found, as cloſe to each other as they are in a foreſt. Their trunks, branches, and leaves were ſo well preſerved, that their different ſpecies could be eaſily diſtinguiſhed.

diſtinguiſhed. About 500 years ago, the earth where theſe trees were found was covered with the ſea; and, before this time, we have neither record nor tradition of its exiſtence. It muſt, however, have been dry-land when the trees grew upon it. Thus the land, that, in ſome remote period, was firm, and covered with wood, has been overwhelmed with the waters of the ſea, which, in the courſe of time, have depoſited 40 or 50 feet of earth upon the ancient ſurface, and then retired. A number of ſubterraneous trees was likewiſe diſcovered at Youle in Yorkſhire, near the river Humber. Some of them are ſo large as to be of uſe in building; and it is affirmed, that they are as durable as oak. The country-people cut them into long thin ſlices, and ſell them in the neighbouring villages, where the inhabitants employ them for lighting their pipes. All theſe trees appear to be broken; and the trunks are ſeparated from the roots, as if they had been thrown down by a hurricane or an inundation. The wood appears to be fir; it has the ſame ſmell when burnt, and makes the ſame kind of charcoal*. In the Iſle of Man, there is a marſh called *Curragh*, about ſix miles long and three broad, where ſubterraneous fir-trees are found; and, though 18 or 20 feet below the ſurface, they ſtand firm on their roots †. Theſe trees are common in the marſhes and bogs

* See Phil. Tranſ. No. 228.

† See Ray's Diſcourſes, p. 232.

of

of Somerſet, Cheſter, Lancaſhire, and Stafford. In ſome places there are ſubterraneous trees which have been cut, ſawed, and ſquared by the hands of men; and even axes, and other implements are often found near them. Between Birmingham and Bromley, in the county of Lincoln, there are hills of a fine light ſand, which is blown about by the winds, and tranſported by the rains, leaving bare the roots of large firs, in which the impreſſions of the ax are ſtill exceedingly apparent. Theſe hills have unqueſtionably been formed, like downs, by ſucceſſive accumulations of ſand tranſported by the motions of the ſea. Subterraneous trees are alſo frequent in the marſhes of Holland, Frieſland, and near Groningen, which abound in turfs.

Subterraneous trees are of different ſpecies, viz. firs, oaks, birch, beech, yew, hawthorn, willow, aſh, &c. In the fens of Lincoln, along the river Ouſe, and on Hatfield-chace in Yorkſhire, theſe trees ſtand erect, as if they were growing in a foreſt. The oaks are extremely hard, and are uſed in building, where they are ſaid to laſt long, which I think improbable, as all the ſpecimens I have examined loſe their ſolidity, after being dried and expoſed to the air. The aſhes are tender, and ſoon fall into duſt. Some of theſe trees are evidently cut and ſawed with inſtruments; and the hatchets, which are ſometimes found along with them, reſemble the knives formerly uſed in ſacrifices. Beſide trees, we

we alſo meet with vaſt quantities of filberds, acorns, and fir-cones, in many other fens in England, Scotland, and Ireland, as well as in the marſhes of France, Switzerland, Savoy, and Italy*.

For four miles round the town of Modena, whenever the earth is dug to the depth of 63 feet, the workmen pierce about five feet more with a boring inſtrument, through which the water ruſhes up with ſuch impetuoſity, that it fills the wells to the top, almoſt inſtantaneouſly. The water in theſe wells continues perpetually, and is neither augmented nor diminiſhed by rains or drought. What is ſtill more remarkable in this ſpot, whenever the workmen dig to the depth of 14 feet, they find the rubbiſh and ruins of an ancient city, paved ſtreets, houſes, and different pieces of Moſaic work. Below this, the earth is ſolid, and appears not to have been moved. Still lower, however, we find a moiſt ſoil mixed with vegetables; and, at the depth of 26 feet, entire trees, as filberds, with nuts upon them, and great quantities of branches and leaves. At 28 feet, there is a ſtratum of ſoft chalk, 11 feet thick, mixed with ſea-ſhells; and after this we ſtill meet with vegetables, leaves and branches of trees, till we arrive at the depth of 63 feet, where there is a ſtratum of ſand mixed with gravel and ſhells, ſimilar to thoſe which appear on the coaſts of Italy. Theſe

* See Phil. Tranſ. Abridg. vol. iv. p. 218, &c.

ſucceſſive ſtrata lie always in the ſame order, wherever pits have been dug; and ſometimes the boring inſtrument falls in with the trunks of large trees, which the workmen pierce with great labour: They likewiſe meet with bones of animals, pit-coal, flints, and pieces of iron. Ramazzini, who relates theſe facts, thinks, that the gulf of Venice formerly extended beyond Modena, and that this land, in the progreſs of time, has been gradually formed by the rivers, aſſiſted, perhaps, by inundations of the ſea.

I will inſiſt no longer upon the varieties in the compoſition of new ſtrata. It is ſufficient to have ſhown that they have been produced by no other cauſe than the waters which run or are ſtagnant upon the ſurface, and that they are neither ſo hard nor ſo ſolid as the ancient ſtrata which were formed under the waters of the ocean.

PROOFS

OF THE

THEORY OF THE EARTH.

ARTICLE XIX.

Of the Changes of Land into Sea, and of Sea into Land.

FROM what has been remarked in article 1. 7. 8. and 9. it is apparent, that the terreſtrial globe has undergone ſome great and general changes; and it is equally certain, from what has been delivered in the other articles, that the ſurface of the earth has ſuffered particular alterations. Though we are not ſufficiently acquainted with the order or ſucceſſion of theſe particular changes, we know the principal cauſes by which they were produced. We can even diſtinguiſh their different effects; and, if we were able to collect all the facts which natural and civil hiſtory afford concerning the revolu-