PROOFS

OF THE

THEORY OF THE EARTH.

ARTICLE IX.

Of the Inequalities upon the Earth's Surface.

THOUGH the inequalities upon the ſurface of the earth may be conſidered as a deformity in its figure, they are abſolutely neceſſary to vegetation and animal life. To be convinced of this fact, we need only conſider what would be the condition of the earth, were its ſurface perfectly ſmooth and regular. Inſtead of thoſe beautiful hills which furniſh abundance of water for ſupporting the verdure of the earth, inſtead of thoſe richly garniſhed fields, where plants and animals find an eaſy and comfortable ſubſiſtence, a dreary ocean would cover the whole globe, and the earth, deprived of all its valuable

valuable and alluring qualities, would be an obſcure abandoned planet, ſuited only for the habitation of fiſhes.

But, independent of moral conſiderations, which ſeldom ought to be employed in natural philoſophy, the ſurface muſt, from a phyſical neceſſity, have been irregular; for, ſuppoſing it to have been originally ſmooth and level, the motion of the waters, ſubterraneous fires, the winds, and other external cauſes, would neceſſarily produce, in time, irregularities ſimilar to thoſe which we now behold.

Next to the elevation of mountains, the depths of the ocean form the greateſt inequalities. This depth is exceedingly diverſified, even at great diſtances from land. In ſome places the ſea is ſaid to be a league in depth; but that is a rare phænomenon; and the moſt common depths are from 60 to 150 fathoms. Gulfs and branches of the ocean which run in upon the land, are ſtill leſs deep; and ſtraits are generally the moſt ſhallow places.

Depths are commonly ſounded by a piece of lead, of 30 or 40 pounds weight, fixed to a ſmall rope. This method anſwers well enough for ordinary depths, but it is liable to error when the depth is very great; for the cord being ſpecifically lighter than water, after much of it has been wound down, the weight of the lead and that of the cord become nearly equal to their bulks of water; then the lead deſcends no more,

but runs off in an oblique line, and floats at the ſame depth. Hence, in ſounding great depths, an iron chain, or ſome body heavier than water, ſhould be employed. It is for want of attention to this circumſtance, that ſome navigators have been led to maintain, that the ſea, in many places, has no bottom.

In general, the depths in open ſeas augment or diminiſh in a pretty regular manner, being commonly deeper the farther from land. But to this remark there are many exceptions; for there are places in the middle of the ſea, as at the *Abrolhos* in the Atlantic, where large ſhelves appear; and there are, in other places, vaſt ſand-banks, well known to the mariners who ſail to the Eaſt Indies.

Along coaſts, the depths are likewiſe very irregular. However, it may be laid down as a certain rule, that the depth is always proportioned to the height of the coaſt: The ſame obſervation applies to rivers.

It is eaſy to meaſure the height of mountains, either geometrically, or by the barometer. This inſtrument determines the height of a mountain pretty exactly, eſpecially in countries where its variation is not conſiderable, as at Peru and other equatorial climates. By one or other of theſe methods, the height of moſt mountains has already been aſcertained; for example, it has been found, that the higheſt mountains of Switzerland exceed Canigau, the moſt elevated of the

the Pyrennees, 1600 fathoms*. Theſe mountains appear to be the higheſt in Europe, ſince they give riſe to a great number of rivers which run into different and very diſtant ſeas, as the Po, which empties itſelf in the Adriatic, the Rhine, which loſes itſelf in the ſands of Holland, the Rhone, which falls into the Mediterranean, and the Danube, which runs into the Black Sea. Theſe four rivers, the mouths of which are ſo diſtant, derive part of their waters from St. Godard and the neighbouring mountains; a clear proof that this place is the moſt elevated part of Europe.

Mount Taurus, Imaus, Caucaſus, and the mountains of Japan, are higher than any in Europe. The mountains of Africa, as the great Atlas, and the mountains of the Moon, are at leaſt equally high with thoſe of Aſia; and the higheſt of all are thoſe of South America, and eſpecially of Peru, which are 3000 fathoms above the level of the ſea. In general, the tropical mountains are more elevated than thoſe of the temperate zones, and thoſe of the latter are higher than thoſe nearer the poles. Thus, the nearer the equator, the greater are the ſuperficial inequalities, which, though conſiderable with regard to us, are nothing when eſtimated in relation to the whole globe. A difference of 3000 fathoms in 3000 leagues diameter, is but a fathom to a league, or a foot to 2200 feet, and, upon a globe

* See Hiſt. de l'Acad. 1708, p. 24.

of $2\frac{1}{2}$ feet, would not make the 16th part of a French line. Hence this earth, which to us appears to be traverſed and interſected by mountains of an enormous height, and by ſeas of a dreadful depth, is, in relation to its ſize, but ſlightly furrowed with inequalities ſo inconſiderable, that they cannot make any variation upon its general figure.

In continents, the mountains form continued chains; but, in iſlands, they are more interrupted, generally riſe in the form of a cone, or pyramid, and are diſtinguiſhed by the name of peaks. The Peak of Teneriffe, in the Iſland of Fer, is one of the higheſt mountains in the earth; it is nearly a league and a half perpendicular above the level of the ſea. The Peak of St. George in one of the Azores, and the Peak of Adam, in the Iſland of Ceylon, are likewiſe exceedingly high. Theſe peaks are compoſed of rocks, piled above each other; and all of them throw out, from their ſummits, fire, aſhes, bitumen, minerals, and ſtones. Some iſlands, as St. Helena, Aſcenſion Iſle, and moſt of the Canaries and Azores, are only the tops or points of mountains. It is alſo worthy of remark, that the middle of moſt iſlands, promontories, and capes, is the moſt elevated, and that they are generally divided into two parts, by chains of mountains which run in the direction of their greateſt length: In Scotland, for example, the Grampian mountains (Grans-bain) extend from eaſt to weſt, and divide the iſland of Great Britain into two

two parts: The ſame thing takes place in Sumatra, the Lucca Iſlands, Borneo, Celebes, Cuba, St. Domingo, the peninſulas of Corea and Malaya, &c. Italy is alſo longitudinally traverſed by the Apennines.

Mountains, as mentioned above, are of different heights; the hills are loweſt; then follow the mountains of an ordinary height, which are ſucceeded by a third range ſtill higher. All theſe are commonly covered with trees and plants; but neither of them furniſh ſprings except at their bottoms. In the laſt and higheſt range, we find nothing but ſand, looſe ſtones, flints, and rocks, the tops of which often reach above the clouds. Preciſely at the foot of theſe rocks, are little plains, or hollows, which collect rains and ſnow, and form thoſe ponds, moraſſes, or fountains, from which the rivers derive their ſources *.

The figure of mountains is likewiſe very different. Some conſiſt of long chains of nearly an equal height; others are interſected by deep valleys; the contours of ſome mountains are pretty uniform; thoſe of others are moſt irregular, and ſometimes a detached little mountain appears in the middle of a plain or valley. There are alſo two kinds of plains; ſome occupy the low grounds, and others appear in the mountains. The former are generally divided by ſome large river; but the latter, though their

* See Lettres Philoſophiques ſur la Formation des Sels, &c. p. 198.

extent

extent be conſiderable, are dry, or furniſhed with a ſmall rill only. The plains in the mountains are often exceedingly high, always of difficult acceſs, and form one country above another, as in Auvergne, Savoy, and other elevated provinces. The ſoil of them is firm, and produces plenty of herbs and odoriferous plants, which make them the fineſt paſture-grounds in the world.

The tops of high mountains are compoſed of rocks of different elevations, which, when viewed at a diſtance, make them reſemble the waves of the ſea *. This is not the only reaſon for our affirming that mountains were formed by the motions of the ſea; I only mention it, becauſe it correſponds with every other phænomenon. But the following facts put this point beyond all controverſy: The foſſil ſhells, and other ſea-bodies, every where found in ſuch profuſion, that they could not poſſibly be tranſported from the ſea, in its preſent ſtate, into continents ſo diſtant, and depoſited at ſuch great depths in the bowels of the mountains: The univerſal paralleliſm of the different ſtrata, an effect which could only be produced by water, and the compoſition even of the moſt denſe of them, as thoſe of ſtone and marble, which clearly evinces, that, before their formation, they had been reduced into a fine powder, and precipitated to the bottom in the form of ſediments:

* See ibid. p. 196.

The

The exactneſs with which the foſſil ſhells are moulded in the matters in which they are found: The cavities of foſſil ſhells, which are uniformly filled with the ſame ſubſtances that contain them: The correſponding angles of hills and mountains, which nothing could effect but the currents of the ocean: The equality in the heights of oppoſite hills, and the different ſtrata uniformly appearing at the ſame levels: And, laſtly, the direction of mountains, the chains of which extend longitudinally, like the waves of the ſea.

With regard to the depths or hollows on the ſurface of the earth, thoſe of the ocean are unqueſtionably the greateſt. But, as theſe are hid from human view, and can only be diſcovered by ſounding, we ſhall confine ourſelves to thoſe which appear on the dry land, ſuch as deep valleys, precipices found between rocks, abyſſes that preſent themſelves in high mountains, as the abyſs of Mount Ararat, the precipices of the Alps, the valleys of the Pyrennees, &c. Theſe depths are a natural conſequence of the elevation of mountains; they receive the water and earth carried down from the high grounds; their ſoil is generally fertile; and they are full of inhabitants. The precipices among rocks are often occaſioned by a ſudden ſinking of one ſide, the baſe, which generally inclines more one way than another, being looſened by the action of the air, and of froſt, or by the violence of

torrents.

torrents. But abyſſes, or thoſe enormous precipices that appear on the tops of ſome mountains, and, to the bottom of which, though their circumference be a mile and a half, or three miles round, it is impoſſible to deſcend, have been formed by the operation of fire. They have been the furnaces of ancient volcano's, the matter of which has been exhauſted by exploſions, and the long action of fires that are now extinguiſhed by the defect of combuſtible matter. Of this kind is the abyſs of Mount Ararat, deſcribed by Tournefort. It is ſurrounded with rocks which are black and burnt. The abyſſes of Etna and of Veſuvius will have the ſame appearance after their inflammable materials are exhauſted.

In Plot's hiſtory of the county of Stafford in England, there is an account of a kind of gulf, which was ſounded by a rope of 2600 feet, without finding either water or bottom, the rope being too ſhort *.

The greateſt cavities, and the deepeſt mines, are generally in the mountains, and ſeldom deſcend to the level of the plains. By them we diſcover the internal ſtructure of the mountain only, not that of the globe itſelf.

Beſides, theſe depths are not very conſiderable. Mr. Ray affirms, that the deepeſt mines exceed not half a mile. The mine of Cotteberg, which, in the time of Agricola, was eſteemed to be the

* See Journal des Savans, 1680, p. 12.

deepeſt

deepeſt in the world, was only 2500 feet of perpendicular depth. There are, indeed, holes in particular places, as that mentioned by Plot, or Pool's hole in the county of Derby, the depth of which is probably very great: But none of them bear any ſenſible proportion to the thickneſs of the globe.

If the kings of Egypt, in place of erecting pyramids as monuments of their vanity and riches, had expended equal ſums in making profound excavations into the bowels of the earth, to the depth of perhaps a league, they might have diſcovered ſubſtances which would have recompenſed their labour; they would at leaſt have extended the knowledge of the earth's internal ſtructure, which might have been productive of much utility.

But, let us return to the mountains. The higheſt of them lie between the tropics; and the nearer we approach to the equator, the greater are the inequalities on the earth's ſurface. A ſhort enumeration of mountains and iſlands will be ſufficient to eſtabliſh this point.

In America, the Cordeliers, which are the higheſt mountains in the world, lie preciſely under the equator, and they extend on both ſides a conſiderable way beyond the Tropic circles.

The higheſt mountains of the Moon, of Monomotapa, and the great and little Atlas, in Africa, lie either under or very near the equator.

In

In Aſia, Mount Caucaſus, the chain of which, under different names, runs into China, and through this whole extent, lies nearer the equator than the poles.

In Europe, the Pyrennees, the Alps, and the mountains of Greece, which form one chain, are ſtill leſs diſtant from the equator than the pole.

Theſe chains of mountains, of which we have given an enumeration, are higher, and of greater extent, both in length and in breadth, than thoſe of more northern countries. With regard to their direction, the Alps form a continued chain which runs acroſs the whole Continent from Spain to China. They commence on the ſea-coaſt of Galicia, join the Pyrennees, traverſe France, by Vivares and Auvergne, run through Italy, and ſtretch into Germany, above Dalmatia, until they reach Macedonia; from thence they join the mountains of Armenia, the Caucaſus, the Taurus, the Imaus, and at laſt terminate on the coaſt of Tartary. Mount Atlas, in the ſame manner, traverſes the whole Continent of Africa, from the kingdom of Fez to the ſtraits of the Red Sea. The mountains of the Moon have likewiſe the ſame direction.

But the mountains of America have an oppoſite direction. The vaſt chains of Cordeliers, and other mountains, run more from ſouth to north than from eaſt to weſt.

What

What we have now remarked concerning the greateſt elevations of the land, applies equally to the greateſt depths of the ſea. The moſt extenſive and deepeſt ſeas lie nearer the equator than the poles. From theſe united obſervations, the truth of our general poſition, that the greateſt inequalities of the globe are to be found in the equatorial regions, is ſufficiently eſtabliſhed. Theſe irregularities on the ſurface of the earth give riſe to a number of curious phænomena. Between the Indus and the Ganges, for example, there is a large peninſula, through the middle of which runs a chain of high mountains, called the *Gate*, which extends from north to ſouth, from the extremity of Mount Caucaſus to Cape Comorin. One ſide of this peninſula forms the coaſt of Malabar, the other that of Coromandel. On the Malabar ſide, between the chain of mountains and the ſea, the ſeaſon of ſummer is from September to April; and, during theſe months, the ſky is ſerene, and no rain falls. But on the Coromandel coaſt, which lies on the other ſide of the mountains, this very period is their winter, and the rains fall in torrents. This reverſe of ſummer and winter happens, in ſome places, no farther diſtant than 20 leagues; ſo that, by croſſing the mountains, a man has it in his power to change ſeaſons. The ſame thing, it is ſaid, takes place at Cape Razalgate in Arabia, and even in Jamaica, which is divided from eaſt to weſt by a chain of mountains. On the ſouth

ſide

ſide of theſe mountains, the plantations enjoy the warmth of ſummer, while thoſe on the north ſuffer all the rigours of winter. Peru, which is ſituated under the line, and extends about 1000 leagues toward the ſouth, is divided into three long and narrow portions, called by the inhabitants *Lanos*, *Sierras*, and *Andes*. The Lanos, which are the plains, extend along the coaſt of the South ſea; the Sierras are hills interſperſed with valleys; and the Andes are the famous Cordeliers, the higheſt mountains of the world. The Lanos are about 10 leagues broad; the Sierras, in many places, 20 leagues; and the Andes nearly the ſame, though ſome parts of them are more, and others leſs broad. The breadth of theſe diviſions is from eaſt to weſt, and their length from ſouth to north. This part of the world exhibits the following remarkable appearances: 1ſt, Along the whole coaſt of the Lanos, a ſouth-weſt wind almoſt conſtantly blows, which is contrary to the ordinary direction of the wind in the Torrid Zone. 2d, In the Lanos, it never rains or thunders, though there are plenty of dews. 3d, It rains almoſt continually at the Andes. 4th, In the Sierras, which lie between the Lanos and the Andes, it rains from September to April.

It was long thought that all high mountains run from weſt to eaſt, till the contrary direction was diſcovered in America. But M. Bourget was the firſt who remarked the ſurpriſing regularity

gularity in the ſtructure of theſe great maſſes. After paſſing the Alps thirty times in fourteen different places, the Apennines twice, and making ſeveral tours in the neighbourhood of theſe mountains, and of Mount Jura, he found, that the contours of all mountains have a near reſemblance to the works in regular fortifications. When the direction of a mountain is from weſt to eaſt, all its projections, or advances, ſtretch to the ſouth and north. This amazing regularity is ſo remarkable in the valleys, that a man is apt to imagine he is walking in a covered way. If, for example, a man travels in a valley from north to ſouth, he perceives that the mountain which lies to the right hand makes projections to the eaſt, and that the projections of the oppoſite mountains regard the weſt, in ſuch a manner, that the prominent and concave angles, on each ſide, alternately correſpond with one another. When the valleys are large, the angles of the mountains are leſs acute, becauſe they are more diſtant from each other, and the declivity is not ſo rapid or ſteep. Theſe angles are not perceptible in plains, except when we ſtation ourſelves on the banks of the rivers, which generally occupy the middle of the plains, and whoſe natural windings correſpond to the moſt advanced angles or projections of the mountains. It is aſtoniſhing that ſuch an obvious fact ſhould have remained ſo long unnoticed; for, it is apparent, that, in valleys lined

with oppoſite mountains, when the declivity of one of the mountains is leſs rapid than that of the other, the courſe of the rivers is not in the middle, but nearer to the ſteepeſt mountain*.

Theſe general obſervations might be confirmed by a multitude of facts. The mountains of Switzerland, for example, are ſteeper on the ſouth ſide than on the north, and on the weſt ſide than on the eaſt. This appearance is obvious in Mount Gemmi, Mount Briſa, and in almoſt all the other mountains in this country, the higheſt of which are thoſe which ſeparate Valleſia, and the Griſons of Savoy, from Piedmont and Tirol. Theſe countries are, indeed, a continuation only of the ſame mountains, the chain of which extends to the Mediterranean; and the Pyrennees are a continuation only of that vaſt mountain, which commences in Upper Valleſia, whoſe branches ſtretch far to the weſt and ſouth, and preſerve, throughout that whole extent, a great height; but, on the north and eaſt ſides, they gradually ſink into plains, as appears in thoſe extenſive countries which are traverſed by the Rhine and Danube before they finiſh their courſe, while the Rhone deſcends with rapidity to the ſouth, and empties itſelf in the Mediterranean. The ſame obſervation is exemplified in the mountains of England and of Norway. But the moſt perfect example is af-

* See Lettres Philoſophiques ſur la Formation des Sels, p. 181. 200.

forded by the mountains of Chili and Peru. The Cordeliers are exceedingly ſteep on the weſt ſide; but they have a gradual declivity to the eaſt, and terminate in vaſt plains, which are watered by the greateſt rivers in the world*.

M. Bourguet, to whom we are indebted for the diſcovery of the correſpondence between the angles of mountains, calls this diſcovery *the Key to the Theory of the Earth*. However, he appears not to have perceived its whole importance; for, in his treatiſe on this ſubject, he gives the ſkeleton only of an hypothetical ſyſtem, in which moſt of his concluſions are either falſe or uncertain. The theory that we have delivered reſts upon four principal facts, the truth of which, after examining the proofs that ſupport them, cannot admit of a doubt: the *firſt* is, That the earth, to very conſiderable depths, is every where compoſed of parallel ſtrata of different matters, which were formerly in a fluid or ſoft ſtate: the *ſecond*, That the ſea has, for many ages, covered the whole earth which we now inhabit: the *third*, That the tides and other motions of the waters, produce inequalities in the bottom of the ſea: and the *fourth*, That the figure, and correſponding direction of mountains, have originated from currents in the ocean.

After peruſing the proofs contained in the ſubſequent articles, the reader will be enabled to

* See Phil. Tranſ. Abridg. vol. 6. part 6. p. 158.

determine whether I am right in maintaining, that theſe facts, when firmly eſtabliſhed, will likewiſe aſcertain the general theory of the earth. What has been remarked concerning the formation of mountains needs no farther explication. But, as it may be objected, that I have not accounted for the formation of peaks, or pointed mountains, nor for ſome other particular facts, I ſhall add ſuch obſervations as have occurred upon this ſubject.

I have endeavoured to form a diſtinct and general idea of the manner in which the materials compoſing this earth are arranged, and have reduced the whole to two claſſes. The *firſt* includes all the matters which are diſpoſed in horizontal or regularly inclined beds or ſtrata; and the *ſecond* comprehends all thoſe matters which appear in detached maſſes, in ridges, or in veins, either perpendicular, or irregularly inclined. In the *firſt* claſs I rank ſands, clays, granites, flints, and free-ſtones in large maſſes, pit-coal, ſlates, and likewiſe marls, chalk, calcinable ſtones, marbles, &c. In the *ſecond*, I include metals, minerals, cryſtals, precious ſtones, and flints in ſmall maſſes. Under theſe two claſſes, all the known materials of the earth are comprehended. Thoſe of the firſt claſs owe their origin to ſediments tranſported and depoſited by the waters of the ſea, and ought to be diſtinguiſhed into ſuch as are calcinable by the application of fire, and ſuch as melt, and are

convertible into glaſs. The matters comprehended under the ſecond claſs are all vitrifiable, with the exception of thoſe called inflammable, or which totally conſume in the fire.

There are, in the firſt claſs, two diſtinct ſpecies of ſand; the one, which abounds more than any other matter in the globe, is vitrifiable, or rather conſiſts of fragments of real glaſs: The other, which is leſs in quantity, is calcinable, and ought to be regarded as the duſt of ſtone, and as differing from gravel only by the groſſneſs of its grains. In general, vitrifiable ſand lies in beds; but they are frequently interrupted by maſſes of free-ſtone, of granite, and of flint; and ſometimes theſe ſubſtances appear in banks of a conſiderable extent.

Sea-ſhells are ſeldom found in this ſand, or in vitrifiable bodies; and even thoſe which appear in them are not diſpoſed in beds, but ſcattered, as it were, by chance: I never, for example, found any in free-ſtone. This ſtone, which abounds in certain places, is nothing but ſand united by a cement. It never appears but in countries where vitrifiable ſand is frequent; and the quarries of it are generally in pointed hills, ſandy lands, or interrupted eminences. Theſe quarries may be wrought on all ſides; and, when they appear in large beds, they are more diſtant from each other than thoſe of marble or calcinable ſtones. Blocks of free-ſtone may be cut of all dimenſions; and, though it be diffi-

cult to work, its hardneſs is inconſiderable; for it is eaſily reduced to ſand by friction, except the black points or nails ſometimes found in it, which are ſo hard as to reſiſt the beſt files. Common rock-ſtone, which I conſider as a ſpecies of granite, is vitrifiable, and of a ſimilar nature with free-ſtone; it is only harder, and more firmly cemented. It has likewiſe ſeveral denſe points, which cut the ſhoes of travellers on mountainous grounds. It alſo contains a great number of talky ſpangles; and the whole is ſo hard as not to be worked without great labour.

After narrowly examining theſe hard points found in free-ſtone and granite, I diſcovered that they conſiſt of metallic matter, which has been melted and calcined by a ſtrong fire, and that they have a perfect reſemblance to certain ſubſtances thrown out of volcano's, of which I have ſeen vaſt quantities in Italy. They are called by the inhabitants *Schiarri*. They are black heavy maſſes, upon which neither fire, water, nor the file, can make any impreſſion. This metallic matter is different from lava, the latter being a ſpecies of glaſs; but the former ſeems to partake more of metal than of glaſs. The points in free-ſtone and granite have a great reſemblance to this matter, which is a farther proof that thoſe ſubſtances have formerly been liquified by fire.

On the tops of ſome high mountains, blocks of granite appear in great quantities. The poſitions of theſe blocks are ſo irregular, that they ſeem

ſeem to have been thrown together by accident; and we ſhould be apt to imagine that they had tumbled down from ſome neighbouring height, if the places where they are found were not higher than any neighbouring ground. But their vitrifiable nature, and their angular and ſquare figures, like thoſe of free-ſtone rocks, diſcover theſe ſubſtances to have an uncommon origin. Thus, in large ſtrata of vitrifiable ſand, we find blocks of free-ſtone and granite, the figure and ſituation of which follow not exactly the horizontal poſition of ſtrata. The rains have gradually brought down from the hills and mountains the ſand with which theſe blocks were originally covered, by furrowing and cutting into thoſe intervals that appear between the yolks or nuclei in free-ſtone, in the ſame manner as the hills of Fontainbleau are interſected. Every point of a hill reſembles a nucleus in free-ſtone quarries, and all the intervals have been ſcooped out by the rains, and the ſand they originally contained has been carried down to the valleys. In the ſame manner, the angular blocks of granite on the tops of high mountains were formerly covered and ſurrounded with vitrifiable ſand, which, being gradually carried off by the rains, left the blocks in the poſition in which they happened to be formed. Theſe blocks are generally pointed at the top, and augment in thickneſs towards their baſes; one block often reſts upon another, that upon a third, and ſo on,

leaving irregular intervals between them: and as, in the courſe of time, the ſand which covered the blocks, and filled the intervals, was waſhed down by the rains, there would nothing remain on the tops of high mountains but pointed piles of irregular blocks; and hence the origin of peaks, or mountains ending in ſharp points.

For, let it be ſuppoſed, as may eaſily be proved by the ſea-bodies found in the Alps, that this chain of mountains was formerly covered by the ocean, and that a thick bed of vitrifiable ſand was depoſited upon their tops, which reduced the whole chain to a level country. This bed of ſand would neceſſarily give riſe to large blocks of granite, of free-ſtone, of flint, and of other bodies, the conſiſtence and figure of which originate from ſand, nearly in the ſame manner as ſalts cryſtallize. Theſe blocks, after the ſand which covered them, and filled their interſtices, was carried down to the plains, by rains, torrents, &c. would maintain their original ſtations, remain bare on the tops of the mountains, and conſtitute all thoſe peaks or pointed eminences ſo frequently exhibited by Nature. To the ſame origin muſt be aſcribed thoſe high detached rocks which are found in China and other countries, as in Ireland, where they are diſtinguiſhed by the name of *Devil's ſtones*, and the formation of which, as well as of peaked mountains, has hitherto appeared ſo difficult to explain. The explication, however, which I have given, is ſo natural,

natural, that it generally occurs to every perſon, who examines theſe objects; and, on this occaſion, I will ſet down a paſſage from father Tartre. 'From Yanchuin-yen we arrived at Hot-'cheou. Upon the road we remarked a ſin-'gular phænomenon, namely, rocks of a ſur-'priſing height, reſembling ſquare towers, in the 'midſt of vaſt plains. I cannot account for this 'appearance, unleſs I be allowed to ſuppoſe theſe 'rocks to have formerly conſtituted a part of 'mountains, and that the earth, ſand, and other 'looſe parts, had been gradually waſhed away 'by the rains, and left rocks bare on all ſides. 'What fortifies this conjecture is, that we ſaw 'ſome of them, the baſes of which were ſtill 'ſurrounded with earth to a conſiderable 'height *.'

The tops of the higheſt mountains, often for 200 or 300 fathoms, conſiſt of rocks of granite, free-ſtone, and other hard and vitrifiable ſubſtances: Below theſe, we frequently meet with quarries of marble, or hard calcinable ſtone, full of foſſil ſhells; as may be ſeen at the great Chartreuſe in Dauphiny, and upon Mount Cenis, where the ſtones and marbles which contain ſhells are ſituated ſome hundreds of fathoms below the points or peaks of high mountains, though theſe beds of ſtone and marble be more than 1000 fathoms above the level of the ſea. Thus thoſe mountains which have peaks or points generally

* See Lettres Edifiantes, tome i. p. 135.

conſiſt

conſiſt of vitrifiable rocks; and thoſe, the ſummits of which are flat, contain, for the moſt part, marbles, and hard ſtones full of ſea-bodies. The ſame remark holds with regard to hills; for thoſe compoſed of granite or free-ſtone are generally interſected with points, eminences, cavities, and ſmall valleys. But thoſe compoſed of calcinable ſtone are nearly of an equal height, and are only interrupted by larger and more regular valleys, with correſponding angles; and they are crowned with rocks, uniform and level in their poſition.

Though theſe two ſpecies of mountains ſeem to be very different, their figures have been produced by the ſame cauſe, as has already been ſhown: But, it may be remarked, that the calcinable ſtones have ſuffered no change ſince the original formation of the horizontal ſtrata. The vitrifiable ſands, however, may have been changed and interrupted by the ſubſequent production of rocks and angular blocks which take place in ſand-beds. Both ſpecies have fiſſures. Thoſe in calcinable rocks are almoſt always perpendicular; but thoſe of granite and free-ſtone are ſomewhat more irregular in their direction. It is in theſe fiſſures that metals, minerals, cryſtals, ſulphur, and all the ſubſtances of our ſecond claſs, are found. Below the fiſſures, the waters aſſemble, penetrate the earth, and give riſe to the veins of water which every where appear under the ſurface.

PROOFS

OF THE

THEORY OF THE EARTH.

ARTICLE X.

Of Rivers.

I HAVE already remarked, that, in general, the greateſt mountains occupy the middle of continents; that thoſe of a ſmaller kind divide iſlands, peninſulas, and promontories; that, in the Old Continent, the direction of the greateſt chains of mountains is from weſt to eaſt; and that thoſe which run to the north or ſouth are only branches of the principal chains. It will appear on examination, that the greateſt rivers have the ſame direction, and few of them follow the courſe of the branches of mountains. To be convinced of this fact, we have only to run our eye over a common globe; and, beginning with Spain, we ſhall find that the Vigo, the Douro,