# An introduction to geology, illustrative of the general structure of the earth

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Chapter VIII.

# CHAPTER VIII.

## ON THE DECOMPOSITION OF MOUNTAINS, THE FORMATION OF SOILS, AND ALLUVIAL PRODUCTS.

*Proofs of the diminution of Mountains.—Elementary agency.—Final causes.—Formation of Soils.—Mixture of different Earths necessary to form good Soil.—Effects of Lime.—Alluvial depositions from Alpine Countries and Secondary Rocks.—Peat Moors, and Subterranean Forests.*

THE diminution of rocks and mountains is constantly taking place by the incessant operation of the elements, until the loftiest eminences are reduced and covered with soil and vegetables, which protect them from further decay. Instances have occurred of whole mountains suddenly falling down and burying the inhabitants of the vales below under their ruins. In the Alps the process of disintegration is rapidly going on; but such is the immensity of these enormous mountains, that ages pass away before any diminution of their bulk is perceived.

That

That the mountains of our island have once been much higher than at present, is evident to every one who has attentively examined them. The rocky fragments in Borrowdale, the deep ravines made by torrents in the sides of Skiddaw, and the scattered rocks at the foot of Snowdon, offer striking proofs of this. The central parts of England have also once had a greater elevation. The white quartz pebbles spread over the midland counties are the remains of the decomposed hills in Charnwood forest, or of others connected with them which are now worn down. Beacon Hill, one of the highest points of this range, I ascertained by trigonometrical admeasurement, does not rise more than 760 feet above the surrounding country; but all these hills are evidently the remains of a more lofty and extended chain of mountains. Large blocks of white quartz lie upon their summits, which once formed veins intersecting higher rocks; this quartz being harder, has remained after the other parts were worn down. Veins filled with similar quartz may be traced near the places where these blocks lie.

Beside

Beside the destructive effects of mountain torrents so sudden and impetuous in alpine countries, there is another powerful agent in nature that can rend the hardest rocks, and to which mountains that contain much metallic matter are particularly exposed,—this is lightning. The antients, whose views of external nature were almost always correct, have described the destruction of rocks and mountains as a characteristic phænomenon attending thunder-storms. In the sublime description of a storm in the first Georgic, Virgil has represented the rending of rocks as one of the common effects of lightning.

> " ———————— ille flagranti
> Aut Atho, aut Rhodopen, aut alta Ceraunia telo
> Disjecit."
>
> Jove's forked bolt pursues its rapid course,
> And rocks and mountains rends with matchless force.

On this subject I shall transcribe part of a letter from a friend, Mr. Jas. Oakes of Derby, who visited Cader Idris in Merionethshire last summer. " Our descent was on the northern side of the mountain, over an immense heap of pillars of porphyritic green-stone which lay scattered

scattered over an extensive surface in every direction. We at first wondered what could have been the cause of such general devastation; but were relieved from our surprise by seeing the ground torn up lower down, and some of the pillars broken in two that lay in that direction. This was evidently the effect of lightning, and we observed many large openings in the side of the mountain among the mass of columns which had recently been made by the same cause."

Were the effects of this powerful agent more attended to, perhaps many anomalous appearances in the mineral kingdom might admit of an easy explanation.

It is, however, to the more constant operation of moisture and change of temperature that the disintegration of rocks and mountains may be principally attributed; but no well authenticated observations have yet been made to determine the extent of these effects in certain periods of time.

It has been vaguely stated that the height of the Pyrennees is diminishing one foot in a century: hence it was calculated that more

than

than a million years would be required to level the boundary which separates France and Spain.

There are, however, agents in nature, earthquakes, volcanoes, and perhaps central subterranean fire, that can entomb whole continents in the ocean, and raise mountains from the watery abyss in a single night. Evident indications exist that such causes have operated extensively on the surface of our planet; but the periods of time in which they are destined to succeed each other, remain beyond the power of human sagacity to determine. By the slow but constant destruction of rocks and mountains new and productive soils are formed to renovate the surface of the globe, and prepare it for the support of animal life: this appears to be the final cause for which the world was created, and to which all terrestrial changes ultimately refer. It has been justly observed by Dr. Paley and others, that in the peculiar conformation of the teeth in graminivorous animals, and in the production of grasses which serve them for food, we may trace evident marks of of relation, and of a designing intelligent cause: with equal reason must we admit that the destruction of mountains and the formation of soils for the support of the vegetable tribes are provided for by the same cause, and are part of a regular series of operations in the œconomy of nature: hence also we may infer that those grand revolutions of the globe by which new mountains or continents are elevated from the deep, are parts of the same series extending through ages of endless duration, and connecting in one chain all the successive phænomena of the material universe.

By a wise provision of the author of nature it is ordained that those rocks which decompose rapidly are those which form the most fertile soils, for the quality of soils depends on the nature of the rocks from which they were formed. Granitic and siliceous rocks form barren and sandy soils; argillaceous rocks form stiff clay; and calcareous rocks, when mixt with clays, form marle; but when uncovered by other strata they support a short but nutritious vegetation. For the formation of productive soils, an inter-

mixture

mixture of the three earths, clay, sand, and lime, is absolutely necessary. The oxyd of iron appears also to be a requisite ingredient. The proportion necessary for the formation of good soil depends much on the nature of the climate, but more on the quality of the sub-soil, and its power of retaining or absorbing moisture. This alone may make one soil barren, which upon another sub-soil would be exceedingly productive. When this is the case, drainage or irrigation offers the only means of permanent improvement.

Different vegetables also require different admixtures of earth. They require it, first, because it is necessary to their growth that the soil should be sufficiently stiff and deep to keep them firm in their place; and also that it should not be too stiff to permit the expansion and growth of their roots; and, lastly, that it should supply them with a constant quantity of water, neither too abundant nor deficient. Hence we may learn why different degrees of tenacity, depth, and power of retaining or absorbing moisture, are required in soils for different kinds of plants.

 Thus,

Thus, in uncultivated countries we find that certain vegetables affect particular situations in which they flourish spontaneously and exclusively; and it is only by imitating nature, and profiting by the instruction she affords, that we can hope to obtain advantageous results, or acquire certain fixt principles to guide us in our attempts to bring barren lands into a state of profitable cultivation. When rocks contain in their composition a due proportion of silex, clay, and lime, they furnish soils whose fertility may be said to be permanent. The most fertile districts in England were made so by nature; their original fertility was independent of human operation.

Some small portion of the earths and alkalies is found by chemical analysis in plants: but it would be contrary to fact and analogy to suppose that the earths in a concrete state form any part of the food of plants. The earths and alkalies which they contain are in all probability formed by the process of vegetation from mere simple elements, for it is now ascertained that the earths and alkalies are compound substances.

The

The principal elements found in plants are hydrogen, carbon, and oxygen, and by recent experiments of Gay Lussac and Thenard* it appears that the hydrogen and oxygen in starch, gum, vegetable oils, and sugar, exist in precisely the same proportion that forms water. Carbon, the other principal elementary substance found in plants, exists both in water and the atmosphere. Water and the atmosphere contain in themselves, or in solution, all the elements necessary for the support and growth of vegetables. But most soils are either too wet or too dry, too loose or too adhesive, to admit plants to extract these elements in the proportions necessary for their growth. Manures supply this deficiency by furnishing in great abundance the hydrogen, carbon, or azote, which they may require. In proportion as soils possess a due degree of tenacity, and power of retaining or absorbing heat and moisture, the necessity for a supply of manure is diminished, and in some instances the earths are so fortunately

* Recherches Physico-Chemiques.

combined as to render all supply of artificial manure unnecessary. He who possesses on his estate the three earths, clay, sand, and lime, of a good quality, with facilities for drainage or irrigation, has all the materials for permanent improvement, the grand desiderata in agriculture being to render wet lands dry, to supply dry lands with sufficient moisture, to make adhesive soils loose, and loose soils sufficiently adhesive.

The intermixture of soils, where one kind of earth is either redundant or deficient, is practised in some countries with great advantage. Part of Lancashire is situated on the red sand rock described in the sixth chapter. This rock, being principally composed of siliceous earth and the oxyd of iron, forms of itself very unproductive land: but fortunately in many situations it contains detached beds of calcareous marle near the surface. By an intermixture of this marle with the soil, it is converted into fertile land, and the necessity for manure is superseded. The effect of a good marle applied liberally to this land, lasts for more than

than twenty years. In some lands, a mixture of light marle which contains scarcely a trace of calcareous earth is found of great service. The good effect of this appears to depend on its giving to the sandy soil a sufficient degree of tenacity. On the contrary, in stiff clay soils, where lime is at a great distance, the land might frequently be improved by an intermixture with siliceous sand. A proper knowledge of the quality of the sub-soil and the position of the sub-strata is necessary to ascertain the capability of improvement which land may possess. It may frequentl yhappen that a valuable stratum of marle or stone which lies at a great depth in one situation, may rise near the surface in an adjoining part of the estate, and might be procured with little expense.

Lime is the only earth which has been generally used to intermix with soils, and has been considered as a manure; but its operation as such is very imperfectly understood. Burnt lime, when caustic, destroys undecomposed vegetable matter, and reduces it to mould,—so far its use is intelligible. It

combines

combines also with vegetable or mineral acids in the soil which might injure vegetation,—here its operation is likewise intelligible; but if we assert that when burnt lime has absorbed carbonic acid and become mild, it gives out its carbon again to the roots of plants, we assume a fact which we have neither experiments nor analogies to support. The utility of lime in decomposing vegetable matter and neutralizing acids is obvious; but its other uses are not so evident, except we admit that it acts mechanically on the soil, and renders the clay or sand with which it is intermixt better suited to the proper expansion of the roots, and more disposed to modify the power of retaining or absorbing the requisite degree of heat and moisture which particular vegetables may demand.

Where earths are properly intermixt, instances are known of land producing a succession of good crops for many years without fallowing or manure. On the summit of Breedon Hill, in Leicestershire, I have seen a luxuriant crop of barley growing on land that had borne a succession of twenty preceding

ing crops without manuring. This is more deserving notice, being in an exposed and elevated situation, and upon the very hill of magnesian lime which has been so frequently referred to by chemical writers as peculiarly unfavourable to vegetation. The lime-stone of this hill contains above 20 per cent of magnesia*.

The temperature requisite for the growth of plants is influenced by the power of different soils to absorb and retain heat from the solar rays, which depends much on their moisture and tenacity. " It is a well known fact, that the vegetation of perennial grasses in the spring is at least a fortnight sooner on lime-stone and sandy soils, if not extremely barren, than on clayey or even in deep rich soils; it is equally true, but perhaps not so well known, that the difference is more than reversed in the autumn."—(Observations on

* The magnesian lime acts more powerfully in destroying undecomposed vegetable matter than common lime, and its effects on land are more durable : hence it is in reality of greater value in agriculture, as a much smaller quantity will answer the same purpose.

Mildew,

Mildew, by J. Egremont, Esq.) This effect Mr. E. ascribes with much probability to the rich or clayey soils absorbing heat slowly, and parting with it again more reluctantly than the calcareous soils, owing to the greater quantity of moisture in the clay, which is an imperfect conductor of heat.

Calcareous soils might frequently be much improved by a mixture of clay, sand, or gravel, which in many situations is practicable with little expense, and would well reward the labour of the experimental agriculturist.

*Ground* properly called alluvial, which has been formed from the materials of decomposed rocks, will differ according to the nature of the rocks in different districts.

In mountainous countries, alluvial grounds are principally composed of fragments of rocks worn by attrition, and of pebbles and sand. Metallic ores, which are very hard, or indestructible, are also found in the alluvial depositions of primary and transition rocks. Tinstone, or ore of tin, is found in the form of rounded pebbles, in the banks and sands of the rivulets in Cornwall, and under the sand on the

sea

sea shore. There can scarcely be a doubt that this ore once formed veins intersecting mountains that are decomposed and worn down. Small pieces of gold have occasionally been found in a similar situation, which, as well as the gold in the sands of rivers in different parts of the world, had in all probability a similar origin. The diamond, and other precious stones which occur in alluvial depositions, were also probably brought there, from decomposed rocks, by inundations and mountain torrents.

The alluvial depositions from secondary rocks form beds of sand, clay, and loam, of greater or less thickness. Whether the immeasurable tracts of sand in Africa or Asia were formed from the destruction of siliceous mountains, or by other processes, cannot be determined. During volcanic eruptions, an extent of some hundred square miles has frequently been covered with volcanic sand; but this is of a dark gray colour, contains a considerable portion of argillaceous earth, and becomes consolidated by moisture. Whether siliceous sand alone has ever been ejected from

volcanoes

volcanoes may be doubtful. Siliceous sand deposited in lakes, or in moist situations, and intermixt with clay and oxyd of iron, will form sand-stone. Breccia, or pudding-stone, consists of pebbles agglutinated in a hard cement formed by the consolidation of the loose materials in which they are imbedded; but some breccias appear to have a different formation, and cannot be classed with alluvial products.

Earthy particles, deposited and agglutinated, form beds of tufa. Calcareous tufas occur in the neighbourhood of lime-stone mountains, and also fragments of lime-stone imbedded in calcareous tufa.

*Peat* is one of the most important productions of alluvial ground; it may be regarded as belonging more properly to the vegetable than the mineral kingdom. Peat formerly covered extensive tracts in England, but is disappearing before the genius of agricultural improvement, which has no where produced more important effects than in the conversion of the black and barren peat moors of the northern counties into valuable land

covered

covered with luxuriant herbage, and depastured by numerous flocks. The following description of the peat moors in Scotland, by Mr. Jameson, is an accurate picture of the remaining peat moors in the mountainous parts of Yorkshire and the adjoining counties.

"In describing the general appearance of a peat moor, we may conceive an almost entire flat of several miles extent, of a brown colour, here and there marked with tufts of heather, which have taken root, owing to the more complete decomposition of the surface peat; no tree or shrub is to be seen; not a spot of grass to relieve the eye in wandering over this dreary scene. A nearer examination discovers a wet spungy surface, passable only in the driest seasons, or when all nature is locked in frost. The surface is frequently covered with a slimy black-coloured substance, which is the peat earth, so mixt with water, as to render the moss only passable by leaping from one tuft of heather to another. Sometimes, however, the surface of peat mosses has a different aspect, owing to the greater abundance of heath and other vegetables, as the schœni, scirpi, eriophora, &c. but this is principally the case with some kinds of what are called muirlands, which contain but little peat, being nearly composed of the interwoven roots of living vegetables. Quick moss (as it is called) is a

substance

substance of a more or less brown colour, forms a kneadable compound, and when good, cuts freely and clean with the spade; but when it resists the spade by a degree of elasticity, it is found to be less compact when dried, and is of an inferior quality. The best kinds burn with a clear bright flame, leaving light-coloured ashes; but the more indifferent kinds in burning often emit a disagreeable smell, and leave a heavy red-coloured kind of ashes. In digging the peat, we observe that, when first taken from the pit, it almost immediately changes its colour, which becomes more or less a deep brown or black, and the peat matter becomes much altered, being incapable of forming a kneadable paste with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackish-coloured powdery matter, capable of supporting vegetation when calcareous earth is added.

"Peat is found in various situations, often in valleys or plains, where it forms very extensive deep beds, from three to forty feet deep, as those in Aberdeenshire: it also occurs upon the sides of mountains; but even there it is generally in a horizontal situation. The tops of mountains, upwards of 2,000 feet high, in the Highlands of Scotland are covered with peat of an excellent kind.

"In Germany it is also found at very great heights; thus, the Blogsberg, a high mountain in Lower Saxony,

Saxony, and the Brohen, the highest mountain of the Hartz, are also covered with peat. It is also found in situations nearly upon a level with the sea: thus, the great moss of Cree in Galloway lies close upon the sea, on a bed of clay, little higher than the flood marks at spring tides*."

A peat moor below the level of the sea has extended along the eastern coast of Lincolnshire and Yorkshire; it is principally cultivated except at Hadfield Chase, near Thorn, which is now enclosing. Under the surface there is a forest of trees considerably below the present high water mark. This forest appears to extend under the sea, from the stumps and roots of trees that may be discovered at low water. It has been supposed that the ground has sunk down on this coast. A similar subterranean forest appears to extend under the sea on the Lancashire coast between Liverpool and Preston, and a peat moor exists at a very low level on that side of the county.

Except organic remains and the particles of metallic matter found in certain sands near

* Mineralogy of the Shetland Islands.

alpine districts, alluvial ground may be considered as more interesting to the agriculturist than the geologist. But even here some knowledge of geology is of considerable practical importance in the improvement of land. An acquaintance with the nature, position, and inclination of the sub-soil and sub-strata is absolutely necessary in order to carry on any extensive system of drainage in the most efficacious and least expensive manner. Mr. Elkington, who first directed the attention of landed proprietors to this subject, and explained the principles on which he proceeded, rendered a most essential service to agriculture; his merits were scantily rewarded, but he may be justly ranked among the first benefactors of his country.