GEOLOGY & ITS CONNECTION WITH SANITARY SCIENCE.

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MR. PRESIDENT, LADIES AND GENTLEMEN,—I am going to read a very plain paper this evening—one which, I trust, will be thoroughly understood by the mere tyro, as well as by the more educated geologist. You will hear nothing about the megalosaurus, the megatherion, the anthracosaurus, the archæopteryx, and other extinct animals of the ancient geological periods, each and all of which have long crack-jaw names, sufficiently terrible to deter all but the most determined student of geology. With synclinals, anticlinals, monoclinals, and periclinals I shall have little to do; and, if obliged to refer to the various directions of the strata, shall use, as far as possible, plain English terms. Speculative knowledge as to the origin of the universe in general, and this globe in particular, will form no portion of my theme. The theory as to how man and other animals became what they are will not be dwelt upon; but I shall deal with a subject most important to the whole human race—yes, and even to the domestic animals—viz., the science of hygiene.

Hygiene is that branch of medicine which busies itself with the investigation into the causes of diseases and death, their prevention, mitigation, and removal. How important such a science is may be estimated from the fact that, out of a population of 25,000,000 in England and Wales, 500,000 die on the average every year. Of this number some 450,000 die prematurely—that is, before, in the order of nature, they should. Only some 50,000 die at seventy-five years and upwards.

Is it not dreadful to think that so many human beings should be cut off in the prime of life, in childhood, and in infancy? These are lives sacrificed for want of knowledge, and destroyed by preventible causes. Consider the diseases which ravage humanity—phthisis and other lung complaints alone carry off 130,000 persons per annum. Infectious diseases, such as typhus, typhoid, scarlet, and other fevers, destroy 78,700 of the population in the year. Rheumatism, gout, scrofula, cancer, and other diseases, are the causes of great mortality. Cholera diarrhœa, and dysentery at certain periods run rampant, weakening and killing.

There are some 900,000 births in France every year; 167,000 infants die per annum in that country. In England infant mortality is very high. For instance, in the Thirty-seventh Annual Report of the Registrar-General, he informs us that 239 out of 1,000 births died in the first year in Liverpool, 161 per 1,000 in London, 148 per 1,000 in Portsmouth. Now, this mortality is very shocking, occurring, too, in a so-called civilised country; and it makes us sad to think of young lives just glimpsing at the world hurried off before tasting any of its joys; of young men and maidens snatched off in the flower of their age; of fathers and mothers carried away to the silent tomb, leaving their offspring to the cold charity of the world; and of husbands and wives separated for ever. Yet it is so. Grim Death is busy every day; he has his agents hard at work in earth and air. Destruction is carried in the water we drink, in the air we breathe, and is stored up in the soil beneath our feet.

Man, however, is his own providence. He, since he obtained intelligence, has commenced to re-act against fate. He is now learning to conquer disease and to lengthen life. No longer does he believe the base doctrine that Heaven decrees death, disease, and pain. Hygiene for all, therefore, is a most important study. Its elements should be taught in every school to both sexes; it should be more frequently inculcated from the pulpit and platform it should form a most important part of the education of every medical man, ss surely the prevention of suffering is better than the cure; and no person should hold any sanitary office in town or country without being thoroughly grounded in the subject. If the earth in the future is to be the abode of a race of men, happy and long-lived, it will never do for sanitary science to be neglected.

A person, to be a thorough hygienist, should understand many sciences. He should be acquainted with physics, chemistry, meteorology, physical geography, and geology. He should know the laws which govern epidemics and the spread of infectious diseases. The influence of certain occupations on health and longevity should be thoroughly studied, and he should make a point of investigating the "principles of population," and should also be a well-informed vital statistician. Possessing the above knowledge, he may go forth to fight against man's greatest foe, *premature death.*

That portion, however, of sanitary science on which I am going to discourse to-night is purely *geological.* Now, I hope you will not for one moment suppose that a knowledge of geology will enable you, when applied to sanitary science, to save all the 500,000 persons who die annually in England and Wales, for it will not. There are other causes of mortality at work besides deficient drainage, bad water supply, and the influences of soil and situation; but, this being a Geological Association, it is not necessary to name them here. However, an acquaintance with geology will enable the sanitary engineer to save many valuable lives.

Ere I pass to the practical portion of my paper, I would like to mention an idea which has more than once struck me; and that is, that perhaps the branch of geology called palæontology, or the science which treats of fossil plants and animals, may throw light on the origin of some diseases. If physicians, naturalists, and others, would examine most carefully the various fossil remains with an eye to the above object, valuable facts might be collected which in the future would be full of beneficial results to man and animals. Wild as this idea may seem, and unsubstantiated as it is, still, no doubt, carefully examining bones and other remains by means of the microscope, and diligently comparing, we should, in course of time, arrive at some conclusion as to the various alterations in structure, &c., of such remains. My foundation for bringing forward the above is, that animals died in primæval times of disease as well as by accident and old age; and, as there is a law of heredity by means of which disease is handed down, a knowledge of the primitive diseases would be of service to us, by throwing light upon the diseases of modern times. One barrier, however, to the complete *post-mortem* examinations of the animals of the ancient world is interposed—viz , the total absence of the soft parts, especially of the viscera. However, if I have opened out a field of inquiry for the pathologist and the naturalist, the mentioning of the above will not have been in vain.

Let us, however, leave hypothesis, and study actual facts. Where a knowledge of geology is of such great value to the hygienist is in the matters of drainage, water supply, and the disposal of the dead. It has also other applications, but the three above named are the most important.

First, then, with regard to drainage. How important to health is it that towns and villages should be well drained we may easily estimate from the fact that, according to certain calculations made by the Registrar-General for 25 years (1850—74) there died annually 866·2 persons per million from continued fevers, typhus, typhoid, &c., and especially from the latter. Now, typhoid is especially a drain fever. It is, I may add, a positive disgrace to any locality, as it demonstrates sad neglect on the part of sanitary officials. Diphtheria, too, seems to depend for its existence upon drain poisons. It has hurried off 39,454 persons between the years 1861-70. Other complaints, such as diarrhœa, sore throats, boils, and some forms of skin-diseases, are, no doubt, more or less influenced by defective drainage. Rheumatism is caused by dampness; a proper system of drainage would lessen this complaint very materially. Phthisis, or consumption, by properly-carried-out drainage works, may be considerably reduced, for Dr. Buchanan has proved that by a thorough drainage of the sub-soil this disease may be very much diminished. He showed that "the prevalence of pulmonary consumption in England is in inverse proportion to the dryness of the soil." Ague, and many other marsh fevers, may be annihilated by thorough drainage of marsh lands.

It is highly necessary, therefore, to understand something of geology, in order to estimate the importance of certain soils and certain strata in drainage operations. We will consider them.

Some of you are aware of the fact that soil is both an air conveyer and a water carrier. All porous soils contain more or less of a gas known to chemists as *carbonic acid gas*. The reason of this is that organic matter—*i.e.*, remains of plants and animals—is found in all soils. Its oxidation gives rise to the above gas. Other gases will find their way through porous soils, such as coal-gas. Now, houses built on such porous soils will suck the gases out of the ground on account of the air in the houses being warmer than the external air. The habitations thus become filled in some localities with gases more or less dangerous to health. For instance, in fen countries the marsh-gas is drawn into the house, and ague is the consequence. Dr. Parkes was of opinion that cholera, dysentery, paroxysmal fevers, typhoid and remittent fevers, were caused by emanations arising from the soil. Drainage may remedy this condition of things to some extent, as such soils are generally more or less saturated with water, and by carrying away the excess of moisture, and making the soil drier, lessen the amount of sickness and death in places unfavourably situated. The lesson to be learnt from the above is to avoid, in building dwellings, all *alluvial soils*, which are very porous and very wet. All such alluvial soils give off malarious exhalations. Dr. Buchanan showed that a pervious geological formation, saturated with fresh water, was favourable to the development of consumption. On the other hand, similar porous formations, saturated with sea water, as at some of the coast-towns and villages, had no such influence. The explanation of the above facts is probably this—the water in the soil near the coasts is kept in a state of constant circulation, owing to the rise and fall of the tides. Inland no such circulation takes place, and the water stagnates.

Dry subsoils, as was shown by Dr. Bowditch, of Massachusetts, greatly influence health. He informs us, in a pamphlet written in 1862, that the inhabitants of a district who are located upon "a retentive geological formation" are more disposed to phthisis than those who are located on a porous formation. The reason of the above is that the retentive formation, such as clay, retains most of the surface water, and makes the soil damp; but the porous formation, such as sand, causes it to quickly drain away, leaving the surface dry.

The humidity of a district is affected by the nature of the surface and of the subsoils. These act in one of two ways—either by retaining the surface water, or by giving passage to springs fed from high lands at some distance. The sanitary engineer must distinguish between these two sources of dampness, as operations adapted to remedy the surface moisture would not remedy the deep-seated moisture.

Soils may be divided into two classes—*porous* and *non-porous.* Gravel, sand, loamy clay, and the comminuted upper strata of the limestones, may be included in the former. The latter consist of stiff blue clays, plastic clays, some kind of gravel cemented by argillaceous, calcareous, and ferruginous materials, and the close-grained limestone, sandstone, and granite rocks which are devoid of fissures. These strata are not placed in any regular order, and this irregular occurrence is one of the great difficulties of drainage.

Suppose a porous structure lies on a non-porous one, the rain will sink through the former till it meets with the latter. If there be no natural overflow, of course the water will collect in the lowest depressions. The hydrostatic pressure in the higher levels will force the water to the surface, or partly to the surface, in the lower levels, making the surface soil more or less damp. Drainage should have for its objects not only the removal of the surface waters, but also the cutting off of the subterraneous waters, which either rise to the surface, saturating the soil, or are confined beneath it.

I am not going to give any description of the various systems of drainage, as I should require a very long evening to do so. My object in addressing you is simply to point out where a knowledge of geology is necessary to the sanitary engineer. He will find conditions vary in different districts, according to the configuration of the country, and according to the degrees of *porousness* and *non-porousness* of the strata. In mountainous districts the rain runs rapidly from the surface, draining into the streams and rivers. Particular localities will even in this matter be found to differ. For instance, the rain quickly runs off the granites, and is not absorbed. The lias and clays are impermeable, and do not absorb the waters, during periods of rain. The oolites and gravel, on the other hand, quickly absorb the water, and perhaps give it out again some time else. The discharge from the granites, lias, and clays is generally in the form of torrents—from the limestones it is more equable. The above information is, of course, of great use in extensive systems of drainage.

The drainage of towns is a subject of vast importance, for upon a properly-carried-out system of works depends the health of thousands. It will be advisable to spend a short time in offering a few remarks on this subject. The soil upon which a town is built will have to be considered in its influence on drainage, as it may promote or impede the passage of land springs. In some parts of London, and also in Southampton, there are small elevations, the surface stratum of which consists of non-porous brick-earth, which lies upon a stratum of sand and gravel, and this latter on a layer of stiff London clay. In some cases the upper stratum of brick-earth is deficient, and the gravel forms the surface stratum. In other cases both brick-earth and gravel are wanting, and the London clay forms the surface. The drains in those places where the brick-earth forms the surface need only be of such capacity as to remove the surface waters; but those drains laid where the gravel or the clay forms the surface must be of such dimensions as to receive all the waters filtering through the gravel bed. In London the exposed surface of gravel is not very extensive, and therefore the water yielded by the gravel need not be taken into account in the construction of the drains, and, as those are made of such dimensions as to carry off storm waters, they will relieve the gravel strata traversed by springs. At Southampton, however, the case is different, because there is a very large surface of gravel exposed. In very wet weather the whole lower portions of the gravel become saturated, and an inundation of the basements below the natural level takes place. The only remedy is to form drains capacious enough to carry away the subterranean waters.

In Paris we have a similar condition of things. A large proportion of the city is built upon an ancient marshy plain, bounded by the Seine on the one side, and the hills of Montmartre and Belleville on the other. The plain is situated upon "the lower fresh-water limestone," as it is called, which is only very slightly porous; the sides of the hills are formed of gypseous deposits and marls. The hills are capped with deep strata of sand and sandstone, and are sometimes covered by the "upper fresh-water limestone." Near Belleville a large portion of country is occupied by sand formations ; these, during heavy rains, receive a large quantity of water. Now, the hills present steep *escarpments*, or bluff, precipitous edges, so that the rains falling upon them flow rapidly away. In order to prevent flooding of the lower parts of this quarter of Paris, the intercepting culvert carried along the line of greatest depression has been made much wider and higher than the area which its drains would appear to require. Yet, notwithstanding, flooding occasionally takes place.

The above examples illustrate how natural difficulties have at times to be taken into consideration in planning a system of drainage for towns. In other cases the configuration of the country is a help rather than a hindrance to draining operations. For instance, in Weymouth the ancient portion of the town called Melcombe Regis is built upon the shingle-bar which cropes the mouth of the Wey. In order to drain away the surface waters, all that is required is to form openings in the paving of the streets and lanes, and the water sinks at once to the level of the sea. In Liverpool the gravel upon which a portion of the town is built is very absorbent. In draining advantage is taken of that fact, in the lower portion of the town, to lay the bricks dry, and not to set them in mortar. Of course, the water soaks through between the bricks, and speedily becomes absorbed by the gravel soil.

I do not intend to give any information in this paper as to the construction of special kinds of sewers. Those who are interested in such matters will find every information in the classic work of Baldwin Latham, "Sanitary Engineering : a Guide to the Construction of Works of Sewerage, &c." Neither shall I treat of the disposal of sewage. I may, however, just mention that soils may be thoroughly poisoned by sewer matter escaping into them ; and houses built upon such soils may be hot-beds of fever. Quoting from a little work, entitled "The House and its Surroundings," "A loose brick, careless laying of pipe sewers, insufficient cementing, and, in fact, any sort of bad workmanship under the house, will, in much less time than is generally imagined, so foul the surface soil round the house that the ground may be aptly compared to a big sponge saturated with sewage. It may be remarked, as regards the power of retaining heat, that (according to Schüller) sand, with some lime (speaking comparatively), retains the most, and fine chalk the least, heat."

Although not exactly connected with the above remarks on drainage, a few words on a certain soil will not be out of place. This soil may be called "made ground." It is not of very ancient date, although possibly it may form a subject curiosity to future geologists. We can see it making every day. It consists of house sweepings, street sweepings, cinders, *débris* of churchyards, rotten vegetables, and other organic matters. Large portions of London, Liverpool, Leeds, &c., are built upon such made ground. The consequences to health are most serious. I cannot speak in terms of sufficient condemnation of sanitary officials and others who allow houses to be built upon this "made ground" to the injury of the inhabitants. All such sweepings should be carefully collected and carted away, to be burnt in some convenient place, and on no account be allowed to be deposited on building ground. I feel that it was necessary to refer to the above, as, by the often mentioning of an evil, the evil is the sooner removed.

Impure water, taken into the body as a beverage, is a fertile cause of many diseases. Cholera and typhoid fever may be often traced to the drinking of impure water; as may also epidemics of diarrhœa and dysentery. It will be seen, then, that it is necessary, in order to secure health, to have a supply of the purest water.

Speaking on the sources of water, a few general remarks may be made. Rain is the first source of all water on the surface of the globe. Now, rain-water, collected soon after a shower commences—if in the country far from towns, or at sea—is the purest that can be obtained. In thunderstorms it sometimes contains nitric acid, and near the sea-coast it may be rather brackish. It is insipid to the taste. It sometimes causes colicy pains, probably on account of the absence of carbonic acid gas. Snow-water contains no air, and, when melted, often deposits a small quantity of dust. Ice-water is very bright and pure, but is difficult to digest Hence, I doubt whether this latter water should be drunk by persons suffering from dyspepsia—as is too commonly done, in the form of iced waters, in America and on the Continent. A disease called *goître* has been ascribed to the drinking of snow-water; but the crews of Arctic exploring vessels have drunk such water for months together without producing that disease. In the districts where glandular swellings of the same nature as *goître* prevail, as in some portions of Switzerland, it is true the inhabitants drink water derived from the melting snows; but it is a well-known fact that many soft waters, from the early secondary formations, will produce *goître*-like swellings; therefore, we may conclude that the disease is not caused by the drinking of pure snow-water, but by matters contained in the snow derived from the formations on which it rests.

Sub-soil water in towns and large villages, as a rule, should not be used for drinking purposes. Why? Because such water very frequently contains nitrates and carbonates, the results of the oxidation of organic matters. All water, therefore, which contains organic matters should be avoided. If the organic matter is animal, the risk in drinking is very great. Diarrhœa, dysentery, typhoid fever, and cholera may quickly follow. Water from marsh lands, although it may not cause diarrhœa, may, however, be the means of inducing an attack of ague in this country, and in tropical climes yellow fever. The presence of nitrates and nitrites in water will indicate its contamination, and such water should not be drunk. The waters containing nitrates and nitrites will dissolve lead from pipes and cisterns in sufficient quantities to produce poisonous effects.

Certain entozoa may be taken into the system by drinking impure water, such as the *Ascaris Lumbricoides*, and other interesting creatures. Some practical advice on the above matter is, if obliged to drink doubtful water, to filter it through animal charcoal. The addition of boiling with a few tea leaves will ensure safety. When cholera or typhoid fever are prevalent, be sure to adopt the above simple safeguards.

Artesian wells afford a means of supplying the inhabitants of large towns with a good supply of capital water. Suppose a pervious rock comes to the surface at some distance from the place where the well is bored down to it. The rain falling upon this outcrop soaks down to a great depth; and, if the pervious rock is covered by an impervious stratum, such as clay, the water collected cannot escape. When the artesian well is bored down to the water-containing rock, the water of course rises in the boring. The lower green sand round the London basin is covered by Gault clay. The outcrop of the green sand collects the rain falling upon it. When borings are made through the Gault clay down to the green sand, the water rises to a height depending upon the height of the country from which it is derived. Similar borings through the London clay, and the chalk is reached, supplying chalk water.

The waters from such strata are often very hard, and contain a large amount of carbonate of lime, dissolved by carbonic acid. They may, however, be softened by Clarke's process. Borings have been made into the New Red Sandstone; but the water so obtained is often brackish, as the New Red Sandstone formation often contains deposits of rock salt.

Dr. Angus Smith says that water collected from the clouds is not fit to drink until it has been filtered through the soil.

The primitive and metamorphic rocks afford the best water supply. Mountain limestone gives a good supply, but the water is much harder. Sandstone formations supply water more or less hard. Water coming from fissures in clay formations often contains organic matter, and is permanently hard, from containing sulphate of lime.

Various impurities are found in waters derived from different strata. The dolomite, or magnesian limestones, the serpentines, and in Italy the sub-Appennine strata, supply waters containing the sulphate, carbonate, and chloride of magnesia. Clays supply waters containing sulphate of lime. The London, Oxford, Kimmeridge, and Lower Lias clays supply considerable quantities of the sulphate of lime.

A hard water, as a rule, is less wholesome than a soft one, besides wasting a large quantity of soap in washing. Carbonate of lime is perhaps not hurtful if contained in small quantity in drinking water. Dr. Parkes considers twelve to sixteen grains per gallon not unwholesome. Those salts which give permanent hardness to waters make these unfit to drink. Dyspepsia, loss of appetite, uneasiness or pain in the stomach, nausea, constipation, and sometimes diarrhœa, will follow from the habitual use of water containing large amounts of sulphate of lime, chloride of calcium, and salts of magnesia.

Goître may be caused by the constant drinking of water containing magnesian salts. In some localities this disease is associated with a kind of idiocy called cretinism.

Avoid hard waters for drinking purposes, and, if obliged to use them, soften them by Clarke's process. On no account use permanently hard waters.

Water containing suspended substances may produce diarrhœa of a severe kind. The mountain dysentery of India is caused by drinking water containing finely-powdered mica in suspension. This water, filtered, is, however, quite wholesome to drink.

Much more might be said concerning water, its origin, constituents, and effects. I think, however, that I have said sufficient to indicate the importance of some knowledge of geology in those who undertake to supply the inhabitants of towns and villages with this vital fluid.

I have before referred to Clarke's soap process. This is a process employed, not only to test the amount of hardness of water, but also to soften it for use. It was invented by a Dr. Clarke. A preparation is made of a diluted solution of soap in weak spirits of wine. The solution so prepared is diluted, until one measure corresponds to one grain of lime. A given measure of the water to be tested is taken, and the soap solution is added gradually. Now and then the water is shaken up, and the measure of soap solution is noted. At last a point is reached when the water begins to lather. The addition of the soap solution is then stopped. A calculation can thus be made, from the amount of soap solution which has been used, what is "the soap-destroying power of the water." This "soap-destroying" power is expressed "in terms of carbonate of lime," thus: "So many degrees of hardness, so many grains of carbonate of lime per gallon." Other tests for impurities in water there is no occasion to name.

Disposal of the dead in graveyards and cemeteries must now be considered. In this matter it is advisable to have an acquaintance with geology, in order to plan places of burial in such soils as are best adapted to the speedy decomposition of the bodies interred, and to guard against the products of decomposition injuring the living.

Cemeteries are at present the localities where bodies are interred. The soil of a cemetery should be dry, close, and at the same time porous. The rain falling upon the surface will thus permeate to the corpses, and hasten their decomposition. If the surface has a covering of vegetable mould, in which trees and flowers will freely grow, the sanitary conditions will be improved, as vegetation absorbs hurtful emanations. The sub-soil should be of such a nature as not to need any under-draining, and not to allow water to collect in the graves or vaults. The cemetery should also be exposed to the north or north-east winds, as these are dry, and do not carry away in solution the noxious gases, like the moist south and south-east winds.

If a cemetery is obliged to be made upon a clay soil, it will be necessary to drain it thoroughly by means of deep cross drains, and by conveying drain-pipes from grave-space to grave-space, and conducting the whole into the main drain. Gravel should also be strewed at the bottom of each grave, and every fresh grave opened out should have its gravel-layer connected with the gravel-layers of the others. Some clay soils will not allow the surface water to percolate down to the bottom of the graves. In such cases pipes might be placed in a vertical position, reaching to the artificial gravel soil at the bottom of each grave. In filling up a grave in a clayey soil, it would be advisable, instead of replacing the clay, to put gravel or sand in its place. However, after all the trouble and expense of making a cemetery situated on a dry soil in a good sanitary condition, serious disappointment is liable to follow; for the gases of decomposition are liable to be retained in the soil for thirty, forty, fifty, or more years. Again, long-continued dry, hot weather will crack some clay soils, and let out the gases. Sudden heat will do the same thing. A cemetery where the soil is dry and porous will, therefore, be the best for burial purposes. Such a soil will order that in some twelve years, or even less, every part of the body shall disappear, unless it be a few of the larger bones.

It is not the object of this paper to describe the advantages or the disadvantages of different methods of disposal of the dead. Each method has its advocates. I have simply pointed out what soils are best in choosing sites for cemeteries. But, as a sanitary adviser, I would here remark that burial even in the best soils—soils which rapidly assist decomposition—is fraught with great peril to the living. Need I mention the foul gases, the noxious odours, which steal up from the soil. The decomposition of corpses gives rise to a large amount of carbonic acid. Ammonia and offensive putrid vapours are also given off. Such gases, carried by the winds from the cemeteries to surrounding places, will lower the health of all who breathe them. As proof of this, I will refer to a report of the French Academy of Medicine, which states that the putrid gases from the cemeteries of Père-la-Chaise, Montmartre, and Montparnasse caused dreadful diseases of the lungs and throat. Dr. Copeland mentions the case of a gentleman who was poisoned by the foul air from the grated openings on the sides of the church steps. He died of a putrid fever in a few days. His wife took it from him, and also died. Numerous other instances might be given. Not only will the air be poisoned by decomposing bodies, but the water also. Wells sunk near burial places are almost certain to be poisoned, especially if the cemeteries are placed on the higher ground. Of course, all the percolations will run into the wells. Dr. Mapother describes a certain churchyard in Ireland which lay so low that in wet weather the river overflowed it. Yet the river supplied 30,000 to 40,000 persons with drinking water.

I have cited the above examples to illustrate the evils of burial, notwithstanding the nature of the soil. Some soils, as I have shown, are better than others; but none will secure the living from risk. I would, therefore, strongly advise the abolition of burial altogether, and the disposal of the dead speedily by cremation, or burning to ashes, in a suitable furnace. That is the only rational and safe method of disposing of the dead. It is a method which will in the future be adopted by all civilised peoples. It has received the sanction of numerous sanitary authorities; and some of you may remember that Mr. Wheelhouse, of this town, spoke in its favour in an address delivered by him at the Medical

School in October, 1874. In the meantime, until cremation becomes general, all corpses should be buried in destructible coffins, and in the dry, porous soils named. Air and water will then have free access to them, and assist to speedily decompose them.

A few other observations, and I have done. There is a wide field open to the hygienist, who is a geologist, in investigating the origin and causes of certain diseases. The scarlet-fever bed of this country will well repay investigation. Scarlet fever is one of the most fatal of the infectious fevers. It destroys annually 21,000 persons, chiefly children under ten years of age. It has, on account of its prevalence and fatality, been named the English Pestilence. Now, it is well known that there are certain localities where this fever is always present, and from which, at intervals, it sweeps over the rest of the country. These localities constitute the scarlet-fever beds, or fields, of this kingdom ; they are "London, the Tyne-side towns, and the mining districts of Durham, Northumberland, some parts of Cumberland (Carlisle, Cockermouth, Whitehaven), the manufacturing districts of Lancashire, Cheshire, and the West Riding, Birmingham, Wolverhampton, and the vicinity, the Potteries of Staffordshire, Bristol, and Flint County." It has never yet been discovered why these districts form centres from which the scarlet fever radiates. The great agglomeration of population will not account for the fact, as there are other localities quite as thickly peopled which are not centres of this disease. May not the nature of the soil, and the emanations therefrom, have something to do with it? I will not theorise, but just hint that future inquirers may be able to work up this subject fully, and be able to throw considerable light upon what is at present very obscure.

The physician, when he orders a patient to seek restoration of health by proceeding to some health-resort either at home or abroad, should have some geological knowledge. He should understand the nature of soils, otherwise his patient may be ordered to a locality where, instead of being benefited, he may be made considerably worse.

I trust, ladies and gentlemen, I have not wearied you with too long a paper. If you consider that I have not been sufficiently scientific for the members of this Association, or that I have dwelt too much on diseases, and have neglected geology, I beg you to remember that all are not geologists. I wished to make my paper plain and simple, to point out where a knowledge of geology would be of service in promoting the health of mankind. I feel certain none of you will go away this evening with your minds confused by a mass of long scientific words; but you will feel that your knowledge is somewhat increased, and that some power has been given to you to benefit and save your fellow creatures.

Remember that science aims to make men happy. Its objects are the removal of death and suffering, and the establishment of longevity and health.

How can I speak of such men who neglect all sanitation for the people? Surely I may say they are murderers, and must be extremely hard-hearted villains. In the words of Dr. Heberden, "Nature seems always to seize on the weakest part, thus teaching us to make all parts of our social system strong, and to chase vice, misery, and disease from the earth." This is our work; let us do it well, and our reward will be—a happy, long-lived, and healthy people.

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