The use of maps in teaching geography : a lecture delivered before the College of Preceptors, May 13, 1896 / by Professor Seeley.

39

THE USE OF MAPS IN TEACHING GEOGRAPHY.

A LECTURE DELIVERED BEFORE THE COLLEGE OF PRECEPTORS, MAY 13, 1896.

By Professor SEELEY, F.R.S., F.G.S., F.R.G.S.

[*Reprinted from the "Educational Times," June, 1896.*]

It has long been disputed whether geography, when classified as a branch of knowledge, should be regarded as literature or as science. It grew out of observation, being the result of practical skill in using instruments and scientific training in recording the form and characteristics of the earth's surface. But, in modern times, it has grown so as to annex results which the historian discovers who concerns himself with man's influence upon the earth, and the changes brought about on its surface by peoples who migrate or found colonies. There are possibly some teachers who do not look beyond this ample field of historical geography. To them geography is literature. The maps in which the territorial changes and events are recorded, which constitute the stages of evolution of nationalities, are the things best worth knowing. It may be conceded that there is a training for the critical faculties in following the steps by which the Roman map of Europe has become transformed into the familiar map of the present time. The classical student however, who stops his inquiries with the decline of the Roman Empire, obtains no such geographical training. The student of mediæval history, who neither considers the causes of the territorial circumstances before him, nor the ends towards which they are moving, escapes geographical training in a similar way. It may be frankly admitted that to exhibit maps of the present state of Russia, Germany, Austria, Italy, Spain, or France, is to present the dry husk of literary knowledge, without the inspiring information by which it may be explained.

Nothing demonstrates the dependence of human affairs upon law more certainly than the facts of historical geography when they are considered in unbroken sequence. And it is quite possible to teach this subject with the aid of maps, so that the best and most complete knowledge shall be available for the student. The teacher must fail, however, who attempts to cover the entire field. School-life is too short for any pupil to work thoroughly through so vast a subject. And historical

the labour is too great. Nor is it desirable to master the geography of any one of the unnatural divisions of Britain, such as counties or Parliamentary districts; but it is quite possible to learn a good deal about the hills and valleys of the south-east or south-west of England or the Pennine Chain. Or a river like the Severn or the Thames or the Yorkshire Ouse may be used as a type, and be studied fully. The coast line emphasises what the plains and hills have made clear—that, although the wearing power of water is comparatively uniform, the varying durability of the rock is the cause which determines the details in form of the shore.

This kind of knowledge cannot be gained from books completely, because the durability of a rock often depends upon the nature of the cement which binds its particles together. And this cement may be absent or changed in a distance of a few miles; so that the rock which in one place forms a hill or headland in another place may form a bay or valley, Still it needs very little knowledge to be aware that the man who can read the main teachings of a geological map has mastered the main outlines of a country's physical geography.

I have never doubted that the reason why so many of the great geographers in past times have been geologists has been that the structure of the earth shows itself upon the surface, demonstrated in hill-ranges, valleys, or mountains, intensified in clearness, so that the geographical features are manifest expressions of geological facts. The geologist in making his map has not only to observe the general features of the surface, but to walk over every portion of it, so as to be certain that there is no geographical fact which has not some relation to a geological cause. When William Smith laid the foundation of geological science in this country by constructing from his own observations

THE FIRST GEOLOGICAL MAP,

which may be seen in the geological gallery at the Natural History Museum at South Kensington, he also drew a number of vertical sections across the country, showing, with a clearness which has never been surpassed, the dependence of geographical circumstances, such as parallel hill-ranges and their intervening valleys, upon the mineral character of the successive layers of rock which form the surface of England, and the angle which they make with the horizon. This knowledge has been so much taken for granted by geologists, and assumed to be the common property of educated people, that they have scarcely realized that the geographer has not always taken advantage of it as the very foundation for his work.

I do not suggest that the student should delay learning geography till he has learned geology, but only that he should base his knowledge of the geographical map upon a knowledge of the geological map. This is a very different thing. In the kindred subject, physiography, it is not necessary to delay till a mastery has been attained of astronomy, physics, chemistry, geology, and biology, all of which contribute in some degree to an intelligent grasp of the processes of Nature's work now

going on upon the earth's surface. The amount of geology which is necessary for a comprehension and reading of the geological map is no more than is required in physiography, though the kind of knowledge is dissimilar.

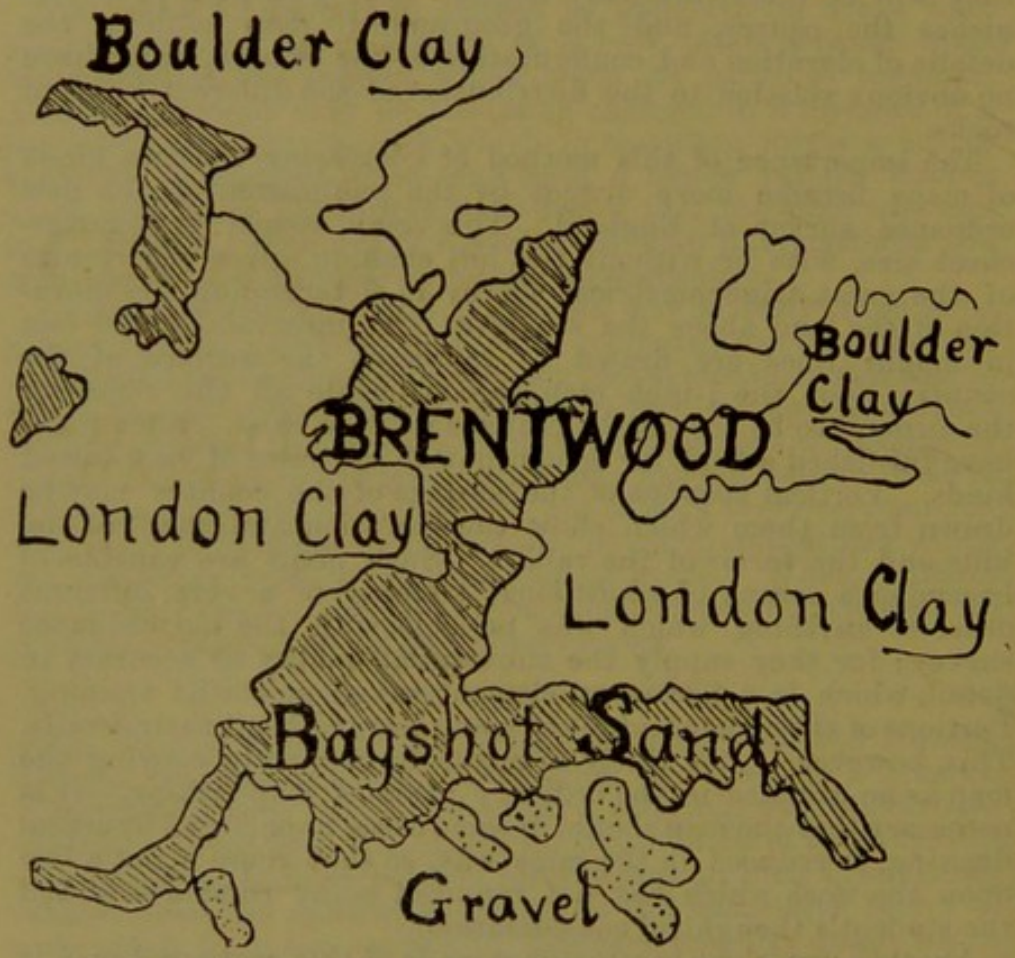
The advantage of requiring this geological basis for geography is that it converts the otherwise unintelligible facts which the geographer observes into logically dependent parts of natural processes. And it changes what was a mere effort of memory into a reasoning process which affords excellent mental discipline. This can be seen by superimposing one map upon the other; or, better still, by comparing them side by side, when they will be found mutually helpful. The geological map furnishes the causes, and the geographical map supplies the details of elevation and configuration of the ground, which have no obvious relation to the distribution of the different kinds of rocks.

The importance of this method of comparing the two kinds of maps became more urgent by the publication of the new ordnance survey of England. This map, issued in quarter-sheet size, with or without the hill shading, gives the results of the great trigonometrical survey in determining the elevation of the land above the sea level. At intervals of 100 feet in height lines are drawn to represent the surface of the country upon the 1-inch map, which enable all the slopes of the ground to be accurately realized as they exist. Such maps have furnished a field for geographical exercises of very varied kinds. Vertical sections of the surface of the country may be drawn from them which show the elevation and shape of the hills and the forms of the valleys. Such maps are capable of becoming a means of educational training of a very different order to anything which was possible with the old ordnance survey; for they supply the substantial quality of accuracy in detail, which is a necessary element in all scientific training. Portions of these maps admit of being learned in all their details. This, however, is not likely to result from merely copying the map as an exercise in the ordinary mode of map-making. It is necessary that the map should in some cases be enlarged by actual drawing, or reduced in the same way, so that there is not a line upon the work which has not required many comparisons and the student's thoughtful consideration.

Another use which is sometimes made of this contoured map is to trace off all the different levels. Then, beginning with the smallest summit area of the hills, cut out the outline of each upon a sheet of stout cardboard, so that the pieces may be superimposed upon each other to reproduce in solid visible form the contours of a hill range or a valley. There is no reason why this mode of using the map should not be made a necessity in dealing with the local geography of the district in which the teaching is given.

Many years since, I conceived the possibility of combining this fund of geographical knowledge and exploration which the new ordnance survey affords with that which may be obtained from a geological map; and, to bring about an appreciation of the

possibility of combining them so that geography could rest upon geology, I have conducted the weekly excursions of the Field Class to accessible places in the London district where the relations of geography to geology could be practically seen. My method has been, during the past eleven years, to prepare as far as possible a geological map and a geographical map, so that both should be in the hands of each member of the class. The map is always limited to the immediate district which is seen, and a mile or two to the north and south, or east and west, as the case may be. These excursions have been planned to illustrate the nature and structure of river valleys and river



Geological map of Brentwood showing limits of the strata. The area of the Bagshot sand is shaded.

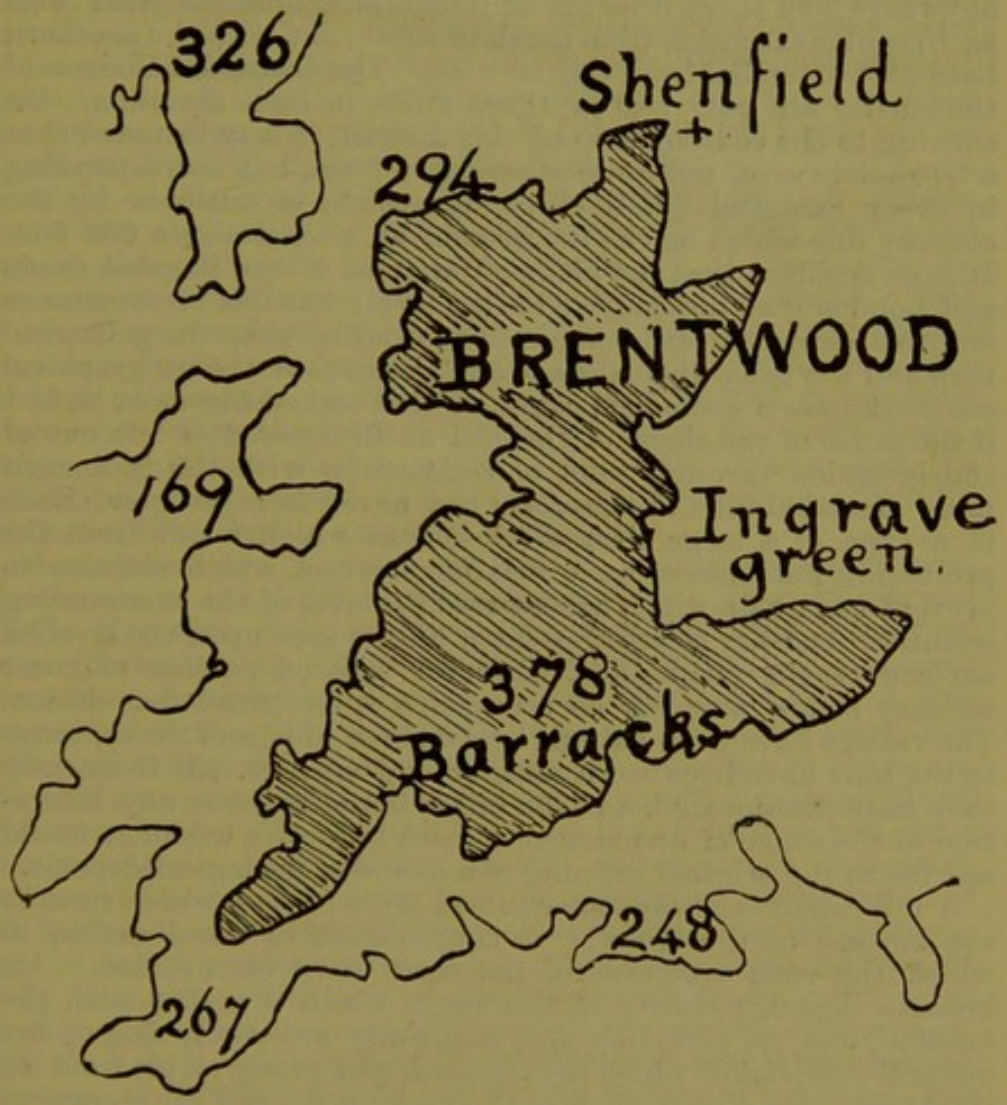
gorges, escarpment valleys, escarpment ranges of hills, isolated hills, and the plains out of which these features have been carved by denudation. This kind of practical knowledge may, I believe, be imparted in some degree by a large number of teachers who are engaged in secondary education; and I believe that the result would justify the teaching in their case, as it has done in my own experience.

The first point which I urge is that the subject should be considered with the object of giving the learner a better knowledge of geographical facts in general, by giving him as good a

knowledge as possible of a few physical features, which may be taken as types of similar features in other parts of the country. This theory of types of what I term

GEOGRAPHICAL STRUCTURE,

raises the standard of geographical attainment to the highest practicable level; so that the learner attains a basis of comparison between his knowledge of some hills or valleys or rivers and his ignorance of others, which is calculated to stimulate and



Geographical contour map of Brentwood showing height in feet. The ground above the 300-foot contour line is shaded.

train habits of observation and reflection which will have an enduring influence. At the same time, the study of geographical types does not augment the amount of work which the pupil must perform, but rather enables teacher and pupil alike to realize that geography is a matter of reasoning, observation, and mental discipline, which claims more serious consideration than it always receives. I propose to illustrate the nature of this use

of maps by examples taken from my own teaching experience. In the first place, a few words concerning isolated hills.

Scattered over Essex and Middlesex is a small series of isolated hills, which are known to the geologist as formed of Bagshot sand, a rock which rests next in succession upon the London clay, and once overspread its whole surface. It has been worn from off the London clay, in time long anterior to the making of the present configuration of the surface. Its influence upon that surface is shown at Brentwood as well as anywhere, and there it forms an irregular tri-radiate mass with an irregular extension from north to south, and with the southern base part extended from east to west. The entire dimensions of the outlier are only two or three miles in each direction. On turning to the contour map of this district, it may be noted that a tri-radiate area, not quite identical in form, but corresponding in every essential detail of configuration, is outlined by the contour line which marks the ground at a level above 300 feet. It is an accident that the plane of junction of the Bagshot sands and London clay lies so near to that level; but this circumstance emphasises the correspondence in contour between the geological map and the geographical map, and shows that the geographical contours have a geological cause, so that something must be lost if the cause of the shape of the hill at Brentwood is left out of consideration through want of comparison with the geological map. Isolated hills of this class can never form ranges. Each is a type of a large class of elevations which result from the protecting influence of an overlying stratum which remains to prevent the waste which has lowered the level of the surrounding country. Another group of isolated hills is seen upon the levelled surface of the chalk hills, wherever isolated patches of lower tertiary strata are left as relics of a wide-spread denudation. The valleys have been cut out below these hills, and the cappings to the hills have been worn smaller and smaller, till frequently they have disappeared, and the hill is found without any indication of the cause of its existence, which inductive evidence would ascribe to the original capping of a denuded geological deposit.

A hill-range is always an inclined layer of rock which rises to the surface of the country in consequence of the direction in which the rock materials of the earth have been folded. Its breadth depends chiefly on the angle which it makes with the horizon, and its elevation and continuity are partly due to the mineral material of which it is formed, and partly result from its thickness. Its slopes, such as the escarpment and counterscarp, result from the way in which the structure of the rock affects its denudation. The combes which cut out its escarpment surface are results of atmospheric waste; but the dry valleys which cut into the dip slope of every hill-range date back to a remote geological period, when deposits covered the country which have now been worn away from its surface rocks. Therefore it is not possible to obtain an idea of a hill-range so easily as we may appreciate the characters of an isolated hill, it being in every way different in origin and much more complex. The chalk hills near London are very good examples of ranges

formed by one geological deposit. But, to obtain even an ordinary idea of the nature of the North Downs, it is necessary to walk first, say, from Redhill to Godstone, along the top of the parallel range of the lower greensand, to see the general features of the horizontal top of the chalk hills and the aspect of the escarpment. It is desirable also to walk at the bottom of the valley which defines the chalk escarpment so that the escarpment may be seen from below; and, as its character varies, it will hardly be understood without taking in the whole extent of country between Box Hill and Dunton Green. The escarpment must also be examined along its summit, and between Merstham and Oxted it presents typical conditions, traversed in part by the old Pilgrim Way. But no one realizes the nature of an escarpment till it has been ascended. If we alight at Nutfield Station on the Weald clay, and climb up to Nutfield on the crest of the lower greensand, and then plunge down into the valley of the gault, and climb White Hill to the top of the chalk, we have the opportunity of comparing an escarpment of sandstone with an escarpment of limestone. This practical geographical work, which the Field Class has carried on year by year, is indispensable for the teacher, but it can only in part be obtained by the pupil. I may be told it requires more labour than the teacher can give, if he is to impart knowledge of this kind to his pupils. In reply, I say that the authorities who control the subjects taught cannot afford to neglect this method of practical teaching.

Many years ago I wandered into a quarry at Pelm, near Gerolstein, in the Eifel district of Germany. The quarry was in the Devonian rock, which we know as the Eifel limestone, very similar to the Plymouth limestone, which is found near Torquay. Asking the first boy if he had any fossils, I was astonished at the reply that he had nothing but a few Trilobites, which all belonged to the genus Phacops; but that, if I went to the *Gasthaus*, the landlord had plenty of corals, Cyathophyllum, and other kinds. On inquiry, I found that this lore had been gained in the primary village school; and that the distinctive feature of German education, beginning with the lowest round of the ladder, has been to train every child in observing, by teaching him to see the things around him, and make them matters of daily thought. We have a country which lends itself more readily to detailed observation than does the surface of Germany, and there is no reason that I can discover why the physical features of Britain should not be the means of creating the scientific instincts and aptitudes, through the medium of geographical training, in every child who comes under a public teacher's care. And I believe that we cannot afford to neglect this advantage in competition with other peoples. Frequently the larger part of the teaching must be given from maps, with only an occasional glimpse of nature. But maps such as those which I refer to and use are the most perfect pictures of nature that it is possible to devise. Nothing but the geological map can make intelligible the gradual widening out in breadth of the North Downs as they are followed from Farnham to the east. But the

geographical student, by means of the contour map, not only realizes this from a different point of view, but he also sees the degree of steepness of the escarpment, the position of every combe, and the descending slope of the counterscarp in all its modifications, so as to be able to draw transverse sections across the hills which would illustrate the way in which the form of the surface is governed by its rock material.

The change of direction of the North Downs at Rochester, like the continuity of the North Downs with the South Downs, and of both with Salisbury Plain, can only be learned from the geological structure of the country, and the circumstances which have led to the removal of the chalk from off the district which is known as the Weald.

I have only chosen this illustration from the North Downs because it is so easy of access for the South-east of England; but the Pennine Chain furnishes grander phenomena, even more beautiful, extending over a wide region of the North, with many of its most striking portions within reach of populations equally large.

The Mendip Hills, or the Cotswold Hills, and many other districts, equally well demonstrate in practice the relation between the physical features and form of the surface and the nature of the ground which rises above the adjacent levels. If the synclinal hills of Wales are not within reach of those who live upon the limestone heights of Lincoln, their mountainous structure furnishes to the Welshman a type of hill elevation which is valuable as requiring a more strictly logical discussion in order to bring structures like the Berwyn Hills under the explanation of general laws. In such regions the geological side of geography is more in need of attention than anywhere else, for every feature of the surface exemplifies the intensity of folds and flexures, of breaking strains and consolidating compressions, such as are only faintly paralleled in such upheavals as the Pennine Chain, the Mendip Hills, or the Weald. No physical feature is on too large a scale, or even too insignificant for notice, when all are brought to a focus of comparison by maps, from which the teacher may extract a practical form of mental discipline more nearly akin to the work of every-day life than is to be wrested from perhaps any other

ENGINE OF EDUCATION.

I am urging that the method which can be followed with most advantage in geographical teaching is to gain a little real acquaintance with those phenomena of nature which are immediately around the place where education is carried on, mainly because what is seen day by day becomes thought over week by week and year by year; so that whatever educational superstructure can be raised on that foundation by the skill of teacher or enthusiasm of pupil should be given the best chance possible of developing the mind.

If it be said that the country does not consist of hills, but that large areas are vales and valleys, such physical phenomena only exercise the observing powers in another way. There are

diverse classes of valley. Take one or two as examples. In the first place, we may consider such river valleys as those of the Darent, or the Wandle, or the Mole. The Darent and the Mole both present the remarkable circumstance that they flow from the south and draw their waters from the Lower Greensand, and without any obvious cause cut a channel through the chalk hills into the Thames. The Darent is divided from the Medway by a very narrow interval. Between Oxted and Westerham the ground rises to 500 feet. This is the water-parting between the Darent, which flows east, and the Kent water, which flows south, into the Medway, and drains the chalk hills about Titsey. After the Darent has run for some time parallel to the chalk, it passes by a steady descent through the chalk, with the hills above its gorge rising 400 or 500 feet on both sides. There is the same expansion of the valley to the south in the direction of the escarpment as is seen in the Wey, and to some degree in the Mole and other streams. As the Darent descends northward with the dip of the chalk, it receives tributary valleys which are perfectly dry. They are of the same kind on both sides, and only differ from the valley which carries the river in having a much more rapid descent, and in rising in the perfectly flat top of the chalk hills. So that the study of the cause which has enabled the Darent to pierce through the chalk is practically inseparable from the excavation of the parallel valleys, which do not pierce through the chalk. If the contour lines of the Darent were taken as commencing at Otford, at the 200-foot level, then this level penetrates into the Austin valley south of Eynsford, and into the Maplescombe valley to the east of Eynsford. The river Mole has very similar tributary valleys. That which comes down from Tothill by Juniper Hill, and drains the north side of Box Hill and Mickleham Downs, carries no water, and it is only after seeing the *wadys* and *kloofs* of Africa, and rivers which during most of the year carry no water at all, that it is possible to realize that the rain is an excavating agency, liable to be undervalued without personal examination of its work in these so-called dry valleys. There is very little difference in width between the valley which carries the river and the valley which is dry, so that no great difference in intensity of the excavating agent need be assumed. The difficulty which is usually felt in dealing with the origin of such valleys is in the circumstance that the geological antecedents of the present state of the earth may be forgotten.

The great geological antiquity of many valleys is well known, because they are necessarily older than geological deposits which have filled them, and have since in part been again worn away. In this district of England, all along the North Downs, little patches of the lower tertiary rocks rest upon the chalk up to the very edge of its escarpment, sometimes only preserved from destruction by being let down beneath its surface into those penetrating tubular masses of gravel and sand which are termed "pipes."

It is, therefore, certain that the tertiary beds spread over the chalk up to its extreme limit. The relics which are left are

associated with chalk flints such as are found in beds of gravel. The waters which swept those beds from off the chalk, which have laid its present surface bare, and which have accumulated gravels at the northern and southern extremities of valleys which pierce the chalk, have obliterated most of the circumstances which account for their origin. But, with evidence that depression would cause the waters of the Thames estuary to reach the beds of gravel at Crayford, it is obvious that under severer conditions of frost the Darent might be dammed to the north, and, for a time at least, the river would find an outlet to the south, reversing its direction and draining into the Medway.

Escarpment valleys are interesting from the certainty that they have been gradually lowered in level, owing to the want of durability of the material of which each is formed. Every escarpment valley consists of three kinds of rock, which run parallel to each other through the country. There is, first, the old layer of material which forms its boundary on the counter-scarp side, which is either a sandstone or limestone; secondly, the clay which forms the floor of the valley, the breadth of which varies with the thickness of the deposit and the small amount of angle at which it rises to the surface; thirdly, there is the boundary on the escarpment side, which is relatively steep and consists of a newer sandstone or limestone. The form of the escarpment valley varies with the form of the escarpment. When an escarpment ridge, like that of the coralline oolite, disappears altogether in the middle of England between Oxfordshire and Yorkshire, becoming replaced by a clay, the valleys which it otherwise separates become blended into a plain, like the great plain of the Bedford Level, which stretches between the lower greensand hills of Norfolk and the limestone hills of Northamptonshire. These valleys are so wide under ordinary circumstances that there are but two between Bath and Swindon. A broad valley of the Oxford clay, on which Trowbridge stands, runs up by Oxford; and the scarcely less important parallel valley of Kimmeridge clay, coming out of Dorsetshire, extends northward by Swindon and the Vale of Aylesbury. It is so manifest that these valleys are geological features of the country that it may be doubted whether the geographer would recognise them as being valleys at all if it were not for the evidence of their nature and origin which geology affords. The existence of an escarpment necessitates an escarpment valley. This valley is defined by rock structure; and it no more depends for its existence upon the depth of its excavation than a mountain depends for definition upon the height of its elevation. But valleys which are not very obvious in nature till the eye is trained to observe them become evident at a glance upon a map which shows the relative altitudes of the ground. It is more easy for the student to carry away sound knowledge and accurate conceptions of the relations of different orders of valleys to each other by using these maps as the basis for learning than it would be to carry away the hazy conceptions which the vague *hachure* shading gives on the maps in ordinary use.

The study of a river valley is somewhat complicated. Every

tributary has a history of its own. Its course is cut down lower and lower with the progress of geological time; and the upper valleys at the present day are always dry valleys, or only carry rain in a diffused film, instead of forming in addition the visible stream of spring water, which is commonly the beginning of a river. Nearly every river is governed in its course by

GEOLOGICAL CIRCUMSTANCES.

Even in the present configuration of the country it is manifest that, as the valley of the London basin — between the hills of Hertford and Cambridgeshire on the north, and the Thames on the south—widens towards the east, the length of the rivers which rise in the chalk hills and drain into the Thames necessarily increases as the source of water supply retreats towards the north-east.

The multitude of tributary streams which feed the Thames on the south, or on the west, is connected with not only the heavier rainfall, and the porous character of the rocks which store the water, so as to keep the flow of streams comparatively uniform, but is also a consequence of antecedent circumstances which have excavated the channels through which the streams flow. By means of the contour maps, the child learns the amount of fall of the river over every mile of its course, and thus appreciates its transporting and excavating influence. He speedily discovers that, while the river cuts its bed downwards, atmospheric agencies cut the sides of the valley backward; so that the valley has dimensions in transverse width which are not to be attributed directly to the work of the river. The breadth, however, of the valleys, at the bottom of which insignificant streams flow, and the absolute removal of the rock material by which they once were filled, indicate an ancient origin and a more vigorous excavating agent.

We need go no further than the south side of the Thames to realize how the island-like masses of high ground have become defined and separated from each other by the valleys which carry little tributaries to the Thames. The Wandle flows to the east of Putney Heath and Wimbledon Common; and the Beverley Brook, which flows down Kingston Vale, separates the Putney Plateau on the west from the high ground which forms a parallel mass in Richmond Hill and Richmond Park. Deep below Richmond Hill the flat lands of the valley of the Thames are seen forming a broad channel below the 50-foot level over which the Thames winds its course. But on top of the heights of Putney and Wimbledon a high-level gravel is found spread horizontally, showing that the existing valleys have been cut out since the time when this gravel extended over the level high land. The story is of the same kind all up the Thames valley. The flat-topped Fox Hills and Chobham Ridges are covered by an exceedingly coarse bed of hill gravel. The ridge extends from north to south, and parallel to it on the west runs the river Blackwater, so that we infer that the Blackwater valley could only have come into existence after this hill gravel had been laid down upon a surface which was then a plain, although

subsequent geographical changes have broken up the continuity of the plateau. It is by examining the sources in different geological deposits from which a river derives its water that it becomes possible to realize how the water supply may eventually become exhausted; and what had been a stream passes away, with no evidence of existence except the dry valley which is continuous with the valley that now carries the water. The river Chess at Chesham is a not insignificant stream, but beyond Chesham there is a crown of radiating valleys, each a few miles long, now perfectly dry, each of which looks as though it might have been the source of the river Chess before the water supply in the chalk was dried up by being tapped at lower and lower levels. To learn that a river must be newer than the kind of rock through which it flows may be in itself a small acquisition; but when that rock is one of the series of gravels which contain the remains of existing shells and existing mammals, grouped with the extinct mammoth and associated types of animals, it is almost startling to learn that so large a number of features of surface geography have been shaped so recently as to be within the period of human history. The contour maps alone can give evidence of the form of the channels through which rivers run, but the geological drift maps of the geological survey supply the demonstration of the time when they were made.

Turning to the sea-shore, evidence is seen of another kind of water work in the movement of the tides. It is evident, especially round our East coast, that the configuration of the land governs the height of the tide and its excavating work in wearing away the cliffs. The geological map shows the kinds of rock which run out into the sea, and the contour maps exhibit the relative height of the ground along the coast line. If our attention is limited to any portion of the coast, such as the South coast, it is clear, first, that the tidal waters are producing a submarine terrace or plain around the coast, of exactly the same kind as those plains which are indicated by the existing high land with its horizontal summits and surfaces now standing at 800 feet, 600 feet, 400 feet, and lower levels, which merge at last in the 50-foot contour, which is wide enough, if the land were lowered for 50 feet, to convert most river valleys into broad estuaries in their lower portions. This form of

MARINE DENUDATION

has affected every part of the earth, and there is certainly no feature more astonishing in our own country than the comparatively uniform level of the larger part of its surface.

These plains descend from the tops of the hills of Scotland, Wales, and the Lake district like a succession of terraces, only differing in degree from the broken descent of horizontal beds of rocks seen in many a Yorkshire waterfall, or upon the sea-shore. The plains, however, have become broken and diversified in time gone by by exactly such processes as now give our shore its distinctive characters. The North Foreland, like the South Foreland, is formed of chalk, and these masses are separated

from each other by an intervening trough, which is bent down so as to preserve the Thanet sands in the hollow. Those sands, being less durable, have been excavated; and the excavation forms Pegwell Bay. Similarly, to the south of Dover, the rocks which rise to the surface from beneath the chalk are less durable, and are excavated to form, first, the small inlet of Folkestone Harbour in the gault clay, and then the line of lower greensand coast which extends westward from Folkestone to Hythe. All round our coast this varying durability of the rocks is exemplified in the formation of headlands, by limestones, sandstones, and crystalline materials; while many of the bays are excavated in clays, or the consolidated form of clay which is termed "shale." If this process is going on between tide marks at the present day, above the plain which is now forming, it may be observed that the valleys which follow the clays down to the shore are almost continuous with the bays.

It is difficult to realize the work of the sea in levelling the land in past geological times when its surface was submerged, without recognising that excavation must have gone on on the surface of what is now dry land similar to that which is forming Filey Brigg and Filey Bay on the Yorkshire coast. It may not be possible to separate out the work of the sea from the work of frost and snows, rain and wind, with the precision that is to be desired. But we should overlook the evidence of facts if we attributed the conditions of the shore entirely to the sea, and the conditions of the interior of the country entirely to the agencies which are now seen to affect it. The relative durability of rock, and the direction in which it extends in consequence of being folded, are not always sufficient to determine whether submarine or sub-aerial agency has been at work. For, while the latter appears always to follow and never to interfere with the folding of the strata, the coast of the English Channel only follows in a very general way the east-to-west direction which the geological deposits take; and along the Yorkshire coast every stratum is cut across by tidal denudation, at right angles to the direction of its extension, to form the cliffs in the line of the sea-shore. And this want of regard for the difference of geological deposits is one of the characteristics by which the work of the sea is in many cases recognised. If the English coast were explained with the aid of the geological map alone, there would be few features in its form and contours for which adequate reasons could not be given. But, when to this record of structure the use of the contour map is added, the headlands appear of their true relative height, and the recently uplifted flats are separated from ground which has not been levelled in the same way.

This method of study of the geographical phenomena of the country by means of typical examples of its physical features, I desire to see taking the place of less exact and, as I believe, less useful methods of geographical teaching now current in text-books. I commend it to my fellow-teachers, not as a theory, but on the basis of my own practical experience with many generations of pupils. I am led by that evidence to believe that

difficulties which may have to be overcome are not inherent in the nature of the materials, or in the power of the learner to appreciate the interest of the maps and sections compared.

It is always a difficult matter to determine the limit of time which should be placed upon such generalities of study as the form of the globe, of the continents, of our own islands; and to fix the precise age at which the study of the local geography, by means of these maps, comparing rock structure and surface form, can be best commenced with advantage. This is a practical matter which must often be solved, quite as much by the conditions of local geography as by the judgment of the teacher. In this country the teacher is not always a free agent to select the from of teaching which he knows to be best calculated to develop the intellectual powers of the pupil. Yet I submit these proposals for improved geographical teaching to their consideration, with some confidence that, if the suggestions meet with the approval of the teaching profession in our country, means will be found for so varying the existing modes of teaching that in time we may realize better than at present the utility of geography as an instrument of education. The student will then, at least, be taught how to learn geography; and organization will extend practical knowledge of typical geographical features of this country through all schools by providing for the use in them of such national maps as the surveys have brought to the hand of teacher and pupil.

[The paper was illustrated by a number of geological and geographical maps, especially the sheets of the old and new geological survey maps, the sheets of the old and new ordnance survey map, maps prepared by the author to illustrate the physical geography of England, and many examples of the comparative geological and geographical maps of the districts visited by the London Geological Field Class.]

Printed by C. F. Hodgson and Son, 2 Newton Street, High Holborn, W.C.