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A Local Geology for Amateurs and Beginners

(First published privately in 1895)

BY

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A POPULAR ARRANGEMENT OF NOTES COLLECTED IN THE NEIGHBOURHOOD OF HASLEMERE, LIPHOOK, PETERSFIELD, AND LYSS,

With a Section Map of Local Strata by Mr. Gilbert Williams.

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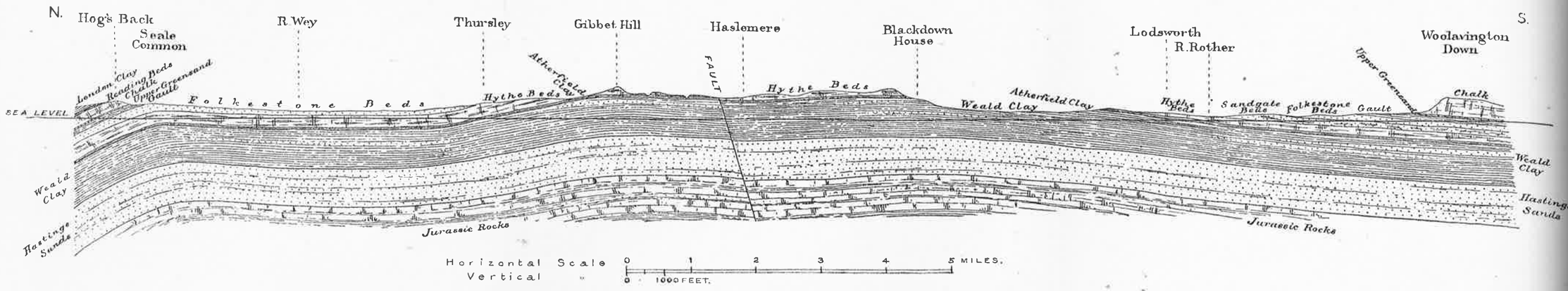


Horizontal section, prepared by Mr. Gilbert Williams, of the Geological Survey, Jermyn Street, to show the approximate position of the strata between Seale Common on the Hog's Back and Woolavington on the South Downs.

It will be observed that the Hythe Beds of the Lower Greensand in the immediate neighbourhood of Haslemere are higher than the Chalk Downs both north and south; they have more successfully withstood denudation than the Gault, Upper Greensand and Chalk. They nowhere exceed 500 feet in thickness, and rest (together with the thin belt of Atherfield clay which lies immediately below them) upon a flattish bank of Weald clay of great depth, often exceeding 1,000 feet.

A fault occurs in the vicinity of Haslemere town. The strata have been fractured and displaced; such displacements are of common occurrence in strata of all ages.

A LOCAL GEOLOGY FOR AMATEURS AND BEGINNERS.[1]

By J. B. FOWLER, B.A.

THE following attempt to catch a glimpse of the physical geography of this district during the time that the solid rocks on which we tread were being deposited, was intended in the first place for quite young readers. It has only been altered sufficiently, as it was thought, to make the reading of more general interest. Readers who start with a knowledge of the subject are asked to exercise a kindly forbearance in their criticisms, and to remember that it is simplicity which is aimed at throughout.

Standing upon the high road near Rake, or upon Hindhead, and looking down and across the beautiful Coombe land, the view is in itself so fair that one may feel well satisfied without wishing to look much beneath the surface, or to carry back one's thoughts in a "flight of fancy" to the beginnings of things. The oaks and beeches that seem quite to fill up the valley are themselves, many of them, older than the houses built along the top, and are but the descendants of other generations of trees that have grown there. Added to this thought, there is such a look of peaceful age about the whole wide

[1] The footnotes have been supplied by Mr. E. W. Swanton, Conservator of Dr. Jonathan Hutchinson's Educational Museum, Haslemere. The fossils, &c., referred to, also a relievo map of the Weald, may be seen in the Museum.

landscape that it seems difficult to imagine it could ever have been very different. And, indeed, there can have been but little change for many hundreds of years, but still startling changes there have been if only we push back far enough. It is only in comparatively late years, I believe, that the Coombe country, with its heavy, stiff, clay soil, has come under the plough. Before it was deeply drained it was found much too difficult to cultivate, so men were contented with the fine oak timber that the land grew, and left things much to Nature's liking. In those days there were few roads, and those only of the roughest kind, and the neighbourhood of the Weald, as it was called, was known as a place to be avoided by peaceable travellers, both on account of its ill-made roads, and also because of the rough characters who, no doubt, found a ready shelter in its thick woods. The word Weald, or "woodland," still serves to describe the Coombe land with its tangled coverts and wide-spreading oaks, and the old saying, "Sousex full of dirt and mire" has meaning enough to-day in many a place where ruts are filled only with furze branches, and wet weather renders travelling slippery and heavy work.

This Weald Clay—to use its geological name—is the oldest rock in the neighbourhood, and seems therefore an appropriate starting-place from which to work our way upwards to the more recent sands of the higher ground that everywhere overlooks the Coombe. It forms the floor of the valley land for many miles, turning northwards round the headlands of Milland, Lynchmere, and Hindhead, and southwards and eastwards following the sandy high ground that stretches from Hill Brow into Sussex. These beds are of great thickness, in some places as much as 1,000 feet, and, in the boring recently made at Lyss in search of water, over 220 feet of this tough clay was passed

through, when the work was stopped for very hopelessness. When freshly exposed, as in the brick pits of the Coombe where it is best seen, it is of a blue colour, though turning a warm russet brown beneath the plough. Although in the lump, or even as seen in the pit, it cannot be said of itself to promise any great source of interest, yet the fossil remains of an ancient world-life scattered through the Weald Clay, when made to tell their story, make the rock in which they are embedded almost to live again for us. Shells, bones, and the remains of plant and tree life, most of them quite different from anything that lives or grows there to-day, are contained in these beds.

But before thinking of these fossil shells and plants, let us stop a minute to ask ourselves what becomes of all the different animals, insects, and plants of our own time that live and die around us; for the Geological Record, as it is called, is not written in a dead language. Nature, as she speaks to us to-day, makes use of the same words and phrases, or writes quietly in the same characters and style as she did a million years ago. If we have learnt to catch her meaning in stream and sunshine, rain and frost, and the life and death of her countless creatures, we shall have gone far towards deciphering the volumes she has written ceaselessly throughout past ages. Think of the thousands of different forms of life there are! Can it be possible that they all live for a short time, and seem so full of life, beauty and interest, and then dying, disappear altogether? And though, no doubt, by far the greater number of them do so, serving their ends in other countless ways, yet it is possible for bones of animals, and the fruit and leaves of trees to be preserved through countless ages. Let us suppose an oak to be growing near some pond, and that some of its leaves, and perhaps a few of its acorns fall upon the soft mud round the margin, or into the water

itself. Most probably they will lie there till they decay, and the evidence of their existence will perish with them. Yet a few may be covered by a thin coating of mud, and thus be protected from the wasting influence of the air. Let us suppose some oak leaves to be safely imprisoned in the thick mud of the pond; though the greater number will most likely be blown away by the wind, and turned slowly into what we call leaf-mould. Nature seems always to be busy in this way, building up with one hand and destroying with the other. Years may pass by, and the oak tree be cut down, or die naturally, and even the pond may dry up, or be drained, so that we might walk over the very same spot without a suspicion that either the one or the other ever existed. But all this time our oak leaves lie buried in the now hardened mud, and even should they perish, they may leave their impression stamped between the layers of their muddy grave. Time passes, the years roll by, and the place is now entirely altered, and maybe what was once the soft mud of the pond has been changed into hard clay or rock. True, it would require a vast number of years for so great a change, but sufficient time with favourable circumstances being given, the thing is possible enough. The oak leaves would now be "fossils," and if we found them we might feel quite sure that at some time an oak tree had once grown close by, even if there were no such trees anywhere in the neighbourhood at the time we found the fossils. We could now read back our story, piecing together what evidence we could collect, but starting fully assured in the possession of our fossil leaves. But it is quite plain that leaves are not so likely to withstand decay, and at length be turned in the course of time into stone as harder, tougher things, such as the bones of fish or animals, or land and water shells. Neither is our imaginary pond so favourable a means of preservation as

larger and less isolated areas of water. In the stiller depths of the sea, where the heavier portions of dead fish or floated matter settle quietly to the bottom, is the most likely place for such remains to be preserved. Or again, at the mouths of great rivers, which carry down quantities of mud and sand, and often dead animal and vegetable remains, there is a great possibility that some of them may be quietly buried, and after the lapse of thousands of years be turned into stone together with the very mud and sand with which they were swept down. One thing is clear, that it is only the very few remains that can possibly be preserved and fossilised compared with the numberless plant and animal lives that must perish daily unrecorded. Hence the scarcity, or absence of fossils in any particular bed of stone or clay is no proof that life did not exist when the mud or sand that forms the rock was being laid down. We must often fill in the picture for ourselves, and "read between the lines" where fossil evidence is scanty, or not forthcoming, and learn to value all the more really what few examples we may meet with. New and endlessly wonderful thoughts will open out if we question rightly, and gain the knack of applying knowledge of the present to things of the past.

As in other things, so in the case of fossils, the smallest are not always the least interesting, and among other examples from the Weald Clay there is one little fellow to be found near here who can throw considerable light on those days of long ago. He is to be found in the railway cutting near Haslemere, and some of his remains were brought up in the boring at Lyss, already referred to. The clay is, in places, as in the Haslemere cutting, hardened into curious thin plates, shale as it is called, on the surfaces of which are a quantity of small, white, seed-like objects. It is only with the aid of a microscope that we can see

them clearly: then each little white point resolves itself into the more or less perfect shell of a very small animal, a kind of diminutive cousin of our well known crab. His descendants still live and thrive in fresh water, and the Cypris must have found things much to his taste in those old days, for there are such numbers of his tiny coverings preserved as fossils. Hosts of them must have oared themselves about, shedding their shells from time to time, or dying to become buried in the mud. Our little Cypris is a very ancient, dignified person, with a very long history attached to him, and certainly not the least interesting fossil to be found here. Although small—1,000 of them would only cover a square inch—his shell is hard, and would stand a good chance of being preserved, especially when we remember the vast numbers there must have been of them. Another Wealden fossil is the Paludina, a fresh water shell-fish, not unlike an elegant pond-snail's shell. It is his remains in the beautiful Sussex marble that furnished the builders of our cathedrals with material for their elegant polished columns.[1] Like the Cypris, the Paludina has descended to our own time as an inhabitant of fresh, or brackish water. Fossil plant remains tell of a neighbouring land surface, else how could they have grown? The hard wing-cases of beetles have also been found, to give a very real colour to the picture, speaking as they do even of the insect life of that far-distant period. But perhaps the most startling fossil remains of the Wealden beds are the teeth and bones of the Iguanodon, whose photograph appeared in the *Illustrated London News* of May 18, 1895. His fossilised bones were first

[1] The following fossils were obtained by Mr. Broyd from a well digging in the clay pits at Grayswood. Exogyra sinuata, Paludina (a small species), Cyrena (Cyclas) media, Cypridea (Cypris) Valdensis (alluded to above), and some fish remains.—E. W. S.

discovered by Dr. Mantell in the Wealden Clay of Sussex, and have since been found in the same beds in the Isle of Wight, and in Belgium. His length has been estimated at from fifty to sixty feet, a gigantic lizard allied to the modern Iguana of South America, and from the curious form of his teeth—many of them found worn down by constant use and mastication—it is pretty certain he was a vegetable eater, and not carnivorous. Not only have his bones been buried and preserved for us in the mud, but he has left behind the print of his footsteps, and as these occur in pairs, it has been concluded that he must have walked almost upright, supporting himself probably by his huge tail, and thus proceeding, with head reared sixty feet in the air, through the neighbourhood of what is now Harting Coombe! We may feel something of Robinson Crusoe's astonishment to find the three-toed footprints of so venerable a personage as the Iguanodon almost at our own doorsteps. Here then, is food—fossil food—for the liveliest imagination. Think of the hoary twilight of a Wealden summer evening; the flitting of those ancient beetles; and the ponderous tread of the Iguanodon crashing through the brakes that fringed the water-side!

Piecing together the evidence of these fossils we find that the shells and the little Cypris were inhabitants of fresh water—an important step towards reading the story. Again, the plant and insect remains point to the near neighbourhood of land, and the Iguanodon, seeing that he has left his footmarks on the soft mud, and that his food consisted of the plant life and herbage growing somewhere near, must have lived and moved along the waterside. In such a place, too, the vegetation would be most plentiful, and rank, and well suited to his tastes. All these, and other Wealden fossils lead us to infer that they lived and died in some fresh water area, or upon its banks hard by

—and at this point the nature of the clay itself is evidence to help us to fill in the picture. Travellers in other countries, describing the mouths and deltas of great Continental rivers, speak of the mud and sand borne down by the flood of water, and heaped in banks and flats about the river mouths. They tell us, too, of the vegetation that grows along the banks down to the water's edge, and in warmer climates, of the turtles and crocodiles that swim lazily about, or bask upon the soft mud close at hand. It is this picture that forced itself upon modern geologists, and led them to suspect a like origin for the formation of the Weald Clay, and, the idea once started, all the evidence was found to point in that direction. If the difficulty arises in our minds of reconciling so vast an estuary, and therefore so large a river—[an estuary that is comparable with those of such rivers as the Nile, or Ganges; for the Wealden beds extend at least so far south as the Isle of Wight, and eastwards into Belgium]—with our knowledge of the present limits of our Island home, we must remember that it is only in quite recent times, geologically speaking, that England has taken its present insular form. Rocks older than the Weald lie buried beneath its thickness, some of which would go to form that ancient continent through which the great river pursued its course in the days of the little Cypris and the Iguanodon. Geologists can only guess at the form and limits of that old land, of which England formed but a part, and to which Ireland on the one hand, and part of what is now Europe on the other, were most probably joined. We must remember that all the high sandy ground of Haslemere and Hindhead, and the undulating uplands of the Chalk Downs were as then unformed, for the Cypris who swam in the quieter reaches of the Wealden river delta dates much further back than Hindhead Hill.

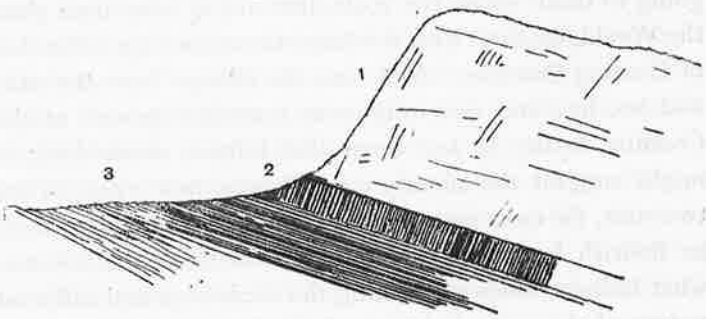
Tennyson had the thought of Nature's ceaseless, changeful workings in his mind when he wrote those lines—containing the spirit of all true geological inquiry :—

"There rolls the deep where grew the tree ;
O earth, what changes hast thou seen !
There where the long street roars, hath been
The stillness of the central sea."

Those lines might have been written on purpose for this neighbourhood of Haslemere and Hindhead, and indeed they would be equally true of any part of England. But we must follow up, as best we can, the wonderful changes that have taken place here since the time when the great river, with all the strange and varied life of those days, flowed near here to form, by its constant accumulations of mud, the stiff clay land of Harting Coombe.

It is not difficult to see, with a little thought, that the rocks which lie *beneath* the Weald Clay are older than it is, whilst those lying *above* must be younger, for they have been laid down upon it. And so it is generally that the lower and deeper we go down the older are the rocks we come to, whilst the more recent ones are nearer the surface, and those forming to-day at river mouths, and upon ocean bottoms, are on the top of all. Hence as we are going to think about the rocks that are of later date than the Weald, we shall look for them above, and upon the clay of Harting Coombe. And here the change from the oaks and beeches, and generally more luxuriant growth of the Coombe, to the fir and gorse-clad hillside overlooking it, might suggest the underlying difference that exists in the two soils, for oaks love the clay, and pines and furze seem to flourish best upon the sand. And though this somewhat indirect mode of learning the succession and different nature of the rocks holds good of all the headlands from Hindhead to Lyss, yet we are not entirely dependent upon it, for the brown and yellow sands are exposed in the pits

and quarries along the higher ground and in many a road-side cutting, whilst it is thrown out lower down by the rabbits from their burrows. But in between the Weald beneath and the sands above, where the slope of the hill inclines more gently, and falls into the general level of the valley, there is a thin bed of brownish clay, not at all easy to find, for even when seen it is easily confounded with the Weald Clay. Between Liphook and Haslemere there are some brick pits where one can see quite plainly the sand on the top resting upon this bed of brownish clay, but the cutting is not deep enough to reach down to the Weald, though we may feel sure it is there. Similarly at the foot of Hatch Lane, near Milland, the sand above may be seen passing into this same brownish clay, though here again the higher ground falls into the general valley level without exposing the junction of the lower part of these beds with the upper part of the Weald. If we could strip off all the grass and trees from the surface, and leave the rocks bare down the side of any one of the headlands overlooking the Weald, either at Hindhead, Milland, Lynchmere, or Lyss, we should probably find a succession of beds somewhat as follows :—



(1) Sand. (2) Brownish Clay. (3) Wealden Beds of the Coombe.

The sand would be on the top (1), forming the bulk of the hill, and reaching almost to the bottom; then would come the thin bed of brownish clay (2), and beneath we should find the thick Wealden beds of the Coombe (3). It is to this thin included stratum of clay that we must pay first attention, and afterwards to the thick overlying deposits of sand, and sand-rock. Like the Weald, this bed extends beneath the overlying deposits, and therefore generally out of sight for a considerable distance; it is by no means peculiar to this district. It is most fully developed, and best seen in the Isle of Wight upon the sea coast near Atherfield Point, and there it occupies the same position as here, with the Weald beneath and the sands above, being in fact but a continuation of these same Lyss beds, and probably more or less connected with them all the way—for what took place in one part of the delta at this time would most probably happen, though possibly with slight variations, over the whole area. It is the fact of being more fully developed at Atherfield than elsewhere that has given to these beds their geological name, Atherfield Clay. Neither at Haslemere, where it is quarried for brick-making, nor elsewhere in this district, have I ever been able to find any fossils that undoubtedly belonged to this Atherfield Clay, but in the Isle of Wight they are to be found, I believe, in plenty.[1] The strangest and most important point to notice is that while the Weald Clay is so full of

[1] Since the above was written the Atherfield Clay has been largely exposed in the neighbourhood of Shottermill and Hammer, and the following fossils found: Cyprina cordiformis (very fine specimens in the Geological Museum, Jermyn Street, are from the railway cutting near Haslemere Station), casts of Trigonia caudata, small specimens of Trigonia nodosa, Barbatia aptiensis (Arca Raulini), Cytherea (Venus) parva, Venus vectenensis, Venus striato-costata, and Nautilus radiatus.—E. W. S.

nothing but the remains of *fresh water* life, the Atherfield Clay, which lies so close, contains quite a different collection; they are all the fossils of marine, or *salt water* life! Looking at the two beds as they lie the one upon the other and paying no attention to the fossils they each contain, it would be easy to imagine that the same agent which laid down the Weald afterwards deposited the Atherfield Clay also. But the fossils cannot but speak truly, they are altogether unmistakable, and we are left to discover some means of explaining how two sets of clays could have been deposited, without apparent break or interval of time, at once so much alike, yet containing a totally different set of fossils. Neither can we imagine any violent change to have taken place whilst the great river was bearing down its muddy burden, for the two beds pass the one into the other almost imperceptibly, so much so that without the guidance of the fossil evidence, they might easily be taken as belonging to one and the same formation.

It is now a well-known physical fact that some areas of land are subject to depression and others to elevation. As for example, in our own times, one portion of Scandinavia is known to be rising, whilst another is slowly sinking, so that in the first case the old sea shore is now raised considerably above and away from the influence of the waves, whilst in the latter case the old sea shore has gradually sunk beneath the encroaching waters. It is no uncommon thing to meet with instances of this change of level in geological times, for, as is known, the sea and land have often changed their relative positions, and every such change implies either elevation or depression of the land. That this same state of things should have set in at the close of the Wealden Age is, therefore, no unparalleled case, and it is the simplest, if not the only way of explaining the evidence of the beds themselves. Looked at in this light

the Atherfield Clay becomes a connecting link or passage bed, as it is called, between the continental period of the Wealden River delta and the marine period of the overlying sands. As the land slowly and gently sank beneath the waves of an encroaching sea, new forms of life would, of necessity, make their appearance, and the fresh water fauna would perforce give place to the marine. At the same time the river would continue to discharge its muddy burden, so that it would not be until after a considerable period, a period that is represented by the Atherfield Clay deposits, that an entirely new state of things could obtain. The Atherfield beds are, therefore, of the greatest interest, as heralding the incoming of a great physical change, and the commencement of that long period during which the sand rocks of Haslemere, Lyss, Liphook and Petersfield were deposited. As may be expected the Cypris found the change an unpleasant one, and we may look in vain for any fossil remains of him after the incoming salt water had once fairly set in. In his place are found at Atherfield the beginning of a marine fauna brought in, so to speak, by the change in the tide of affairs. Thus, there are fossil oysters, lobsters, remains of salt water fish of various species, and fragments of coral. Indeed, I am told by the brick makers in the Haslemere clay pits that they have met with fossil oyster shells when digging there. Just as the passage from the Wealden to the Atherfield Beds seems to have been a gradual, almost imperceptible one, so it continued until the marine sands began to be deposited. Indeed, we have every reason to believe that Nature has always preferred to work in this same quiet unobtrusive manner, for the real secret of the physical changes that have taken place throughout past ages in this country is not to be attributed to vast cataclysms, or sudden upheavals and depressions, but to the same orderly working, through

vast continued periods of time, of those same forces with which we are familiar to-day.

The thick deposit of sand, sand rock and impure clays and limestones that mark this new geological era has been divided, according to certain local changes in the beds themselves, into three groups. These, like the Atherfield Clay, have been named after the places where they are most fully developed, or most clearly seen, namely, Folkestone, Sandgate and Hythe, all places on the coast of Kent. But it must be borne in mind that the history of these sand rocks is a continuous one, and that the division under three distinct names is merely one of convenience and does not mark any difference in the agent that formed them one and all. Thus, the more general term for the whole series is Lower Greensand, a name perhaps not very applicable in this district where yellow, brown and white sands abound, and where any truly green grains may almost be considered a "find," but given to this formation because of the distinct green colouring of these same sands in other parts of England. The changes in the nature of the rocks themselves from sands to clays or limestone, as we work upwards from the Atherfield Clay, prevents the same general treatment in description as was possible in the case of the Weald, but I shall try to keep a continuity throughout, and only digress where it seems unavoidable.

The Lower Greensand Beds sweep all round the Weald from near Beachy Head to the coast of Kent. Of the three divisions above mentioned the Hythe Beds were the first to be deposited, and lie therefore immediately upon the Atherfield Clay. They consist, roughly speaking, of brown, impure sands, termed "hassock," and sand rock, and in the upper beds contain a brownish-blue limestone full of quartz-grains, or sand, which is known as Bargate. It is over these sands that the high road from Hindhead to

Sheet, just north of Petersfield, passes, and which form the high scarped terraces before mentioned as overlooking the Weald, and rising often into eminences but little inferior to the Chalk Downs. From the poorness of the soil, and the absence of calcareous matter, the Hythe Beds often give rise, in this district, to wild, uncultivated common land, as at Hindhead and Milland. The line of junction with the Atherfield Clay below is often marked by springs, or by a general dampness of the soil, and examples of this kind occur all along the base of the escarpment upon the outer edge of the Coombe. The loose, sandy beds which form the higher ground act as a splendid collecting ground and reservoir for all rain-water falling in this area, which sinking down until it reaches the impervious Atherfield Clay, is thrown out at the lowest surface level. Thus springs issue forth to feed the River Wey, whilst others are caught into dip-wells to supply the neighbouring hamlets with constant and wonderfully pure water. As a beautiful example of this cause of springs in these beds it would be well here to mention the Punch Bowl at Hindhead. Geologists say that this curious natural formation owes its origin to sub-aerial waste—rain, frost, wind, and running water; and miniature punch bowls may sometimes be seen, in all stages of completeness, carved in the face of soft clay or sandstone, by a number of converging runnels. But it is only possible to guess when, where, or how the erosion began, though we may be sure it is of great antiquity. In the course of time all the thickness of the Hythe and overlying beds has been worn away, and the Atherfield Clay exposed for some distance along the valley bottom. The line of junction is clearly marked by a succession of fine springs, the main body of which, after coursing over a cherty, sandy bed, and supplying cottages and clustering farmhouses with water, joins the Wey at

Elsted. Thus it is the wasting away of the rock that has, in this case, given rise to the spring, and not the spring that has caused the denudation, though it may have assisted in the work latterly. Given the time, it seems, Nature will carve punch bowls, or remove mountains, only making use of such ordinary every day instruments as air, wind and running water.

The Bargate Stone, spoken of before as occurring in the upper part of the Hythe beds, is not regularly stratified in continuous layers, but is in more or less detached lenticular, or rounded masses. It seems, both from its position and composition, to take the place in this district of the Kentish Rag of Kent and elsewhere, for it consists of sand grains, and a few sage green grains, held together by a calcareous cement, and 70 per cent. of it may be said to be almost a pure limestone. It is quarried near Lyss Station, and about Liphook, the better sort for building purposes, and the more crumbly layers for road metal. It is also often removed from well-sinkings in concretionary masses of great hardness. Though the Bargate at Godalming contains a fairly plentiful supply of fossils, they are very scanty in this neighbourhood. Indeed, the whole thickness of the Hythe Beds is singularly destitute of fossils about here; possibly the depth of the water, or the nature of the deposits was not suitable for the support or preservation of marine life.[1] At Hythe, on the other hand,

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[1] The Museum collection of local fossils from the Hythe Beds comprises: Ammonites Nutfieldiensis, A. Martini, A. Deshaysii (fragments only of the three species). A large Ammonite measuring 2 ft. across was recently found near Haslemere; unfortunately it had been broken into several pieces before we saw it. Nautilus plicatus, and a huge septum of N. lævigatus; Crioceras Bowerbankii, Exogyra sinuata, Gervillia anceps, Panopœa plicata; Pholadidea prisca (a burrowing mollusc); Gastrochæna, with burrows in wood. Two stems

in these same beds, fossils are plentiful enough, principally salt water shell fish, such as, it is thought, would be likely to flourish in a shallow or only moderately deep sea Some of the sandy rag stone about Liphook contains what may be the matrices of fossils [Trigoniæ], roughly triangular holes often to be seen in walls built of this stone. And at Lyss there are what appear to be the fossilised burrows of earth worms that worked in the sand when it was soft and yielding. Good hand-specimens of these may often be picked up off the heaps of road metal by the roadside. These holes, which seem to occupy the same upright position as that in which they were doubtless formed, would probably be originally filled with loose sand, which has since been removed by percolating water, but the hardened sides of the tubes have remained. Similar examples of the tracks and burrows of worms are found in other rocks, and the supposition that these are genuine fossils is not unlikely in itself. The presence in these sands of fossil wood, specimens of which I have found at Sheet, near Petersfield, points to a neighbouring land surface, and this, taken together with the general character of the formation itself, and the fossils it contains, supports the theory that the Hythe Beds were laid down in the shallow sea that had encroached upon and completely covered the area of the Wealden river basin.

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of a sponge (genus Chenendophora?), and another. Nucleolites (an echinoderm), a small species of Belemnite; and Chondrites fastigiatus, a problematical seaweed.

Pebbles of quartz, jasper and slate are occasionally found in the Weald and the Hythe Beds. In the former they point to the wearing away of the river banks in that part of the continent to the north-west which was drained by the Wealden River; in the latter to the fight for supremacy going on between land and ocean. Quartz pebbles, collected by Miss Money in gravel pits between Lyss Station and Stodham Park, may be seen in the Museum.—E. W. S.

Overlying the Hythe, the Sandgate Beds[1] consist of dark brown sandy clays, which, from their nature, generally give rise to low-lying, often swampy ground. For example, starting from Sheet, near Petersfield, it forms most of the valley through which the railway line and the Rother stream run side by side. From Lyss it continues to follow the line for some distance, and then strikes off at the foot of Weaver's Down, through Fowley and Conford to Headley, where it dies out altogether. It can often be determined from the more barren sands of the Folkestone and Hythe Beds on either side by its brighter green herbage, and damp, rush-covered flats. At Sheet, the beds contain coarse sands, which gives rise to somewhat higher ground than is generally the case with the Sandgate. It is in the neighbourhood of Sheet, and at Frimstone Lodge, Liphook, that I have found my only Sandgate fossils, masses of curiously mixed wood and shells, which mark, I believe, the junction with the Hythe.

Passing on to the Folkestone Beds, the last, and uppermost division of the lower Greensand, we meet with almost pure white sands and a dark, ferruginous grit, known as Carstone or Foreststone. As might be expected, the soil is so poor that the Folkestone Beds are marked in this neighbourhood by a succession of uncultivated heaths. Such for example, are Trotton Common, Petersfield Heath, Midhurst Common, Weaver's Down and the Forest, and Frensham Common. At Weaver's Down the sand is compact and firm, giving rise to a bold, heather-clad headland overlooking the green valley of the Sandgate. There are some curious, thin courses of white clay amongst the

[1] The Sandgate Clay in the neighbourhood of Griggs Green, about a mile and a-half from Liphook Station (on the road to Woolmer), is now being worked for bricks. The present exposure does not much exceed four feet in thickness. No fossils have been found.—E. W. S.

sand at Trotton, Hollywater and elsewhere, and I have wondered whether these, together with the peaty soil, may not help to hold up the water in some of the large ponds [*e.g.*, Petersfield and Woolmer], that occur upon the Folkestone Heaths.

The Carstone, which is much used in this neighbourhood as road metal, is too curious to pass over without more mention. Sometimes it forms a regular layer of coarse, iron-stained grit, but more often seems to be broken up into disconnected fragments of all sizes scattered amongst the sand. The form that the stone sometimes takes is singularly like artificial drain pipes that seem to defy all attempts at explanation. It has been suggested that these may have been formed round the trunks of fallen trees, the wood afterwards decaying away from the inside, and leaving only the envelope which was subsequently hardened by infiltrated ferruginous matter; but there seems very little evidence to support such a theory. Occasionally the stone is curiously crumpled and contorted, and some specimens show signs of what appear to be current, or ripple markings, and even rain pittings, "fossilised breezes and showers," in fact. And these, somewhat doubtful examples as they are, seem to be in this district the only fossil remains to be found in the Folkestone Sands. Looking back on the three divisions of the lower Greensand, and treating them as one continuous formation, we may say that they speak of a shallow, though at times deepening sea. Here local changes of depth, caused by elevation or depression, and currents bearing in different sediments from time to time, gave rise to the various sands, sand rock, clays, and limestones that now go to form the surrounding country. Speaking broadly, and judging from the character of the rocks in this district only, it seems almost as though the Hythe Beds had begun to be de-

posited in shallow water, as would be natural when we remember that the submergence of the Wealden area was even then only in its earlier stages. This seems marked by the thick deposits of coarse sands, clay or hassock, that form the lower portion of this division. After this, submergence seems to have continued, though probably at intervals, or with even temporary periods of partial elevation, until the close of the period marked by the Sandgate deposits. Having reached its greatest degree of depression, the area seems, during what we may call the Folkestone Age, to have been considerably elevated, for the coarse sands, and possible current markings and rain-pittings point to a shallow sea. Be this partially true or not, we know that when the period marked by the Folkestone Beds had come to an end, a succession of new and great physical changes followed, many of which must represent vast periods of time. Chief of these was the long Marine Epoch, during which the thick deposits of white chalk were slowly built up at the bottom of an ancient Atlantic. But before that next great era it is thought that the Folkestone Beds must have been, for a time at least, heaved again out of the sea, and worn down by the action of the air and running water. There are signs of this break in the succession of the strata to be seen in some of the brick-pits near Petersfield, where the Folkestone Sands are exposed, together with an overlying bed of thick blue clay (Gault). Hence geologists have made a division in the two sets of strata, calling the older one the Lower and the later one the Upper Greensand. But as we only purposed to question and examine the Wealden and overlying sands and sand rocks of this neighbourhood, the close of the Folkestone Period brings our task—but very imperfectly conducted I know—to an end.

In conclusion, however, we may add that it is to the varied nature and alternation of the rocks that we owe the possession of one of the most changeful and the most beautiful pieces of country scenery in England. The successive beds of rock which Nature built up in those old times she has since carved by wind, rain and frost into hill and valley, headland and coombe, and clothed the whole with forest, furze, or pasturage. It is the harder beds that have best withstood this continued wearing influence, and which therefore stand out above the general level of the country, whilst the softer sands and clays have been more readily carved and moulded into coombe and valley.

> "The hills are shadows, and they flow
> From form to form, and nothing stands;
> They melt like mists, the solid lands,
> Like clouds they shape themselves and go."