HAMPSHIRE VALLEYS AND WATERWAYS.

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In previous Papers and Proceedings of the club I have written on the "Springs and Streams of Hampshire"[1] and on "Hampshire Mudlands and other Alluviums."[2] These subjects are closely connected with this Paper, "The Hampshire Valleys and Waterways."

As the chief surface rock in Hampshire is chalk, the most remarkable of these valleys are wholly or partly chalk valleys. The chalk in the form of an irregular parallelogram stretches over more than half the county from the south east to the north west, lying between Rowland's Castle and Odiham on the east, and Dean Hill and Combe Hill on the west, the hightest part of it being at Combe Hill, 972 feet above the sea.

The formation of the Hampshire Valleys is one of the most interesting subjects connected with the physical geology of the county, for their origin, carries us back to the study of the effects of the forces of nature on the land, for as long a time as what is now Hampshire has been above the sea, and it is also to these valleys we must look for the traces of the earliest settlements of man. Every Hampshire valley is a waterway, but every waterway is not a valley. The water in some instances flows above the ground down gentle inclines as in our rivers and streams, and in other instances its flow is first into the strata more or less vertically, and afterwards through underground sloping channels. There are consequently waterways which we may see, and others which we cannot see.

[1] Papers and proceedings of the Hampshire Field Club. Vol. II., pp., 33-58.

[2] Ibid. Vol. II., pp., 181-200.

We may also see in Hampshire the sites and little channels of former waterways, which are not water channels now, being choked up with debris, but which were channels at a remote period, as we reckon time ; geologically at a somewhat recent period. These may be seen in the sections of some of our railway cuttings and chalk pits as pockets of clay and gravel extending down into the chalk.

There are courses also in this county by which the water flows quickly back to the sea, and there are other courses which it takes, along which it is detained for a time, as when it is arrested by chalk, gravel, sand, or bog. When rain falls on any part of the county where clay exists on the surface, or as a subjacent bed, through which it cannot percolate, such as over the areas of the London and Bracklesham clays, it is quickly collected into streams and conveyed away. By far the greater part of the surface of Hampshire however consists of porous beds which first absorb the rain, and after detaining it for a time, give it up again.

I will first draw your attention to several geological principles affecting the formation of our valleys and waterways.

The land which we now call Hampshire probably emerged from beneath the sea, as the result of a gradual elevating process, during which marine forces acted upon its rising surface.

There is at the present time a line more or less elevated, passing through this county, from the neighbourhood of Petersfield and Alton to Combe Hill, at its north western corner, which marks its great water parting, dividing the drainage of the streams which flow northward to the London geological basin, from the streams which flow southward and which form part of the Hampshire geological basin.

I do not propose in this paper to discuss the series of geological changes, the elevations and submergences, and the great variations in climate under which this southern part of England finally became dry land. The chalk which is on the surface, or underlies the greater part of Hampshire must have been beneath the sea while the Tertiary beds were deposited on it. The central and northern parts of the county must have been above the sea for a longer

period, than the southern parts including the Isle of Wight, for the fresh water Headon and Bembridge beds were deposited in a great estuary while our chalk areas were covered with Tertiary clays and sands. After successive changes there came a time when the land we now call Hampshire, although not much like what it is now, was elevated. It was not separated from the continent all at once.

When the formation of Hampshire valleys first began, and their rivers first began to flow, they probably flowed into a valley, where the English channel now is, as tributaries of a great river flowing westward, of which the Seine was the main stream. Even in the newer stone age, when the men who made the polished flint implements lived here, the Isle of Wight was probably part of the mainland for the so called submerged forests, and the peat from which Neolithic worked stones have been obtained are found beneath the water along parts of the coast and are all included within a depth of a few fathoms. An elevation of about 12 fathoms would connect the island with the mainland. When Hampshire assumed its present main outlines, the Isle of Wight must have been part of it.

The upheaval of the land was effected or accompanied by a bending of the strata, which as they lay beneath the sea were horizontal, into several arches and troughs. The crest of the main arch which has since been much planed down, is now represented by the ridge of elevated ground that forms its chief watershed. This upheaval gave rise to the dry land, but it was not effected without a struggle, for as the land was slowly lifted up the waves attacked it, and layer after layer was planed off its top. Thus for a time, perhaps a very long time, a struggle went on, between two opposing forces, the one a force of upheaval, and the other, the force of the waves, a denuding force, striving to wear the upheaved parts down to the sea level. Finally the upheaving force overcame the action of the waves, and the land arose above the sea as part of the series of geological arches and troughs which may be traced through England.

As the land was thus formed by the struggle of opposing natural forces, and the sea planed down the higher parts of

the geological arches or anticlines, its surface, as it finally emerged from the sea, although it probably had some hollows and ridges, produced by bending of the strata, must have been much more even than it is as present. As the northern part of Hampshire owed its existence to a bending up of the horizontal beds along the line which in all probability now marks its chief watershed, it must have been higher along that line than at its limits either on the north or south, and this is the reason why the slope in either direction from its chief watershed is in the same direction as the dip of the beds. We find the chalk dipping under the Tertiary beds of clay, sand, and loam both in the north and in the south of the county. As there still are patches and debris of these Tertiary beds lying here and there upon the chalk, which formed part of the chief arch of elevation, we may see in these patches the remains of the continuous extent of these beds which once connected the clays and sands of the north with those of the south. The chief part of Hampshire after the elevation of its strata must consequently have consisted of two inclined planes having irregular surfaces which sloped from the crest of its elevated ridge towards the place where the sea level on the south now is, and to what is now the valley of the Thames on the north.

We may walk at the present time along its chief watershed, from Noar Hill near Selborne, past Medstead, Dummer, South Litchfield, Church Oakley, and thence by the Seven Barrows to Combe Hill, and see spread out before us on the south, and also on the north what remains of these two inclined planes; but as the ridge or watershed which marks the line of the old arch of elevation has been itself much worn down and changed by natural agencies, so these inclined planes which originally met along this arch have also been irregulary worn, and are planes no longer, for rain, occasional land streams, rivers, floods and frost, have sculptured these surfaces, and left their marks on the hills they have shaped and the valleys they have cut, down which the rainwash still flows, and through which the permanent and occasional streams still find their way to the sea.

The water slope from the ridge of elevation, which we now call the North Downs was not originally, an uninterrupted

slope southwards, but was broken by at least one other anticlinal or arch of elevation, the ridge represented in the east of Hampshire by Portsdown Hill, and in the west by Dean Hill, but this was depressed in the neighbourhood of Southampton so that this course offered a convenient outlet for the rivers.

Further south there was another ridge of elevation passing through what is now the Isle of Wight.

The first stage in the formation of the Hampshire valleys was therefore the elevating stage, during which the water partings were formed. The newly elevated land was then attacked by rain, rivers and floods. The water as it fell on the land became collected into any little hollow places and irregularities on its surface which could act as channels, and thus the earliest system of drainage began. As no continuous river courses yet existed, this drainage must have consisted of streams flowing as best they could, perhaps some of them through lakes in which the water collected and rose, until it was sufficiently high to pass over any harder ridge of rock which obstructed its course, and so flowing over one obstruction after another found its way down the inclined surfaces into the valley which is now the English channel on one side, and the Thames drainage on the other gradually deepening and widening its courses.

The valleys of the Test, Itchen, Meon, and other Hampshire streams were originally cut in this way as trenches, which became wider as the rivers flowed from the higher ground and drew nearer to their outlet.

The streams thus formed by the flow of the water down the inclined surfaces, of what we now call Hampshire, formed its transverse valleys, *i.e.*, the valleys which have been cut across the outcrop of the beds, across the general direction of the hills, as they exist now, or so to speak across the grain of the country.

These valleys may all be observed to widen as they near the sea. The southern anticlinal, which is not elevated in the neighbourhood of Southampton, must have been broken through at an early period, and this depressed part of the anticlinal enabled the Test and Itchen to reach the sea. Let us now take a general view of what a careful observer may see as regards the valleys of Hampshire at the present time.

The longest transverse river valley in this county is that of the Test. It flows through openings in the chalk hills until it reaches the Tertiary formations in the neighbourhood of Romsey. The river of which the Test is the modern representative must have found the line which is now marked by this valley, the line which presented the fewest obstructions to the flow of water to the sea. The water consequently flowed along this line, overcame the obstructions one after another, and gradually wore down its barriers until a channel was made for an uninterupted flow. At this early period the Hampshire streams flowed from higher ground, and were of greater volume. Consequently they were able to exert a greater excavating force in cutting their transverse valleys through the strata across which they flowed. The longest valleys have been cut through the chalk, but those of the Rother and Wey have been cut partly through the chalk and partly through the upper greensand beds which lie beneath, while the valleys in the south and some of those in north have been excavated through the Tertiary beds, under which the chalk dips. In the south also we may see that some of those valleys have been cut since the plateau or high level gravel was deposited by drift agency of some kind, probably during the glacial age, in a sheet or bed on these Tertiary beds. This gravel is found on the high ground on both sides of Southampton Water, and on the high ground between most of the valleys of the New Forest.

Those who have observed the chalk in various parts of Hampshire must have noticed that its beds are of different degrees of hardness. In some instances one of these harder bed may be seen cropping out or lying near the surface, and extending for many miles. In other instances softer beds lie near the surface for long distances. Softer beds generally occur on the hill slopes where the valleys are widest, and harder beds are commonly met with where the valleys are more contracted, or near the tops of hills which have bold features. The variable width of the valleys is accounted for by the rainwash which more easily wears away the softer chalk.

It may be observed also that the larger valleys through which the Avon, Test, Itchen, and other streams flow, have

smaller valleys, which branch off from them through which lesser streams flow at a greater or less angle with the main stream. These smaller valleys are called longitudinal valleys because they commonly extend *along* the line, which marks the outcrop of the beds—or which marks the junction between two different strata. One of the best examples in Hampshire is that of the Micheldever valley, through which a stream flows from West Stratton into the Test. The line of this valley is along the line of the chalk beds, and not across them. Longitudinal or branch valleys occur in the south of Hampshire, near the junction of the Reading Beds, and London clay with the chalk, as for example, that which occurs between Hursley and Otterbourn, or further eastward where the Meon river receives a stream which feeds it near Wickham.

As the chief watershed of the county was formerly higher than it is at present, the original rivers must have flowed down a steeper incline and so have exerted a greater excavating force than they do at present. The rainfall also was certainly much greater under some of the climatic conditions which are known to have prevailed since Hampshire has been above the sea.

Even at the present time, where the gradient of a stream is steep, it may be seen to have excavated a deep and narrow channel, as may be observed along the upper courses of the Rother and the Wey, but where the gradient is less and the flow of the stream is less rapid, it may be observed often to stray from its channel and to widen the valley under excavation, as may be seen also along the lower courses of the same rivers.

Where the ground consists of a similar kind of soft strata and the gradient is moderate, a stream may be seen to have deepened its channel simultaneously throughout, and at the same time to have widened its valley, as it approaches the sea, as may be observed along the great part of the courses of the Test and the Itchen.

In the lower parts of these rivers and also that of the Avon, one of the effects of the stream has been to deposit a sediment, and raise the level of the adjacent flats by its floods. These are some of the results of the action of

Hampshire streams, which we may see in our valleys at the present time.

Although the gradients of the Hampshire rivers do not vary greatly now in different parts of their courses, yet they do vary, and may be seen to flow more rapidly in some parts of their valleys than in other parts; for example; the Test as it flows under Fullerton Bridge, will be found to have a more rapid flow than in some parts higher up or lower down the same valley, and where it flows fastest the valley will be found to be contracted.

As we wander through the river valleys of Hampshire, we may observe that great extents of alluvial land prevail where they are widest and that these alluviums are absent or small, where the sloping ground is inclined almost down to the water's edge.

As the river flows through the marsh it sometimes shifts its positions and in the course of thus shifting, attacks one side of the valley more than the other, undermining that side more than the other, according to the variation in the water power at particular times, and the nature of the rock against which it is deflected.

This is the reason why the river cuts the valley back more on one side than the other. Owing to these causes, gentle slopes and terraces with alluvial flats, may be seen in many of the Hampshire valleys to exist on one side of the river's course, while escarped banks against which the stream has been strongly deflected prevail on the other. These phenomena are interesting to others besides the geologist, for the student of anthropology may observe in the Hamshire valleys the remains of human work of all periods of the history of man, from the present century back to those dim ages concerning which no records of man exist. It is indeed to the valleys that he must look for such traces as may be found, of the earliest race of all which has been known to have lived here. That race lived here before the English Channel was entirely formed, and before the valleys were excavated as we now see them. They were known as the men of the Early Stone Age, or river drift men, because the roughly chipped flint implements they fashioned are found in the beds of drift gravel, which were formed of material

brought down from higher ground and deposited on the valley sides. The river having first deposited this gravel wore it away so that only terraces or patches of it are now left.

As the old rivers gradually excavated the valleys and made deeper channels, they left here and there these gravel patches, at levels which mark the height at which they flowed at successive periods. This river drift contains sand and loam as well as gravel, lodged on the hill sides at various elevations, the higher beds being deposited while the rivers flowed at greater heights, and consequently at a much earlier period than when they flowed not much above the levels of the present streams. These gravels have been found to contain not only implements of the Early Stone Age, but the debris of land animals, and fluviatile land shells of animals living at the time of the river's history, when the material in that particular terrace was deposited. These animals must therefore have been contemporary with the river drift man, and among them was the early elephant (Elephas primigenius), examples of whose teeth found in this neighbourhood are preserved in the Hartley Museum. The drifted material in these river terraces is all local, and has been derived from the strata higher up the country in the same river basins.

Thus the evidence is clear, not only that man lived here before the valleys were excavated, but that these valleys have been formed by river action, and also that the old rivers, although they flowed at higher levels, were confined to the same basins as at present. That the water power was formerly greater than it is at present is certain, but this was not necessarily due to a more extensive drainage area, but to a greater rainfall or greater floods, such as would be caused by those different climatic conditions which enabled such a growth of vegetation to exist as supplied subsistence for elephants and other types of animals of warmer climates, which are known by their remains to have lived here. The men who lived here contemporaneously with Elephas primigenius saw the valleys of the Avon, Test and Itchen in the earlier stages of their process of excavation. They roamed over the higher ground and hunted the animals on

which they lived, while much of the gravel we now see at lower levels still existed as flints in situ in the chalk, or as weathered debris on its surface.

I have alluded to the circumstance that the most important Hampshire valleys are found to extend across the outcrop of the beds, *i.e.*, they have been eroded in the same direction of the general dip of the beds, across what may be termed the grain of the country.

In some places where the chalk crops out from beneath the Tertiary beds, as at Otterbourn and Michelmersh, it may be seen to rise at once to considerable elevations on each side of the valley.

The rivers Itchen and Test, in the process of cutting channels for themselves through the chalk strata, have left these chalk hills and made moderately deep and wide transverse valleys. The valley which the Avon has formed in Hampshire is also a good example of a transverse valley, cut across the line of the chalk hills near Downton, and across the general direction of the Tertiary beds between Downton and Christchurch, where the river now reaches the sea.

I have mentioned one of the feeders of the Test, the Micheldever stream, which flows from east to west along what is probably the line of the outcrop of some soft bed of chalk, a circumstance which has enabled the stream to form a longitudinal valley, as a branch valley of the larger transverse valley which the Test has cut for itself through the chalk strata almost at right angles to it.

It commonly happens that a river flows for part of its course through a longitudinal valley and part of its course through a transverse valley, and a good illustration of this occurs in Hampshire.

The present main course of the Itchen, until it reaches King's Worthy, is along a line which marks the general direction of the chalk beds, *i.e.*, probably along the outcrop of some soft beds. About two miles above Winchester it makes an abrupt turn to the south, and the hills near that city and southwards as far as Shawford and Twyford, show how the valley has been formed by the oid river, assisted by rainwash, cutting out for itself a way to the sea between the hills it has left and whose contours it has shaped.

All the chief Hampshire streams as they enter the sea, flow in the same way through transverse valleys, across the direction of the general trend of the hills, or across the grain of the country.

Anyone who carefully observes the Hampshire valleys may also notice that where a valley runs more or less parallel to and near another valley which is more deeply cut, the stream flowing through the valley which is higher than the other adjacent to it, will be found to have a much smaller volume of water. This may be seen by comparing the Wallop valley and its stream with the neighbouring valley of the Test. The elevations of the two streams may be compared as follows—Wallop stream at Middle Wallop is 200 feet above the sea, while the Test over the hill at Longstock is only 130 feet in elevation. Further down, at Lower Wallop, the Wallop stream is 160 feet above the sea, while over the intervening hill at Stockbridge the Test is only 114 feet above the sea. The origin of these valleys was co-eval. Water began to flow down them at the same time, but the Test is a large stream, and the Wallop brook is a small one. We see here geological cause and effect. The Wallop stream assisted by the rainwash down its hill slopes, has been unable to cut its valley so deep as the Test with its much greater volume of water and its greater rainwash, has been able to cut its valley. Where the chalk valleys have been cut down below the ordinary line of saturation of the chalk strata, *i.e.*, below the level at which water issues from the *permanent* springs, they necessarily have a stream flowing through them, but where the valleys have not been cut down below the level of the existing permanent springs, but only below the level of the *occasional* springs, they have only a bourn or occasional stream flowing through them. These bourns only flow in very wet seasons when the line of saturation in the chalk is unusually high. At other times the dry bourn channel may be seen extending for many miles up such a valley, as in that which leads up to Hambledon, the valley above St. Mary Bourne, the Itchen valley between Cheriton and Bramdean, the Candover valley above Chilton Candover, and the valley of the Collingbourn. In ordinary seasons when the line of saturation is below the level of the

bed of the bourn, the valley has an underground or mole stream, as in the case of the Collingbourn, the water level of which is often 60 feet below the dry bed of the channel, along which it flows from South Tedworth to West Cholderton, in very wet seasons.

Rain and rivers which have been the chief agencies in excavating the Hampshire valleys are still engaged in modifying their shapes and transporting their waste material to the sea. Rain often forms surface floods in the valleys which have now no permanent streams. At such times it washes the flint debris or gravel into the bottoms of these dry valleys, as may be observed in the Netherton valley, and in those above Bramdean and Bishops Waltham, where the gravel is dug for road material.

In other localities the rain may be observed to have washed much of the soil from the higher parts of the hill sides into the valley bottoms where an unusual thickness of it is often found, while the chalk is sometimes found almost bare on the upper part of the same slope.

It is, of course, during wet seasons that the physical action of rain and rivers are the greatest. Those whose business takes them across the chalk country in wet weather cannot fail to notice the many temporary streams which flow at such times down the hill sides and bottoms across the fields, or along the roadsides until the water reaches some permanent stream, or meets with some porous stratum which absorbs it. Each of these streamlets carries some material down from the higher ground. During a great rainfall water may be observed to stand in large pools, which rapidly dry up as it is absorbed by the porous chalk. Such hollow places are known as swallow holes, and they play their part in modifying the surface as regularly as any other agency. Rain as it falls on the surface of the chalk, is free from mineral matter, but not a drop of it reaches the sea without bringing with it some mineral matter in solution.

Man imitates Nature. Roadmakers in former times have cut many artificial roadways to lessen the gradients of the Hampshire hills, such as that at Butser Hill, and railway engineers have made deeper railway cuttings for modern traffic.

The drainage of roads and railway cuttings across the chalk districts of Hampshire, has been effected by imitating Nature. Nature makes in the bottoms of dry valleys swallow holes, which absorb and carry off the water in these valleys, and road surveyors and railway engineers have imitated her, by making artificial channels leading into little pits or hollow places, by which the surface water can run off the roads and railway cuttings, and be absorbed into the chalk, which acts as a great reservoir. This may be seen in the railway cuttings between Micheldever and Basingstoke, where little pits have been made in the chalk to absorb the water.

There is considerable geological evidence to show that when the Isle of Wight was joined to Hampshire the Solent was the lowest of the Hampshire valleys, through which, at a remote time, the main stream flowed of which the Avon, and the other Hampshire streams were branches. This is a valley no longer, but an arm of the sea. The former stream flowed eastwards from what is now Poole Harbour, having on the south of it a ridge of land which formerly connected the Needles with the coast of Dorsetshire. We may observe at the present time the eastward trend of some of the rivers which were its feeders, the chief of which was that formed by the junction of the Test, Itchen, and Hamble, now called Southampton Water. Then came geological changes, certainly a subsidence, and this aided by marine action caused the ridge between the Isle of Wight and Dorsetshire to be broken through. The valleys which are now the Solent and Southampton Water, must have been the chief waterways of Hampshire before their subsidence, but owing to that subsidence they became much more important waterways. The maritime advantages of Southampton and Portsmouth, in ancient and modern times, and the consequent prosperity of this southern part of Hampshire, may be traced ultimately to the great physical changes produced by the subsidence of these former river valleys.

If we closely observe the higher valleys of Hampshire, we cannot fail to see a difference between the chalk valleys, and those in the districts of the Tertiary clay formations. The chalk valleys through which streams flow, are, as I have mentioned, continued beyond their permanent springs, higher

up towards their watersheds, as dry valleys, sometimes also called bourn valleys. This is not the case with the valleys which have been cut through the Tertiary clays. They have no bourns. Some of the most remarkable examples of the bourn valleys of Hampshire may be observed in the valley of the Collingbourn, in the Netherton valley, between Hurstbourn Tarrant and St. Mary Bourn, in the Itchen valley between Bramdean and Cheriton, in the Meon valley between Westbury and West Meon, in the valley south of Hambledon, in the Wallop valley above Nether Wallop, and north-west of Andover, between Penton Mewsey and Charlton. In addition to these upper chalk valleys which are marked by visible bourn courses, there are also still higher continuations of these bourn valleys themselves, which are not so marked by a dry stream course, and other branch valleys in which the rain is absorbed as it falls by the porous strata. These have been called rain valleys, and they are a marked feature in chalk districts.

Wherever we may go over the higher chalk country of Hampshire, we cannot fail to meet with these rain valleys. These are some of the phenomena which may be observed at the present time in the Hampshire valleys and waterways. I will now consider in more detail the formation of one of them, in which we are all interested, viz., the valley of the Itchen.

The river Itchen is an old river, so old indeed that the word ancient does not properly represent its antiquity. We may wander along its course at the present time and see some of the remains of the early inhabitants of this county, such as that of the entrenched Celtic camp on St. Catherine's Hill; we may view remains of the Roman period, at Bittern, Twyford, Winchester and Itchen Abbas; we may see parts of Saxon Churches at Headbourn Worthy and elsewhere, but all these, and many other objects of antiquity which still exist on the banks of the Itchen, are but modern when compared with the age of the river itself. That river, with the help of its feeding streams and streamlets, has carved out a valley about 200 feet deep, with many lateral valleys leading into it. If it has not removed mountains it has removed a vast mass of material between hills, and given

their shapes to those hills which it has left. Its former sources must have been on the high watershed, then much higher than at present, near Basingstoke and Popham, towards the north, and in the east near Petersfield, for its dry valleys extend up to some of these positions at the present day. Rivers perform the chief part of their excavating work in the hey-day of their youth and the vigour of their prime. When they become geologically old, and have cut down their channels, they become less active as geological agents. They then form alluvial plains, and so to speak, begin to take life more easily. It has been so with the Itchen. The Itchen flows down no steep slope now from the chief water shed in the north of Hampshire, and it is no longer fed by a semi-tropical rainfall, such as must have prevailed in former geological times. It has long been taking its life more easily, forming extensive alluviums, such as you may see along its course, shifting its channel in these alluviums so as to form here and there river cliffs, still doing some geological work in its old age, by wearing away its higher banks, and transporting their material to the sea, but nothing comparable to the work it did in its youth and prime.

The present course of the Itchen above Winchester is probably not the course of the primitive stream. That course must have been down the dip slope from the north. Transverse valleys, such as the north and south valley of the Itchen, are usually first formed by all rivers flowing down a dip slope. Longitudinal valleys along the outcrop of the beds, are the valleys which tributary streams form to feed a main river. Two miles above Winchester the present course of the Itchen abruptly changes. From an east to west course it makes a sharp turn to a north and south course. The north to south course, although much shorter, was its original course down the dip slope, and its former upper north and south course has long since become dry land, and even its direction almost obliterated. The direction the old channel took from the north can still be traced as a hollow between the chalk hills, however, for some miles north of Headbourn Worthy.

What caused a tributary of the Itchen from the east to become its main stream and its original source from the

north to become dried up and lost? Two geological causes, I think, which are interesting subjects for all who are interested in the geology of Hampshire. Streams which flow through longitudinal valleys along the outcrop of soft beds, are often able, through the softness of these beds, to cut their channels deeper than those streams which flow across the grain of a country, so to speak, *i.e.*, across the successive lines of outcrop of the beds. This has been the case with the Itchen. Its chief tributary from the east cut its valley backwards and deeper down than the old main upper stream was able to do, and so the tributary has become the main stream, and the water in it being at a lower level, has drained the water off underground, from the north of Headbourn Worthy, to feed the springs, which may be seen there. These springs sometimes cause floods even at the present time. The upper part of the old Itchen drainage has, I think, been partly diverted by another geological cause. If you look at the map of Hampshire and notice that the great dividing ridge between the Thames basin and the Hampshire basin extends from Combe Hill, in the extreme north west, across the county in a south-easterly direction to Noar Hill, near Selborne, you will observe that it is a much longer course from the watershed to the sea, in the west of Hampshire, than it is in the east. This is the reason why the rivers in the west of Hampshire—the Avon and the Test—have a much longer course from north to south than those in the east. The Test drains a greater area than the Itchen, and its drainage area has probably been increased at the expense of that of the Itchen.

About eight miles north of Winchester, across what was originally within the north and south flow of the Itchen drainage, the longitudinal valley of the Micheldever stream has been formed. The water flow down this old waterway has gradually extended the valley backwards until the country round Micheldever and Stratton has become included within its drainage. These places are but six miles north of Headbourn Worthy, and in a direct line between it and the great northern watershed. The old Itchen drainage area on the north has thus been tapped by the extension of the longitudinal valley of Micheldever,

and thus part of the primitive Itchen waterflow has been diverted into the Test.

I think that these two causes at a remote period, long before the range of history, dried up the original surface waterflow into the Itchen, down the primitive waterslope from the north.

These considerations show us that the Itchen is a stream which has experienced, and has caused many changes. In its old age it has been deprived of part of its original water supply. In its fragmentary gravel patches, we see the remains of the more or less continuous terraces, formed by itself during the hey-day of its youth and prime, and which have long since been themselves almost washed away. The Itchen has played havoc with the chalk strata, and has sculptured the hills it has left. It is so old that it baffles all exact chronology. The remains of Saxon and Roman work which exist along its course are but as yesterday compared with its age. The Bronze and Neolithic ages are recent when compared with the period of its prime. For that we must go back to the Early Stone Age, when the river drift men, whose weapons we find, and the elephants, whose teeth we find, were contemporary inhabitants of the country along its course.

As we stand on St. Catherine's Hill viewing the little river flowing in its valley, and call to mind the vast changes it has caused, and also remember the relics which remain of ancient but more recent time connected with the former glories of Winchester, we may say of this river as Longfellow said of the far greater Rhine—

> "Beneath us flows the Itchen, and like the
> Stream of Time, it flows amid the ruin of the past."

The deepening of the valley of a main stream or of a main tributary stream has affected other Hampshire waterways, and caused other old water channels to become dry. The Netherton valley is now a rain valley only, except in very wet seasons, when it has a bourn stream part of the way up it. The Itchen valley, eastward of Bramdean, is a rain valley which has not even a bourn. The Hambledon valley and the Collingbourn valley are bourn valleys. Such valleys which at long intervals have bourns, and rain valleys

which never have any streams from springs, occur in all the chalk area of Hampshire. These springless valleys have a surface flow of water sometimes, but such flood water is quickly absorbed by the porous strata.

The chalk valleys of Hampshire are therefore of three classes —(1) The valleys through which permanent streams flow which have been cut down the deepest; (2) those which have only occasional streams from springs; and (3) those which have no springs and may be called rain valleys, and these are the highest. When the work of excavating the valleys of this county began, we may assume that the conditions were about equal, and that where a stream has not cut its valley so deeply as another stream it is because either the beds were harder or the volume of water passing down it has been less.

There is one long branch of the Itchen valley which is of much geological interest, viz., the transverse valley of Candover. The upper part of this valley forms the most northern limit of the Itchen drainage. You may stand on the high ground at Farley Wallop, a few miles south of Basingstoke, and look southwards into the long dry upper valley which begins about 700 feet above the sea, and gradually descends until you meet with its first permanent springs at Chilton Candover, 400 feet lower down. When water first began to flow down the slope in this direction, the height of the watershed was certainly more than 700 feet. It had a capping on it of several hundreds of feet of Tertiary beds, which have since been removed by denudation, but whose former existence is known by the remains of it here and there. Under ordinary circumstances transverse valleys down a dip slope must have been formed before their branch longitudinal valleys. But this stream now flows into the longitudinal part of the Itchen valley. The geological question then arises—Where did the water of the Candover valley first find its outlet? Was it some tilting of the strata which caused the water to flow westward to the north and south Itchen stream, as now, or was it southwards to the sea?

The water of the upper Candover valley before the lower valley was cut so deeply, may have found its way southward

by an independent channel. It began to flow at an elevation of probably from 1,000 to 1,200 feet, and between the highest springs of the Itchen and the Meon river at Warnford, the elevations of both of which are less than 300 feet, there is at present only an additional elevation of about 100 feet. These circumstances may possibly point to part of the present drainage area of the Itchen having been originally connected with that of the Meon valley, and that the deepening and extension of the Itchen valley eastwards has tapped part of the original waterflow of the Meon valley from the northwards, in the same way as part of the northern water flow of the Itchen itself has been tapped.

The diversions of old waterflows into other channels are geological phenomena of which examples are found elsewhere. In view of the constant denudation of the land, which is, and has always been going on, changes in the watersheds, especially in soft limestone districts like the chalk, must occur, and as rain, rivers and floods wear down and extend a valley backwards, they wear back also the watersheds and in some instances almost obliterate them. Such an instance occurs in the north of Hampshire, between the sources of the Test and the Loddon. There must have been a time when higher land, part of the chief watershed of the county existed between the sources of these streams, but at the present time you may pass from the drainage area of one of these rivers, into that of the other without passing over any higher ridge of ground whatever. The observations of the late Colonel George Greenwood, who lived long in the upper part of the Itchen valley, are interesting in this respect. He tells us in his book on "Rain and rivers," that the dry valley from Froxfield to Bordean is in the process of changing from the waterslope of the Itchen to that of the Rother, a branch of the Arun.

There are some valleys in Hampshire which have streams flowing through them at the present time, which present features different from the other valleys of the county. These are the synclines or trough valleys formed by the lines of elevation. The Wallington stream which flows westward and enters the upper part of Portsmouth Harbour by a sharp bend on the west of Portsdown hill flows through one of

these valleys, and the Dean stream which has a course from the westward near Dean and empties itself into the Test near Dunbridge is another example. These valleys have in the course of ages, been denuded by the rain fall, rainwash, and the action of their streams, but they were trough valleys originally, formed by the process of elevation of the ridges south of them by the bending of the strata.

One of the most obvious features of Hampshire scenery is the large number of short dry valleys, the so called rain valleys which exist. Rain falls upon their surfaces and is quickly absorbed by the porous chalk. The short dry valleys of which you may see examples near Winchester, and elsewhere, are sufficiently elevated above the river channels, to have been left high and dry by the rivers deepening the channels of the main valleys near them. The rain which falls upon them merely flows away under their surfaces, instead of as originally it did upon their surfaces.

Another class of dry valley are those which may be seen in the more elevated parts of Hampshire. These have assumed their present character, partly through the removal of beds of clay from their higher slopes, by which the chalk has been brought to the surface, and the water from the rainfall enabled to pass into it and so flow away underground.

On the higher slopes of some of the elevated dry valleys, a layer of clay with flints occurs. This clay, which is insoluble, has been produced by the waste of the chalk, for chalk contains a small proportion of clayey matter. When heavy rains occur on such clay slopes, land streams and small floods are produced, until the water reaches some place where it can be absorbed by porous gravel or other beds. This occurs at Privet, 580 feet above the sea, where the water flow of this kind was known a thousand years ago as Privet flood, and is mentioned by that name in the Anglo-Saxon Chronicle.

The valleys of Hampshire near the coast have been affected by the subsidence of the land. The proofs of this subsidence may be seen in the beds of peat which are found underlying the estuarine mud and the so-called forest beds at Brook in the Isle of Wight, and elsewhere.

The encroachment of the sea on the land as a result or partly the result of this subsidence, has worn back many of the little valleys and waterways on the Hampshire coast. It has also caused the seaward ends of valleys to become partly silted up with deep alluviums.

The little watercourses which have been worn back are called bunnies in Christchurch Bay, and the more precipitous ones in the south of the Isle of Wight are known as chines.

The little streams of these bunnies and chines formerly flowed down gentle slopes to the larger rivers they helped to swell, or to the sea.

As the cliffs were formed and the little valleys worn back towards their watersheds, these little waterways became deepened to form bunnies, while in the south of the Isle of Wight the channels became so steep that the water formed cascades as it passed down them.

The deepening and wearing back of some of the valleys in the eastern part of Hampshire has had an effect somewhat similar to that which has produced the bunnies and chines, and different from that produced by the deepening of valleys in the chalk districts. The deepening of a main chalk valley has caused the small neighbouring laternal valleys to become dry, through the porous chalk absorbing the water.

In some of the eastern parts of Hampshire, where beds impervious to water underlie porous beds, the wearing back and deepening of a valley such as that of one the branches of the Wey at Bramshott, has caused the water of this branch stream to flow down a steeper slope, and this has produced the rapid descent of the stream through its valley, as at Wagners Wells, near Bramshott.

The subject of this paper is not only valleys but waterways. Many old roads in Hampshire are old waterways, and if you go along them in wet seasons you will find them impassable on foot because they are sometimes water-courses at the present day. The road which leads into Shipton Bellinger, from South Tedworth is really part of the bed of the Collingbourn stream, which has apparently, as long as man has lived in a settled state in that neighbourhood, been used as a road, because the Collingbourn is usually dry and the dry bed of the stream formed a convenient road.

Many of the old hollow roads up the hill sides of Hampshire are the older watercourses, down which the surface water and that from land springs flowed and cut the way originally as a water channel, like the old way was made in an Eastern country, which Job described, and which he says "was cut down out of time, whose foundation was overflown with a flood." Floods have flowed down the hollow ways or deeply cut roads of Hampshire from time immemorial, and in many instances after these old waterways became used as roads, channels were cut for the watercourses on one side of them. Examples of such old roads are found all over the county.

The valley scenery of Hampshire is constantly changing, and in some respects more rapidly now than in previous centuries. Most of the higher slopes of the chalk valleys of the county present a different appearance at the present time from what they presented a century ago, before the enclosure of the common lands, when the downs were covered with grass and scrub. The effect of the rainwash down these slopes is necessarily greater now than it was before the conversion of the downs into arable land, because the soil is looser. On the other hand we find in many parts—especially in the east of the county, the steepest hill sides covered with woods, known locally as hangers, and these hangers lessen the geological action of rainwash.

The old terraces on the hill sides (many of which have not been cultivated for many centuries) must also have prevented the rain from washing the soil down the hill sides into the bottoms of the valleys, as the vineyard terraces in the Rhine valley do at the present day. There are also other terraces to be seen on the sides of some valleys, which have been formed by rainwash against old hedgerows.

The ancient hedgerows planted across the hill slopes, many of which have been grubbed up in recent years, were another practical illustration of the technical knowledge of our ancestors in preventing the waste of soil by the action of rain.

The valleys of Hampshire have determined its history. It was up the valleys and water courses that the earliest settlers in this part of England wandered, as they explored

the country, as explorers in unknown countries wander in their explorations now. It was in the valleys that the early settlers established their primitive villages, and most of these sites were adopted by the conquering people of successive races who followed them. It was not as old inhabitants of this county have been heard to say, by a providential arrangement, that so many streams and water sources are found close to village sites, but because the original settlers found in such valley sites one of the first necessities of life, and around these sites soils ready for tillage, made during the processes by which Nature made the valleys.

These early settlers have left in some of our valleys remains of their language.

The names of places in some of the valleys and of their streams are names which were originally given to them by these early inhabitants. Candover, Andover, Anmore, and Ower, are names, part of which may have come down to us from Neolithic time, while the Itchen (anciently Icenan), the Test (anciently Terstan), the Avon and the Wey, have come down to us from the Bronze age or early Celtic period. Fontley and Stratton are Romano British names, while Hamble and others are Saxon names.

Whatever part Hampshire has played in English History (and it has been not an insignificant part) it has been enabled to play through the advantages afforded by its valleys.