17. Notes *on the* River Wey. By Henry Bury, M.A., F.L.S., F.G.S. (Read February 19th, 1908.)

[Plates XXXVI & XXXVII—Maps.]

Contents.

I. Introduction.

That part of the River Wey which lies within the Wealden area may for convenience be divided into six sections; but it is almost entirely with the last three that the present paper is concerned. (See Pl. XXXVI.)

Section I is a consequent river, cutting through the Chalk at Guildford, and is marked on Pl. XXXVI as 'River Wey (Consequent).' It is the only portion of the Wey that rises in the Weald Clay, its upper waters being mainly derived from a subsequent river running nearly parallel to the Lower Greensand escarpment.

Section II is a subsequent stream flowing in from the east, parallel with the Chalk escarpment, and joining Section I at Shalford. It is described in Topley's 'Geology of the Weald' as the Tillingbourne.

Section III is another subsequent river joining Section I from the west at Broadford. Between Godalming and Broadford its course is north-easterly, but from Tilford to Godalming its general direction is easterly, parallel to the Hog's Back, which lies about 3 miles to the north. This branch, which may for convenience be called the Godalming River, receives several tributaries from the south, some from Hindhead, others from the Lower Greensand ridge between Hindhead and Hascombe. The latter form notches in that ridge, and seem to have been reduced in length by the retreat of the Lower Greensand escarpment before branches of the River Arun. Some unimportant obsequent streams drain the Lower Greensand area to the north, between this river and the Hog's Back (Chalk escarpment).

Section IV, or the Tilford River, is now a continuation westwards of Section III, although it will be shown to have had a separate origin. It also is roughly parallel to the Chalk escarpment, which here has a nearly due north-easterly course. About 5 miles south-west of Tilford the river forks: the smaller branch continues the line of the main river westwards, rising as an obsequent stream at the foot of the Chalk escarpment at Selbourne. It receives two obsequent tributaries from the north, one of which, opposite Bentley, I shall have occasion to refer to later as the

Blacknest Stream. The more important branch of Section IV, only a portion of which is shown in Pl. XXXVI, rises in a deep valley in the Lower Greensand between Blackdown and Hindhead (from both of which it receives contributions), and flows at first nearly due west to Liphook: there it turns north-westwards, and, after being joined by a stream (marked as 'Deadwater' on the Ordnance-Survey map) which receives the drainage of Woolmer Pond, and of a large flat area to the west of Hindhead, it turns north-eastwards to join the main trunk of Section IV not far from Headley. It will be referred to later on as the Headley Stream.

Section V is a short obsequent stream joining Section VI to Section III at Tilford, which is thus the meeting-place of three sections (III, IV, and V). For convenience it may be called the Waverley River, from the Abbey founded on its banks; but there is no need to describe it here.

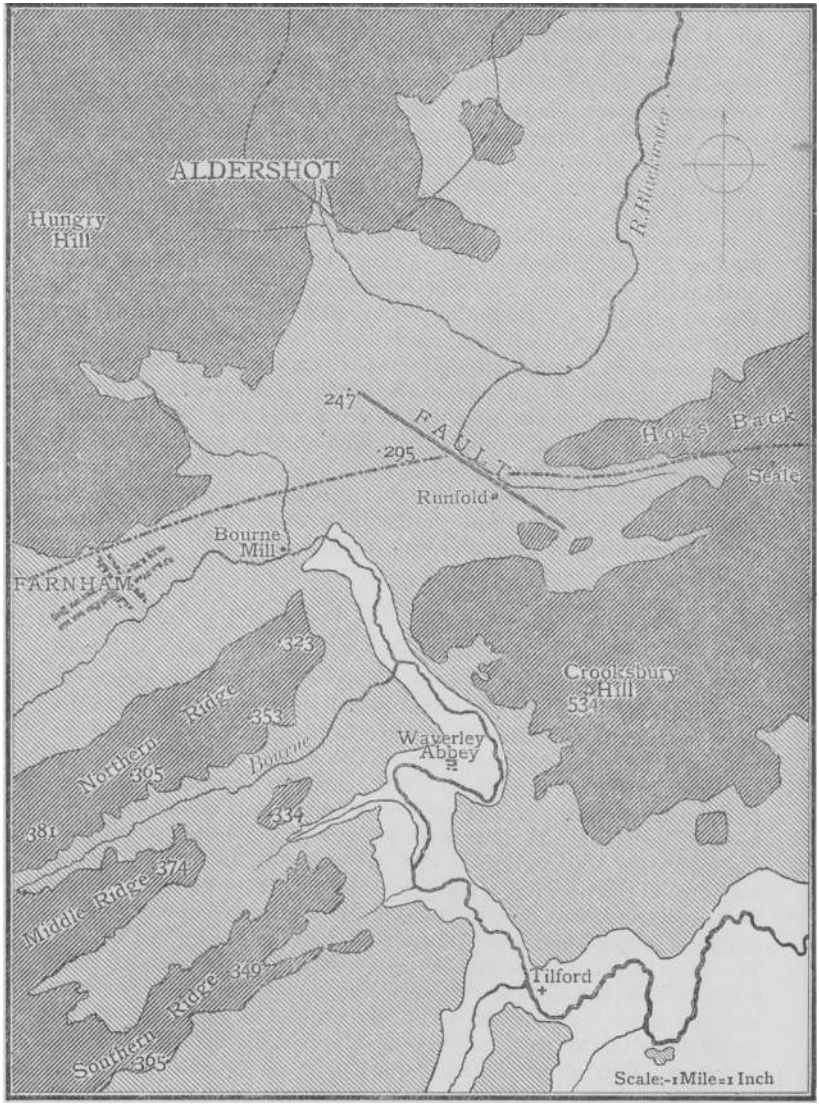
Section VI is another longitudinal river, parallel to Section IV, but running close to the base of the Chalk escarpment. It follows a very straight course from Alton to a mile east of Farnham, where it joins Section V almost at right angles; but its continuations above Alton are too complex to be described here. Both this and Section IV are marked in the maps as the River Wey; but for the sake of clearness they will be referred to in this paper as the Farnham and Tilford Rivers respectively.

II. The Relation of the Wey to the Blackwater.
(Map, p. 320.)

The former extension southwards of the River Blackwater is recognized by Prof. W. M. Davis,[1] but all that he says is that 'the Wey has recently taken off the head of the Blackwater.' An attempt will here be made to show some of the details of the process by which this result was brought about, though unfortunately, owing to the softness of the strata, but few definite traces of earlier stages can now be found. The Farnham River, where it curves round into the Waverley Valley, is just 200 feet above O.D. This curve is bounded on the north by a steep bank 50 to 70 feet high, and when we have surmounted this, we find ourselves, after traversing a space of almost level ground, slowly descending into the Blackwater Valley. The total width of the gap in the Chalk escarpment, which thus forms a col between the two rivers, is, at the 300-foot level, about 2 miles, but almost in the centre of the gap a mound of Chalk rises to 295 feet, and thus divides it into two valleys (east and west), each about 50 feet deep, and nearly a mile in width. It is the western of these two valleys which lies opposite the bend of the Farnham River (see Map, p. 320). A small stream, coming down from Hungry Hill in an easterly direction, runs to the bottom of this valley, and then, about opposite the Chalk mound, turns abruptly southwards, and descends through a short ravine

[1] Geogr. Journ. vol. v (1895) p. 146.

Map showing the relation of the Wey to the Blackwater.



[The heavy broken line marks the lower edge of the Chalk.]

to the Farnham River at Bourne Mill. About a mile to the north of this stream, and roughly parallel to it, another brook descends from Hungry Hill, and forms the present head of the Blackwater; it continues on an east-south-easterly course till it comes opposite the end of the Hog's Back, and then turns sharply northwards.

The valley to the east of the above-mentioned Chalk mound deserves especial attention. A subsequent valley runs down past Seale at the foot of the Hog's Back, and at present only produces a mere trickle of water; but there is a suggestion that it may once have extended nearly to Puttenham, before being beheaded by an obsequent tributary of the Godalming River. At first sight it looks as if this tiny stream flowed to the south of the Chalk mound to join the Farnham River, but more careful observation reveals the fact that it turns northwards near Runfold and flows out over the Chalk to join the Blackwater. This very interesting fact—that a stream does still flow out from the Wealden to the Tertiary area at this point—was, I find, noted by George Long in 1839,[1] but was afterwards entirely overlooked. Topley,[2] indeed, asserts that there is no stream flowing through this pass, although the alluvium deposited by it is marked on the Geological-Survey map.

It has long been known that pebbles derived from the Hythe Beds of the Lower Greensand, which must have come at least as far as from Hindhead, are to be found in the gravels to the north of the Chalk in this region. They occur very sparingly in the 'Southern Drift'[3] to the north of Farnham, 600 feet above O.D.; much more frequently in the lower, and probably later gravels bounding the Blackwater Valley (Fox Hills, Chobham Ridges, Hartford-Bridge Flats, etc.)[4]; and in moderate quantities in gravels lying on the Chalk itself in the gap already described (Water Lane, see 6-inch Ordnance-Survey map). All this showed to earlier writers that there must have been some Wealden river flowing northwards in this region; but, until the principles of river-capture had been fully expounded by many writers on both sides of the Atlantic, its connection with the recent river-system could not be clearly understood. With our present knowledge, we may safely assume that at no very distant date there was a consequent river coming down from Hindhead and flowing through this gap, after being joined by the Tilford and Farnham Rivers on the west, and the Seale stream on the east. But it is a curious fact that this consequent river is hard to identify among the many streams from Hindhead, and it is possible that during the present cycle of erosion it never attained to any great size[5]; while many of the Lower Greensand pebbles were doubtless supplied by the other streams which are now collected by the subsequent Tilford River. It is doubtful whether there was ever a stream of importance

[1] Proc. Geol. Soc. vol. iii (1838–42) p. 101.
[2] 'Geology of the Weald' Mem. Geol. Surv. 1875, p. 279.
[3] J. Prestwich, Quart. Journ. Geol. Soc. vol. xlvi (1890) p. 161.
[4] H. W. Monckton, *ibid.* vol. xlviii (1892) pp. 29 *et seqq.*
[5] The Darent is another Wealden river which has no well-marked consequent head.

joining this consequent river from the east; certainly the bulk of the Godalming River must be regarded as a subsequent outgrowth from the Guildford Wey. The next stage of evolution seems to have been the capture of the consequent river and the Tilford stream by the Godalming River at, or near, Tilford. I can find no direct evidence of this, and nothing to show how much the level of the river at Tilford was lowered by this capture; but it is perhaps significant that, while flints are found in fair numbers in the gravels on both sides of the Tilford River, they are almost entirely absent in the Godalming Valley, except at a very slight elevation above the present river-bed.

The Waverley Valley would at this stage be left practically dry, but the Farnham and Seale Rivers would still continue to join the Blackwater. Previous to this the whole gap in the Chalk between Hungry Hill and the Hog's Back formed one wide valley, but now the mass of water was so far diminished that the Seale and Farnham Rivers got separated, and proceeded to carve out each its separate valley, leaving the existing Chalk mound between them. If this be a correct interpretation of the facts, this mound may be taken (with due allowance for recent denudation) as a measure of the level of the river-bed at the time when the consequent river was diverted; and we shall see other reasons later on [1] for thinking that this is the case. We may further infer that the erosion of the Blackwater Valley since that time has been extremely slow, for the tiny Seale stream has been able to carve out a comparatively wide valley.

The final change by which the present river-system was established was doubtless the outgrowth of an obsequent stream from Tilford, along the line of the old consequent valley (Waverley Valley) until it met the Farnham River; then the latter turned aside from the Blackwater, and rapidly lowered its bed some 50 feet to accommodate itself to the level of the Godalming River. Herein lies the interest of a gravel-capped terrace which runs along the south side of the Farnham Valley, from its junction with the Waverley Valley to a point some 3 miles farther west. It stands about 50 feet above the present river-bed, and thus corresponds closely in level with the watershed now dividing the Wey from the Blackwater. It is, in fact, a remnant of the old river-bottom, and affords a useful example of the formation of a terrace by river-capture, without any help from local or general elevation; while the steepness of the bank below is an indication that the changes which gave rise to it were both rapid and recent.[2]

The entrance to the Waverley Valley presents a striking contrast with the Farnham Valley, out of which it leads, being much narrower and steeper; and indeed it exhibits just the features which we might expect to result from the diversion of a longitudinal river into a small obsequent valley. The latter does not follow exactly the line of the old consequent valley, but has shifted more to the east. This is shown, not only by the steepness of the left bank all the way

[1] § III, p. 326.

[2] Other proofs of this are to be found all the way up the valley.

to Tilford, but also by a remnant of the old obsequent river-bed, still traceable on the right bank from Tilford up to about the mouth of the Bourne, and exhibiting, as we might expect, a steeper gradient than the present river. Traces, too, of the old consequent river are to be found on this side, but they will be discussed in § III.

Two points in connection with the old river-bed between the Wey and the Blackwater must be dealt with briefly before we leave the subject.

(1) It has already been mentioned that Lower Greensand fragments are less common in the gravels lying in this pass ('Water Lane,' etc.) than in the older gravels on the Fox Hills. The explanation of this is simple: the latter (nearly 400 feet above Ordnance-datum) received their supply direct from Hindhead by way of the consequent river; but the gravels of Water Lane (about 250 feet) were laid down long after the capture of the consequent river, and their Hythe-Bed pebbles therefore were only derived at second hand from the older gravels bordering the Farnham Valley.

(2) In the preliminary description of this region it was seen that a stretch of nearly level ground separated the Blackwater from the edge of the steep bank which bounds the Farnham Valley on each side of Bourne Mill. It might be expected from its origin that most of this old river-bed would drain towards the Blackwater; but such is not the case. The actual turning-point, so far as I can ascertain, is at a spot to the east of Weybourne House, marked 247 feet on the 6-inch Ordnance-Survey map, about 1500 yards from the Farnham River, and half that distance from the Blackwater. It happens that this point is close to, if not on, the line of fault, as mapped by the officers of the Geological Survey; and it is, therefore, just possible that some slight earth-movement has taken place here in recent times. Perhaps, however, it is more probable that this is a case of 'aggrading'—the Blackwater, which comes down from Hungry Hill almost at right angles to the plain, having deposited so much sediment as to dam back the drainage of the marshy land to the south. In either case a very small alteration of level would be sufficient to give rise to the present conditions.

III. The Palæolithic Gravels of Farnham.

The high ground between the Tilford and Farnham Rivers, from the Blacknest Valley (opposite Bentley) in the west to the Waverley Valley in the east, is readily divided, as the map shows (Pl. XXXVI) into a western or Alice-Holt area and three parallel ridges; but there are good grounds for believing that these ridges have been only recently separated, and that the whole must be regarded as the dissected remnant of an old plateau of river-origin. Only one small patch in the north-western corner of Alice Holt rises above the 400-foot contour, but almost the whole of the ground shown on the map as being above 300 is, in fact, more than 350 feet above Ordnance-datum. The plateau shows, especially along the northern

ridge, a general slope to the north-east; but there are indications also of a less regular slope towards the south-east, as the following measurements, taken along lines at right angles to the Farnham Valley, will show:—

	Feet.
1. North-western corner of Alice Holt	400
1 mile south-east of this	393
¾ mile farther south-east	361
2. Clay Hill (Wrecclesham)	388
Base of southern ridge (Rowledge)	367
3. Northern ridge (a little east of 'Highlands')	370 [1]
Eastern end of middle ridge	374
Southern ridge (corresponding part)	349

The actual heights would, of course, be altered by removing the drift which is present at all these points, but the relative levels would scarcely be affected.

The northern edge of the plateau corresponds approximately with the axis of the flexure which gives rise to the Peasemarsh inlier (near Guildford), and is here dying away, not being traceable farther west than Bentley [2]: and this flexure gives rise not only to a westerly dip, which brings the Lower Greensand to the surface about half way along the northern ridge, but also to a slight southerly dip, in consequence of which this outcrop of the Lower Greensand is pushed farther eastwards on the southern ridge than on the northern, although, as we have seen, the former is somewhat the lower. With the exception of these eastern ends of the ridges, the whole plateau consists of Gault.

Patches of drift (mostly gravel) occur on all the higher parts of the plateau, especially along the northern ridge, where its greatest depth is given by Lasham [3] as 40 feet, and by Monckton & Mangles [4] as 25 feet: it would be interesting to know the exact spots at which these very great depths occurred, but I do not think that they can have been on the crest of the ridge, where the thickness rarely exceeds 10 feet. It is from this northern ridge that the most perfect of the well-known Palæolithic implements of Farnham have been obtained; many, it is true, occur in the gravel-beds slightly lower down, on the southern slope of the Farnham Valley, but these are almost invariably waterworn,[5] and are probably derived from the plateau. The drift of the middle and southern ridges is usually much less thick, and varies greatly in character, being sometimes mainly sand; but where gravel occurs it is very similar in character to that of the northern ridge, except that it contains a far larger percentage of chert and other Lower Greensand pebbles. Monckton & Mangles, whose careful account of the Farnham gravels should be consulted, describe as a river-gravel a bed (marked D on their diagram), which lies apparently at the base

[1] This is approximate only: the rest are from the Ordnance Map. The last of the series (349 feet) probably does not belong to the plateau proper: see p. 326.

[2] 'Geology of the Weald' Mem. Geol. Surv. 1875, p. 229.

[3] Coll. Surrey Archæol. Soc. vol. xi, p. 27.

[4] Proc. Geol. Assoc. vol. xiii (1893–94) p. 77.

[5] *Ibid.* p. 78.

of the middle ridge; and I have no hesitation in ascribing a similar origin to the gravels of Rowledge and the southern ridge.

The patches of drift scattered over Alice Holt I have had no opportunity of studying in section, but from examination of the surface-material I should judge their composition to be very similar to that of the Rowledge gravels—certainly Lower Greensand pebbles are present in greater quantity than on the northern ridge.

In ascribing all these drift-beds to one river, which also planed down the underlying Gault and Lower Greensand, I am running counter to the teaching of the maps of the Geological Survey, on which only the gravel of the northern ridge is described as 'River-Gravel,' while all the other beds are classed as 'Gravel and Sand of uncertain age and origin.' I do not know the grounds for this distinction, but perhaps the following passage from Topley's 'Geology of the Weald' (p. 196) throws some light upon it:

> 'Flints are scattered about over the high land of Farnham, Frensham, and Thursley Commons,[1] and over Alder Holt; but these are probably the remains of the Chalk which once covered the lower beds and are not a deposited gravel.'

This, of course, was written before Monckton's & Mangles's recognition of some of the beds as of fluviatile origin; but, quite apart from that, it should have been obvious that mere disintegration of the Chalk and Upper Greensand could not plane down the lower strata to one level, and that this planing is conclusive in favour of river-action.

But, although the formation of this plateau by a river admits of no doubt, yet it is not at once obvious what the course of that river was. At the present day we find the Farnham River immediately on the north, and the Tilford River on the south, with no vestige in either case of a former watershed which would enable us to identify our plateau-river with either. It is true that the gravel of the northern ridge is continued for a short distance down the slope of the Farnham Valley, while on the southern ridge the drift hardly extends to the edge: but that, of course, is not conclusive, and on the other hand the tendency, already noted, of the whole plateau to slope south-eastwards might be held to point to the Tilford stream as the modern representative of the plateau-river. The key to the problem lies, I think, in the junction with the old consequent river which we have already traced: for, while it is easy to understand how this junction might shift downstream (that is, northwards) it hardly seems possible for the Tilford River, if it formerly joined in as far north as the plateau extends, to have shifted its point of junction upstream to Tilford. We have already seen reason to believe that the consequent river was not beheaded till a lower level than the plateau had been reached; and I will now add some further evidence pointing in the same direction.

Each of the three ridges of the plateau, after maintaining for a considerable distance the plateau-level (of which 350 feet may be

[1] Farnham Common embraces the eastern ends of the three ridges; Alder Holt is the name erroneously substituted for Alice Holt on the old Ordnance-Survey map.

considered the lowest point), drops with some suddenness to a lower platform, half a mile or more in extent, before its final plunge into the Waverley Valley. The relation of this platform, which is still well over the 300-foot level, and is covered with gravel, can best be studied at the end of the northern ridge, on which the following gradients are found:—

1. From Alice Holt (400 feet) to Greenhill (353 feet, about a mile south-east of Farnham) from 1 in 650 to 1 in 250. Average for $3\frac{1}{2}$ miles = 1 in 413.
2. From Greenhill to the edge of the Waverley Valley (about 320 feet), 1 in 90.
3. Slope of Waverley Valley = 1 in 12.

It is, I think, a reasonable assumption that this lower platform is a remnant of the left bank of the consequent valley as it was just before it was beheaded. How much farther east it extended and how much lower than 320 feet it fell, there is no direct evidence to show, since the old bed of the river, together with the whole of its right bank, has been destroyed in the formation of the obsequent Waverley Valley. Taken, however, in connection with the Chalk mound (295 feet) in the pass a mile farther north, it justifies, I think, my assumption that the latter represents approximately the level of the river at the time when it was beheaded. Further evidence may perhaps be derived from the character of the gravel of this lower platform on the northern ridge, but at present only a superficial examination is possible, and that is seldom satisfactory: so far I have found but few Hythe-Bed pebbles in it; but it is curious that these pebbles, which are scarce along most of this ridge, suddenly become common at Greenhill. In view of this irregularity in their distribution, it would probably be unwise to draw conclusions from the presence or absence of these Hythe-Bed fragments on the various portions of the plateau; but a few general remarks may be useful. Many of them are distinctly angular, and although they must have come originally from Hindhead,[1] may have reached their present position only from an older drift; but the bulk of them probably came direct at the time when the plateau was formed. How many streams were concerned with this supply, it is impossible now to say, but probably the principal source was the Headley River; and to this I attribute the formation of the south-western portion of Alice Holt, which, as the map (Pl. XXXVI) shows, is out of the line of the river coming from the Alton Valley and forming the rest of the plateau. This connection of the Headley with the Farnham River appears to have been maintained, after the plateau was abandoned, along the line of the Blacknest Stream, which cuts a gap in the line of hills almost 100 feet deep, and only 50 feet above the bed of the Farnham River. No doubt this Headley stream was finally captured by the Tilford River (which must until then have been but small), though I know of nothing to show exactly at what stage this took place.

[1] R. A. C. Godwin-Austen (Quart. Journ. Geol. Soc. vol. iv, 1848, p. 260) attributes the 'cherty sandstone' so common on the southern ridges to the Upper Greensand; but I have failed to match it among local specimens of that age, and believe that almost the whole of it comes from the Hythe Beds.

In conclusion, it is worthy of remark that the Alice-Holt plateau, on which the drift must have accumulated under rather peculiar conditions, stands quite alone in the western area of the Weald. The only other extensive sheet of high-level gravel is on Hungry Hill, 250 feet above this plateau; but it belongs to a far earlier period (Southern Drift), and contains no traces of Palæolithic man. If, as is possible, this Southern Drift marks the close of the first cycle of erosion [1] (and it can scarcely be earlier), then more than half the denudation of the second cycle had taken place before the Palæolithic gravels were deposited; but, on the other hand, all the adjustments which we have followed, from the capture of the consequent river to the diversion of the Farnham River, are of decidedly later date than those implements.

IV. The Alton District. (Pl. XXXVII.)

The Farnham branch of the Wey (Section VI) runs a very straight course between Alton and its turning into the Waverley Valley—a distance of about 10 miles,—but passes over several different strata. Roughly speaking, the lowest third of its course is in Lower Greensand; the middle third in Gault; and the upper third in Upper Greensand and Chalk. But, although the main valley is continued up to Alton, what is generally regarded as the head of this branch of the river comes in from the south nearly a mile below that town, not far from the village of Wilsham, and is marked in the 6-inch Ordnance-Survey map as the Caker Stream (see Pl. XXXVII). Following it up towards its source we first pass through a narrow gorge in the Chalk, and almost immediately find ourselves in a broad and flat valley, which seems at first sight to stretch all the way to Selbourne (8 miles); but the southern end of it, though separated by no very well-marked watershed, drains into the Oakhanger Stream (Section IV). On the east side of this valley the Upper Greensand rises, with a gentle dip-slope, to about 500 feet above Ordnance-datum; while on the west is a range of Chalk hills, rising to about the same height, but interrupted by frequent valleys, and presenting extensive surfaces of nearly-level ground. The Caker Stream runs, for the most part, at the junction of the two strata; while the Chalk, however, contributes but little to it, several streams join it from the Greensand slopes, and it is to these that Topley alludes when he writes [2]:—

'The streams which feed the Wey itself' [that is, the Farnham branch] 'take their rise often in the Upper Greensand itself, and flow over the Chalk to the north and north-west. The drainage of this north-eastern' [north-western is meant] 'corner of the Weald is exceedingly curious and unlike that of any other parts of the district.'

But, before attempting an explanation of this very interesting fact, we must first face the larger problem (not directly referred to by Topley) of how so great an extent of Chalk ever came to drain into the Wealden area. Elsewhere the only contributions of the Chalk

[1] See W. M. Davis, Geogr. Journ. vol. v (1895) p. 135.
[2] 'Geology of the Weald' Mem. Geol. Surv. 1875, p. 196.

to the Wealden drainage take the form of isolated obsequent streams, seldom more than 2 or 3 miles in length; but here, in the Alton district, we find an extremely-complicated system of Chalk valleys, which spread over something like 50 square miles of country, all uniting together at, or close to, Alton, and discharging their waters into the Wealden area about 2 miles north-east of that town.

The most important line of drainage in this Chalk area is a valley which comes in from the south, past the villages of East Tisted, Faringdon, and Chawton, and which may conveniently be referred to as the Tisted Valley. From Privett Station, which is nearly its southernmost point, to Alton, it is about 7 miles long; and it is everywhere wide and open, and receives numerous lateral tributaries. Of these, the longest ($4\frac{1}{2}$ miles) has rather an unusual direction, rising in Medstead Hill, and running about south-eastwards to join the main valley near East Tisted. A little farther north are two valleys coming in from the south-east, which deserve notice, not so much on account of their length (2 to $2\frac{1}{2}$ miles), as because they reach the Chalk escarpment, and (one of them dividing into two) form three deep notches in it. The upper portions of these valleys, near the escarpment, are exceedingly wide and flat, with a very gentle gradient towards the Tisted Valley; and it is, I think, impossible to avoid the conclusion that they were already well established before the escarpment reached its present position. Opposite each of the notches, which are 150 feet in depth, is an obsequent tributary of the River Rother.

Another important valley which also joins the main valley at Alton comes from Lasham Hill, about $4\frac{1}{2}$ miles from that town, and has in the main a south-easterly course, but turns sharply eastwards at its lower end. It may be conveniently referred to as the Lasham Valley, and its approximate parallelism to the Medstead branch of the Tisted Valley should be noted. Not far from Lasham Station it is joined almost at right angles by a valley which starts on the north side of Medstead Hill, and runs a course about 3 miles long rather to the east of north.

Besides these two important valleys there is a third, also joining in at Alton, which is worthy of mention rather for its position than for its size. It starts at the 'Golden Pot' Inn, $2\frac{1}{2}$ miles north of Alton, and runs due south, with all the characters of an ordinary obsequent valley; but it is interesting because it lies right in the line of the Tisted Valley, and has at its head a distinct, though not very deep notch, in the line of Chalk hills; while on the north side of this notch is a tributary of the River Whitewater. It is further to be noted that this valley lies exactly at the point at which there is a change in direction of the ridge of Chalk hills which here forms the watershed between the river-system under consideration (Wey) and the more direct tributaries of the Thames—the Whitewater, Lyde, and Loddon. On its east side this ridge runs north-eastwards, parallel with the Farnham Valley; while on the west it runs north-westwards, in the direction of Kingsclere, and parallel with the Lasham Valley.

It will be seen that the valley-system in the Chalk round Alton is complex, and presents several features by no means easy to understand. The district is known to present a number of subsidiary folds,[1] and when these are worked out in detail they will probably throw light on the river-system; at present, however, they are not, so far as I can gather, sufficiently well known to be of much assistance. But although we are unable to follow all the steps in the evolution of this system, we may perhaps allow ourselves some speculation as to its most salient feature—the connection with the Wealden area. It will, I think, be evident from the foregoing description, and it is still more obvious on the ground itself, that this valley-system was established at a very early period, when the Chalk spread much farther to the east than at present, and that its connection with the Wealden area is clearly secondary; but where, then, did it discharge its waters before this connection was made? The first suggestion that presents itself, as a possible working hypothesis, is that the Tisted Stream is the remnant of an old consequent river, which joined the Whitewater by way of the Golden Pot, and was afterwards captured by the Farnham River, which we will regard for the present as a subsequent river belonging to the Wealden area. It will be worth while to examine in some detail the various propositions involved in this hypothesis.

(1) Is the Tisted Stream the remnant of a consequent river?—The main water-parting in the western area of the Weald is formed by the Petersfield anticline. In it one of the western branches of the Wey (Deadwater) rises not far from Liphook, while it is easy to trace its connection with those branches of the Rother which join that river at Iping and Selham. The westernmost branch of the Rother, it is true, appears to be an exception, since it reaches almost as far north as Selbourne; but I do not believe that this represents its primitive position. The way in which it follows the soft beds of the Lower Greensand round the curved end of the Wealden dome suggests strongly that its presence north of the anticline is due to a modern encroachment, assisted possibly by the beds having been already levelled by the river to which Woolmer Pond belongs. Anyone who visits the district will see that it is still encroaching, and that it is likely at no very distant date to capture Woolmer Pond itself.

This view is borne out by a study of the Chalk district immediately to the west of Petersfield; for here we find the Meon River rising in the anticline and flowing southwards, while our Tisted Valley starts from a point only a little to the north of this line. It is therefore very unlikely that there should be, in so narrow an area, separate lines of water-parting for this branch of the Rother and the rivers on either side of it.

Farther west again, although the Petersfield anticline is still traceable, it is no longer dominant; and the Rivers Itchen, Test, and Avon, in a gradually lengthening series, take their origin in

[1] 'The Cretaceous Rocks of Britain—The Upper Chalk of England' Mem. Geol. Surv. vol. iii (1904) p. 183.

the anticline which gives rise to the Kingsclere, Shalbourne, and Pewsey inliers. It will be seen, therefore, that the area drained by the Tisted Stream corresponds to that of the Meon River, and that the two together occupy an intermediate position between the rivers of the Weald, rising in the Petersfield anticline, and the rivers of the Hampshire Uplands, rising in the Kingsclere anticline; and there can be no question that, if the Tisted Stream flowed at the present day past the Golden Pot, and into the Whitewater, we should unhesitatingly ascribe to it a consequent origin.[1]

(2) Is there any evidence of a former connection with the Whitewater?—The alignment of the Tisted and Golden-Pot Valleys with a tributary of the Whitewater is suggestive, but of course not conclusive: it may be due to chance, or to something in the folding of the Chalk at this point; for, as we have seen, the Golden-Pot Valley marks a change in the line of hills. Given the alignment, the notch in the hills would follow as a matter of course, and as there is no gravel in this notch, or in the valleys immediately north and south of it, it cannot be said that there is any clear evidence of a former connection. We may even argue against it, that it is unlikely that a river which had a fairly-straight run to the Thames would be captured by one (the Blackwater) which pursues a very devious route; but this is not an insuperable difficulty, for although we know nothing of the causes which have led the Blackwater to assume its present course, it is hardly likely that that course is primitive. Lower Greensand fragments are found in the region drained by the Whitewater,[2] and it is tempting to suppose that they were brought here by the Tisted Stream; but so far I have found none in the Tisted Valley, nor any evidence that it was connected with the Wealden Beds.

(3) Did the Farnham River originate as a subsequent river in the Wealden area?—It is well known that an anticline runs past Farnham, as far west as Bentley; and we have seen evidence on pp. 323–26 that the river ran along and even south of this line at no distant date, though it now lies slightly farther north. We can easily understand how such a longitudinal anticline might give rise to a subsequent river, and therefore, if the eastern end of the Farnham River, which runs through Gault and Lower Greensand, stood alone, we should be in no doubt as to its origin; but it is its western end which makes us pause. That a Wealden river should eat its way back through a mile of Upper Greensand (a highly resistant rock in this region) and 2 miles of Chalk is not indeed impossible, though certainly improbable; but that it should accomplish this feat without leaving any traces of

[1] It might have been expected that the consequent rivers in the west of the Weald would not run north and south, but would radiate from the end of the Wealden dome. If, however, there is any trace of this radiation within the Wealden area, there is none outside, and our Tisted Valley is parallel with the Whitewater and Loddon on the north, and the Meon, Itchen, Test, and Avon on the south.

[2] H. W. Monckton, 'On the Gravels south of the Thames from Guildford to Newbury' Quart. Journ. Geol. Soc. vol. xlviii (1892) p. 37.

recent origin—without any narrowing of its valley or steepening of its sides—is well-nigh incredible. Yet that section of the valley which lies between Alton and Cuckoo's Corner (the junction of Chalk and Upper Greensand) shows a bottom as wide and almost as flat as at Farnham itself; and indeed from one watershed to another it is actually much wider than at that town, some 8 miles lower down. There is plenty of evidence in the neighbourhood to show that the Lower Chalk is comparatively non-resistant, and is readily levelled down when exposed; but, if the valley is an outgrowth from the Weald, how did such a width of these strata become exposed? And, even if we assume (without any justification) that all the Chalk is soft in this region, we are still in difficulties with the Upper Greensand, which is, beyond all doubt, a highly-resistant rock. The only explanation that I can find which will meet all these facts is, that a broad valley must have been already formed here in the Chalk (and perhaps Eocene Beds) and have been already connected with the Blackwater near Farnham, before the Wealden strata of this region were uncovered. An examination, however imperfect, of the history of the denudation of the Weald will show us that this conclusion is not so improbable as it may at first sight appear.

It is generally agreed that the Weald, after passing through a first cycle of denudation was reduced almost to a plain. This used to be referred to as a plain of marine denudation, but perhaps at the present time Prof. W. M. Davis's view would receive more support—that it was a peneplain due to fluviatile erosion. But, although this belief in a plain has long existed, no satisfactory attempt has, so far as I know, been made to show at what horizons we may seek at the present day for remnants of it. I am far from possessing enough knowledge to attempt such a reconstruction, and in what follows I am merely seeking to ascertain the lowest points that may have been reached by parts of that plain, so as to get some idea of the extension of the Chalk at the close of the first cycle of erosion. In the western portion of the Weald, with which alone I am concerned at present, the highest point is Blackdown Hill (918 feet) immediately south of Hindhead; but nothing as high as this is found in either the North or the South Downs. Therefore we may probably infer that the upheaval which ushered in the present cycle of denudation was of a differential character, affecting the central axis more than the sides, and perhaps also raising the southern slopes more than the northern, since we find several points in the South Downs rising above 800 feet (including Butser Hill, 889 feet), while in the North Downs we find only two hills west of Dorking which rise above the 700-foot level—White Down (712 feet), near Dorking, and Holybourne Down (728 feet), close to Alton. If, then, we wish to ascribe any lower points to the plain, we must, on the marine theory, postulate some longitudinal irregularities in the upheaval, as well as the above-mentioned transverse one. But it is less necessary to do this if we adopt the fluviatile hypothesis, since a peneplain allows of the existence of hills of moderate height above the general base-level of denudation.

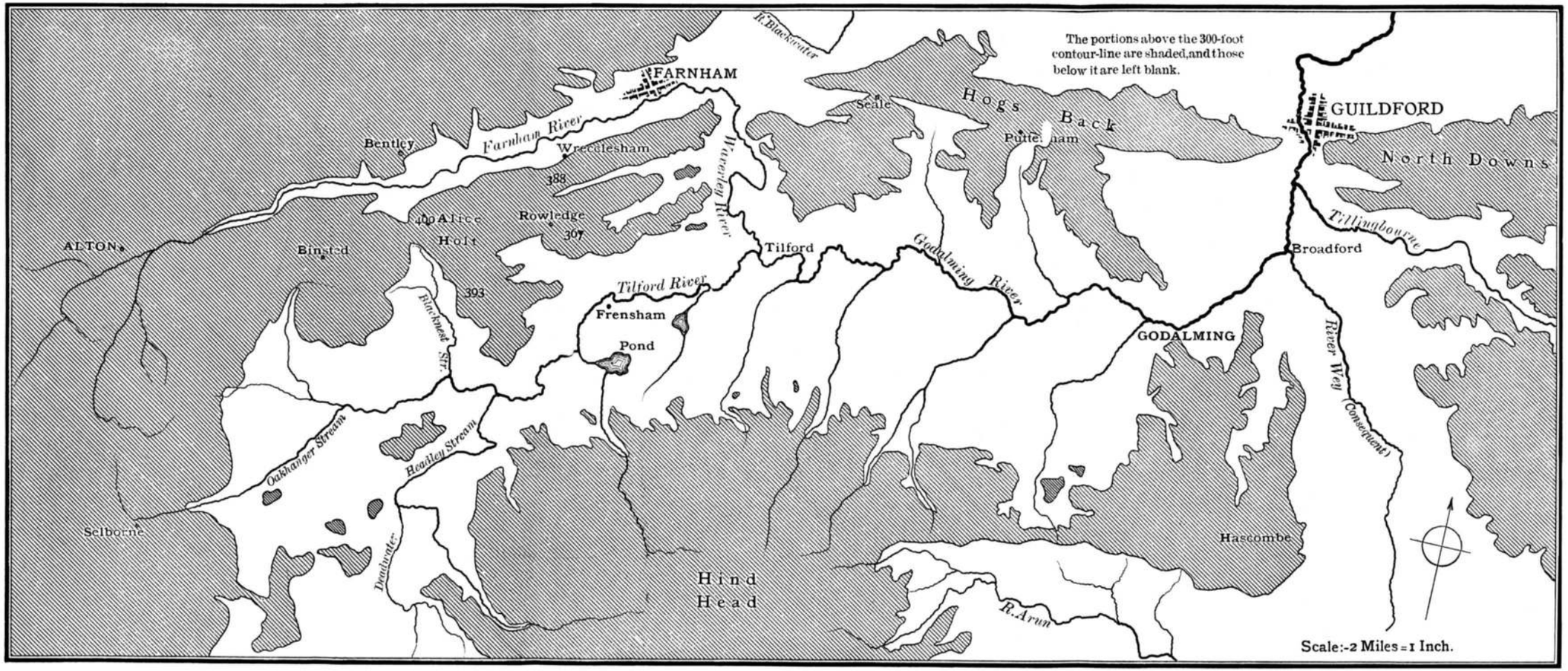
In this way it may be possible to regard the Southern Drift on the hills above Farnham (Beacon Hill, Cæsar's Camp, and Hungry Hill, 615 feet at the highest point) as part of the original peneplain. In suggesting this I must not, however, be understood to express any opinion as to the origin of these beds: I am only, as I said before, seeking for the lowest point of the peneplain, and no one is likely to look for it lower than this Southern Drift. Now at this horizon the Upper Greensand would certainly be exposed along the crest of the anticline opposite Farnham, perhaps as far west as the village of Wrecclesham; but I do not think that the Gault would be uncovered except in the actual bed of the consequent river (Waverley Valley); and, as the Upper Greensand is here almost as resistant as the Chalk itself, there cannot at that time have been much of a subsequent river of Wealden origin at this point. South of the anticline, too, the Chalk would extend to within 2 or 3 miles of Hindhead, while to the west of Wrecclesham it would be continuous with the Hampshire Uplands. All this vast area of Chalk must have had its own lines of drainage; and, although these perhaps were mainly transverse (consequent), yet the wonder is, not that the Farnham River should have originated in this area, but that other longitudinal rivers in the Weald should not show traces of a similar origin. Perhaps when they are more carefully examined they will be found to do so.

All this, though it does not directly affect the question of whether the Tisted Valley was ever continuous with the Whitewater, renders that hypothesis much less necessary. While the Farnham Valley was held to be of Wealden origin, an earlier outlet for the Tisted Valley had to be found somewhere; but now it seems possible that the connection of the two valleys may date back nearly, if not quite, to the time of the plain, or beginning of the present cycle of denudation. The present height of the Golden-Pot pass is 584 feet above Ordnance-datum; and, allowing for recent reduction, which, with a valley on each side it must have undergone, we arrive at a level not far short of that of the Southern Drift, which I have here assumed (but without any fixed convictions on the subject) to belong to the first cycle of denudation. As to what extension these valleys may have had before that time, it is perhaps hardly profitable to speculate.[1]

A word may be added here concerning the comparative inconspicuousness of the Chalk escarpment along the Farnham Valley, noted by Drew [2] and apparently connected by him with the lowness of the dip; this ought, however, to produce precisely the opposite result. I believe it is partly due to the hardness of the Lower Greensand, which masks the Chalk slopes from many points of view by forming an imperfect escarpment of its own; and, in part also, it may indicate that these Chalk slopes are not in their origin an escarpment at all, but rather the sides of an open Chalk valley, such as may be found at the present day all over the Hampshire Uplands.

[1] The great development of lateral valleys in the Tisted, as compared with the Farnham, Valley should be noted, but does not necessarily imply a difference in age.

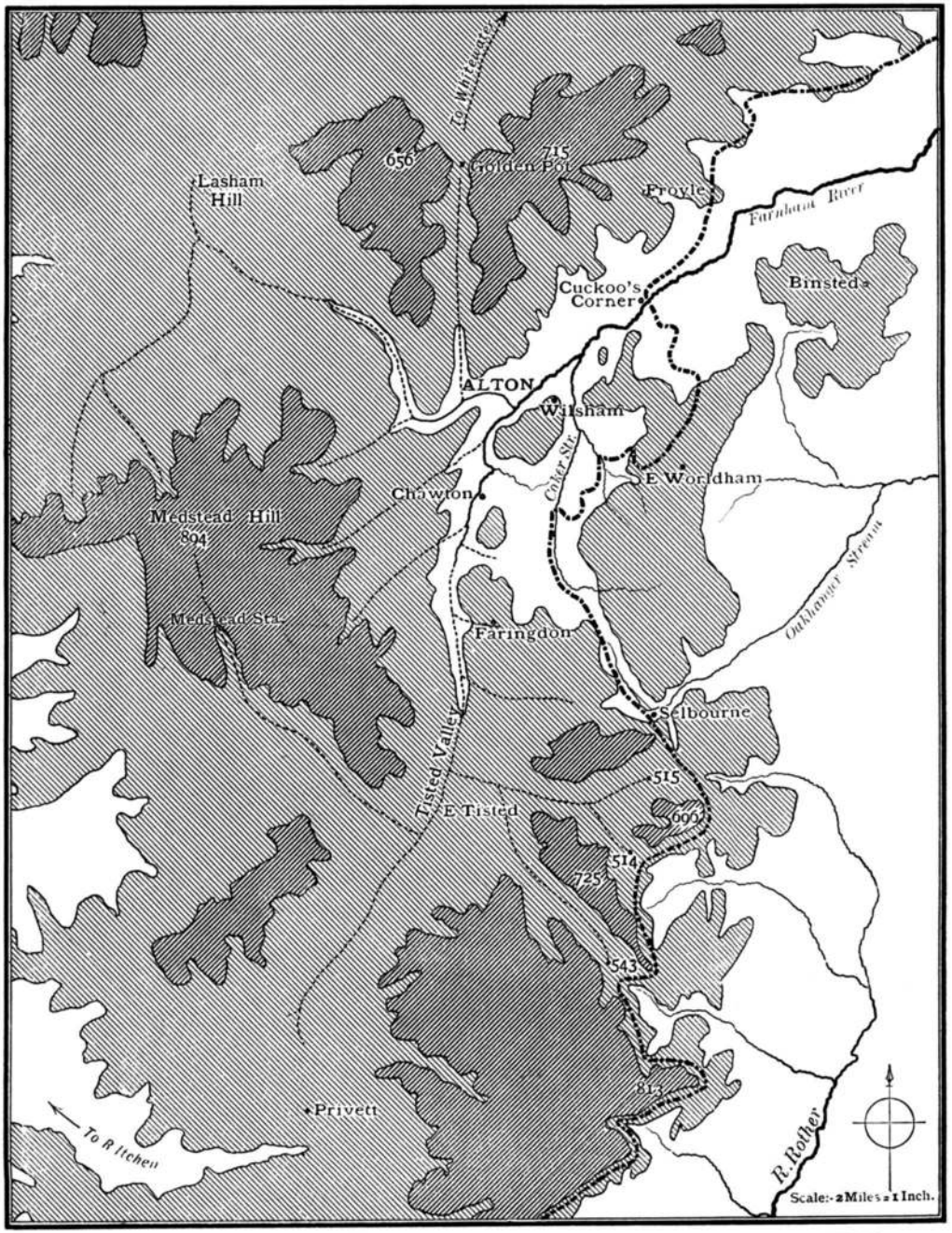
[2] Quoted by W. Whitaker, 'Geology of the London Basin' Mem. Geol. Surv. vol. iv (1875) p. 358.



MAP SHOWING THE SIX SECTIONS OF THE RIVER WEY WHICH LIE WITHIN THE WEALDEN AREA.

(The upper part of the River Wey [consequent] and the branch of the Headley Stream which comes down from Haslemere are not included.)

[The shaded portions are above the 300-foot contour-line.]



MAP OF THE ALTON DISTRICT.

[The courses of the principal valleys are marked by dotted lines. The heavy broken line marks approximately the lower outline of the Chalk.]

The Caker Stream.—It will be remembered that the Caker Stream flows for some distance at the junction of the Chalk and the Upper Greensand. These junction-beds are sandy,[1] and there is abundant evidence all along the foot of the western Downs that they constitute a line of special weakness. The Lower Chalk also, as we have seen, is non-resistant, and here, as elsewhere, forms large areas of nearly level ground. The Malm Rock (Upper Greensand), on the other hand, is very hard, and has been but little removed from the hills to the east of this valley.

There is hardly any room for doubt that the present conditions have been brought about by the simple removal of the Chalk from part of a river-system originally established in the Chalk alone, and that this result has been greatly facilitated by the presence of the weak junction-beds; but the details of the original valley-system are rather obscure. The wall of Chalk separating this valley from the nearly parallel Tisted Valley is broken through in three places by wide and flat passes, and the drainage in all three gaps is mainly towards the Tisted Valley. If the original drainage had been along the present line of the Caker Stream, by a valley comparable to, though smaller than, the Tisted Valley, we should certainly expect tributaries from this western side, as well as those which, as we have already seen, flow in from the Greensand. The comparative absence of these, coupled with the size and apparent age of the three branches of the Tisted Valley, leads me to think that the latter indicate the original lines of drainage, which the Caker Stream, being the first to reach the soft junction-beds, has succeeded in capturing one after the other.

It is, however, unnecessary to enter into further discussion of this point, because the conclusion of main interest to us is the same in any case—namely, that we have here another example of the conversion of a Chalk valley into a Wealden one. In the Farnham Valley it is the lower end which has changed its character; here, by an odd combination of circumstances, it is the upper end of the stream which has entered the Wealden Beds; but the time is perhaps not so very far distant when the rest of the Chalk will be removed between Wilsham and Cuckoo's Corner, and then this stream will be difficult to distinguish throughout its course from one of purely Wealden origin.

EXPLANATION OF PLATES XXXVI & XXXVII.

Plate XXXVI.

Map on the scale of 2 miles to the inch, showing the six sections of the River Wey which lie within the Wealden area. The upper part of the River Wey (consequent) and the branch of the Headley Stream which comes down from Haslemere are not included.

Plate XXXVII.

Map of the Alton district, on the scale of 2 miles to the inch. The courses of the principal valleys are marked by dotted lines, and the heavy broken line marks approximately the lower outline of the Chalk.

[1] 'The Cretaceous Rocks of Britain' Mem. Geol. Surv. vol. i (1900) p. 113 & vol. ii (1903) p. 60.

Discussion.

Dr. R. D. Roberts said that some months ago the Author had shown him the rough draft of the paper with illustrative maps, and had taken him over a part of the ground. He had been greatly interested, and had formed the opinion that the Author was doing a very admirable piece of work. He much regretted the absence of the Author, whom he had hoped to hear in person laying before the Society the results of his observations. It was difficult to follow the paper without the maps, and quite impossible to discuss it in any effective way. He felt sure, however, that when the paper was printed with the illustrative maps, the Fellows would find it to be a most interesting and valuable contribution to the study of the development of river-systems.

Prof. Watts stated that the Author had expressed his regret that his absence, caused by illness, had prevented him from reading the paper, and presenting a proper series of illustrations on the screen. He regarded the paper as a very careful piece of work, and thought that it ought to be published as an example of the researches carried out by the Author in his district.

Mr. G. W. Young joined with previous speakers in deploring the absence of the Author and of maps to illustrate the paper. He thought that there could be little doubt that the upper waters of the Wey did, at one time, form part of the Blackwater system. In a paper read before the Geologists' Association last year, now passing through the press, he (the speaker) had already suggested that their capture by the Wey was caused by local earth-movements. His view was that the Hog's-Back movement did not take place until long after the general elevation of the Wealden anticline, and after the principal river-systems of that district had been established. Then a sharp movement took place in the extreme north-western corner, which bisected the Blackwater system and diverted the head-waters of that stream into the Wey system. Near Farnham there was evidence of shearing and of both dip and strike-faulting, the latter in one place showing a throw of probably not less than 200 feet—for the zone of *Terebratulina gracilis*, the uppermost zone of the Middle Chalk, could be seen abutting against the base of the Lower Chalk. He welcomed the appearance of the paper as a contribution to the elucidation of a very interesting, but hitherto somewhat neglected problem.