

THE GEOMORPHOLOGY OF THE TILLINGBOURNE

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THE purpose of this paper is to present a morphological description of the area drained by the Tillingbourne, a tributary of the Wey: an attempt to analyse the development of the present landscape.

The major consequent streams of the northern Weald have already had considerable attention paid to them but, apart from Wooldridge and Linton's account (1955) of the western Wey, little work has been done concerning the development of the strike vales which give the northern and southern edges of the Weald their characteristic form.

The Tillingbourne is one of the most important subsequent strike streams on the northern side of the Weald, and it is thought that a fairly intensive analysis of the morphological features associated with it, with the object of reconstructing its erosion history, would have possible application over a much wider area; particularly with regard to the feature known from east Kent to the Hampshire border as "Holmesdale".

PHYSICAL BASIS

That part of the Cretaceous sequence which underlies the Tillingbourne catchment is indicated in the Table below:

		Formations	Thicknesses in ft.
Upper Cretaceous	{	Upper Chalk	500
		Middle Chalk	150
		Lower Chalk	120
		Upper Greensand	40-80
		Gault	40-120
Lower Cretaceous	{	Sandy Folkestone Beds	200
		Puttenham Beds	370
		Bargate Beds	0-40
		Hythe Beds	120-300
		Atherfield Clay	20-60
Wealden	100		
		exposed	

The topographic expression of the various members of the Table is obviously important to this study.

The resistant members of the sequence are the Hythe Beds, with interbedded chert bands, Sandy Folkestone Beds, with bands of ironstone, Upper Greensand and Chalk. The Weald Clay, Atherfield Clay and Gault are the weaker members, the Bargate Beds and Puttenham Beds falling somewhere between these two extremes, because of their calcareous and loamy nature.

Being north of the main anticlinal axis of the Weald the regional dip in the

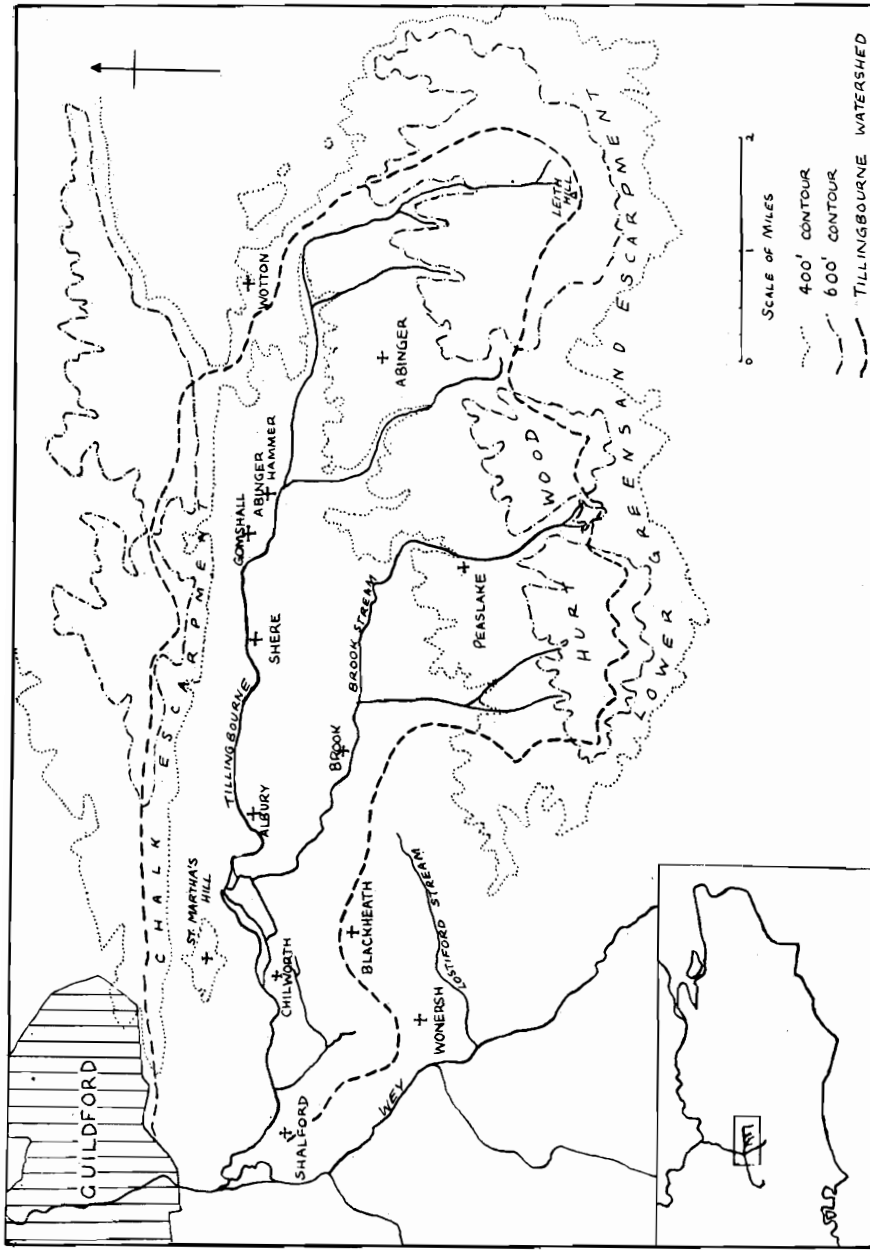


FIG. 1.
The position and setting of the Tillingbourne catchment.

area is northwards, but certain minor flexures or rolls were superimposed upon this general dip, at the time of the Alpine folding. The structure of the area under consideration is dominated by two such flexures, the Peasmarch anticline, whose axis is aligned roughly west-east along a line from Shalford to Westcott; and a parallel shallow syncline to the south, its axis running through Blackheath. These cause duplication of outcrops within the Lower Greensand as one moves northwards through the area, and exercise some control over the development of the landscape. North and south of these flexures the regional dip is dominant and its significance in the landscape ideally demonstrated by the parallel escarpments of Chalk and Hythe Beds (the latter technically outside the limits of the area).

The Tillingbourne catchment is bounded on the north and south by the crests of these two escarpments, in the east the watershed between the Tillingbourne and the Pipp Brook runs from Coldharbour Common northwards to Wotton, and the western boundary is the minor watershed separating it from the Wey.

The main Tillingbourne stream, rising at a point just north-east of Leith Hill Tower, flows north for two-and-a-half to three miles, then turns westwards near Wotton. The remainder of its course is approximately coincident with the axis of the Peasmarch anticline, joining the Wey near Shalford. It receives from the south four main tributaries, which drain the large area of the Hythe Beds outcrop, the two eastern ones joining the main stream after short northward-flowing courses. The largest tributary, the Peaslake-Brook stream, flows north for one mile and then turns westwards to join the main stream four miles further on, at Albury Mill. The fourth tributary is very small, joining the Tillingbourne at Shalford. There is only one stream entering from the north or right bank, that from the spring at the Silent Pool, Shere, the only scarp-foot spring in this catchment.

METHOD

Any landscape may be divided into two categories of surface, "slopes" and "flats". A "flat" in the physiographic sense is defined as an area of uniform surface having observably less inclination than the adjacent slopes. It will obviously be bounded by "breaks" of slope. Inland the commonest "flats" are the result of lateral planation or deposition by streams. They are the remnants of former valley floors, surviving as "river terraces". The concave "break of slope" at the back of the "flat" indicates the widest extent of the valley floor at its particular stage of erosion.

By mapping the breaks of slope forming the boundaries of the flats, and by correlating those which are remnants of the same valley floor—up- and downstream, a good idea of the stages in which the present landscape has been carved may be obtained. Each stage, represented by a series of graded flats, indicates a major stillstand in the uplift of the land surface, a time therefore when lateral corrasion would be at a premium in the work of any river. The size of the remnants of each former valley floor, their distribution and density, will be pointers towards the relative importance of each stage in the erosional history of the whole area.

The flats of the Tillingbourne catchment were recorded by the accurate

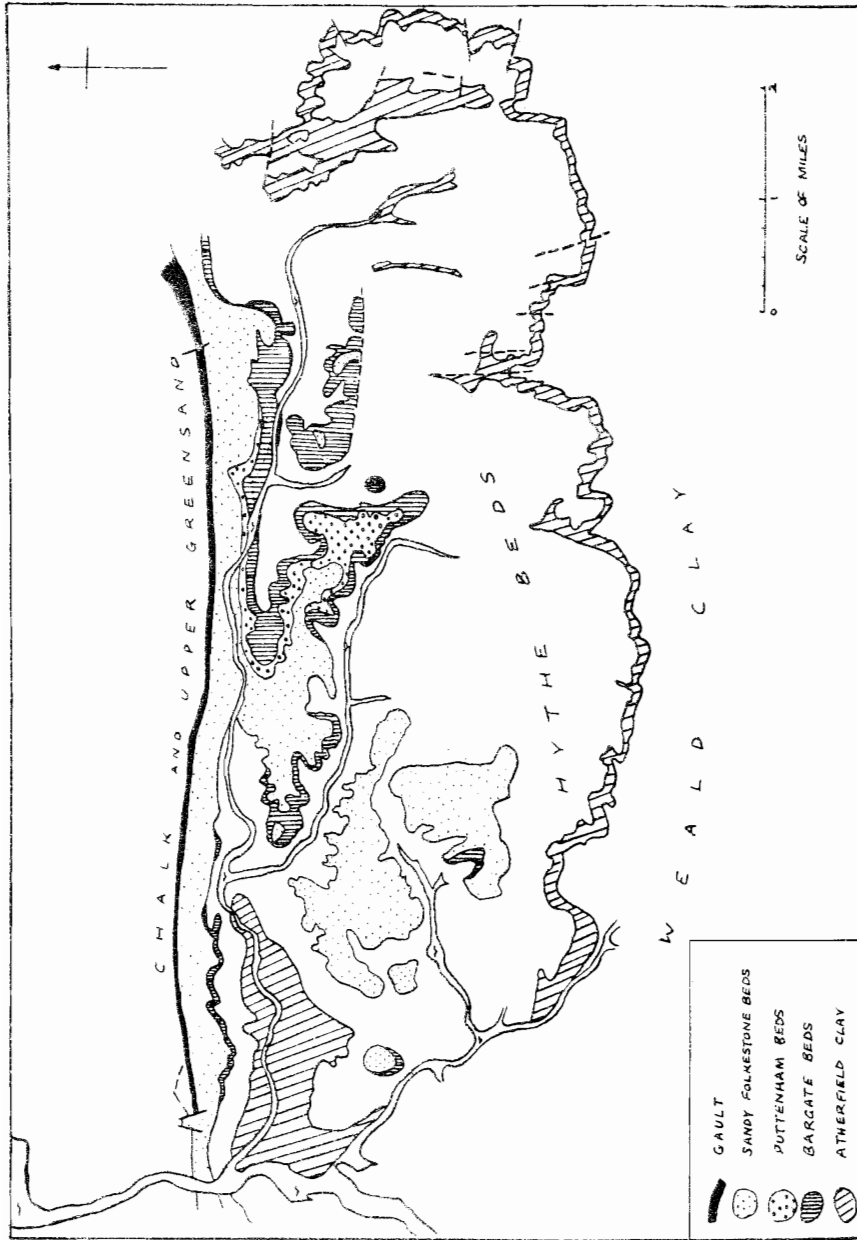


FIG. 2.
The geological background. Bargate Beds in part after J. F. Kirkaldy.

mapping of the breaks of slope bounding them. Their heights were recorded from bench-marks and, where necessary, heights were obtained by levelling from the nearest bench mark with an Abney Level. Errors arising from this method are to a large extent outweighed by the inevitable degree of modification that the surface has undergone since its origin, by weathering, and downwash from the slopes above. Careful attention was paid to superficial deposits on these flats; they would obviously have a bearing upon denudation at that stage, and—a more important function—would also serve as confirmatory evidence in correlation within stages.

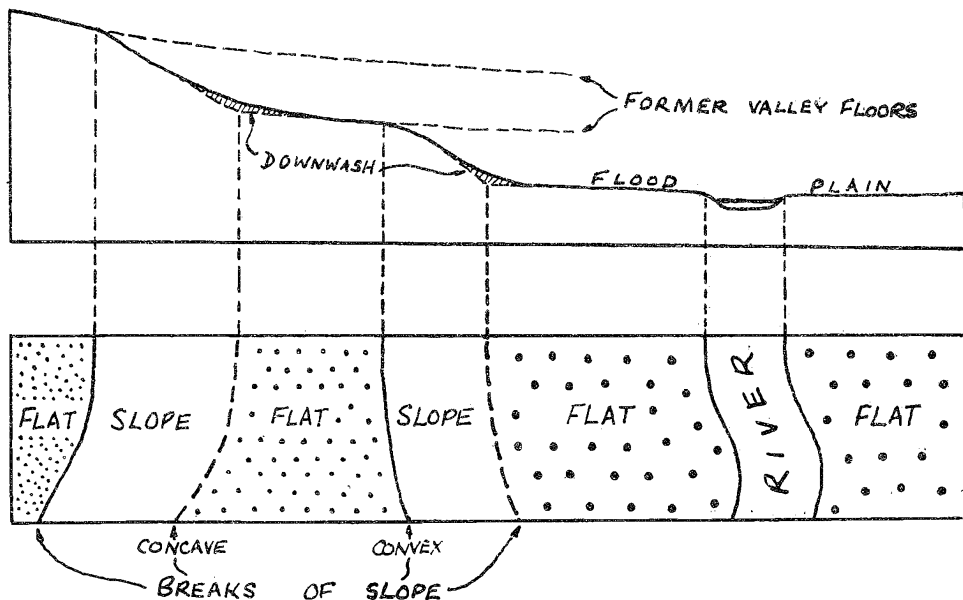


FIG. 3.

Strip of an idealised field sheet correlated with a diagrammatic section through a valley side. (Note: This mapping is concerned only with the recording of "flats", and not to be compared with various techniques of comprehensive morphological mapping.)

Mapping was carried out on field sheets of the Ordnance Survey Six-inch Provisional Edition, mapped flats being transferred from the field sheets to the 1:25,000 map for analysis. With an area of this size the fieldwork is a very long drawn out process; the need to analyse, and to begin to make correlations as the work proceeds, cannot be over-emphasized.

ANALYSIS

The Tillingbourne shows a more extended terrace sequence than a corresponding stretch of the Mole or Darent in the Vale of Holmesdale, or in the

western Wey basin. Fig. 4 indicates all the flats recorded in the catchment, and an attempted correlation into stages. There appear to be nine stages in the terrace sequence, which have been subdivided as follows:

		Heights in ft. above O.D.
A. Two upper flats or benches on the highest parts of the interfluves.	Hurtwood I	690-625
	Hurtwood II	575-525
B. Three middle stages distributed fairly evenly over the catchment area.	Wotton	510-410
	Blackheath	410-375
	Albury Park	350-310
	Postford	285-260
C. Four lower stages closely associated with the present stream pattern.	Little Tangley	250-210
	Chilworth	180-150
	Shalford	150-130
		148-110
D. The present flood plain upstream to the mill at Waterloo.		

A. *Hurtwood Stages I and II*

These two stages are separated from the remainder mainly on the evidence of their distribution, clearly shown on Fig. 4. They occur in two parallel lines aligned east-north-east, across the southern part of the catchment. This suggests that they are remnants of two bench-like features, dissected by northward flowing streams since their origin. Each flat is situated on the crest of an interfluvic, they are much degraded by weathering but are recognizable erosive features, having well marked "backs". Because of their very slight gradient it seems unlikely that they are related to any stream commensurate with the present catchment area. However, they are very near the position of an "inferred margin of the Pliocene land" (Wooldridge and Linton, 1955), and very near the height of the Caesar's Camp Gravel of the Geological Survey. It is also noticeable that only in the east are the Downs on the same meridian higher than these flats. (It may be noted that a similar flat on the summit of St. Martha's Hill is within the height range of Hurtwood II). From this it is suggested that Hurtwood Stages I and II are remnants of the surface upon which the strike drainage, subsequent to initial consequent streams, was developed on first rejuvenation associated with the retreat of the Plio-Pleistocene sea. The immediate predominance of these strike streams is demonstrated by the fact that a consequent drainage line, inferred by Wooldridge and Linton (1955), through the col above Colekitchen Farm (087487) must have been beheaded very early, as the col is now at 600 ft. O.D.—little below Hurtwood I.

B. *Wotton, Blackheath and Albury Park Stage*

(1) *Wotton Stage*

The remnants of this stage (see Fig. 4) are largest and most numerous in the extreme east of the catchment area around Wotton itself. Wotton is situated centrally on the watershed between the Tillingbourne and Mole basin, and many flats of this stage occur on this interfluvic. These may be called "summit flats", and are of great significance as will be seen later. The flats are well preserved along the southern slopes of the catchment area as far west as Reelhall Hill (041441), but to a much less extent in the north. In fact, west of the meridian of Abinger Hammer, only nine small remnants occur, seven of these

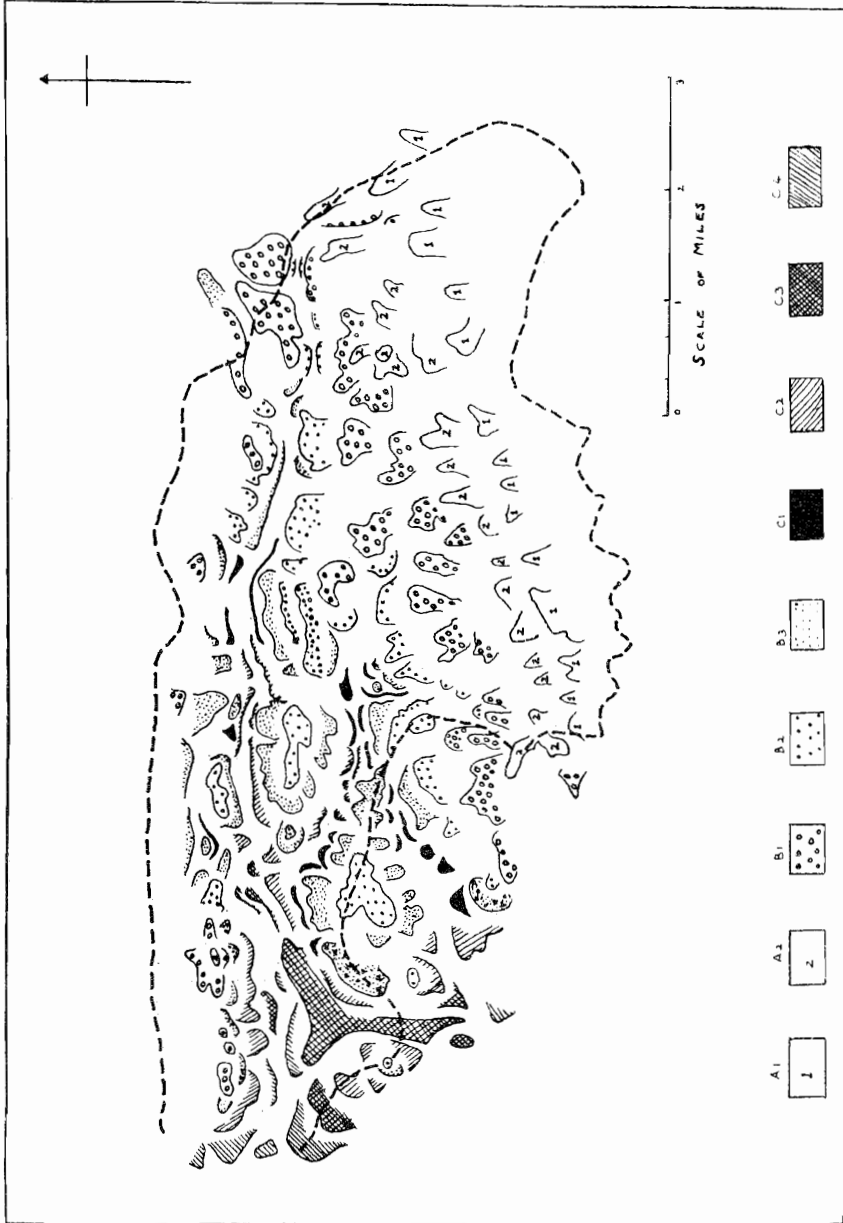


FIG. 4.

The "flats" of the Tillingbourne catchment. For key to stages see text.

on the slopes of St. Martha's Hill (028483) and Chantries (013483), presumably preserved by the relative resistance of the Folkestone Beds in the northern limb of the Peasmarsh anticline. The two remaining occur as flattened spurs at the mouths of two coombes in the Chalk escarpment. These may confirm the development of obsequent drainage on these lines by this stage—as should be the case, if consequent drainage on such lines had already been disrupted as was suggested in the previous section.

On many of these terraces chert and sandstone gravels are present and some flint gravel occurs at Burrows Cross (083463), and Hazel Hall (086451). This is the highest flint gravel found in the catchment.

In the lower parts of the valley, at Farley Green (062453), Shophouse Farm (061448) and Burrows Farm (081471), there appear to be several flats slightly below the graded level of this stage. These may indicate a minor rejuvenation following a long stillstand of base-level, a not unfamiliar situation.

The prevalence of "summit flats" at this stage is a clear indication that the present stream pattern was not in existence at the time they were generated. That nothing higher intervenes between the remnants of this stage has only two possible explanations: either that they are remnants of one valley floor, or the result of the coalescence of a number. Both explanations suggest a sufficiently lengthy stillstand for maximum lateral planation to take place.

The fact that these "summit flats" occur on the present watershed of the catchment makes it plain that the watershed was elsewhere at this stage of stream erosion. A well-marked col at 430 ft. O.D. above Wotton church (126479) may mark a former course of the main Tillingbourne headstream when it was a tributary to the Mole system. The watershed was then presumably further west. This is supported by the fact that the large flat immediately west of Wotton appears to grade both eastward and westward from a central line through 122475—which, when produced, continues the line through Leith Hill and Old Park Hill (127468). The stream must have been beheaded, and the col initiated, during rejuvenation following the Wotton stage. This is evident from the occurrence of remnants of the next, Blackheath, stage upstream in the Tillingbourne valley but at a lower level than the col.

(2) *Blackheath Stage*

East of the meridian of Shere the remnants of this next lower stage are confined entirely to the sides of the present stream valleys. This suggests that the beginnings of the present pattern, at least in the east, were initiated on the renewal of downcutting after the generation of the Wotton stage flats. The importance of the Blackheath stage is best demonstrated in the western half of the catchment. Here "summit flats", largest on Albury Heath and Blackheath, indicate a local condition similar to that which obtained throughout the catchment at the Wotton stage. On these particular flats there are distinctive deposits of assorted flint gravel, cobbles and pebbles, highly suggestive of derivation from destroyed Plio-Pleistocene beaches. Similar gravels, though more fragmentary, are found on various other relics of the Blackheath stage flat. On this evidence it would appear that residual material was once more widely distributed at this stage, possibly more being derived by obsequent drainage, persisting on the lines mentioned in the previous section.

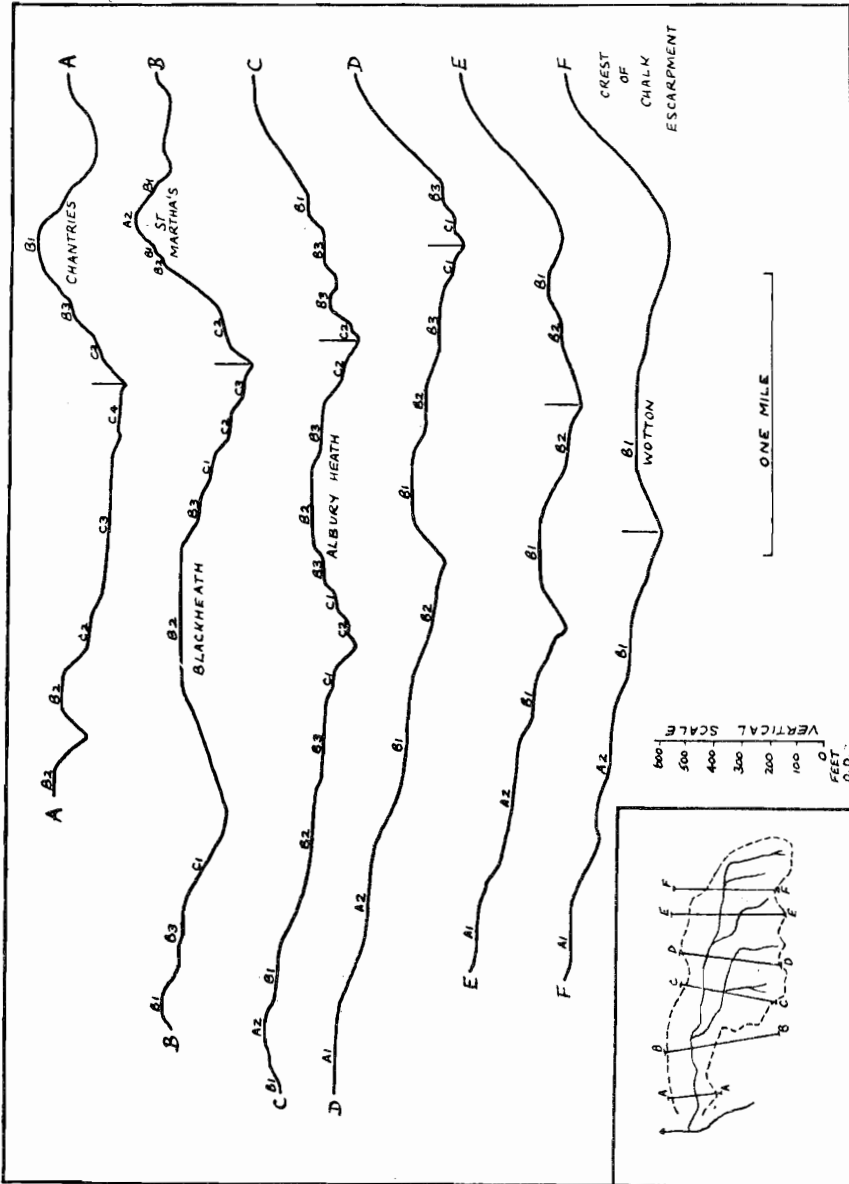


FIG. 5.

Serial sections across the Tillingbourne catchment. For key to stages see text.

It was probably at this stage that the only important strike tributary in the present system, the Brook stream, began to assert itself as a dominant drainage line. For its two headstreams, flowing for a short distance northwards, turned west, south of shallow cols leading on northwards to the main valley of the present Tillingbourne. Flats of the Blackheath stage occur on either side of the subsequent section of the Brook stream, between the confluences of the two headstreams, thus affording a relative date for the inferred captures.

It should be noted that the Brook stream is dissecting the Folkestone Beds preserved in the shallow syncline mentioned earlier. In this connection the "summit flats" of Blackheath and Albury Heath are probably preserved for similar reasons; the valley of the Brook stream is certainly at its narrowest between these two features.

(3) *Albury Park Stage*

We have already noted that the present pattern of drainage took shape at the Blackheath stage. Its persistence through the Albury Park stage is confirmed by the total absence of "summit flats", implying that existing interfluves withstood lateral corrasion, either because the length of the stillstand in the lowering of base-level was shorter than those preceding this stage, or possibly because of the stability of the Folkestone Beds along the synclinal fold.

East of Shere the flats are small and close to the stream, having nothing like the lateral development of the two preceding stages in this area. Downstream, however, the flats broaden out considerably on the left bank of the main stream and on the northern flanks of Blackheath. It must be noted that remnants of this stage occur at the foot of the Chalk scarp. They are separated fragments of the flat, from which we may infer that obsequent erosion along the scarp foot continued for some time after the Albury Park stage.

C. *Postford, Little Tangle, Chilworth, and Shalford Stages*

Remnants of the four stages of this group are everywhere confined to the present stream valleys, and at any point in the valley their height range is no greater than a hundred feet. Many of them are depositional terraces, in contrast with the vast majority of erosional flats representing the preceding stages.

(1) *Postford Stage*

This is small and poorly represented in the main valley, first appearing near Gomshall where it forms a slight terrace feature. It is better developed in the lower part of the Brook valley, where facets of it occur on most of the lower spurs; also in the Lostiford valley south of Blackheath, technically outside our area. The present stream in the Lostiford valley is obviously a misfit, and so presumably part of the present Tillingbourne catchment once drained out along that line.

(2) *Little Tangle Stage*

Terraces of this stage do not occur above Shere, but are much more widespread downstream than those of the preceding stage. Presumably the second stage was considerably longer, and the corrasion which produced these flats,

removed what little there was of the Postford valley floor. Flint gravel is associated with the surface of the terrace, and it has been suggested that it may have affinities with a widespread surface at similar heights in the Mole basin to the east.

(3) *Chilworth Stage*

The first flats of this stage appear below a knickpoint just west of Albury, and persist along the valley almost continuously to Shalford. The stage is most notable for one continuous flat, stretching from Chilworth Station (031473) to Bradstonebrook (015469) and south through a dry gap to Wonersh. It has been suggested (Dines and Edmunds, 1929) that the dry gap is a former valley of the eastern Wey, which then joined the Tillingbourne at Bradstonebrook. Another tributary, flowing north-eastward, turned north-westward at Bramley to occupy the present valley of the eastern Wey. The gravels of the Chilworth stage, spread over a wide area, suggest a state of aggradation in these streams. It is reasonable to suppose that the elbow at Bramley migrated north-eastwards and captured the Wey.

(4) *Shalford Stage*

This, the lowest stage, is confined to the main valley, and then no further upstream than a knickpoint west of Waterloo Mill (037479). Narrow within the valley, it widens out considerably at Shalford itself—almost in the main Wey valley. There are many remnants of the stage in the Wey valley downstream from the confluence, and for some distance up the valley of the western Wey.

CONCLUSIONS

It is impossible to trace the development of the present landscape of the Tillingbourne catchment further back than the time of a supposed Mio-Pliocene peneplain, locally bevelled by the Plio-Pleistocene sea. In this landscape the effects of lithology and structure would have been reduced to a minimum and, upon initial retreat of the sea, drainage appears to have followed lines suggested by Wooldridge and Linton (1955, page 95). During this intermittent retreat and associated rejuvenation of drainage, subsequent streams would rapidly pick out the weaker geological elements in the surface. Notably these are the axis of the Peasmarsh anticline and the outcrop of the Gault.

It is possible that the Gault outcrop was duplicated by the anticline at this time, and the present line of the Lostiford stream may well indicate the position of the southern part. The corresponding northern outcrop would obviously coincide with the axis of the anticline (Wooldridge and Linton, 1955), thus increasing the relative weakness of this line. It may be suggested, then, that erosion would be fairly rapid on and near this line, lateral corrasion would take place all the time, and vertical corrasion whenever the fall of base-level allowed. Whatever Upper Greensand remained in the syncline between these two Gault outcrops would be rapidly removed, at least by the time of the production of the Wotton stage, and the Gault may well have been cut through along the line of the axis.

Upon the next rejuvenation main lines of drainage would probably be along the zone incorporating synclinal Gault and anticlinal Folkestone Sands. The northerly Gault outcrop narrowed because of the steeper northern limb of the anticline, and, soon affected by strike faulting, would probably only carry minor tributary streams. The southern Gault would probably be removed fairly rapidly by lateral planation at the next stillstand, represented by the Blackheath stage. Exposure of the more resistant Folkestone Beds on the synclinal axis would increase the tendency of a strike stream to migrate northwards, particularly if by now the Bargate Beds were exposed along the anticlinal axis.

As can be seen, this situation approximates to that existing in the present landscape near the eastern and western extremities of the anticline. It is suggested that the basic lines of the present drainage pattern within the Tillingbourne catchment were initiated during rejuvenation from the Blackheath stage. This rejuvenation was shortlived and a long stillstand followed, during which the Albury Park stage was produced. Evidence for this is afforded by the "summit flats" of the Blackheath stage. Excavation has followed along these lines since, and rejuvenation has only been punctuated by very minor stillstands, as witness the small lateral extent of any terrace features below this stage, and the production of "valley-in valley" forms, which indicate a gradual diminishing of the time interval, volume of water and work done as contributory factors in the production of the landscape.

REFERENCES

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 WOOLDRIDGE, S. W., and LINTON, D. L. (1955). *Structure, Surface and Drainage in South-East England*. Philip.

MAPS:

- Ordnance Survey Sheets*: One inch to a mile, Sheet 170. 1:25,000 Sheets TQ/04, TQ/14, SU/94.
Geological Survey Sheets: One inch to a mile, New Series Nos. 285, 286.