Part I

GEOLOGY AND PALÆOLITHIC STUDIES

BY

KENNETH P. OAKLEY, B.Sc., Ph.D., F.G.S.

GEOLOGY AND PALÆOLITHIC STUDIES

THE GEOLOGY OF THE FARNHAM DISTRICT.

(See accompanying Map)

THE history recorded in the river-drifts of Farnham, relating both to the succession of early human industries and to the development of the river-systems which drain the area, is the main concern of the earlier sections of this Survey. However, before turning to this more obvious meeting-ground of geology and archæology, it is well to consider the "solid" formations which underly the "drifts." Not only have the "solid" rocks a bearing on the interpretation of the more superficial deposits, but also they largely determine the local phytological and hydrological conditions which have controlled to a great extent the distribution of human settlements.

Geological Structure of the Region (see Figs. 1 and 2).

The Farnham district lies on the north-western margin of the great dissected dome of the Weald, so that the general dip of the "solid" rocks is towards the north in the eastern half of the area, and more to the north-west in the western half. Locally, the direction of dip may vary considerably on account of minor rolls in the strata.

The northern third of the area is occupied by the gently dipping Tertiary formations which constitute the southern limb of the London Basin. The Cretaceous rocks (Secondary), which occupy the greater part of the district, are sharply flexed along the northern rim of the Wealden dome, the Chalk and Gault there forming the almost vertical limb of a monoclinal fold (the Hog's Back fold). On account of their steep dips the Chalk and the Gault have very narrow outcrops in the neighbourhood of Farnham. Southwards the rocks curve over more gently, so that the outcrop of the underlying Lower Greensand occupies the whole of the southern half of our area —with the exception of the high ground to the west, which has a capping of Gault (Fig. 2).

The Hog's Back fold is broken by a line of reversed strike-faulting. This is crossed by a series of tear-faults.[1] Both sets of faults were produced by the same compressive forces —probably in Miocene times. One of the main tear-faults has dislocated the line of the Chalk outcrop in the region of Runfold.

The "Solid" Rocks.

1. Cretaceous.

Only the topmost division of the *Lower Greensand*, namely, the Folkestone sands, is exposed within the area under consideration. These beds are yellowish sands of marine origin, often current-bedded, and with layers of concretionary ironstone. They give rise to dry and rather sterile soils which form heathland or support coniferous woods. The underlying division, the chert-bearing Hythe Beds, is exposed farther south, as around Hindhead.

The *Gault*, which succeeds the Lower Greensand, is a soapy blue-grey marine clay. Its outcrop forms a narrow belt extending across the area from east to west at the foot of the Chalk escarpment. To the west its outcrop swings southwards, broadening out and occupying the high ground of Alice Holt and Rowledge.

The Gault clay is suitable for pottery-making, and is worked for the purpose at Wrecclesham (Farnham Pottery). In this district the top beds contain nodules of phosphate of lime. which is valuable as a mineral fertilizer. Under natural conditions the Gault clay-land would be heavily timbered, but it has been now largely brought under cultivation. In the valleys it forms swampy ground.

[1] Faults are indicated on the accompanying geological map by white lines.

The *Upper Greensand* forms a rather narrower outcrop than the Gault. At the base of this formation there is a thick bed of soft, brownish-white rock, rich in soluble silica. It was formerly dug extensively as a top dressing for the sandy soils of the region under the impression that it was marl; actually it is extremely deficient in lime! This rock passes up into a hard, compact brownish rock known as "Fire-stone," which was used locally during the last century as a building stone. In places the Upper Greensand contains hard cherty "doggers."

The outcrop of the *Chalk* forms the narrow strip of high ground which runs approximately east and west across the district. To the east this ridge becomes the Hog's Back. To the west, beyond the limits of the area we are now considering, the outcrop swings round south-westwards and broadens out considerably. The Lower Chalk, some 120 feet thick, is greyish-white, marly towards the base, and devoid of flints. The Middle Chalk is about 150 feet thick. A hard nodular bed (the Melbourn Rock) occurs at its base, and in the upper part small grey-skinned nodules of flint occur. The Upper Chalk is 500 feet thick; it is white, and on the whole softer than the Middle Chalk, although hard nodular beds occur at intervals. Flint occurs throughout, either in the form of tabular sheets, or, more commonly, as layers of nodules.

2. Tertiary (Eocene).

The oldest Tertiary rocks in the district are the *Reading Beds*. These rest discordantly on the Chalk. They have a maximum thickness of about 80 feet, and consist of red, yellow and grey mottled clays of brackish or freshwater origin. They form a narrow linear outcrop running parallel with that of the Chalk, and give rise to heavy pasture soil. Swallow-holes, or swillets, formed through solution of the underlying Chalk, are of common occurrence along the margin of the outcrop of these beds, as in Farnham Park.

A white plastic clay in the Reading Beds was at one time dug at Badshot Lea and Farnham Park for pottery-making. The clay obtained from the Farnham Park pit was utilized as far back as the sixteenth century, particularly for making the special green pottery which was much used at the Inner and Middle Temple at that time (Loseley MSS. IX, 118, 19 Aug. 1594).[1]

The succeeding formation, the *London Clay*, is of marine origin. It is blue-grey in the unweathered state, but turns brown through oxidation after long exposure. Although only about 300 feet thick in this region, it has an extensive outcrop on account of its low dip. It forms the southern slopes of the Tertiary escarpment at Cæsar's Camp and Hungry Hill. Small nodules of pyrites—which on decomposition give rise to selenite—and large calcareous concretions ("septaria") are of common occurrence in the clay. Seams of black flint pebbles are a feature of the lowest beds of this formation. The clay gives rise to heavy soil suitable for pasture. Near Aldershot it has been exploited for the making of bricks.

The incoming of sandy layers near the top of the London Clay marks the passage to the overlying *Bagshot Beds*. These are of deltaic origin and consist of fine yellow sands with thin seams of pipe-clay. They are about 80 feet thick, and outcrop around Cæsar's Camp and Hungry Hill. Springs arise at their junction with the London Clay on the steep slope of Hungry Hill and supply the headwaters of the present Blackwater.

The *Bracklesham Beds* mark a return to more thoroughly marine conditions; they comprise grey clays, yellow and green sands, and pebble beds. They attain a thickness of 65 feet. The succeeding *Barton Sands* form an outlier on Cæsar's Camp Hill which is largely capped by Pliocene gravel. They are fine grained, evenly-bedded sands, buff-yellow in colour, and of marine origin.

Sarsens.—Blocks of intensely hard, fine-grained, silicified sandstone are occasionally found on the drift-covered areas of the Farnham district. Most of these sarsens, as they are termed, represent silicified portions of the Bagshot sands which have survived after the unconsolidated, softer parts of the beds have disappeared through denudation. Some may have originated through the surface silicification of the Barton Sands. The latter are regarded as the source of the sarsens

[1] This information was kindly contributed by Mr. W. F. Rankine. Major A. G. Wade informs me that a reference is quoted in W. Chaffer, *Marks and Monograms on Pottery and Porcelain* (1863), p. 36.

which are found below the Plateau Gravels on the Fox Hills and Chobham ridges outside our area to the north-east.

Rarely the so-called " conglomeratic sarsens ", characteristic of the Chalk uplands of the Alton district, have found their way into the Farnham region. These differ from normal sarsens in containing numerous pebbles of flint and quartz. They may have been transported into the Farnham district by fluviatile agency, but in some cases, at least, it is suspected that the hand of man has been responsible. A few have been found on the southern slopes of the Upper Hale plateau, and one water-worn example is recorded from the gravels of Terrace D at Farnham (Bury, 1922).[1]

The " Drift " Deposits.

Extensive areas in the Farnham district are covered by " drift " deposits. These include gravels, sands and loams, varying in age from Pliocene to Recent, and mostly the deposits of rivers. These occur either as terraces along the present river valleys, or as isolated relict patches on hill-tops and ridges. Such deposits are mainly the remnants of former river flood-plains which have been dissected by erosion, and in the Farnham district they are of special interest to the archæologist on account of the artifacts of Palæolithic Man which many of them have yielded.

The Pliocene and Pleistocene deposits are considered in detail in later sections of the Survey (see pp. 18 *ff.*).

Most of the pits in Pleistocene gravels referred to in this Survey are indicated on the accompanying geological map.

[For a detailed account of the geology of the Farnham district reference may be made to Dines and Edmunds, *The Geology of the Country around Aldershot and Guildford* (1929), a Memoir of the Geological Survey written in explanation of the one-inch sheet No. 285. An excellent general account of the geological and physiographic history of the Weald as a whole is to be found in Edmunds, *The Wealden District*, one of the regional handbooks recently (1935) issued by the Geological Museum.]

[1] See references on p. 20.

THE DRAINAGE OF THE FARNHAM DISTRICT AND ITS DEVELOPMENT.

(See Figs. 1a–e)

The district with which this Survey deals is drained by two river systems, namely, by the Blackwater and the Wey.

The Wey is a river with a number of branches, any one of which may be referred to as the Wey (Fig. 1e). What may be regarded as the trunk stream arises on the Lower Greensand near Alton and flows in a north-easterly direction through Farnham, keeping close to the foot of the Chalk escarpment. This section is termed the Alton-Farnham river. At a distance of about a mile to the east of Farnham it turns at right-angles and flows southwards along the " Waverley valley " to join the Tilford section of the Wey. The Tilford river, as this section is sometimes called, arises near Selborne and flows in a deep valley which is cut in the Lower Greensand and runs parallel with the Farnham river. The combined waters of the Farnham and Tilford rivers flow eastwards through Godalming and join a northward-flowing branch of the Wey (the " primary Wey ") at Broadford. Thence the main river flows through the gap in the Chalk escarpment at Guildford, and maintaining a course slightly east of north, flows into the Thames at Weybridge.

The Blackwater arises on the London Clay at Heath End, near Aldershot, and after flowing for about 1½ miles in a south-easterly direction turns at right angles and flows northwards. The valleys of the Blackwater and the Farnham Wey are now separated by the line of the Chalk escarpment, but the existence of a low col in this escarpment north of Runfold (the Aldershot gap), exactly between the elbow-like bend in the Blackwater and the similar bend in the Wey at the head of the Waverley valley, is evidence that the Blackwater at one time arose to the south of the escarpment. The present state of affairs came about through the capture of the head-waters of the Blackwater by the River Wey. This now classical example of river-capture was first recognized by Professor W. M. Davis, and the complicated series of events which led up to it has been investigated in detail by Mr. Henry Bury.

Bury's investigations of the Pleistocene river gravels of the Farnham area in relation to the history of the drainage have made it possible to correlate the main events in that history with phases of human culture. Before passing to a detailed account of the Palæolithic gravels of the district we may briefly outline the evolution of the drainage. The following account is based on the work of Bury, Linton, Dines, Edmunds and others who have written on the rivers of the Weald, and has no special claim to originality.

The primary drainage of the Weald consisted of a series of streams flowing northwards and southwards from the central, east-west axis of uplift. Such streams are spoken of as *consequents*. The initiation of this consequent drainage probably took place when the Wealden area was slowly rising above the sea as a dome at the beginning of Tertiary times. The surface of the island dome consisted of Chalk. Before the Weald was again submerged by the sea, in Eocene times, the combined action of subaerial weathering and stream erosion removed much of the Chalk from the centre of the region, thus exposing the Gault and Lower Greensand. This we know from the occurrence of pebbles of Greensand chert in the Eocene pebble beds. In Oligocene times the Wealden dome underwent further uplift and the radial drainage was re-established on its surface. The blanket of Tertiary rocks was quickly removed in the anticlinal region, and the rivers once more traversed the Cretaceous rocks. In the subsiding area to the north (the London Basin) the rivers ran out on Tertiary deposits, as they do to this day. Erosion of the Wealden area continued throughout Miocene times, and it was during this period that the main lines of the present drainage system of the country were blocked out. The Weald was reduced to an area of comparatively low relief with a general slope on the northern side towards the London Basin. The latter was invaded by the sea in Pliocene times, and the southern shores of the gulf so formed coincided approximately with the line of the North Downs. Beach shingle deposited by the Pliocene sea is preserved in patches along the North Downs, resting on a wave-cut shelf at about 600 feet above O.D. It is probable that the Cæsar's Camp Gravel belongs to this stage (see pp. 18–20). Uplift was renewed in later Pliocene times and the rivers of the Weald entered on a new cycle of erosion. This cycle of erosion is still incomplete.

Returning to the initial stages of river development: as soon as the rivers in their upper reaches had cut down to the soft Gault clay, erosion became more rapid. Springs arose at the junction of the Chalk and the Gault, swelling the volume of the rivers, and the valleys became widened in the region of the clay outcrop. Lateral tributaries (called *subsequents*) developed, and those on the Gault clay eroded their beds more rapidly than those on the Chalk. This led to differential denudation of the Chalk and the Gault, so that before long the Chalk stood up as a ring-like escarpment running round the circumference of the Weald, breached only by gaps cut by the main consequent streams.

The number of primary consequent rivers draining the Weald has steadily diminished in course of time, and now several of the originally simple radial drainage systems have been replaced by a network of rivers. Some of the more important of the present Wealden rivers, including the Wey, run for the greater part of their courses in a direction at right angles to that taken by the old consequent rivers. This development is due to the phenomenon of river-capture, whereby subsequent rivers develop at the expense of consequents. Those consequents which, on account of local irregularities, reached the Gault first, cut down more rapidly than their less successful neighbours. The subsequent tributaries of these more active rivers extended their heads along the strike of the rocks until they ultimately encroached on the catchment areas of the neighbouring river systems, which were then deprived of their drainage water, to the gain of the pirate rivers. Thus the less active consequents lost first their tributaries and finally their headwaters. The beheaded remnants of the consequents dwindled in size and have either disappeared completely or now occupy valleys far out of proportion to their present size. The River Blackwater is an example of such a *misfit*. At the "head" of a misfit it is usual to find a notch, or dry gap, in the escarpment, marking the course of the ancestral consequent river prior to the diversion of its headwaters.

By a repetition of the process described above a subsequent

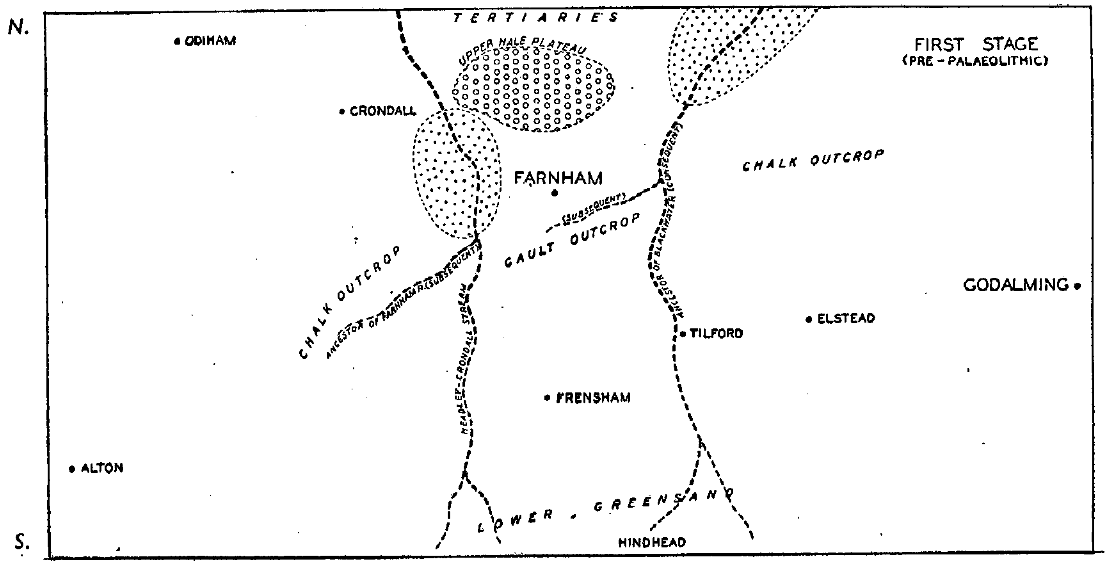


FIG. 1a.

FIGS. 1a–1e.—DIAGRAMS ILLUSTRATING PROBABLE STAGES IN THE EVOLUTION OF THE DRAINAGE OF THE FARNHAM AREA.

(*Diagrams of later stages adapted from Dines and Edmunds, 1929.*)

river can extend along the strike of the rocks and develop at the expense of a whole series of consequents. This has been the case with the River Wey.

Turning from the history of the drainage of the Weald in general to that of the Farnham area in particular, it would appear that the primary drainage of this sector consisted of two parallel consequent streams flowing northwards. These two streams were: on the east, the ancestor of the River Blackwater flowing across the Chalk outcrop along the line marked by the Aldershot gap; and on the west, a river flowing from the region of Headley along the line marked by the dry gap at Crondall. Both these rivers arose on the outcrop of the Lower Greensand. There is evidence (see p. 19) that these two rivers were already in existence when the Pliocene sea transgressed on to the peneplained surface of the Weald. Their probable positions at the beginning of Pleistocene times are indicated in Fig. 1a, *First Stage*.[1]

With the regression of the Pliocene sea, following uplift of the Weald, erosion became active in the river valleys of this area and the development of subsequent tributaries began to modify the simple drainage plan of the Farnham sector. First of all a tributary of the Blackwater consequent extended its head westwards along the line of the Gault outcrop until it captured the headwaters of the Headley-Crondall stream, together with its tributary known as the Alton stream, at a point estimated to have been 420 feet above O.D. This piratical subsequent was in fact the embryonic Farnham river, and after its first and only theft it continued the line of the Alton stream. Northwards of the point of capture the Headley-Crondall stream soon dwindled and disappeared, leaving the dry col in the escarpment south-east of Crondall (Fig. 1b, *Second Stage*).

Now it seems the headwaters of the Headley stream were diverted by another subsequent river—the Tilford river. This tributary extended in a south-westerly direction, parallel with the Farnham river, and lay to the south of what is now the Alice Holt plateau. Linton estimates that this river captured

[1] Other consequent streams, to east and west of the two shown, would have crossed the area covered by the sketch-map at this stage (see Bury, 1910, p. 666), but are omitted for the sake of simplicity.

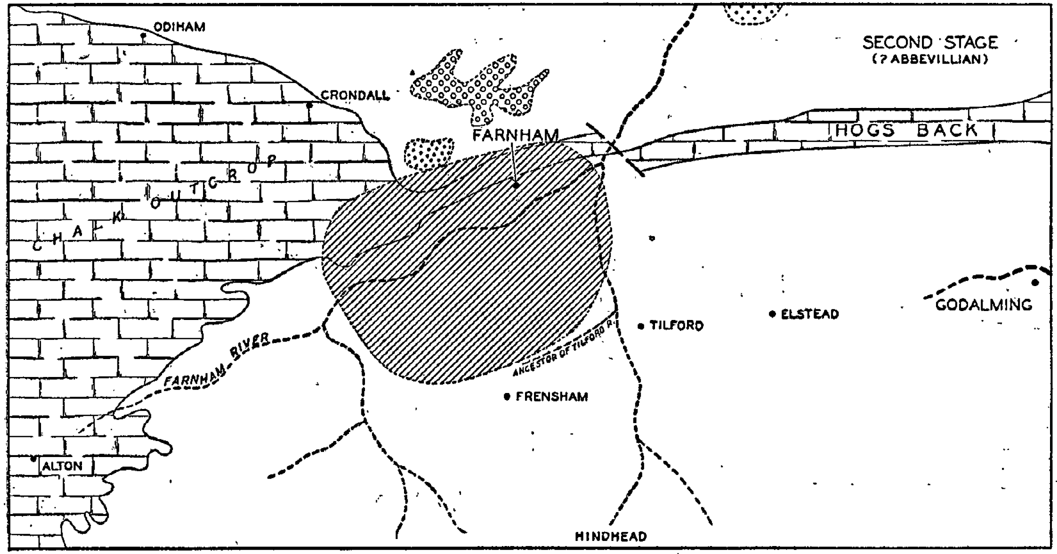

SECOND STAGE
(? ABBEVILLIAN)
ODIHAM
CRONDALL
FARNHAM
HOGS BACK
CHALK OUTCROP
GODALMING
ELSTEAD
TILFORD
ANCESTOR OF TILFORD R.
FRENSHAM
FARNHAM RIVER
ALTON
HINDHEAD

FIG. 1b.

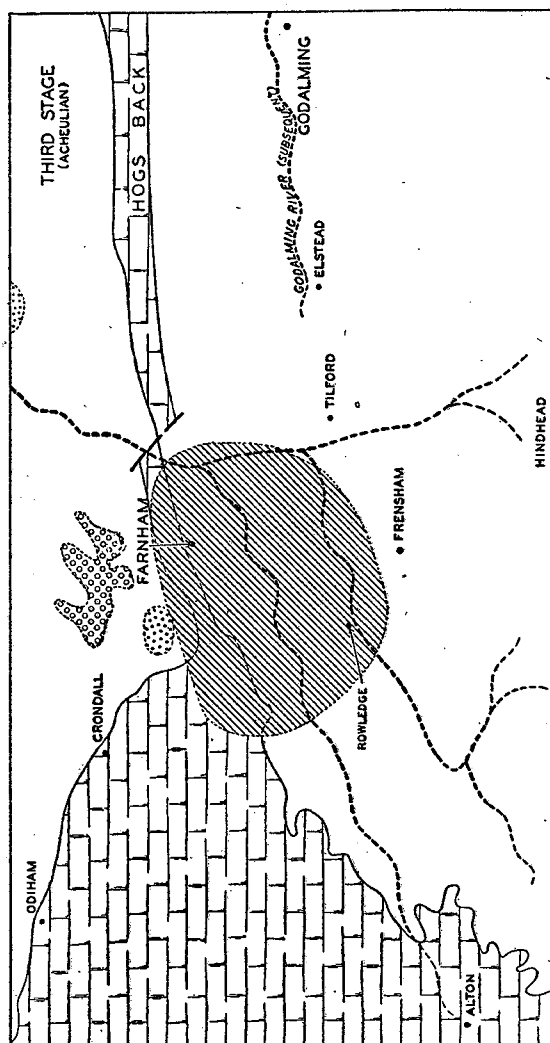

THIRD STAGE
(ACHEULIAN)
HOGS BACK
GODALMING
GODALMING RIVER (SUBSEQUENT)
ELSTEAD
TILFORD
HINDHEAD
FRENSHAM
FARNHAM
ROWLEDGE
CRONDALL
ODIHAM
ALTON

FIG. 1C.

the Headley stream, which had shifted westwards since its capture by the Farnham river, at a height of about 340 feet above O.D. This capture, if correctly deduced, is an example of the rather rare phenomenon of a river "biting off its own tail," for the Headley river at the time of the capture was flowing into the Farnham river. Both the Farnham river and the Tilford river were at this period tributaries of the Blackwater. (See Fig. 1c, *Third Stage*.)

Meanwhile another river was encroaching on the catchment area of the Blackwater, namely, the subsequent Godalming river, a tributary of a consequent river which arose in the centre of the Weald and flowed northwards through what is now Guildford. This latter river, which persists to this day, may be regarded as the primary Wey (see p. 8). The Godalming river no doubt originated on the Gault, but as erosion proceeded the outcrop of the clay receded northwards, and the river became entrenched in the underlying Lower Greensand. The Godalming river captured the headwaters of the Blackwater together with its tributary the Tilford river (Fig. 1d, *Fourth Stage*). This capture took place at about 320 feet above O.D., probably during the same period of base-levelling as witnessed the capture of the Headley stream by the Tilford river.

The Waverley valley was now deserted, and the Farnham river continued to flow through the Aldershot gap into the Blackwater valley.

The final change in the drainage of the area, whereby the present arrangement became established, took place as a result of the outgrowth from the Tilford-Godalming river of a scarp-stream, or *obsequent*. This scarp-stream extended its head along the line of the abandoned Waverley valley and ultimately tapped the Farnham river at a point near the site of High Mill, and so diverted the headwaters of the Blackwater into the valley of the Godalming Wey.[1] The Aldershot gap was thus left dry (Fig. 1e, *Fifth Stage*).

As a result of previous captures the territory of the Wey had already been greatly augmented at the expense of the

[1] There seems no need to invoke a movement of the Runfold fault to explain the diversion of the Farnham river, although this has been postulated as a cause (Young, 1909).

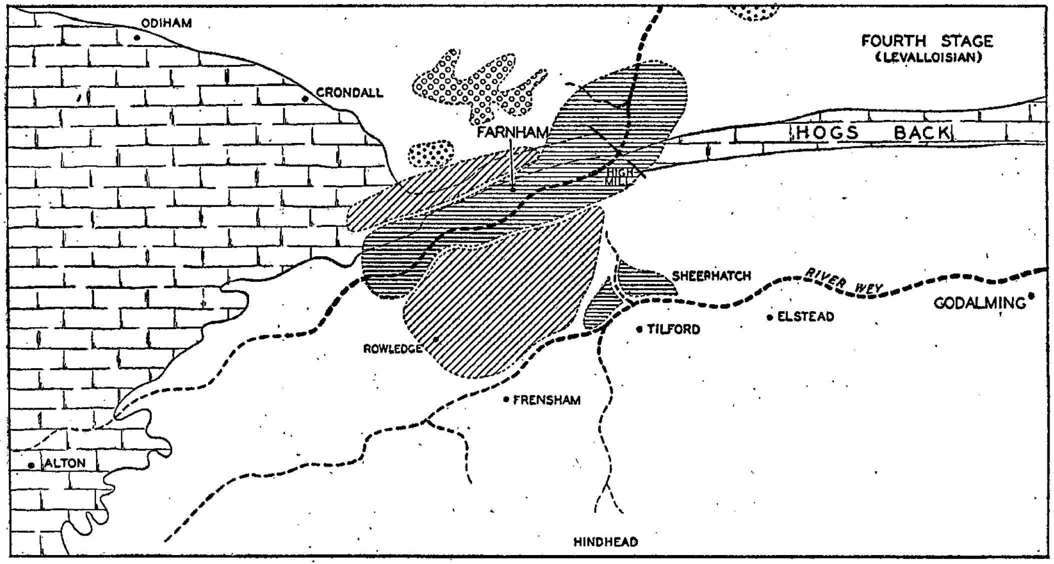

FOURTH STAGE
(LEVALLOISIAN)
ODIHAM
CRONDALL
FARNHAM
HOGS BACK
HIGH MILL
SHEERHATCH
RIVER WEY
GODALMING
ELSTEAD
TILFORD
ROWLEDGE
FRENSHAM
ALTON
HINDHEAD

FIG. 1d.

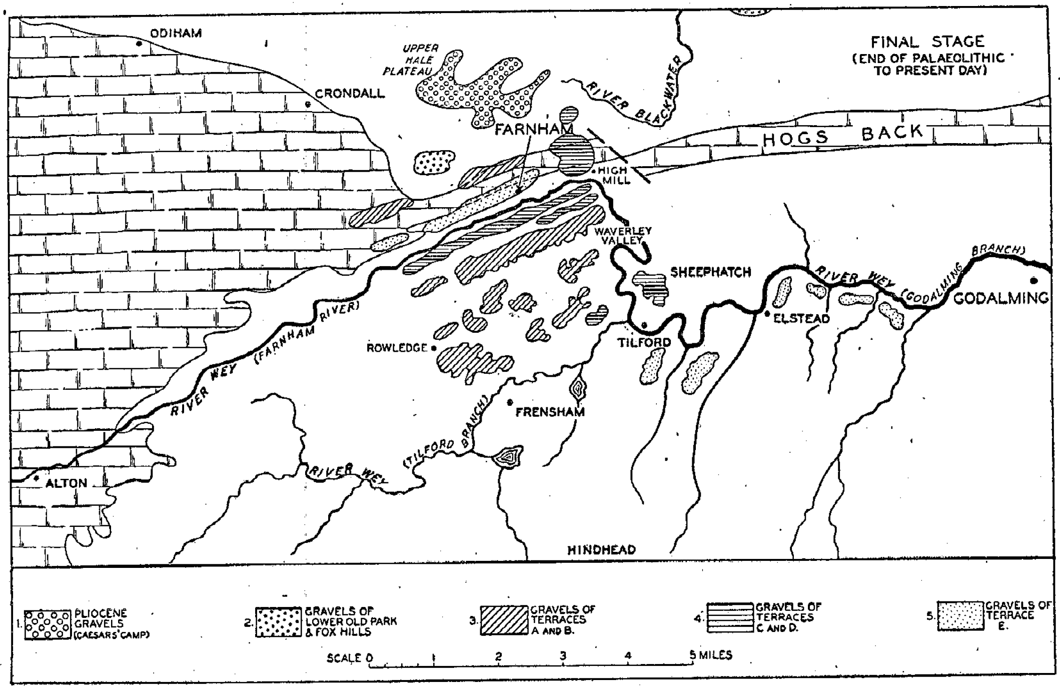


FIG. 1e.

(*Based on Dines and Edmunds*, 1929.)

Blackwater, so that erosion in the Wey valley had outstripped that in the higher reaches of the Blackwater before the final capture took place. At the time of this capture the floor of the Blackwater valley at High Mill stood at 250 feet above O.D., whereas the more active Godalming Wey had cut down to 200 feet above O.D. As a consequence, when the Farnham river was diverted into the Godalming valley it rapidly lowered its bed by nearly 50 feet to accommodate itself to the level of the river by which it had been captured. The present Wey has a fairly steep gradient in its upper reaches. Opposite Wrecclesham the river-bed is 220 feet above O.D.; at High Mill, east of Farnham, 200 feet; and at Tilford, 165 feet. At Weybridge the river flows into the Thames at 36 feet above O.D.

A study of the terrace gravels of the Blackwater and the Wey has made it possible to date in a general way the main events described in the foregoing account.

References.

Bury, H. 1908. "Notes on the River Wey." *Quart. Journ. Geol. Soc.*, LXIV, pp. 318–34.

—— 1910. "The Denudation of the Western End of the Weald." *Quart. Journ. Geol. Soc.*, LXVI, pp. 640–92.

Dines, H. G., and Edmunds, F. H. 1929. "The Geology of the Country around Aldershot and Guildford." *Mem. Geol. Surv.*

Linton, D. L. 1930. "Notes on the Development of the Western Part of the Wey Drainage System." *Proc. Geol. Assoc.*, XLI, pp. 160–74.

Wills, L. J. 1929. *The Physiographical Evolution of the British Isles.* Arnold & Co., London. See pp. 198–207.

Wooldridge, S. W. 1927. "The Pliocene History of the London Basin." *Proc. Geol. Assoc.*, XXXVIII, pp. 49–132.

Young, G. W. 1909. "The Chalk Area of Western Surrey." *Proc. Geol. Assoc.*, XX, pp. 422–55.

PLIOCENE GRAVELS.

The oldest of the high-level gravels in the Farnham district have not yielded any indications of human occupancy, but they are nevertheless of interest as bearing on the origin and history of the rivers which were later to lay down the Palæolithic deposits. The most ancient of these pre-Palæolithic gravels are those which cap the Upper Hale plateau. They are sometimes known as the *Cæsar's Camp Gravels.*

The Upper Hale plateau consists of a central elevated plain, about a mile long from east to west and about a third of a mile wide, from which a series of flat-topped spurs project. The most conspicuous spurs are those on the northern side of the plateau; their terminations are known as Beacon Hill, Cæsar's Camp, and Hungry Hill.

The plateau is formed of Bagshot sands and Bracklesham Beds and is covered by a sheet of coarse gravel overlain by sand. The elevation of the greater part of this sheet is between 580 and 600 feet above O.D., but on Hungry Hill and along the whole of the southern fringe of the plateau the gravel descends to 560 feet O.D.

The gravel itself is characterized by the abundance of large nodular flints, many of them unbroken, but some showing "beach-noding." The matrix is a coarse sand containing flint chips and small angular pebbles. The latter include black-skinned flints from the Tertiary formations, and cherts derived from the Lower Greensand of the Weald.

Stratification can be made out only locally, as where lenses of sand occur in the gravel. On the basis of their heavy-mineral assemblages, these gravels and sands are considered to be the shingle deposits laid down at the margin of a gulf of the sea which occupied the London Basin in Pliocene times (Wooldridge, 1927). Further, according to Bury, the concentration of pebbles of Greensand chert in the gravels at the eastern and western extremities of the plateau indicates that two consequent rivers discharged into the sea on either side of the central plain. These rivers may be regarded as the ancestors of the River Blackwater and the Headley-Crondall stream (*cf.* Fig. 1a, *First Stage*). Chert pebbles are occasionally found in the gravel occupying the central part of the plateau; these might have been washed along the coast by longshore currents. In the centre of the plateau the thickness of the Cæsar's Camp gravels is 10–12 feet, but thicknesses of up to 27 feet are recorded on the western flanks, and even greater thicknesses on the southern flanks. This suggests that the gravels were deposited during a period of submergence and thus filled pre-existing river valleys, both longitudinal and transverse. The fact that the coarse gravels are everywhere overlain by sands is a further indication of the gradual drowning of the topography during this stage.

References.

Bury, H. 1922. "Some High Level Gravels of North-East Hampshire." *Proc. Geol. Assoc.*, XXXIII, pp. 81–103.

Dines, H. G., and Edmunds, F. H. 1929. "The Geology of the Country around Aldershot and Guildford." *Mem. Geol. Surv.*

Wooldridge, S. W. 1927. "The Pliocene History of the London Basin." *Proc. Geol. Assoc.*, XXXVIII, pp. 49–132.

THE RIVER TERRACES OF THE FARNHAM DISTRICT.

Introduction.

The spreads of river gravels occurring at various heights in the Farnham area represent relics of formerly extensive flood-plains. The earlier of these gravel spreads cap plateaux and hill-tops; they represent dissected flood-plains of great antiquity and bear little relationship to the present drainage system. Later gravels occupy terraces along the sides of the present valleys. The deposition of each of these sheets of gravel took place at the end of a cycle of downcutting, when erosion was at a minimum and generally at a time when the rivers had become adjusted to the contemporary base-level. Under such conditions the rivers would have meandered over wide flood-plains. An exceptionally thick deposit of river gravel would indicate a period of prolonged aggradation of the river bed probably due to an actual rise of the controlling base-level (*e.g.*, a rise of sea-level relative to the land). Whenever the base-level falls rivers renew their downcutting and leave the margins of their former flood-plains as terraces along the valley sides. Thus the existence of a series of terraces indicates that there has been an alternation of periods of valley-cutting (corrasion) and periods of aggradation, with the balance in favour of erosion.

The Pleistocene river-gravels of this area can be classified most conveniently according to height (see Fig. 2). Bury recognized five Palæolithic terraces, A, B, C, D, and E. A

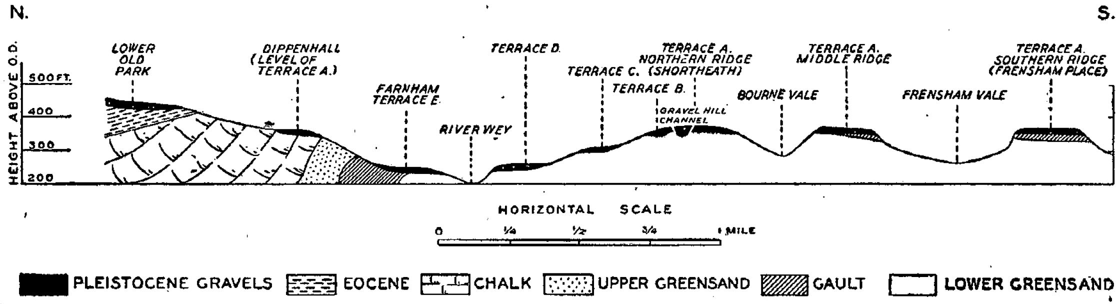


FIG. 2.—DIAGRAMMATIC SECTION ACROSS THE FARNHAM DISTRICT, SHOWING THE GRAVEL TERRACES.

(*Based on Dines and Edmunds,* 1929.)

pre-Palæolithic terrace can be recognized at a higher level than Terrace A. It may be termed the Old Park Terrace (P.).

The following account is based largely on the published works of Bury, a list of which is appended at the end of the section.

Pre-Palæolithic Gravels—Old Park Terrace.

The patches of gravel lying between 420 feet and 450 feet above O.D. at Lower Old Park on the north side of the Farnham valley were in all probability laid down by the consequent river which has been named the Headley-Crondall stream (see Fig. 1a, *First Stage*). They are grouped about a line passing from south to north through the Crondall Gap, and lie at about the same elevation as the floor of that gap. They grade with the chert-bearing gravels which occur on the spurs of the Fox Hills on the east side of the present Blackwater valley. These latter gravels were probably laid down contemporaneously by the parallel Blackwater consequent. Chert pebbles are also relatively abundant in the Lower Old Park gravels, and their large size indicates direct derivation from the Hythe Beds of Hindhead. No implements have been found in this terrace.

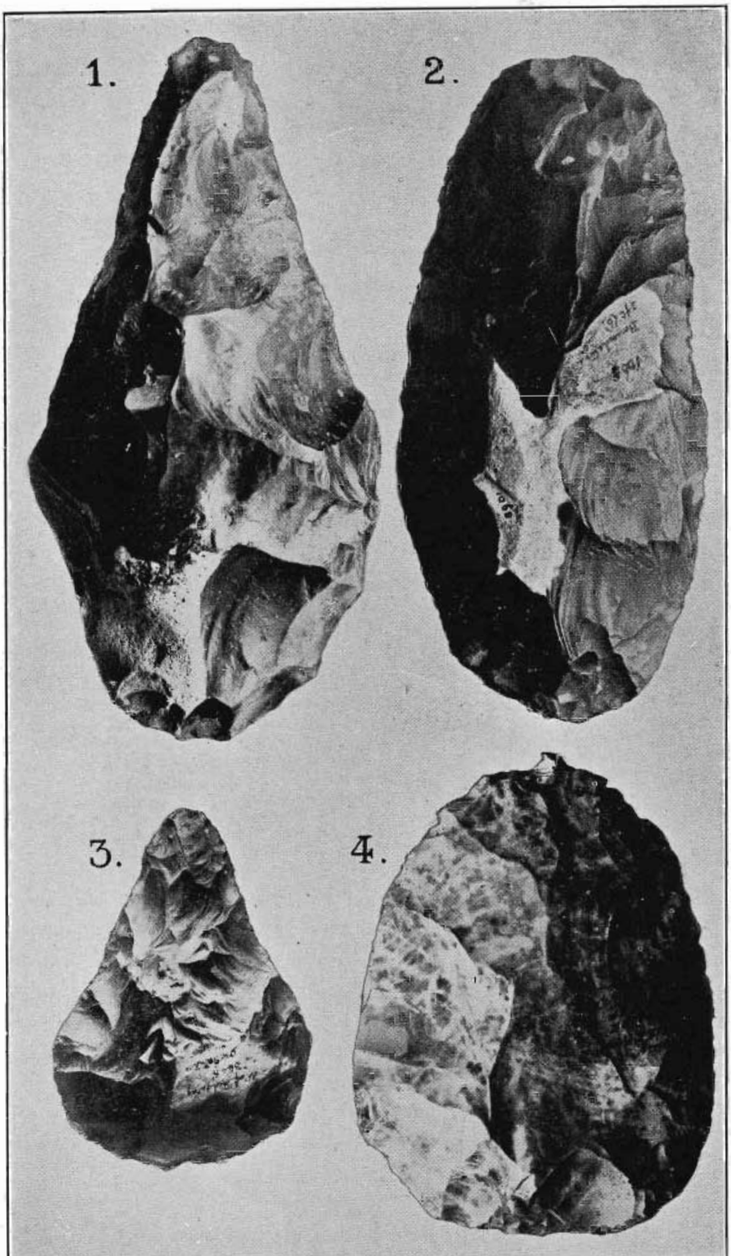
Dippenhall Gravels.

These occur at a distinctly lower elevation than the gravels of Lower Old Park, and they are here classified with Terrace A (see pp. 23–4). It is possible, however, that they are pre-Palæolithic in age. The only flint resembling an artifact which has been found in the Dippenhall gravels (Bury, 1916, p. 153) is now considered by Bury (*in litt.*) to be natural.

Palæolithic Gravels.

Terrace A.

This is the highest of the Palæolithic river terraces. Its gravels cap the remnants of a dissected plateau lying between the present Farnham river and the Tilford river. The most



PALÆOLITHS FROM FARNHAM DISTRICT.

1. Early Acheulian hand-axe from Terrace A, Farnham. (½) 2. Early Acheulian hand-axe from Terrace A, Boundstone. (½) 3. Middle Acheulian hand-axe from Terrace B, Farnham. (½) 4. Hand-axe of Levalloisian type from Terrace D, Farnham. (½)

(*Reproduced from Bury*, 1913.)

extensive remnant of this gravel-capped plateau is the high ground to the west of the area, occupied by Alice Holt forest. From the Alice Holt plateau three parallel ridges extend eastwards across our area as far as the Waverley valley. Each of these is capped by ancient river gravels. The coombes which separate these ridges are certainly of recent origin, and there can be no doubt that the gravels which cover the summits of the latter, together with those on Alice Holt plateau itself, once formed part of a continuous sheet of alluvium. The full extent of this former flood-plain is difficult to determine, but it is probable that the gravels on which the village of Dippenhall stands, and other patches of gravel at about the same level along the north side of the Farnham valley, are all remnants of the same sheet.

The plateau shows a general slope towards the north-east, the surface falling from 400 feet above O.D. at Alice Holt to 353 feet above O.D. at the eastern termination of the northernmost ridge. This was clearly the general direction of the drainage at the time when the gravels which lie on the plateau were laid down.

The northern ridge extends from Alice Holt through Shortheath to Greenhill Farm. It has become known as the Shortheath ridge. It is separated from the middle gravel-capped ridge by the Bourne vale. The middle ridge extends from Rowledge through Boundstone to Longdown and Gold Hill. The Frensham vale separates it from the southern ridge, which runs from Rowledge *via* Frensham Place to Gong Hill.

Alice Holt plateau itself is cut in Gault clay, while its eastward extensions are formed of Folkestone sands. The gravels of Terrace A, which are preserved in patches on the plateau and on the crests of the ridges, have an average thickness of from 7 to 10 feet, but much greater thicknesses have been recorded locally. Monckton and Mangles give the greatest thickness of gravel on the Shortheath ridge as 25 feet. The gravels consist mainly of sub-angular flints, together with small proportions of black-coated pebbles from the Eocene beds, and pebbles of quartz and Lower Greensand chert. The content of Greensand chert in these gravels varies considerably from place to place. On the northern ridge only about 1 per cent of the pebbles are cherts, except near Greenhill Farm, at the eastern extremity of the ridge, where the percentage is much higher. The gravels on the middle and southern ridges are on the average much richer in chert than those on the northern ridge. The Dippenhall gravels (Bury, 1910) are relatively rich in chert, and some authorities regard this as an indication that they were not laid down by the subsequent river responsible for the deposition of the gravels on the Shortheath ridge, but by the former Headley-Crondall stream. However, on account of their elevation being lower than that of the Old Park gravels they are here classed with Terrace A. One thing that is quite certain is that the gravels comprising Terrace A are not all of one age. The Dippenhall gravels are probably the oldest components of this group.

In discussing the antiquity of a terrace it is necessary to distinguish carefully between the age of the solid platform and the age of the gravels which rest on it. The Alice Holt plateau is undoubtedly a very old physiographic feature. It represents the peneplain which resulted from a period of prolonged base-levelling by the Blackwater consequent, the Headley-Crondall stream, and their tributaries. Regarded thus, "Terrace A" is probably a late Pliocene feature. During subsequent periods, rises of base-level, and perhaps other factors, caused the rivers flowing on this peneplain to aggrade their beds so that sheets of gravel were laid down on wide flood-plains. The conditions were such that the deposits of separate rivers co-mingled during periods of flooding. It was probably during such periods that river-captures were initiated, although these changes in the drainage would not have become firmly established until the rivers had been rejuvenated through a fall in base-level.

While the gravels of Terrace A may be of more than one age, it is unlikely that any of them are older than Lower Pleistocene. The distribution of Palæolithic implements, together with their varying conditions of preservation in different parts of the Terrace, points to the rivers having returned to Terrace A through aggradation of their beds after having descended to lower levels. Each time the rivers aggraded their beds to the level of Terrace A they would naturally tend to re-sort gravels which were already there. At several localities on Terrace A the gravels have yielded

Abbevillian (Chellian) hand-axes, but these are always found in a highly abraded condition. They are, however, commoner at this level than on lower terraces. It is probable that gravels were laid down on Terrace A during Abbevillian times, but it is likely that at some subsequent period they were resorted by fluviatile action, and their contained implements abraded in the process. In redeposited gravels such implements would be associated with types contemporary with the resorting. Amongst the latter there would be a larger proportion of unrolled specimens. These are the conditions which apparently apply to the implement-bearing gravels on Terrace A.

Many of the flint implements recorded as having come from this terrace have undoubtedly come from the surface layers which have been disturbed by a process known as " trailing " (see pp. 28–9). Such finds are, of course, no evidence of the date of the fluviatile deposits. There are only two or three localities on Terrace A where unabraded implements have been found in the undisturbed, stratified river gravels. The most important of these are in the so-called Gravel Hill channel,[1] on the northern ridge, and at Boundstone on the middle ridge. The characteristic implements recorded from both localities are large hand-axes of Early Acheulian type. It is probable that these implementiferous deposits represent the infillings of channels which had been cut through the main sheet of Terrace A gravels. At Gravel Hill the gravels descend to a greater depth than in neighbouring parts of the ridge. Thicknesses of at least 25 feet have been recorded along a belt trending north-eastwards across the locality. This belt must represent the infilled channel of a longitudinal stream which flowed into the transverse valley of the Blackwater consequent lying east of the line of the Tilford road. The deposits filling this Gravel Hill channel—as Bury has named it—are deficient in pebbles of Hythe chert and therefore were presumably deposited by a river flowing directly from the south-west, receiving no contribution from the Hindhead area. Such would be the case with the Farnham river after the capture of the Headley stream by the Tilford river (Fig. 1c, *Third Stage*).

[1] Two pits have yielded implements here : Ward's pit (where Bourne Church now stands) and the Averley Tower pit (still open). See Map.

The Gravel Hill and Boundstone channels clearly mark a period of ravinement when the main consequent stream was flowing at a level below that of Terrace A. (*i.e.*, at the Stoneyfield level; see p. 38). Subsequently aggradation filled these channels up to the level of the surface of Terrace A, so that

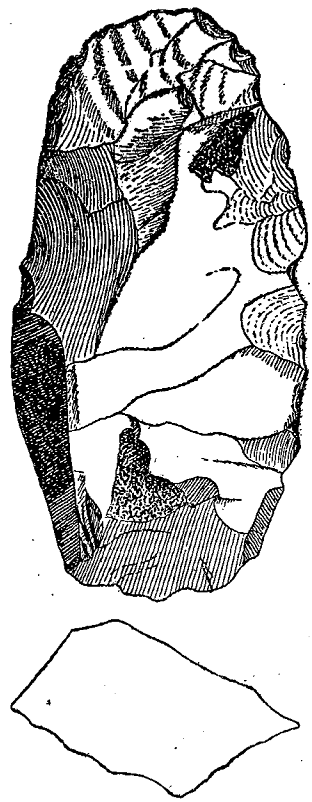


FIG. 3.—EARLY ACHEULIAN HAND-AXE FROM TERRACE A, BOUNDSTONE. (½)
(*Reproduced from Bury*, 1916.)

the longitudinal streams which had occupied them were again free to shift their courses.

The Boundstone gravels are precisely comparable with those filling the Gravel Hill channel. They lie below the main plateau level, their surface being only 360 feet above O.D., whereas the nearest point on the northern ridge has a surface level of 374 feet above O.D. They have yielded large Early Acheulian hand-axes in unrolled condition, similar to those from Gravel Hill (see p. 29). The Boundstone gravels are much richer in chert than any on the northern ridge, and therefore it seems probable that they were deposited in a channel of the ancestral Tilford river, which had at this stage captured the headwaters of the Headley stream and would consequently have been receiving contributions from the Hindhead area. Bury, however, considers that during Early Acheulian times the eastward extension of the Alice Holt plateau was drained by a whole series of longitudinal streams, of which the Gravel Hill channel stream was only one. He suggests that others have survived as the Bourne and Frensham vales, and he would refer the Boundstone gravels to an early stage of the Bourne. It seems equally reasonable to attribute the Gravel Hill channel to the ancestral Farnham river, and the Boundstone gravels to the ancestral Tilford river, and to regard the Bourne and Frensham vales as having originated independently in recent times through spring action.

Recently it has been claimed that the gravels on Terrace A are not fluviatile at all, but are to be ascribed to some sort of "glacial" action. This claim has been made by Wade and Smith (1935), who suggest that the gravels would be better described as "contorted drift." It may be said with fairness, however, that these suggestions have been completely countered by Bury (1936). In the first place there is not a shred of evidence that glaciers ever extended as far south as the Farnham area during Pleistocene times. No northern erratics are found in the gravels of the area. Glacial action in the strict sense can therefore be ruled out. The main argument employed by Smith and Wade against the fluviatile origin of the Terrace A gravels is that they are unstratified and show contortions. Bury, however, has demonstrated that this applies only to the upper 4 feet or so, and that where the gravels are of greater thickness than this there is unmistakable evidence of stratification below. This is well displayed in the pit at Averley Tower (surface level, 354 feet above O.D.) which exposes some 14 feet of the gravels filling the Gravel Hill channel (Pl. II, Fig. 1). Here, 4 to 7 feet of grey gravel overlie 7 to 10 feet of red gravel and sand. To a depth of 4 feet the grey gravel is considerably disturbed, many of the pebbles having their longer axes vertical. The amount of disturbance diminishes with depth, and below about 7 feet from the surface the section shows layers of coarse gravel interstratified with lenses of well-graded sand. In the Farnham Gravel Company's pit (surface, 366 feet above O.D.), Green Lane, lying to the west of the Gravel Hill channel, the gravels, although thinner and disturbed almost throughout their thickness, show patches of well-stratified material near the base.

There is no denying the disturbed condition of much of the gravel on Terrace A, but there is no reason to suppose that such material was never stratified. The term "contorted drift" merely describes the present condition of a Pleistocene deposit, and should leave the origin of the deposit, and its character prior to contortion, entirely open. It is perfectly clear that in the case of the high terraces of the Farnham area we are dealing with gravels that were originally stratified throughout, but which have been affected by certain "trailing" agencies which have tended to obliterate stratification to depths of 4 feet or more.

Although the Farnham area has never been glaciated, it would, nevertheless, have been a periglacial region during the various glacial phases of the Pleistocene when ice-sheets occupied East Anglia and Central England. Under periglacial conditions two agencies are at work which tend to disturb the upper layers of drift deposits, namely *brödelbewegung* and solifluxion. Both these phenomena are connected with alternate freezing and thawing of the subsoil in sparsely vegetated areas. During the coldest phases of the Pleistocene the ground in the periglacial area would have been frozen to a considerable depth. The upper few feet of this *tjaele*, or frozen zone, would have been affected by seasonal thaw. On sloping surfaces the top few feet of the tjaele in arctic or periglacial regions tends to flow as the ground-ice gradually thaws. This process is known as solifluxion. If the tjaele is a gravel, the flints in the partly frozen sludge are dragged over the hard, permanently frozen zone below, and in this way their surfaces become scored and striated just as do the erratics on the "sole" of a glacier.

1. Terrace A: Averley Tower pit, showing 4–6 feet of well-stratified gravel overlain by 4–6 feet of disturbed gravel.

2. Terrace B: Stoneyfield pit, showing stratified gravel and sand overlain by solifluxion gravel. Depth, about 7 feet.

(*Photos by courtesy of Mr. H. Bury.*)

The minimum slope required for solifluxion may be estimated to be about 1°, that is approximately a fall of " 1 in 50." The surfaces of terraces frequently have transverse slopes exceeding that.

The other process, for which there is no single expression in English and for which we therefore employ the German term *brödelbewegung*, is most marked on flat surfaces. Each time the water-gorged subsoil in the periglacial zone is re-frozen after the seasonal thaw, the pressure of growing ice-crystals tends to rotate the stones and arrange them in positions which seem to simulate convexion currents in a boiling liquid. The physics of this process are still being investigated in arctic regions, but their effects are familiar. They lead to the formation of " stone-polygons " on the surface, and to the formation of festoons of " up-ended " stones in depth [1]; the festoons are visible in vertical sections. The constant repetition of this process leads ultimately to the destruction of stratification in the deposit affected, to a depth of 3 feet or more.

Both the processes described above appear to have been active in destroying stratification in the upper layers of the gravels on Terrace A. That such disturbance has occurred is scarcely surprising when it is realized that these gravels are of considerable antiquity and have probably witnessed at least two major periglacial phases.

The gravels in the Gravel Hill channel do not appear to be so deeply disturbed by solifluxion or so weathered as those beyond the limits of the channel, exposed, for instance, in the Green Lane pit. It is probable on general grounds that the older deposits on Terrace A pre-date, and that the gravels filling the Gravel Hill channel post-date, a major glacial phase : the Lower Chalky Boulder Clay glaciation.

Turning to consider the implements from the gravels of Terrace A in more detail, it may be emphasized again that the majority of the implements from the Gravel Hill channel are massive pear-shaped or long-ovate hand-axes of Early Acheulian type (Figs. 4–6, and Pl. I, Fig. 1). They are made of a peculiar cherty flint, yellowish-grey in colour. An extensive collection of these was accumulated by Lasham, but unfor-

[1] Dutch geologists have introduced the term *cryoturbate* to describe such structures.

tunately this has apparently been dispersed.[1] They were nearly all obtained from Ward's pit, which was situated where Bourne church now stands, on the east side of the Frensham road. From the high percentage of unrolled examples in the collection, we may conclude that the Early Acheulian type was contemporary with the filling of the channel. The Boundstone gravel pit has yielded a number of unrolled hand-axes of precisely the same type (Fig. 3, and Pl. I, Fig. 2), so that there is little doubt that the Boundstone gravels belong to

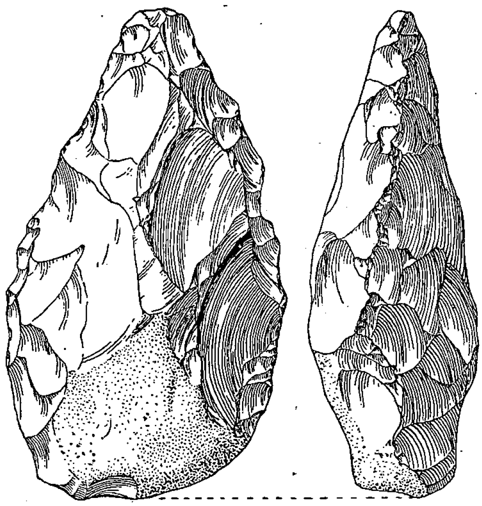


FIG. 4.—EARLY ACHEULIAN HAND-AXE FROM TERRACE A, FARNHAM. (½)
(*Wade Coll. del.* M. Leakey.)

the same phase of aggradation. Early Acheulian implements extend beyond the limits of the Gravel Hill channel, probably indicating that at this time there was a good deal of re-sorting of the older gravels. As pointed out above, it is probably for this reason that the Abbevillian hand-axes obtained from the older gravels of Terrace A are almost invariably in an abraded condition.

Several ovates of Middle or Upper Acheulian type are on record from Terrace A, but there is little doubt that they are

[1] Part of the collection is preserved in the museum of Sherborne School, Dorset.

all surface finds. In fact, many have the white patina characteristics of such palæoliths.

In addition to hand-axes, the gravels of the Gravel Hill channel have also produced a few Early Clactonian flakes (Bury, 1913, pp. 193, 196). This is of great interest in connexion with the correlation of these gravels.

Many of the hand-axes from the channel agree closely with the Early Acheulian bifaces from the 40-metre Terrace of the Somme at St. Acheul, figured by Commont (as "Chellian")

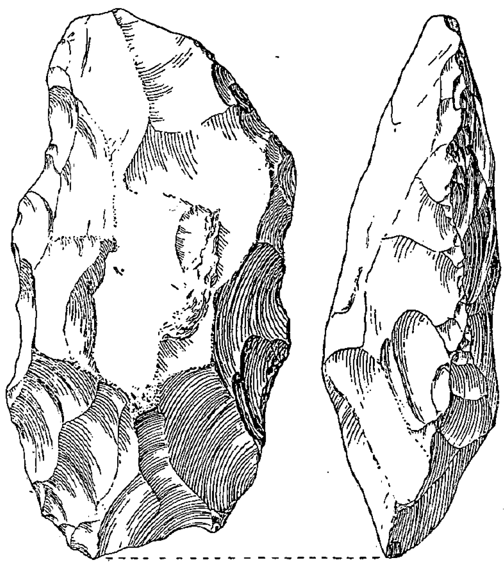


FIG. 5.—EARLY ACHEULIAN HAND-AXE FROM TERRACE A, SHORTHEATH, FARNHAM. (½)
(*Wade Coll. del.* M. Leakey.)

and reproduced by Breuil and Kosłowski (1931, p. 467, Fig. 7). However, the most advanced examples from Gravel Hill should probably be compared with the St. Acheul II bifaces which occur in the fluviatile gravels at the base of the 30-metre Terrace at St. Acheul. These latter gravels correspond with the Lower Gravel of the 100-foot Terrace of the Thames at Swanscombe.

It is probable, therefore, that the aggradation responsible for the filling of the Gravel Hill channel is to be equated with the Lower Barnfield stage recognized in the Lower Thames valley (King and Oakley, 1936, p. 56). The Lower Gravel of Swanscombe and the Gravel Hill channel both yield contemporary Early Clactonian artifacts, but whereas in the former they occur to the exclusion of other types, in the latter they are accompanied by, and in abundance exceeded by, Early Acheulian bifaces. It is not difficult to reconcile this difference with the suggested correlation because it is known that the

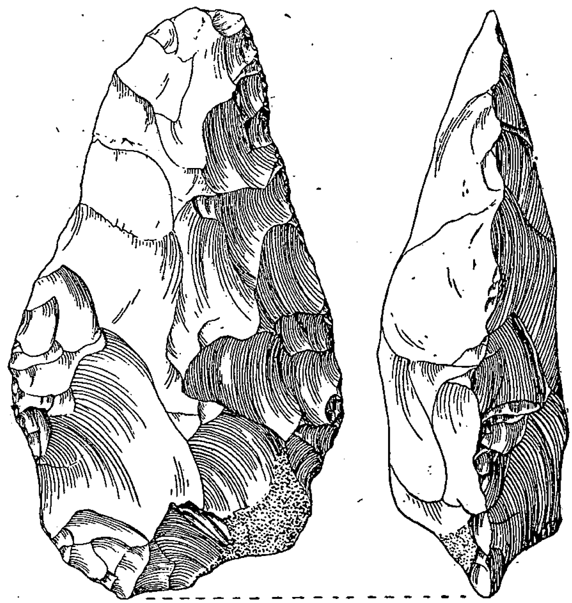


FIG. 6.—EARLY ACHEULIAN HAND-AXE FROM TERRACE A (GRAVEL HILL CHANNEL), FARNHAM. (½)
(*Wade Coll.* *del* M. Leakey.)

distribution of Acheulian culture at this time failed to coincide with that of the contemporary Clactonian culture. Whereas Early Acheulian industries are well represented in the Lower Somme valley, in the Hampshire valleys and in the Wey valley, they are much rarer in the Thames area and practically lacking in East Anglia. In these more northerly regions it may be surmised that Early Clactonian flake cultures predominated and occured locally to the exclusion of Acheulian hand-axe cultures. It has to be borne in mind, however, that the absence of Early Acheulian implements in the Lower Thames valley is partly due to the fact that the valley as we know it only came into being at the close of the period when that industry was current.

Terrace B.

Excavations for gravel along the northern edge of the Shortheath ridge, as at Great Austins, Knight's Field, Broken Back Field, and Paine's Field, have shown that there is a strip of stratified gravels and sands banked against the cliff of Lower Greensand which forms the northern edge of Terrace A. This strip of gravel extends from the Tilford road to Green Lane, and constitutes Terrace B of Bury. It is probably a polygenetic terrace.

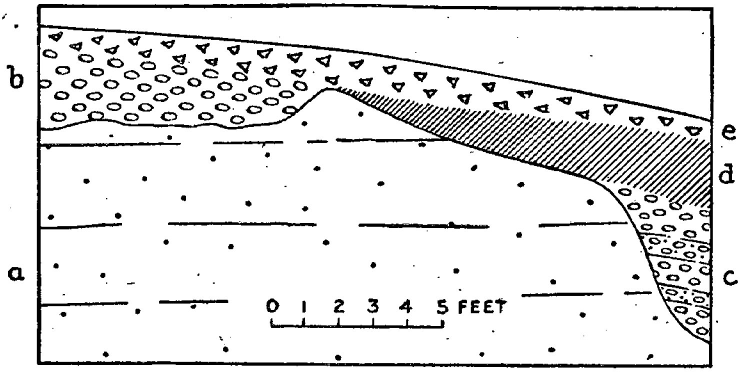


FIG. 7.—SECTION SHOWING JUNCTION OF TERRACES A AND B, BROKEN BACK FIELD, FARNHAM.

a, Lower Greensand. *b*, Terrace A gravels (with abundant chert). *c*, Terrace B gravels (almost devoid of chert). *d*, Brickearth. *e*, Solifluxion gravel.

(*Based on Bury.*)

The ground slopes away uniformly from the edge of Terrace A, so that there is no surface indication of the presence of this second terrace; in fact, the Geological Survey did not attempt to separate it from Terrace A. Excavations have shown, however, that although the gravels forming the so-called Terrace B are built up to the level of Terrace A, they actually rest on a narrow shelf, some 200 yards wide, which is nearly 20 feet lower than the base of that terrace. The gravels of Terrace B are usually capped by brickearth, and this in turn by trail produced by solifluxion of the gravels of Terrace A (Fig. 7). It is largely the presence of this trail which is responsible for the masking of Terrace B as a surface feature.

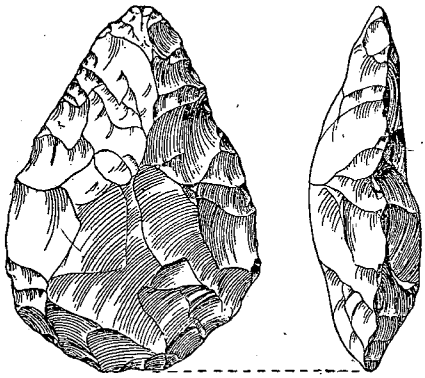


FIG. 8.—LATE-MIDDLE ACHEULIAN HAND-AXE FROM TERRACE B, FARNHAM. (½)
(*Wade Coll. del.* M. Leakey.)

The bottom of the Gravel Hill channel is practically on a level with the base of Terrace B. However, the contemporaneous implements from the gravels of the latter are more

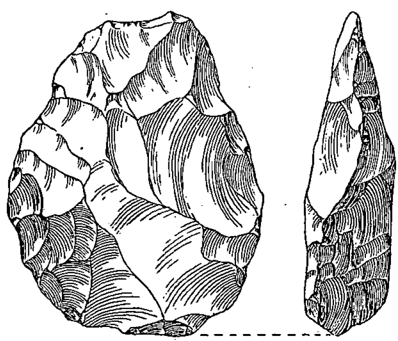


FIG. 9.—LATE-MIDDLE ACHEULIAN HAND-AXE (TWISTED OVATE) FROM TERRACE B, STONEYFIELD. (½)
(*Wade Coll. del.* M. Leakey.)

advanced in type than those from the channel, so that there is good reason for concluding that Terrace B marks a distinct and later phase of aggradation.

An extensive series of flint implements has been recovered from the gravels of this terrace, including numerous small pointed hand-axes with straight edges (Fig. 8; Pl. I, Fig. 3) referable to a Middle Acheulian culture. Ovate hand-axes occur,

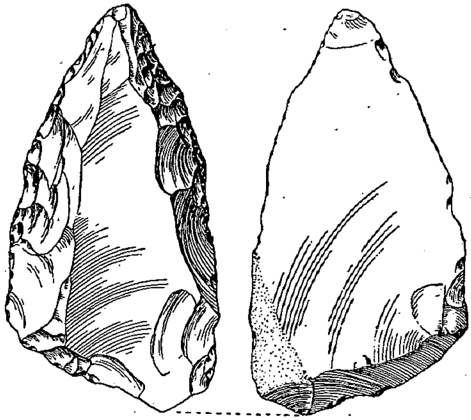


FIG. 10.—FLAKE-TOOL FROM TERRACE B, FARNHAM. (½)
(*Wade Coll.* *del.* M. Leakey.)

including a few of the twisted type (Fig. 9). These forms probably belong to a late stage of the Middle Acheulian. Although

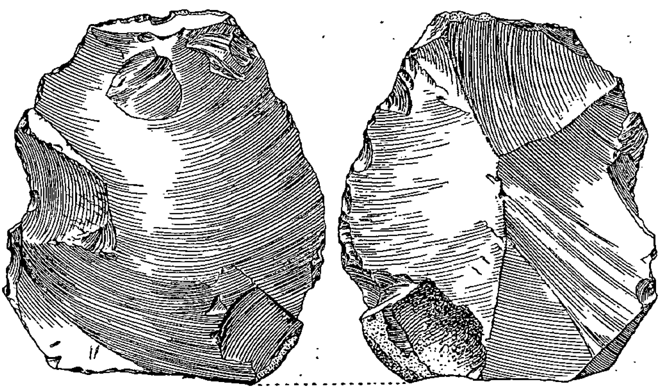


FIG. 11.—ROUGH CLACTONIAN FLAKE, TERRACE B (MIDDLE). NORTH OF RIDGEWAY ROAD, NEAR FARNHAM. (½)
(*Bury Coll.* 763. *del.* C. O. Waterhouse.)

only about 40 per cent of the hand-axes from Terrace B are unworn, the abraded ones are in the most cases identical in type with the unabraded ones. Compared with the Early

Acheulian forms found in the Gravel Hill channel and at Boundstone, they are remarkable for their small size. Accord-

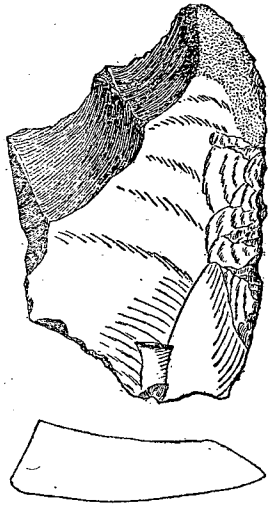


FIG 12.—FLAKE-TOOL OF EVOLVED CLACTONIAN OR HIGH LODGE TYPE FROM TERRACE B, FARNHAM. (½)
(*Reproduced from Bury*, 1916.)

ing to Bury's calculations 80 per cent of the hand-axes from Terrace B are less than 4 inches long, whereas the average

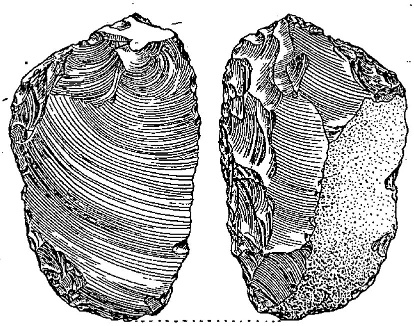


FIG. 13.—FLAKE-TOOL, OF TYPE APPROACHING HIGH LODGE CLACTONIAN. TERRACE B. BROKEN BACK FIELD, NEAR FARNHAM. (½)
(*Bury Coll.* 1273. *del.* C. O. Waterhouse.)

length of the hand-axes from Boundstone is 6 inches. Derived examples of the large hand-axes characteristic of Terrace A are very rare in the terrace.

Flake-tools are also found in the gravels of Terrace B, and while some are probably Acheulian (Fig. 10), many are unmistakably Clactonian in facies. Of the latter those from the lower layers of the terrace appear to belong to an advanced stage of Clacton II, whereas in the middle and upper layers evolved Clactonian forms, almost approaching the High Lodge type, occur (Figs. 12, 13 and 14). In the style of their secondary

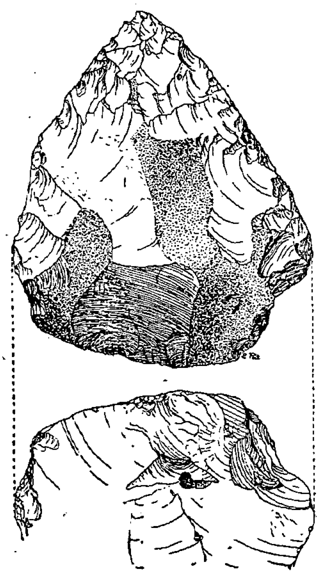


FIG. 14.—FLAKE-TOOL OF CLACTONIAN III TYPE, SHOWING SIGNS OF ACHEULIAN INFLUENCE. TERRACE B (NEAR TOP). RIDGEWAY, FARNHAM. (½)

(*H. Bury Coll.* 1250. *del.* E. Paterson.)

working, some of these latter (Fig. 14) show indications of Acheulian influence.

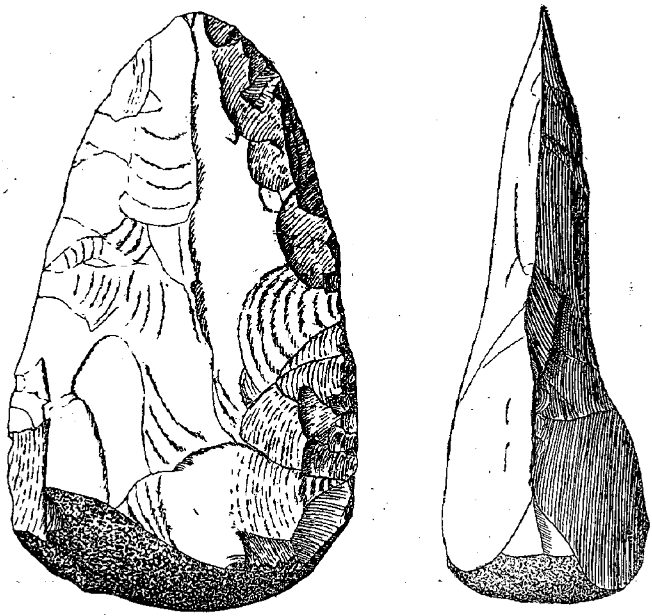
From its contained implements, Terrace B would seem to correspond exactly with the Middle Gravel of the 100-foot Terrace of the Thames at Swanscombe.

The main lines of the drainage of the area had probably changed little between the time of the filling of the Gravel Hill channel and the deposition of the gravels on Terrace B, but important changes in base-level appear to have taken place.

After the aggradation of the Gravel Hill series the Farnham river and the consequent Blackwater became rejuvenated and excavated the floors of their valleys to a considerable depth. The exact depth to which the valleys were eroded at this time is uncertain. There was clearly a pause accompanied by lateral planation at 25 to 30 feet below the top of Terrace A, during which the bench of Terrace B was cut, but it is probable that this was followed by renewed downcutting. Bury suggests that the Farnham river may have cut down to the level of Terrace D before the aggradation represented by the gravels on Terrace B set in. In support of this he cites the occurrence of a hand-axe of Middle Acheulian type at the base of deposits resting on the bench of Terrace D. This is not, however, indubitable proof that the river occupied the level of Terrace D at some stage during Middle Acheulian times, since the implement might have been transported by solifluxion from a higher level within a lump of gravel, and thus escaped abrasion. On the other hand, the occurrence of a transverse furrow across the solid floor of Terrace B (Bury, 1916, p. 162; 1936, p. 65) proves that erosion to below the general level of that terrace took place before the aggradation of the gravels which rest on it. This phase of erosion, coming between the deposition of the Gravel Hill deposits (which as we have seen probably correspond with the Lower Gravel of the 100-foot Terrace of the Lower Thames) and the aggradation of the gravels on Terrace B (equivalent to the Middle Gravels of the 100-foot Terrace of the Thames), appears to correspond exactly with the inter-Boyn Hill erosion stage (King and Oakley, 1936, p. 57), during which the Clacton channel was cut.

The south-westerly derivation of the deposits forming the main stretch of Terrace B in the Farnham valley is attested by the occurrence of seams of clay in their make-up. This clay was picked up by the Farnham river as it traversed the outcrop of the Gault in the south-western part of the area.

The formation of Terrace B pre-dated the capture of the headwaters of the River Blackwater by the Godalming river, for the terrace can be traced along the western side of the Waverley valley, sloping northwards from Gong Hill, through Lodge Hill to Stoneyfield. At Stoneyfield the terrace is represented by a spread of gravels lying some 30 feet below the level of Terrace A, and separated from the latter by a marked transverse bluff running NNW.–SSE. Further proof that the Stoneyfield gravels belong to the old Blackwater consequent, and not to the Farnham river, is found in the relative abundance of Greensand chert in their make-up. The Stoneyfield spread (surface level, 320 feet above O.D.) has suffered greater degradation than the gravels of the main Terrace B in the



a b

FIG. 15.—LATE ACHEULIAN HAND-AXE FROM BRICKEARTH OVERLYING TERRACE B, FARNHAM. (½)

(*Reproduced from Bury.* 1916.)

Farnham valley, largely owing to its more sandy constitution—another reflection of the southerly derivation of its constituent material.

The thin representative of the fluviatile deposits of Terrace B preserved at Stoneyfield is overlain and locally replaced by a spread of solifluxion gravel (Pl. II, Fig. 2). The stratified gravels of this terrace in the main Farnham valley are similarly overlain. Locally, the surface of the stratified deposits is channelled and capped by loam with festoons of solifluxion gravel near the top. A sharp cordate hand-axe (Fig. 15), comparable with a type which in France would probably be referred to St. Acheul V of Breuil's classification, has been recovered from this loam. It seems to fix the formation of some of the " coombe deposits " on the surface of Terrace B as being contemporary with the Main Coombe Rock solifluxion of the Lower Thames valley.

Terrace C.

This terrace, sometimes termed the Culverlands Terrace, is mainly preserved along the right bank of the Farnham Wey, but small patches of gravel of corresponding elevation can be traced along the left bank. On the right bank the terrace can be traced continuously from Snailslynch to a point just east of Green Lane. The triangular patch of gravel on which Wrecclesham stands has been shown by Major Wade to belong to this terrace.

The terrace has a maximum width of about 200 yards, with a relatively even base some 90 feet above present river-level. The fine stratified gravels which form it are locally overlain by a thin spread of clayey loam. The total thickness of deposits averages about 10 feet. Where there is capping of loamy clay or brickearth the surface of the gravel appears to be slightly eroded, but there is much less evidence of solifluxion on this terrace than on Terrace B. In Wakeford's pit gravelly festoons occur at the base of the capping of brick-earth (Pl. III, Fig. 1).

We may conclude that after the aggradation of the gravels which compose Terrace B, the Farnham river was rejuvenated and proceeded to re-excavate its valley to a depth of about 50 feet. During or immediately after this phase of valley deepening there may have been a period of cold accompanied by marked solifluxion. There followed a period of aggradation in the course of which the gravels of Terrace C were laid down. This was followed by further slight solifluxion and formation of brickearth.

Unlike the preceding terrace, Terrace C proper cannot be traced from the Farnham valley into the Waverley valley, so that it is almost certain that the capture of the headwaters of the Blackwater by the subsequent Godalming river took place between the deposition of the Terrace B gravels and the formation of Terrace C. On general grounds (see p. 24) it seems most likely that the capture took place on the flood-plain represented by the surface of Terrace B.

Thin spreads of gravel of rather doubtful character occur at Sheephatch and Tilford Reeds in the region of the debouchment of the Waverley valley into the Godalming valley. From their elevation above present river-level they would appear

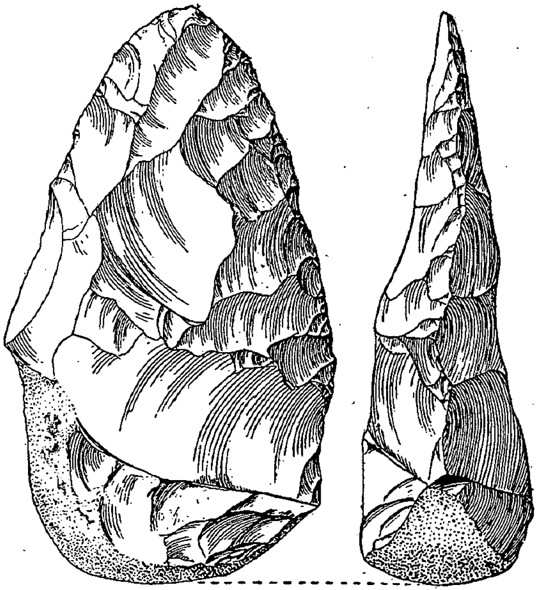


FIG. 16.—LATE OR LATE-MIDDLE ACHEULIAN HAND-AXE FROM TERRACE C, WAKEFORD'S PIT, FARNHAM. (½)
(*Wade Coll. del.* M. Leakey.)

to correspond with Terrace C of the Farnham valley. The fact that they are predominantly flint gravels indicates that they represent a wash from the north, and therefore that they post-date the capture of the headwaters of the Blackwater. That is to say, they are probably of about the same age as the gravels of Terrace C of the Farnham valley, but of independent origin.

During the deposition of the gravels of Terrace C the Farnham river flowed through the gap at Runfold into the valley

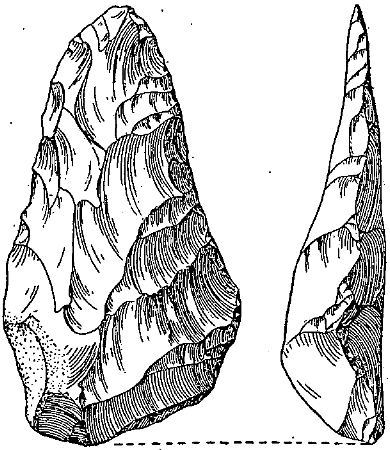


FIG. 17.—LATE ACHEULIAN HAND-AXE FROM TERRACE C, ELLSMORE'S PIT, WRECCLESHAM. (½)

(*Wade Coll.*, B.M., 1934, 12-16, 24. *del.* M. Leakey.)

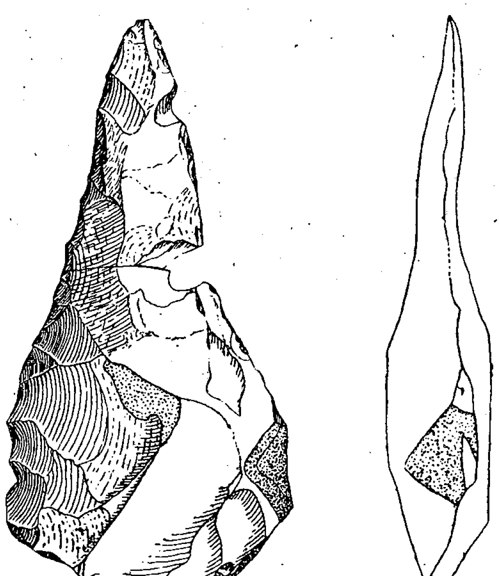
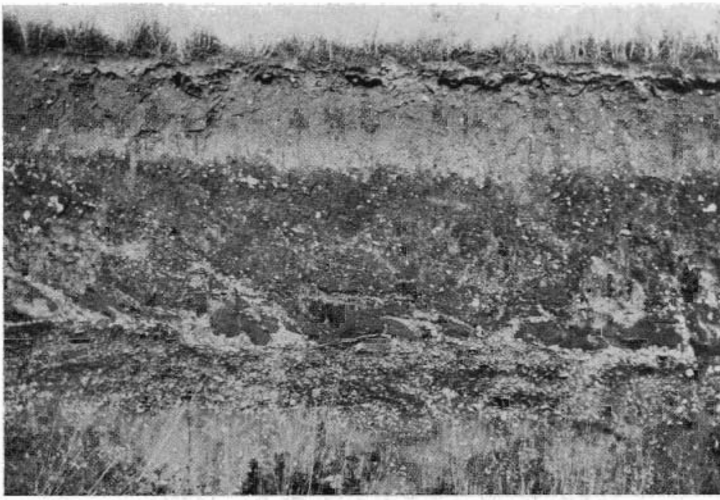


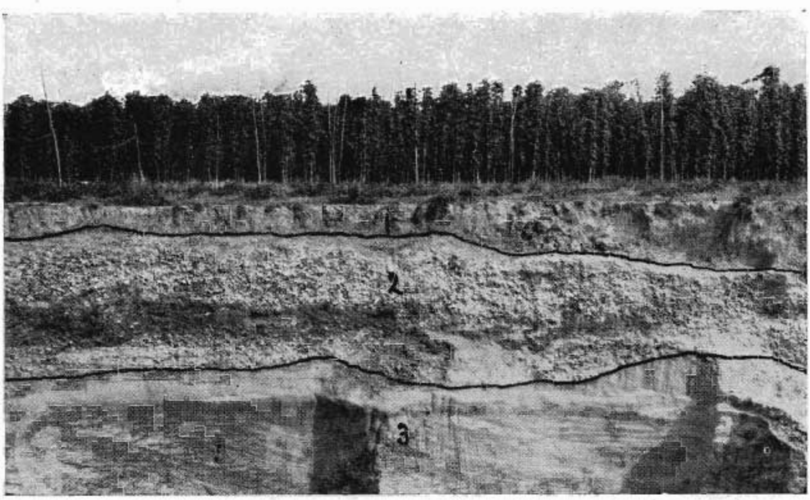
FIG. 18.—LATE ACHEULIAN HAND-AXE FROM TERRACE C, FARNHAM. (½)

(*Reproduced from Bury*, 1916.)



1. Terrace C: Wakeford's pit, Farnham, showing brickearth, with gravelly festoons near base, overlying stratified gravels. Depth, about 6 feet.

(Photo A. G. Wade.)



2. Terrace D: Weydon pit, near Farnham, showing (1) brickearth, (2) gravels, (3) Lower Greensand.

(Scale indicated by 12-foot hop-poles.)

(Reproduced from Moir, 1929.)

facing page 42]

of the beheaded Blackwater. At Heath End, north of the gap, there is a patch of river gravel which grades with Terrace C of the Farnham valley.

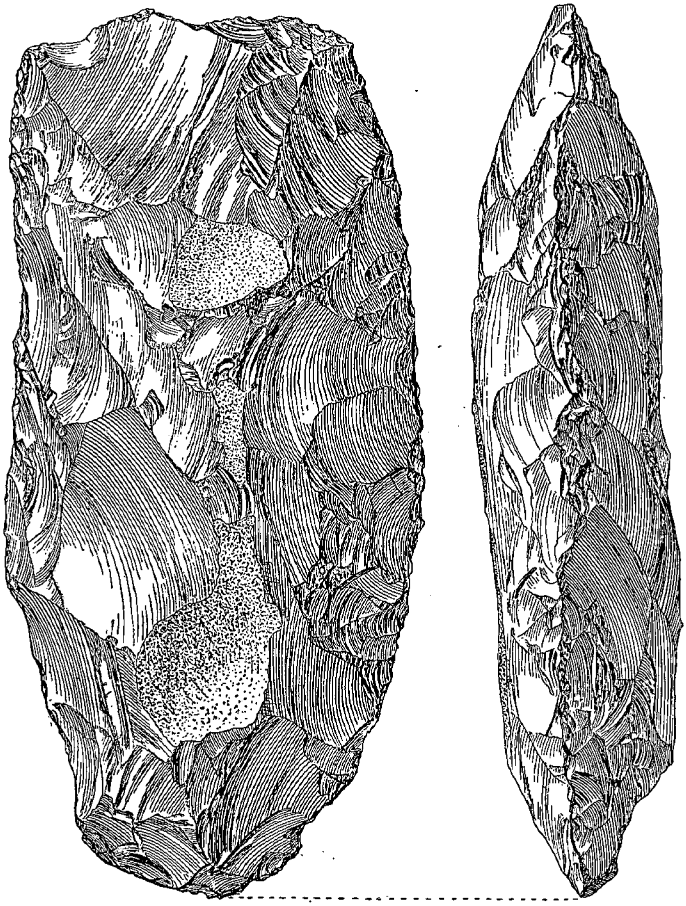


FIG. 19.—MIDDLE ACHEULIAN "CLEAVER" ($9\frac{1}{8}'' \times 4\frac{1}{4}'' \times 2''$) FROM TERRACE C, WAKEFORD'S PIT, FARNHAM. ($\frac{1}{2}$)
(*Smither Coll. del.* C. O. Waterhouse.)

Typical sections in Terrace C are provided by Wakeford's pit, east of Tilford Road (Pl. III, Fig. 1), and the Upper Snailslynch pit, where the surface levels are respectively 312 feet and 302 feet above O.D.

Flint implements are rarer in the gravels of Terrace C than in Terrace B, and the great majority are derivatives from higher levels. A certain number of thin hand-axes of Micoque

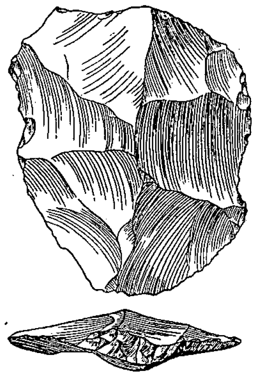


FIG. 20.—LEVALLOISIAN FLAKE FROM TERRACE C, FARNHAM. (½)
(*After Bury*, 1913.)

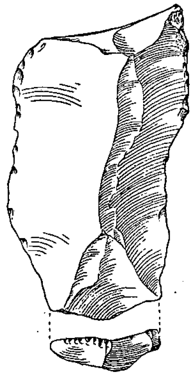


FIG. 21.—MIDDLE LEVALLOISIAN FLAKE. TERRACE C. TANNER'S PIT, WRECCLESHAM. (½)
(*Wade Coll. del.* M. Leakey.)

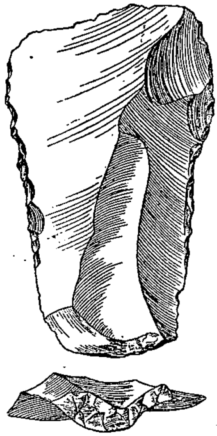


FIG. 22.—MIDDLE LEVALLOISIAN FLAKE FROM TERRACE C, FARNHAM. (½)
(*After Bury*, 1913)

(or at any rate Upper Acheulian) type occur, and it may be that these are contemporary with the gravels of the terrace (Figs. 16–18). Of greater significance, however, is the occurrence of numerous flakes with the faceted butts which typify the Levalloisian industries. Although these Levalloisian flakes are in most cases slightly rolled, they nevertheless provide a clue to the date of the terrace, since they are not found in the stratified deposits of any higher terrace. Some of them are undoubtedly Early Levalloisian, but many make a close approach to Middle Levalloisian types (Figs. 20–22). The relative abundance of Early-Middle Levalloisian flakes in Terrace C indicates correlation with the Late 50-foot, or Taplow Terrace of the Lower and Middle Thames valley.

An interesting recent find in the gravels of Terrace C is a large "cleaver" (Fig. 19), remarkable for its straight edge.

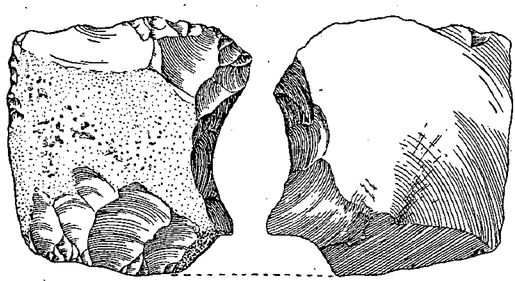


FIG. 23.—FLAKE-TOOL OF LATE CLACTONIAN TYPE, FROM UNDER CLAY AT TOP OF GRAVELS OF TERRACE C. ELLSMORE'S PIT, WRECCLESHAM. (½)
(*Wade Coll. del.* M. Leakey.)

This type of hand-axe is commonly associated in England with Middle Acheulian culture. A similar implement has recently been reported from the East Burnham gravels (Lacaille, 1939, p. 178; Pl. XL, No. 12).

The occasional occurrence of unabraded Middle Acheulian hand-axes in parts of Terrace C suggests that the Terrace may include remnants of the gravels laid down during the period of aggradation which culminated in the deposition of the Terrace B gravels (see p. 38).

Wade and Smith (1935, p. 351) have reported a flake-implement of Clacton III type from the loamy clay overlying the gravels in Ellsmore's pit, Wrecclesham (surface level, 332 feet above O.D.). Bury considers that this clay is of the nature of a hill-wash, and that the implement in question is a derivative of Terrace B. However, the fresh condition of the implement rather suggests that it is contemporaneous with the containing deposit. Another example, found more recently, is shown in Fig. 23. Perhaps these represent a late revival of the Clactonian—a suggestion which finds support in Burchell's discovery of finely made flake-tools, indistinguishable from the High Lodge type, on Crayfordian (*cf.* Middle Levalloisian) "floors" in the 50-foot Terrace of the Thames.

The aggradation represented by the gravels of Terrace C was arrested by a fall of base-level which resulted in a renewal of excavation of the valley. The river cut down about 50 feet, and then a change of conditions caused it to slow down and to deposit the coarse alluvium which now forms Terrace D.

Terrace D.

The main stretch of this terrace extends for 3 miles along the right bank of the Farnham Wey, from the foot of Alice Holt forest, in the south-west, to a point about half a mile north-east of Farnham Station, in the opposite direction. It reappears on the opposite bank, north-east of Farnham. A large rectangular patch of the gravels of this terrace is preserved to the north of High Mill, and extends into the Aldershot gap at Runfold.

Along the right bank of the Wey, Terrace D forms a well-marked feature. Its outer edge is defined by a steep 50-foot bluff bounding the present flood-plain (Pl. IV, Fig. 1). It has a flat top, some 400 yards wide, along which the Southern Railway Line runs (hence Terrace D is sometimes known as the Railway Terrace). The solid bench of the terrace maintains a fairly constant level, although locally its surface is channelled. It lies at about 50 feet above the present level of the Wey.

The gravel on Terrace D is 10 to 16 feet in thickness, and along the main stretch of the terrace is overlain by 4 to 8 feet of red loamy brickearth, possibly of subaerial origin (Pl. III, Fig. 2). The gravel is largely composed of flints. The lower layers are fairly well stratified, with lenses of sand. The upper layers are remarkable for their lack of grading and their clayey matrix. This may be largely due to the fact that the river which deposited them was traversing the Gault, and was conse-

[Geol. Surv. Photo. A3754.

1. Terrace D: the 50-foot river-cliff, at the top of which lie the gravels of the old Blackwater river. Wey valley, ¼ mile North-East of Farnham Station.

(Geol. Surv. Photo. A3760.

2. Terrace D: Lower Snailslynch pit, near Farnham, showing poorly-sorted river-gravels overlain by "trail" and brickearth. Depth, 10–12 feet.

facing page 46]

quently loaded with clay ; but the intimate admixture of clay-, sand- and gravel-grades in the upper beds of the terrace suggests that the river which deposited them lacked the necessary energy to sort fine material from coarse. The explanation is probably to be found in the climatic conditions which prevailed during the deposition of these upper gravels of Terrace D. The fauna and flora recorded in the lower beds of the terrace indicate an approach to tundra conditions. It is probable that when these cold conditions reached their maximum phase the ground was frozen to a considerable depth. During the seasonal thaws there would have been much solifluxion on the sparsely vegetated hill sides. Masses of partly-frozen sludge would have debouched into the main valley and loaded the river to such an extent that it was forced to deposit material without adequate sorting. Numerous small dry valleys debouch on to Terrace D, and these may well have contributed solifluid material to the river under the conditions postulated.

Mr. W. F. Rankine, who has had all exposures in deposits of Terrace D under observation for some years past, has drawn up the following generalized section. It is based on observations in nine pits.[1]

Brickearth	2 feet 6 inches
Festooned or unstratified gravel with clayey matrix	3 feet
Water-laid sub-angular gravel with clayey and ferruginous binding	4 feet
Current-bedded sand with large lenses of coarse gravel	3 feet

The sequence clearly records the development of progressively colder climatic conditions culminating in the disappearance of the river and the formation of trail on a frozen land-surface.

The stratified lower layers of the terrace have yielded bones and teeth of Mammoth (*Elephas primigenius*), Woolly Rhinoceros (*Tichorhinus antiquitatis*), and Wild Horse (*Equus caballus*). Mammoth teeth are common in the basal beds of the terrace throughout the Farnham valley (see p. 56). Mr.

[1] The majority of these are now derelict. At the present time good sections in the deposits of Terrace D are available in Tanner's pit, 1¼ miles west of Farnham Station (surface level 270 feet above O.D.) ; Lower Snailslynch pit ; and Weydon pit. See Geological Map.

Rankine has recently observed lenses of peaty material in the gravels exposed in Patterson's pit, close to Farnham Junction (Junction Pit), and in a pit at Badshot Lea. These have yielded remains of flowering plants and mosses, together with shells of freshwater and terrestrial mollusca. The shells recovered from the raft of peat exposed in the Junction Pit have been reported on by Mr. A. S. Kennard, who identified the following species (see Rankine, 1936):

Limnæa palustris (Müll.).
Planorbis leucostoma (Mill.).
Pupilla muscorum (Linn.).
Columella columella (Von Mts.).
Arion sp.
Limax sp.
Succinea pfeifferi (Rossm.).

Mr. Kennard remarks: "The freshwater forms are dwarfed and conditions were unfavourable. The faunule is clearly of the same age as Ponders End and shows boreal conditions probably similar to those of Lapland to-day."[1]

Miss M. E. J. Chandler kindly undertook to report on the flowering plants. In her detailed report, which appears in Appendix II (p. 54), she shows that the plants indicate a cool-climate flora essentially similar to that recorded from the so-called Arctic Beds of the Lea Valley (Reid, 1915) and Barnwell Station, Cambridge (Chandler, 1921). One sample of peat was found to be rich in the remains of mosses; these were sent to Mr. H. N. Dixon, who was good enough to investigate them. His report, which is also given in Appendix II (p. 55), reveals the occurrence of mosses which at the present time have a boreal-arctic distribution, or if they still occur in Britain are confined to the summits of certain Scottish mountains. He agrees that the flora is similar to that from the Arctic Bed at Ponders End (see Dixon, in Warren, 1912).

Although, as Miss Chandler has pointed out, a flora of the Ponders End type might have recurred at more than one period during the Pleistocene, in this case its occurrence falls into line with other evidence which indicates that the contain-

[1] July Isotherm: 8°–10° (Kennard and Woodward, in Warren, 1912, p. 239).

ing deposit is of the same age as the Ponders End beds (Warren, 1912, 1916, 1939). In other words, the 50-foot Terrace of the Farnham river corresponds not, as might be supposed, with the Taplow Terrace of the Lower Thames, but with the Upper Flood Plain Terrace. Sections in both terraces show a similar sequence. The stratified gravels in both show progressively less grading in upward sequence, the succession culminating in a well-marked trail (see King and Oakley, 1936, p. 67). At Ponders End, as at Farnham, the rafts of peat and the mammoth remains occur in the basal gravels. The flora and fauna of these peats may thus belong to the period preceding that of the maximum periglacial phase, and so they

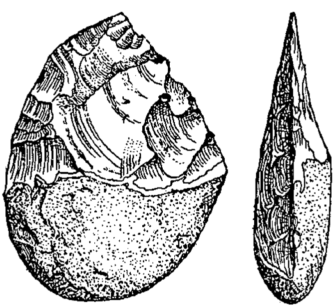


FIG. 24.—HAND-AXE, POSSIBLY LEVALLOISIAN, FROM TERRACE D, PARKFIELD PIT, FARNHAM. (½)
(*Rankine Coll. del.* W. F. R.)

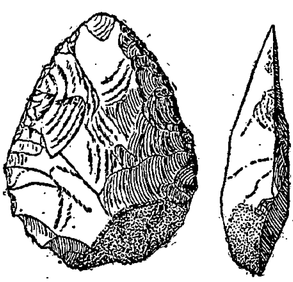


FIG. 25.—LEVALLOISIAN HAND-AXE FROM TERRACE D, FARNHAM. (½)
(*Reproduced from Bury*, 1916.)

cannot be taken as indicating the coldest conditions attained during this period. Even so they probably indicate a depression of the July Isotherm by at least 6°.

Implements are not common in the gravels of Terrace D. Nearly 90 per cent of the implements from this terrace are in a rolled condition. The unabraded ones have a distinctive appearance. Whereas those derived from higher terraces usually have an ochreous patina, the approximately contemporaneous ones are blackish with a white, or bluish, basket-patina. The artifacts in freshest condition are small cordiform hand-axes with thin edges (Figs. 24 and 25, Pl. I, Fig. 4). Some of these are made from flakes, and are comparable with Levallois V types from the Somme. Thin, parallel-sided flakes with faceted butts, referable to a late stage of the Levallois, also occur. It is probable, therefore, that Terrace D corresponds with the glacial phase with which the Upper Mousterian of the classic cave-stations is generally associated.[1]

The only distinctive artifact known from the brickearth which caps the terrace is a *dos rabattu* blade (Fig. 26) apparently of Aurignacian type (Moir, 1929). It came, however, from a disturbed level.

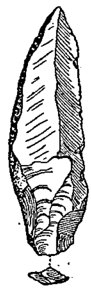


FIG. 26.—BACKED-BLADE OF AURIGNACIAN TYPE, FROM BRICK-EARTH OVERLYING TERRACE D, WEYDON PIT, FARNHAM. (½)
(*H. Bury Coll. Reproduced from Moir*, 1929.)

The period of aggradation represented by the gravels of Terrace D was brought to a close by the important change in the drainage of the Farnham area described above (p. 15). At the time when the gravels of this terrace were being laid down the Farnham river turned abruptly northwards near the site of High Mill, and flowed through the gap at Runfold into the valley of the present Blackwater. The floor of this gap in the Chalk ridge, now forming the watershed between the Wey and the Blackwater, is at the same level as the base of Terrace D. Moreover, it is covered with river gravels corresponding exactly with those on the Railway Terrace of the Farnham valley. The gravels are exposed in the pit near Six Bells Inn and at Badshot Lea. Apparently during the period of flooding which ended the "sub-arctic" phase of Terrace D, the waters of the Farnham river were switched off into the main Wey valley, thus joining the Godalming river, and flowing—as they do to-day—into the Thames *via* the Guildford gap. This capture was effected by an *obsequent* tributary of the Godalming-Tilford Wey, which developed along the line of the deserted Waverley valley. The point of capture must have

[1] The age of the Ponders End deposits has for long been doubtful. At one time they were regarded as belonging to the Magdalenian cold phase, but recently there has been a tendency to relegate them to one of the "Monsterian" cold phases. Since this Survey was prepared, late Levalloisian flakes, similar to those described from Terrace D at Farnham, have been reported from the gravels at Ponders End (Warren, 1939)—seemingly a confirmation of the correlation here suggested.

been close to the site of High Mill. At the time of the capture the bed of the Tilford-Godalming river was some 50 feet lower than that of the Farnham river, so that as soon as the latter was diverted into the Wey valley it rapidly lowered its bed in accommodation to the new level. The result was the formation of the steep 50-foot high river-cliff which forms the edge of the Railway Terrace. This is a good illustration of the formation of a river terrace by river-capture without local or general elevation, or fall in sea-level.

It is probable that this final change in the drainage took place early in Upper Palæolithic times, perhaps some 15,000 years ago. The second beheading of the River Blackwater so reduced its volume that it has been unable to continue eroding in its higher reaches. The headwaters of the Blackwater are to this day nearly 50 feet above the level of the Farnham Wey. They flow, in fact, only a few feet below the level of the gravels equivalent to those on the 50-foot Terrace of the Farnham river. The relatively small stream which constitutes the Upper Blackwater is an obvious misfit in the broad mature valley through which it flows, and speaks eloquently of the robbery this river system has suffered.

Terrace E.

The strip of gravels along the left bank of the Farnham river, on which the town of Farnham itself is situated, was formerly classified as Terrace D, but it has now been shown that these gravels lie on a bench which is nearly 20 feet lower than the base of the Railway Terrace, and they are now recognized as a distinct terrace. The deposits of Terrace E consist of gravels with loam seams overlain by brickearth. The deposits of this terrace are visible in a pit to the west of Farnham, near Cox Bridge. The surface level is here 232 feet above O.D. The brickearth on Terrace E is somewhat different in character from that on Terrace D, and is probably more of the nature of a flood-loam. Owing to the great thickness of deposits on this terrace there is an overlap between it and the lower part of Terrace D.

Since the base of Terrace E lies below the watershed of the Wey and the Blackwater, this terrace must have been formed after the capture of the Farnham river by the Wey. It may be noted that it post-dates the period of intense cold which caused the formation of the trail on the surface of Terrace D, since its surface is not so affected. Terrace E may be tentatively regarded as an equivalent of the Lower Flood Plain Terrace of the Thames, the deposits of which have been shown to be continuous with the filling of the main buried channel of that river. There is no buried channel in the Farnham valley.

There are spreads of low terrace gravel in the Godalming section of the Wey valley. These also are later than the capture and may be considered as of approximately the same age as Terrace E of Farnham. They rest at 10 to 15 feet above present river-level. A pit in one of these spreads, situated to the east of Hankley Farm (in the extreme south-east corner of the map), shows 4 to 6 feet of stratified sands and gravels. The latter are largely composed of flints, with a slight admixture of Greensand chert.

No distinctive implements have been recovered from deposits of the Terrace E group, but the occurrence of Early Mesolithic "floors" on the surface of this terrace in the Farnham valley (see p. 65) probably indicates a Palæolithic date for its formation.

Correlation of the Farnham Terraces with those of the Thames Valley.

The elevation of the Farnham terraces above present river-level affords no direct basis of comparison with the terraces of the Lower Thames owing to the abnormal amount of erosion consequent on the capture of the Farnham river by the Wey. Bury has suggested, however, that the equivalence of the Farnham terraces to those of the Thames might be arrived at by deducting 40 feet from the elevation of the former relative to the present river-level. That is to say, by subtracting an amount equal to the vertical interval between the base of Terrace D and the present flood-level of the Wey at Farnham. The heights of the several Farnham terraces, relative to significant reference levels, are as follows:

	Height above Hypothetical Datum (cf. Thames).	Height above Farnham Wey.		Height of Surface above O.D.
		1. Surface.	2. Base.	
	Feet.	Feet.	Feet.	Feet.
Terrace A . .	105–115	155	145–150	355
Terrace B . .	75–100	140	115–130	340
Terrace C . .	45–55	95	80–90	295
Terrace D . .	10–25	65	40–50	265

On these grounds, Terraces A and B might together be equivalent in part to the Boyn Hill Terrace Group, Terrace C to the Taplow Terrace, and Terrace D to the Upper Flood Plain Terrace. This correlation is supported by the latest archæological (and palæontological) evidence which, however, goes further and indicates that the oldest part of Terrace A is probably equivalent to the Binfield Stage,[1] the Gravel Hill and Boundstone gravels to the Lower Barnfield Stage, the Terrace B gravels to the Middle Barnfield Stage, the Terrace C to the Taplow and Crayford Stages, and the Terrace D gravels to the Ponders End and Slades Green Trail Stages. It would follow that Terrace E might be equivalent to the Halling Stage.

APPENDIX I.

Palæoliths from the Farnham District.

Implements recovered from time to time in the terrace gravels of the district are distributed amongst a large number of collections, both public and private. A representative collection is preserved in the Guildford Museum. The British Museum also has an extensive series of implements from Farnham (including those in the Sturge Collection); while, of the private collections the most noteworthy are those of Messrs. Borelli, H. Bury, H. Falkner, Dr. J. Gibson, Messrs. J. A. Patterson, W. F. Rankine, Harry Smither and Major A. G. Wade.[2] Part of the collection of the late Mr.

[1] Represented by the Lower Gravel-train of the western part of the Thames Basin (Wooldridge, 1939, pp. 640–1).

[2] Recently Major Wade has presented his more important finds to the British Museum.

F. Lasham is preserved in the museum of Sherborne School, Dorset. In 1934 a special exhibition illustrating the Palæoliths of Farnham was arranged in the Department of British Antiquities at the British Museum. The Museum's own collection was supplemented by specimens borrowed from some of the private collections referred to. Notes on this exhibition were published in the *Antiquaries Journal*, XIV (1934), p. 422.

APPENDIX II.

Report on Samples of Peat from Terrace D at Farnham.

In 1935 Mr. W. F. Rankine recovered portion of a raft of peat which appeared near the base of the gravels of Terrace D in Patterson's pit,[1] close to Farnham Junction. This was sent to Miss M. E. J. Chandler, who reported as follows:

" A small sample of peaty material from a lenticle in the 50-foot Terrace at Farnham was submitted to me by Mr. K. P. Oakley. It proved to be rich in plant remains, of which the following have been determined:

Draba incana L.[2, 3]	2 carpels.
Cochlearia alpina Wats.	Seeds usually worn. Rather small; may be this or some closely allied species.
Armeria arctica Wallroth.[2, 3]	1 fruit.
Polygonum viviparum L.[3]	1 bulbil.
Oxyria digyna Hill.[2]	1 fruit.
Salix herbacea L.[2, 3]	Several small leaves.
Carex spp.	Much-worn fruits.
Mosses (not determined).	

Also two or three undetermined fruits or seeds, including a small seed of a Caryophyll.

" In spite of its smallness, this flora testifies unmistakably to a cool climate. All the plants specifically determined now extend into Arctic regions, or belong to the floras of upland moor and mountain slope in temperate regions.

" Four of the six determined species occur also in the Lea valley cold flora, all four being found at the Angel road site, and all but *Oxyria* at the Ponders End site. Four species also occur in the cool flora of Barnwell Station, Cambridge.

" It is not possible to say on palæobotanical evidence that the Farnham deposit is contemporary with the Barnwell Station or

[1] This pit has now been filled in. Rafts of peat had been observed by Mr. Rankine from 1930 onwards.

[2] Recorded from Lea Valley " Arctic Beds."

[3] Recorded from Barnwell Station " Arctic Bed."

Lea Valley beds, for we have no proof that a flora of this kind did not recur at more than one period in the Pleistocene. Clearly, however, it is of the same cool type and is composed of the same elements as far as its composition is known."

In view of the great interest of this discovery, Miss Chandler expressed the wish to see further material if it were obtainable. In 1936 Mr. Rankine succeeded in recovering a further sample of peat—this time from a raft which had appeared in the basal gravels of Terrace D at Badshot Lea. In this second sample Miss Chandler was able to determine the following plants:

Ranunculus flammula L.[1, 2]	
Batrachium sp.	
Stellaria media Cyr.	
Lychnis sp.[3]	
Arenaria gothica Fries.[4, 2]	
Hydrocotyle vulgare L.	
Armeria planifolia Syme (?)	2 fruits; look rather immature.
Polygonum viviparum L.[2]	Bulbils.
Betula nana L.[1, 2]	Tiny fragments of leaf.
Salix sp.	Fragments of small-leafed species.
Carex flava L.[2]	
Carex lagopina Wahl.[2] (?)	
Carex spp.	
Cyperaceæ ?	

Miss Chandler says (*in litt.*): "Although the plants identified are few, the fragments of leaf [*Betula nana*], the *Polygonum* and *Arenaria*—and possibly the *Armeria*—give a decidedly cold look to the flora and bring it into line with the material sent before, and with the colder horizons of the Lea Valley, also with the Barnwell cold flora."

The difference in the composition of the plant assemblages in the two samples is unlikely to be a reflection of a difference in age. It is more likely to be fortuitous, or at the most to be due to the two rafts representing slightly different "fossil environments."

The second sample contained abundant moss remains, and these were kindly examined by Mr. H. N. Dixon, who was able to identify the following species:

Camptothecium nitens (Schreb.) Schimp.
Hypnum turgescens Schimp.

[1] Recorded from Lea Valley "Arctic Beds."
[2] Recorded from Barnwell Station "Arctic Beds."
[3] "Not identifiable with the species available for comparison."
[4] "One could scarcely tell living and fossil specimens from one another."

Hypnum molle Wils.
Hypnum schreberi Brid.
Amblystegium serpens (Hedw.) Bry. emend.

He remarks (*in litt.*): " The material is in a complete state of trituration. The dominant moss is *Camptothecium nitens*, a plant of boreal-arctic distribution now almost extinct in Britain, but occurring in nearly every glacial and post-glacial deposit that I know of.[1] It is a bog moss. *Hypnum turgescens* is of very similar distribution now, and also all but extinct in Britain. I have it from the Arctic Bed at Ponders End.[2] *Hypnum molle* is interesting because it is a truly arctic-alpine species, only found on the summits of two or three of our Scottish mountains now. I have it from the Pleistocene 'Mammoth surface' at Ponders End.[3] *Hypnum schreberi* and *Amblystegium serpens* are common terrestrial mosses at the present time." The latter occurred in the Arctic Bed at Angel Road in the Lea Valley.

APPENDIX III

Distribution of Mammoth Remains in Terrace D at Farnham.

Mr. W. F. Rankine has contributed the following record of remains of *Elephas primigenius* found in the basal gravels of Terrace D.:

	Molars.	Tusks.	Bones.
Junction Pit	6	2	—
Six Bells Pit	2	2	+
Lower Snailslynch Pit	8	1	—
Fair Fields Pit	3	—	—
Park Field Pit	5	1	+
Weydon Pits	2	1	—
Tanner's Pit	1	2	—

The tusks were all seen *in situ* by Mr. Rankine before their removal. In some cases the finds were not made by him personally, but their provenance was in each case carefully verified.

ACKNOWLEDGEMENTS.

In conclusion I wish to record my thanks to those who, by freely putting information at my disposal or by offering constructive criticism, have helped in the production of this survey of the geology and earlier prehistory of the Farnham region. In particular I must mention my special indebtedness in these respects

[1] It occurred in the "Arctic Beds" at Ponders End.
[2] Lowest bed. [3] Lowest and middle beds.

to Mr. Henry Bury, Mr. H. G. Dines, Mr. C. F. C. Hawkes, Mr. W. F. Rankine, Mr. Reginald Smith and Major A. G. Wade. Thanks are also due to Miss M. E. J. Chandler and to Mr. H. N. Dixon for kindly undertaking to report on the plant remains from Terrace D.

I wish to acknowledge the use of blocks which have been lent by the Council of the Society of Antiquaries and the Council of the Geologists' Association, and to indicate my gratitude to Mr. Henry Bury and to Mr. J. Reid Moir, F.R.S., for permission to reproduce figures which have appeared in their papers. Finally, I am indebted to Mrs. T. T. Paterson and to Mr. W. F. Rankine for supplying the drawings for Figs. 14 and 24 respectively.

References.

Breuil, H., and Kosłowski, L. 1931. "Études de stratigraphie paléolithique dans le nord de la France, la Belgique et l'Angleterre." *L'Anthropologie,* XLI, pp. 449–88.

Bury, H. 1908. "Notes on the River Wey." *Quart. Journ. Geol. Soc.,* LXIV, pp. 318–34.

—— 1910. "The Denudation of the Western End of the Weald." *Quart. Journ. Geol. Soc.,* LXVI, pp. 640–92.

—— 1913. "The Gravel-beds of Farnham in Relation to Palæolithic Man." *Proc. Geol. Assoc.,* XXIV, pp. 178–201.

—— 1916. "The Palæoliths of Farnham." *Proc. Geol. Assoc.,* XXVII, pp. 151–92.

—— 1917. "Some 'Flat-faced' Palæoliths from Farnham." *Proc. Prehist. Soc. E. Anglia,* II, pp. 365–74.

—— 1936. "The Farnham Terraces and their Sequence." *Proc. Prehist. Soc.* (for 1935), N.S., I, pp. 60–69.

Chandler, M. E. J. 1921. "The Arctic Flora of the Cam Valley at Barnwell, Cambridge." *Quart. Journ. Geol. Soc.,* LXXVII, pp. 4–22.

Dines, H. G., and Edmunds, F. H. 1929. "The Geology of the Country around Aldershot and Guildford." *Mem. Geol. Surv.*

Gibson, J. H. 1926. "The Six Bells Gravel Pit at Farnham." *S.A.C.,* XXXVII, pp. 88–9.

King, W. B. R., and Oakley, K. P. 1936. "The Pleistocene Succession in the Lower parts of the Thames Valley." *Proc. Prehist. Soc.* (for 1936), N.S., II, pp. 52–76.

Lacaille, A. D. 1939. "The Palæolithic Contents of the Gravels at East Burnham, Bucks." *Antiq. Journ.,* pp. 166–81.

Lasham, F. 1892. "Palæolithic Man in West Surrey." *S.A.C.,* XI, pp. 27–29.

Moir, J. R. 1929. "Some hitherto Unpublished Implements." *Antiq. Journ.,* IX, pp. 10–12.

Monckton, H. W., and Mangles, H. A. 1893. "Excursion to Farnham." *Proc. Geol. Assoc.,* XIII, pp. 74–81.

Rankine, W. F. 1936. "Discoveries in the Gravels of the Fifty-foot terrace at Farnham, Surrey." *Proc. Prehist. Soc.* (for 1935), N.S., I, pp. 148–49.

Reid, C. 1915. "The Plants of the Late Glacial Deposits of the Lea Valley." *Quart. Journ. Geol. Soc.*, LXXI, pp. 155–61.

Reid, E. M., and Chandler, M. E. J. 1923. "The Barrowell Green (Lea Valley) Arctic Flora." *Quart. Journ. Geol. Soc.*, LXXIX, pp. 604–5.

Smith, R. A. 1931. "The Sturge Collection" (*British Museum Monograph*), pp. 82–85.

Wade, A. G., and Smith, R. A. 1935. "A Palæolithic Succession at Farnham, Surrey." *Proc. Prehist. Soc. E. Anglia* (for 1934), VII, pp. 348–53.

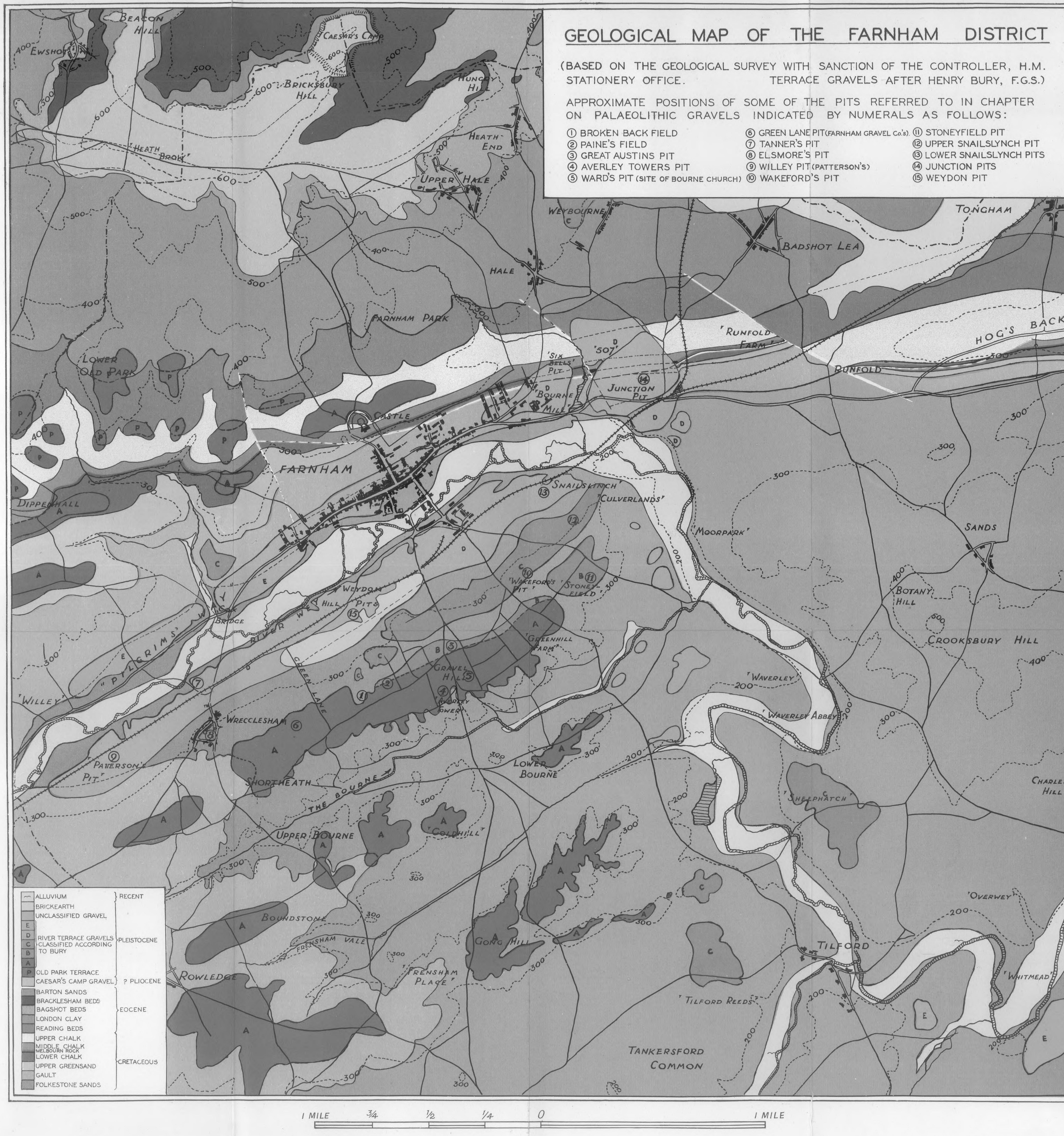
Warren, S. H. 1912. "On a Late Glacial Stage in the Valley of the River Lea, subsequent to the Epoch of River-Drift Man." *Quart. Journ. Geol. Soc.*, LXVIII, pp. 213–51.

—— 1916. "Further Observations on the Late Glacial, or Ponders End, Stage of the Lea Valley." *Quart. Journ. Geol. Soc.*, LXXI, pp. 164–82.

—— 1939. "The Correlation of the Lea Valley Arctic Beds." *Proc. Prehist. Soc.* (for 1938), N.S., IV, pp. 328–9.

Whimster, D. C. 1932. "The Archæology of Surrey." *The County Archæologies.* Methuen.

Wooldridge, S. W. 1939. "The Glaciation of the London Basin and the Evolution of the Lower Thames Drainage System." *Quart. Journ. Geol. Soc.*, XCIV, pp. 627–67.


GEOLOGICAL MAP OF THE FARNHAM DISTRICT
(BASED ON THE GEOLOGICAL SURVEY WITH SANCTION OF THE CONTROLLER, H.M. STATIONERY OFFICE. TERRACE GRAVELS AFTER HENRY BURY, F.G.S.)
APPROXIMATE POSITIONS OF SOME OF THE PITS REFERRED TO IN CHAPTER ON PALAEOLITHIC GRAVELS INDICATED BY NUMERALS AS FOLLOWS:
① BROKEN BACK FIELD
② PAINE'S FIELD
③ GREAT AUSTINS PIT
④ AVERLEY TOWERS PIT
⑤ WARD'S PIT (SITE OF BOURNE CHURCH)
⑥ GREEN LANE PIT (FARNHAM GRAVEL Co's)
⑦ TANNER'S PIT
⑧ ELSMORE'S PIT
⑨ WILLEY PIT (PATTERSON'S)
⑩ WAKEFORD'S PIT
⑪ STONEYFIELD PIT
⑫ UPPER SNAILSLYNCH PIT
⑬ LOWER SNAILSLYNCH PITS
⑭ JUNCTION PITS
⑮ WEYDON PIT
ALLUVIUM
RECENT
BRICKEARTH
UNCLASSIFIED GRAVEL
RIVER TERRACE GRAVELS CLASSIFIED ACCORDING TO BURY
PLEISTOCENE
OLD PARK TERRACE
CAESAR'S CAMP GRAVEL
? PLIOCENE
BARTON SANDS
BRACKLESHAM BEDS
BAGSHOT BEDS
LONDON CLAY
READING BEDS
EOCENE
UPPER CHALK
MIDDLE CHALK
MELBOURN ROCK
LOWER CHALK
UPPER GREENSAND
GAULT
FOLKESTONE SANDS
CRETACEOUS
BEACON HILL
EWSHOT
CAESAR'S CAMP
BRICKSBURY HILL
HUNGRY HILL
HEATH END
'HEATH BROW'
UPPER HALE
WEYBOURNE
HALE
TONGHAM
BADSHOT LEA
FARNHAM PARK
LOWER OLD PARK
CASTLE
FARNHAM
'RUNFOLD FARM'
RUNFOLD
HOG'S BACK
'SIX BELLS' PIT
'507'
'BOURNE MILL'
JUNCTION PIT
DIPPENHALL
SNAILSLYNCH
'CULVERLANDS'
'MOORPARK'
SANDS
BOTANY HILL
CROOKSBURY HILL
WEYDON HILL PITS
'WAKEFORD'S PIT'
'STONEY FIELD'
BRIDGE
RIVER WEY
"PILGRIMS' WAY"
'GREENHILL FARM'
GRAVEL HILL
GREEN LANE
'WILLEY'
WRECCLESHAM
'WAVERLEY'
'WAVERLEY ABBEY'
'PATERSON'S PIT'
SHORTHEATH
THE BOURNE
LOWER BOURNE
'SHEEPHATCH'
CHARLES HILL
UPPER BOURNE
'COLTHILL'
'OVERWEY'
BOUNDSTONE
FRENSHAM VALE
GONG HILL
TILFORD
ROWLEDGE
'FRENSHAM PLACE'
'TILFORD REEDS'
'WHITMEAD'
TANKERSFORD COMMON
1 MILE
3/4
1/2
1/4
0
1 MILE