

11. *On a recent SECTION through WALTON COMMON exposing the LONDON CLAY, BAGSHOT BEDS, and PLATEAU-GRAVEL.* By W. H. HUDLESTON, Esq., M.A., F.R.S., Sec. G.S. (Read January 13, 1886.)

INTRODUCTION.

DURING the past autumn the London and South-Western Railway Company has been engaged in widening the line between Walton and Weybridge stations, and consequently there has been an excellent exposure of the beds composing the Walton-Oatlands plateau. The communication now made to the Society relates only to such portion of the railway-cutting as extends from Walton station in a west-south-west direction to the boundary of Oatlands Park, and more particularly to that portion of it known as "America." The total length, as measured on the 6-in. Ordnance map, is 1070 yards. This distance is divided unequally by the railway bridge on Walton Common known as "Sir Richard's." The distance between Walton station and the centre of this bridge is 710 yards, whilst the distance from this point to the boundary of Oatlands Park is 360 yards, or thereabouts.

For the purposes of description and convenience of reference, the entire section may be divided into *four* blocks.

Block A extends from Walton station to where the unaltered London Clay in seen to occur *in situ*—a distance of 313 yards.

Block B extends from this to the point where the Bagshot Beds are first seen *in situ*—a distance of 345 yards.

Block C extends from the above to the point where the Bagshots are first cut through to the level of the line, and the hollow filled up with Plateau-gravel—a distance of 165 yards.

Block D exhibits the relations of the Bagshots to the Plateau-gravel, where the latter is most fully developed—a distance of 247 yards.

The above divisions are shown on the generalized section (fig. 1), which may be regarded as a summary, on a small scale, of the sections presently to be detailed. It must be borne in mind that, owing to the exaggeration of the vertical scale, a certain amount of distortion is inevitable.

A few remarks on the topography of the district, and on the formations composing it, together with a brief notice of the literature, may be of use in the first instance.

Walton station is 17 miles from Waterloo; it is situated about midway between the 50-feet and the 100-feet contours (see fig. 2), and lies within the drainage of the river Mole. The line is 68 feet above O. D. at this point. The 100 feet contour is reached at the bridge, where the cutting is estimated to have a depth of 24 feet. At Weybridge station the surface of the ground is marked as 120 feet above O. D. Hence the plateau traversed by the railway, which we may call the Walton-Oatlands plateau, ranges from a little under to a little over the 100-feet line, forming a low *massif* or

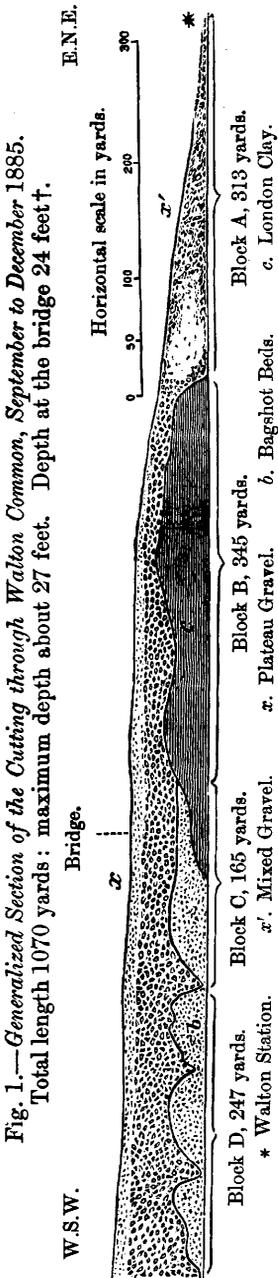
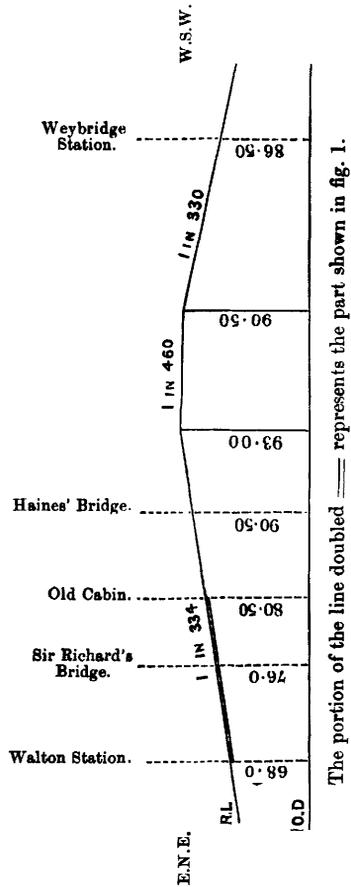


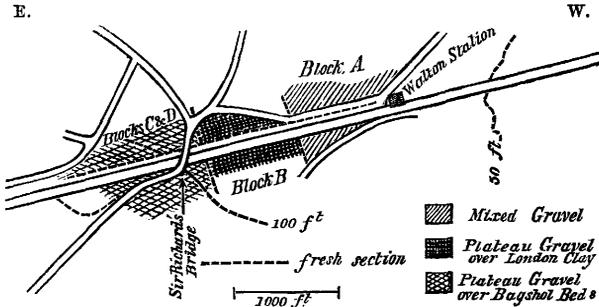
Fig. 1'.—Profile of Railway line between Walton and Weybridge Stations.



† The official measurements are 2 feet higher in each case; but these comprehend material which probably could not fairly be included in a geological section. The annexed figure (fig. 1'), supplied by the engineer's department, through the courtesy of Mr. J. W. Jacomb Hood, shows the gradients between Walton and Weybridge stations.

promontory, which separates the valley of the Mole from the valley of the Wey. Towards the former the slope is gradual, towards the latter somewhat abrupt. It should also be borne in mind that towards the south-west this plateau reaches the northern slope of St. George's Hill, whose northern brow attains a height of 245 feet, where another and much narrower area is continued towards the south for about

Fig. 2.—Sketch-map showing the position of the section.



one mile. Hence there are two principal plateaus in this district, of which one is about 140 feet higher than the other. It is on these flats, and not by any means on the slopes, that the Plateau-gravel is found*.

The following may be regarded as the principal formations or subformations of the district which we shall have to consider. (See fig. 1.)

- | | | |
|------------------------|---|--------------------|
| a. Superficial | { | y. Top sand. |
| | { | x'. Mixed gravel. |
| | { | x. Plateau-gravel. |
| b. Lower Bagshot Beds. | | |
| c. London Clay. | | |

Of these the "top sand" (y) and the "mixed gravel" (x') are more or less local deposits, not to be found perhaps under precisely similar conditions elsewhere. The *Plateau-gravel*, also described as "hill-gravel of doubtful age," is well known to dwellers in the Bagshot districts, though it generally occupies higher ground. In fact the Walton-Oatlands plateau is perhaps the lowest elevation where this particular kind of gravel is known to occur. It is briefly described by Mr. Whitaker†, who says, "It is not unlike much of our later

* The following distances of certain points from Sir Richard's Bridge, taking this as a convenient centre, are given:—

Nearest point of River Mole, E. by S.	1 m.	735 yds.
Nearest point of River Thames at Walton water-works, N.N.W.	1 m.	
Oatlands-Park hotel, W.N.W.		1465 yds.
Weybridge station, W.S.W.	1 m.	930 yds.
St. George's Hill, north end of plateau, S.W. ...	1 m.	840 yds.

† 'Guide to the Geology of London,' p. 63.

gravel, which is connected, more or less, with the present valley system, and it is, indeed, sometimes hard to distinguish the two." Prof. Rupert Jones*, referring more especially to the neighbourhood of Camberley, estimates the depth of the Plateau-gravel with loam at 12 feet (p. 433), and he also remarks (p. 438) that "it is not the Tertiary sands that form the actual surface of the Bagshot district, but certain gravels which have been referred to as coating the plateau and hill-tops. The gravel consists chiefly of sub-angular flints from the Chalk with Tertiary pebbles (usually dark in colour); there is also a large percentage of chert from the Neocomian sands of South Surrey, a free sprinkling of quartz in small pebbles (rarely so large as a thrush's egg), and occasional large blocks of concretionary sandstone from the Bagshot Sand." Further on, the same author describes the character, and discusses the origin of the Plateau-gravel, alluding especially to the formation of "iron-pans" therein at various levels, but more especially at the bottom, and shows how such pans have acted in the preservation of the underlying sands.

The Bagshot Beds of the Weybridge district were noticed in Prof. Prestwich's classical paper written in 1847†. The author observes (p. 381) that "at St. George's Hill near Weybridge the [Lower Bagshot] sands may be traced from the London Clay at the base of the hill to the outcrop of the green sands [Middle Bagshots] about halfway up it, a thickness of about 130 feet." He also says, "This division [viz. the *Lower Bagshot Sands*] reposes conformably on the *London Clay*," adding in a note, "This was well exhibited in the railway-cutting through St. George's Hill. At the end, near the Walton station, I traced the *London Clay* for a distance of several hundred feet passing conformably below the *Lower Bagshot Sands*." This is quoted by Mr. Whitaker‡ in 1872 in describing the main tract of the Lower Bagshot Beds. Very interesting lithological details of these beds are given by Prof. Prestwich, who, amongst other things, has noted an instance§ in Goldsworthy Hill of the lateral passage of these light-coloured siliceous sands into a dark-grey laminated clay. This occurs at the top of the series and immediately below the Middle Bagshots.

DETAILS OF THE SECTION. BLOCK A. (See fig. 3.)

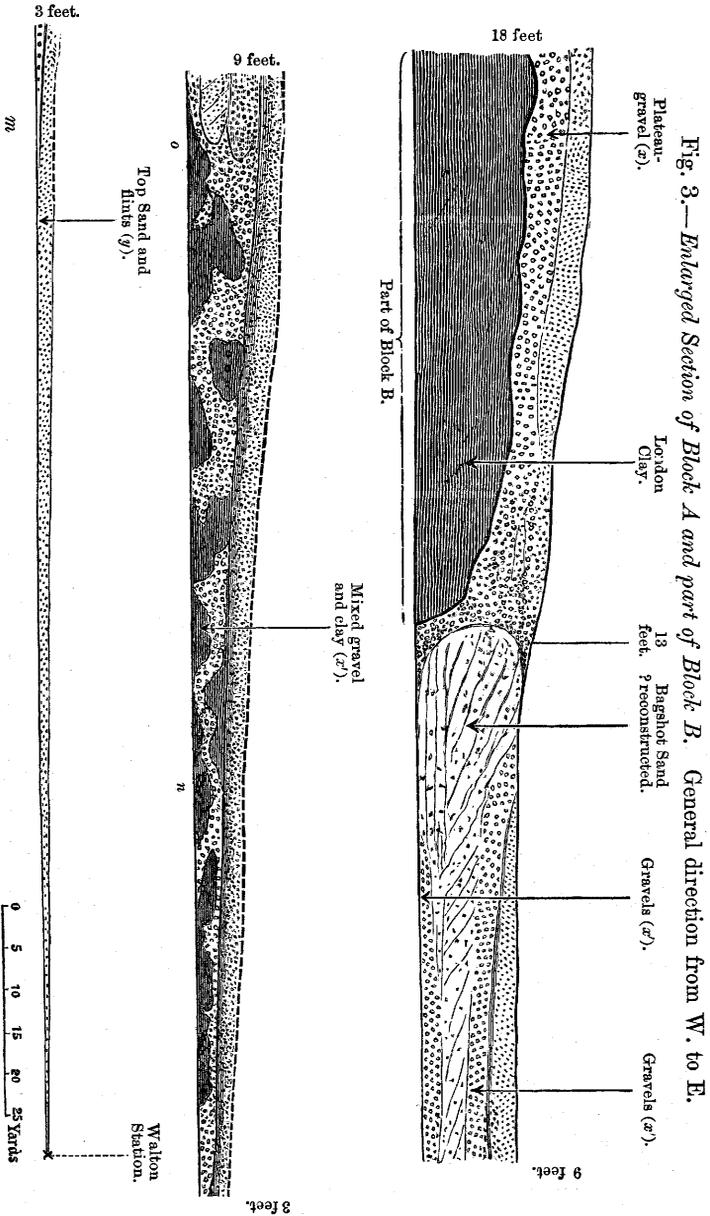
The line at Walton station is on the level of the country, and as we proceed westward the rise for the first 60 yards is so slight that no certain exposure is yielded; such indications as exist are of a sandy character. The first bed which becomes distinct is the "Top Sand," here about 2 feet thick. At the point marked *m* (fig. 3) we find indications of the "Mixed Gravel" series (*x'* of the general section), and water is noted in the gutter for the first time. The

* "Excursion to Camberley," Proc. Geol. Soc. vol. vi. p. 329, and "Geology and Physical Features of the Bagshot District," *ib.* p. 429.

† Quart. Journ. Geol. Soc. vol. iii. p. 387 *et seq.*

‡ 'Geology of the London Basin,' p. 315.

§ *Loc. cit.* p. 382.



remainder of block A, with the exception hereinafter to be mentioned, is made up of this series overlain by 2 or 3 feet of a "Top Sand," rather flinty in its lower parts. This mixed gravel and clay makes a very wet line hereabouts. At the point *n* (192 yards from the station) the following section was disclosed:—

	ft. in.
Made surface of old path	0 4
(<i>y</i>) Top Sand, sometimes with bleached flints towards the base	3 0
(<i>x'</i>) Clay, sand, and pebbles with bleached flints	2 10
Total.....	6 2

The succeeding 50 yards discloses still more of this curious mixture. As a whole, its character is strongly argillaceous, but neither on the line nor in the section can a blue clay be discovered. Lumps of brownish clay with pebbles occur in the midst of the sands. Some of these lumps may be in continuity with the London Clay beneath; but, so far as we can judge from this section, the whole must be regarded as a disturbed series, and classed with the superficial deposits.

At the point marked *o* (about 240 yards from the station) the clay and sand with pebbles or "mixed series" is jømmèd against the end of an included mass of what appears at first sight to be yellow Bagshot Sand. The true nature of this mass of sand, 70 yards in length, fully 12 feet thick at the west end or "corner," and tapering to about 2 feet at the east end, is by no means clear. If we examine it where narrowest, it can be regarded as nothing more than a tongue of sand in the "mixed series," since the gravel underlies it as well as overlies it; but further up, where it gets thicker, nothing can be seen to underlie the mass, of which the lowest visible bed is a wet sandy loam. Where thickest, the yellow sand is much current-bedded with inclination towards the east, but chiefly in the middle and upper portions. The sand of these false-bedded portions is in no respects like the sand of the main mass of the Lower Bagshots, being entirely devoid of the laminated character, and also having the grains larger and more unequal. It has more resemblance to the lowest bed of the Lower Bagshots (No. 1) presently to be described, but is coarser and more unequal in the grain. Both, however, are sharp, clean sands, in comparison with the "soft sand" of the main mass of the Lower Bagshots hereabouts. It is a singular accident that the almost ubiquitous "Top Sand" is absent where this mass comes to the surface. The whole terminates in a most remarkable and sudden manner (see fig. 3, junction of blocks A & B, 313 yards from the station) against an equally sharp and sudden rise of London Clay covered by Plateau-gravel. The space between the clay and sand is filled with a mixture of gravel and loose yellow sand, and this gravel passes for some distance underneath the solid mass of yellow sand itself.

The above remarks are strictly descriptive, but the "mixed series" and the sudden termination of the yellow sand cannot fail to provoke

a certain amount of speculation. In the Survey map, which gives the superficial geology of London and its environs, Lower Bagshot Sand *in situ* is represented here; and a fringe of Lower Bagshots is shown all along the eastern margin of the great mass of Plateau-gravel to which allusion has been previously made. When first I saw this place it occurred to me for a moment that there might be a fault here which had let down the Bagshots, so as to preserve them from destruction, and also accounting for the singular position in which the yellow sand is found in reference to the London Clay. Something of this kind there may be, yet it could hardly account for everything on the supposition that the yellow sand is nothing more than a mass of Lower Bagshot *in situ*. Besides, the lithology is against this supposition. On the whole I am rather inclined to believe that the upper and more false-bedded portions of the yellow sand have been reconstructed with a slight intermixture of foreign material. The only portion, then, really *in situ*, on this supposition, is the lowest part of the mass, beneath which no gravel can be detected. It is perfectly obvious that the eastern end belongs to the "mixed series;" and perhaps the whole of the "yellow sand," with the exception of the horizontally bedded sands at the base, should be classed with the "mixed series" (*x'*).

This latter may be regarded as constituting a sort of passage between the Plateau-gravel and the Thames-valley gravel—a view which accords well with its position on the slope. If this be correct, it is just possible that the old margin of the Mole-valley inlet may at one time have been at the spot where this reconstructed Bagshot Sand now abuts against the steep surface of London Clay covered by Plateau-gravel. The action of coast-ice, too, may have had something to do with the peculiarities to be noted hereabouts, and some of the sand lumps in these gravels may have been frozen, and so kept together; but I am inclined to think that reconstruction by water will account for most of what we see as regards the yellow sand.

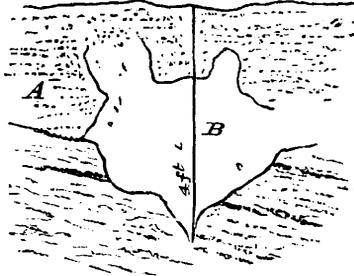
On reexamining this section in the early part of January 1886, the improbability of this yellow false-bedded sand at the "corner," representing Bagshots *in situ*, as indicated in the Survey map, was still more strongly impressed upon me, since the general structure of the sand and the entire absence of the thin argillaceous layers is so different from what obtains even in the basement-bed of the Lower Bagshots. These remarks apply more especially to the upper part of the deposit, where a singular appearance was noted towards the surface, which I have endeavoured to represent in fig. 4.

The following notes as to the character of the two varieties of sand are appended:—

A. The main mass or false-bedded series. The quartz grains are irregular, and are often pebbles reaching a diameter of 3 millim. Bleached flint chips 5 or 6 millim. in diameter are not uncommon. It contains the elements of the basal sands of the Lower Bagshots, together with rounded grains of dull quartz of the size before mentioned. Resembles in many respects the sands of the Plateau-gravel, but cleaner.

B. Contains pebbles. One of iron-sandstone between 50 and 60 millimetres in longer diameter, also a bleached angular flint of about the same size. The quartz grains are more rounded, duller, and more unequal than in A.

Fig. 4.—*Singular Appearance in the false-bedded Sands at the "Corner."*



B represents a mass of sand irregular in shape and devoid of bedding, enclosed in the false-bedded series (A). Its outline is ill-defined, much more so than in the figure, and but for the complete absence of bedding one would hardly notice it. The current-bedding of A, which inclines to the eastward, appears to suffer no interruption.

Block B. (Fig. 1 and part of fig. 3.)

Commencing with the sudden appearance of the London Clay *in situ*, the second block comprises that portion of the cutting where the London Clay forms the sides, and is directly overlain by the Plateau-gravel. This is the longest block of the four, and perhaps, on the whole, the most monotonous. Within this space the portion of the London Clay exposed above the permanent way, after rising pretty sharply at the "corner," constitutes a sort of plateau of denudation, ranging from 10 to 15 feet above the line. The surface is undulating within these limits, more especially towards the western extremity of the block, where a shallow valley may be noted. Beyond this the curve of the London-Clay surface rises to 13 feet, just before commencing that well-developed drop which brings in the bottom beds of the Lower Bagshots on the west. No fossils or Septaria were observed by me. The clay, when wet, is bluish and tenacious; when dried it is seen to be moderately sandy, and of a darkish grey. The discoloured layer at the top is mostly of a dull red, but varies to brown and yellow. It is usually less than a foot thick beneath the gravel, except where there has been a slight rupture of the surface, in which case the zone of discoloration is wider. These phenomena are very similar to what was observed in the "red loam" or "wet clay" of the New-Law-Courts site*.

* See paper by Hudleston and Price, Proc. Geol. Assoc. vol. iii. p. 44 (1872).

The following note is given as to the character of the dried clay. The London Clay of the Walton cutting breaks into greyish lumps made up of finely granular matter with sparkling points. These are mostly clean quartz, with perhaps a speck here and there of white mica. These lumps crush into a fine grey and subangular powder. There is considerable equality amongst the constituent granules, which have an average diameter of $\cdot 08$ millim. The granules are mainly quartz, but nearly always invested with a greyish white kaolin-like substance, which breaks off in very thin flakes; it is by means of this substance that the aggregation of the quartz granules is effected. As in the Lower Bagshots there is a moderate quantity of green grains, both pale and dull green, always very small. Pieces of an iridescent mineral, probably sulphide of iron undergoing oxidation, may also be noted.

One of the slides exhibited represents the very coarsest particles after washing, and here a certain number of larger quartz grains may be noted; these are mostly rather rounded at the edges, and present an exceptional feature as regards size. Amongst the thin flakes of the kaolin-like substance are numerous specks of quartz (much smaller than the grains), but notwithstanding their extreme smallness in very good optical condition. This is shown in another slide.

When the section was very fresh the bedding of the London Clay was almost invisible, and the clay looked like a mass entirely homogeneous. Weathering has subsequently developed the bedding, especially of the upper layers, which, on the whole, are more sandy than those of the base of the cutting. It is only in a few places that the bedding is visible. For instance, wherever the sides of the cutting have been sloped, the sliding forward of the superincumbent gravel has effaced every feature; but there are some portions towards the centre of block B where the bedding is very well seen. The occurrence of ribands of light-grey sand, near 2 inches in thickness, helps to bring it out more distinctly. Where visible there is a dip of about 1° , or rather less, down the line, *i. e.* towards the west. If this is continued the beds at the junction with the Bagshots must be higher in the series than those in the middle of block B. Besides the ribands of sand already mentioned, lenticular patches of small extent may be noted. The deficiency of calcareous matter is probably the cause of the absence of *Septaria* throughout the London Clay of this cutting.

A further microscopic examination of the sand-grains in the London Clay shows that angular quartz, mostly of a highly vitreous kind, immensely preponderates over all other constituents, which latter may be regarded more or less as mere accessories. In the clayey or unctuous varieties these grains are often more like quartz chips or splinters, and range from $\frac{1}{30}$ to $\frac{1}{40}$ millim. in diameter, but with an admixture of a larger size, from $\frac{1}{8}$ to $\frac{1}{10}$ millim., which were originally more cubical in shape, and are sometimes a little rounded. This seems to point to two independent sources for the material of the deposit. In this variety the black specks are mostly

due to iron mineral. Glauconite granules were not observed; but there are a few angular fragments of a clear green mineral substance.

In the more sandy beds there is not quite such an immense preponderance of quartz, since we find more "glauconite," of a pale greenish grey, and in some cases of a marked green colour. The quartz is more frequently cubical in form, but rarely rounded; vitreous varieties predominate. The size of the granules is perhaps from $\frac{1}{10}$ to $\frac{1}{2}$ millim. but with stray pellets up to $\frac{1}{8}$ millim. Within the above limit, there is considerable variety in the different beds, more especially as regards the amount of "glauconite." In the ribands of sand before mentioned the grains are quite clean, and may be examined without washing. The sample is very similar to the washings obtained from the sandy clays, but the general colour of the mass is rather paler.

The Plateau-gravel over the London Clay.—At the "corner," where everything is muddled up, pieces of discoloured sand may be noted in the Plateau-gravel. As a rule, throughout the eastern portion of the block, even including the "Top Sand," here very thin, it does not exceed 6 feet in thickness, but further westwards is seen to increase. The undulations in the London-Clay surface are compensated by the irregular depth of the Plateau-gravel. Over the clay area the proportion of sand is less. Pebbles and regular bedding predominate in the lower portions; the upper part of the gravel is more messed, contains more angular flints, and is, on the whole, more sandy. The downward action of solvents has caused the lower pebbles to possess the strongest coating of iron oxide. In some places there is a thin ferruginous pan at the junction with the London Clay; and in one place this has assumed rather considerable proportions. The higher pebbles and subangular flints are more or less bleached.

The preceding considerations lead us to conclude that the line of London Clay on Walton Common, in maps showing the solid geology, should be advanced westwards till within 30 yards east of the centre of Sir Richard's Bridge: whilst, if shown on the permanent way, the boundary-line must be advanced considerably beyond that bridge.

BLOCK C. (Fig. 5.)

Though the shortest of the blocks, perhaps this is the most interesting, since we here obtain evidence of the relations of the basal beds of the Lower Bagshots to the London Clay. Fig. 5 is an enlargement of that portion of block C which lies west of the centre of the bridge.

As the curve of the London-Clay surface sinks in a series of minor undulations towards the west, traces of the lowest bed (No. 1) of the Lower Bagshots may be noted about 30 yards east of the centre of the bridge. It is a yellow sand, nearly 2 feet thick here, and terminates with a very blunt point against the London Clay. At the centre of the bridge the following section was observed:—

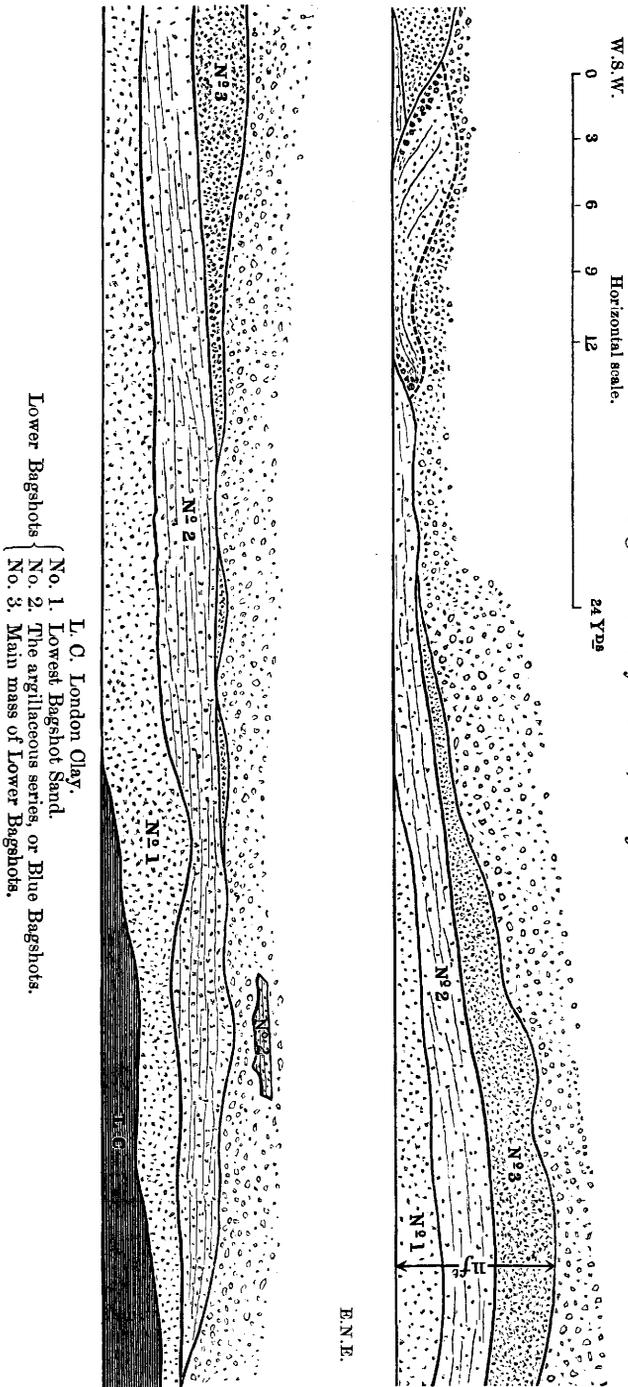


Fig. 5.—Part of Block C, enlarged.

L. O. London Clay.
 Lower Bagshots { No. 1. Lowest Bagshot Sand.
 No. 2. The argillaceous series, or Blue Bagshots.
 No. 3. Main mass of Lower Bagshots.

E. N. E.

Section at Sir Richard's Bridge.

The superficial beds (estimated)			ft. in.
			17 0
			ft. in.
No. 1. Lower Bagshots...	Yellow sand.....	0 5	
	Buff sticky clay	0 8	
	Sharp yellow sand with ochrey layers	0 11	2 0
London Clay	Discoloured clay	0 6	
	Blue Clay.....	4 6	5 0
Total			24 0

No. 1 is rather nipped here by the superficial beds*, but presently acquires considerable thickness; at the west end of the bridge it is seen to be covered by No. 2, as shown in the figure. Originally this bed may have overlapped No. 1, but there is now no trace of it east of the bridge. One might as well try to diagnose the colour of a chameleon as to describe No. 2 with any pretensions to absolute accuracy. Speaking generally, it is a very dark sticky clay in thin laminae; but it is so much permeated by sands of all colours, and changes, within such short distances, to brown and red clays, with thin pans of iron-rust, that no single description will suffice. The general effect produced in section, by contrast with the sands above and below, is a dark blue; hence I call this bed, or series of beds, the "Blue Bagshots." The average thickness is about 4 feet.

Already, at the point where the London Clay falls below the level of the permanent way, the Bagshots have attained a thickness of 10 feet, partly made up of No. 2, but principally owing to the great expansion of No. 1, which is very irregular and false-bedded, sometimes pinched by No. 2, and sometimes expanding suddenly. This false-bedding frequently changes in direction, and especially on either side of a thin seam of brown clay, as may be noticed in the annexed sketch by Mr. Foord (fig. 6). A very few inches of No. 3, which represents the main body of the Lower Bagshots hereabouts, contributes to the total of 10 feet at this point.

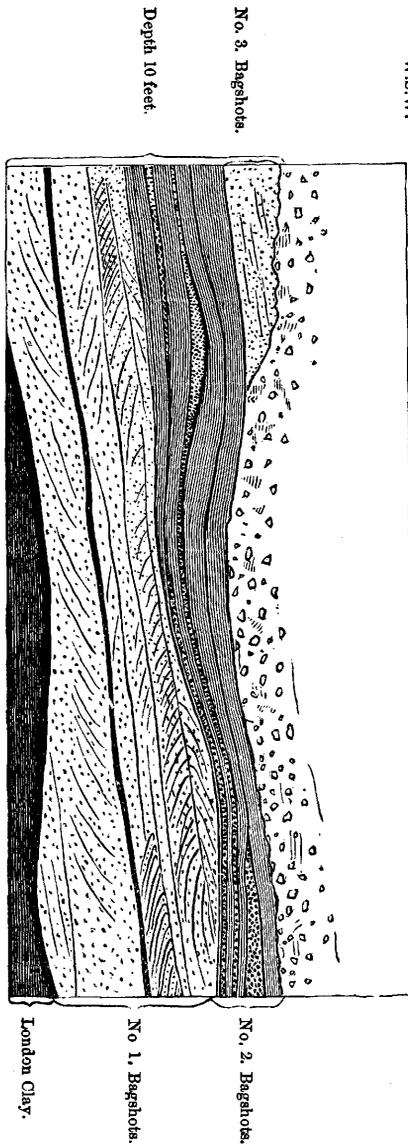
About 80 yards west of the centre of the bridge the Bagshots attain their maximum thickness in block C. This is made up as follows:—

No. 3. Buff sands, partially laminated.....		ft. in.
		4 2
		ft. in.
No. 2. Upper clay	0 10	
Red sands	1 10	
Lower Blue Clay.....	1 2	3 10
No. 1. (Base not seen)		3 0
Total		11 0

West of this, No. 1 is lost on the dip, whilst No. 2 is cut out as shown in fig. 5, together with the overlying bed. The consideration of this feature belongs more properly to the fourth block (D).

* Perhaps the construction of the new arch may have helped this.

Fig. 6.—Part of Block C. The Basement-beds of the Lower Bagshots, west of Sir Richard's Bridge, Walton Common.
W.S.W. E.N.E.



In block C the contrast of colouring is very effective. The dark blues of the moist clays, and the reds, chocolates, yellows, and whites of the sands produce a pleasing and striking effect, which prolonged exposure to the atmosphere will doubtless tone down. At first sight there is a superficial resemblance between the London Clay of the section and No. 2 of the Bagshots, but the former is more homogeneous, and not laminated, and the thin ribands of intercalated sand, which it contains at rare intervals, are regular in their occurrence and deposition.

The entire section is strongly suggestive of unconformity between the London Clay and the Lower Bagshots at this point. It would be impossible to find a sharper lithological contrast than is presented by the London Clay and the yellow sands of No. 1, the lowest Bagshot bed. At the same time the stratigraphical evidence seems also to point in the same direction. There is no conformability between the London-Clay surface and the undulations of No. 1. On the contrary, where the surface of the London Clay presents a slight depression this bed not seldom shows a protuberance. To me it seems probable that these loosely aggregated and current-bedded sands were deposited against the eroded slope of the London Clay, just as we now see them. An important feature in the case is that the London-Clay surface rises at least 4 feet higher on the east than any part of the lowest sand-series (see fig. 1). Doubtless both the blue beds (No. 2) and the buff laminated sands (No. 3) overlapped, and have been removed by denudation; but this does not alter the fact that the lowest bed of the Bagshots is seen to abut against a surface of London Clay, and not to conform to it. Moreover, the westward slope of the London Clay visible in section, which falls from 13 feet to zero in about 100 yards, has not by any means the appearance of a true dip-slope. On the contrary, the undulations of its surface seemingly point to erosion previous to the deposition of any of the Bagshot beds*.

As before observed, the very marked change in the lithology also points in the same direction. There are, of course, numerous instances where a clay series *gradually* becomes a sandy series, and yet where the change of colour is often rather sharp, although the lithological differences at the point of contact of the two colours may not be very strong. But in this case the contrast between the grey London Clay, sticky and dark coloured, and the bright-yellow sand of No. 1, incoherent and full of false-bedding, is fairly borne out by an examination of their intimate composition. A brief notice of the lithology of the London Clay at this place has already been given,

* It is much to be regretted that the works of the bridge prevent a thorough understanding of this, the most critical part of the whole section. The mean slope of the London-Clay surface at this place may be taken at 1 in 23, which gives an angle of about $2\frac{1}{2}^{\circ}$ to the westward, or not very much in excess of the observed dip of the London Clay of the central portions of block B. Unfortunately that portion of the London Clay which underlies the Bagshots is too much "muddled" for the bedding to be made out. If we could prove with certainty that the ends of the beds were truncated by the slope, the evidence of unconformity would be complete.

and I will now proceed to make a few observations on the Bagshot Sands of this place, selecting No. 1 as the type, because the constituent grains are comparatively large, and because, where it is thick and current-bedded, the grains are remarkably free from ochreous or other investment.

The sample now under description was taken from the very thickest part of the bed and towards the middle of it: it is a light-grey sand with black specks, passing laterally into bright-yellow sand. The following are the chief constituents in order of abundance:—

(1) Vitreous quartz, mostly angular: size of grains ranging from about 0·9–0·27 millim., average perhaps 0·4 millim. This forms the bulk of the sand.

(2) Opaque and coloured quartz, partly, perhaps, chalcedonic: grains often rounder and slightly larger than in the other variety.

(3) Angular, subtranslucent fragments, black in reflected light, believed to be chips of flint or chert. Also angular fragments of a dull black mineral, probably the “lydite” of authors.

(4) Green renuline granules, some of which must evidently have been casts of organisms, probably Foraminifera. These granules are smaller, on an average, than the quartz grains, and are frequently fractured, appearing as fragments. They are not sufficiently numerous to materially affect the colour of the sand. Doubtless this is the so-called “glauconite,” which, in the present case, I take to be mainly a hydrous ferric silicate, with variable proportions of alumina and small quantities of protoxide bases.

(5) Granules of iron-oxide here and there; magnetite extremely scarce.

Supplementary Note as to Nos. 1 and 2 Bagshots.

No. 1. A fresh sample of this clean bright sand confirmed the features already indicated. Many fine examples of glauconite in renuline granules, some after *Globigerina*. The average size of the granule in this sample was estimated at $\frac{1}{2}$ millim.

Noted an oval grain of quartz, $2\frac{1}{2}$ millim. in length. The dark flakes are evidently some chalcedonic form of silica; but how is it that they are not bleached like the flint chips in the sands of the gravels? A single small fragment may be a bleached flint chip.

No. 2. The sandy beds of No. 2 contain a considerable amount of iron mineral. The red sands of this series and associated clays contain quartz pebbles up to 4 and 5 millim. in diameter.

About the junction of Nos. 1 and 2 are numerous woody fragments bored by *Teredo*, and afterwards partly pyritized. Very often hardly anything is seen but the form of the tube associated with brown oxide of iron.

The next bed which has to be considered is No. 2, or the Blue Bagshots: this is mainly argillaceous, but with seams of sand included, which are often rather coarse and very ferruginous. As before remarked, the lithology of this bed varies so much within short distances that a detailed description would be interminable.

Some of the clay is intensely greasy. There is one phase which occurs so frequently that it may be deemed characteristic. It is where the dark unctuous clay is pervaded in a very singular manner by very fine grey sand, which can neither be said to occur in seams nor in layers. This peculiarity is recognized by well-sinkers, and serves to distinguish it from the London Clay. Towards the south-east of St. George's Hill, about a couple of miles from our section, there is a well which is said to go through a great many feet of "blue sandy stuff," which is not London Clay. Part, at least, of such a well-section may be in the "Blue Bagshots;" but if so, they must have thickened enormously. To a certain extent one is prepared for this thickening by an inspection of the vertical section of the Bagshot strata disclosed in the trial-boring for the deep well at Wellington College supplied by Mr. Irving*, who gives no less than 35 feet of "blackened marl and clay, laminated in its upper portion." That author remarks, with reference to the Wellington-College bore-hole, that the uppermost 25 feet of the bed referred to are strongly laminated; the remaining 10 feet pierced have more the character of London Clay than anything else. "Here then," he says, "we seem to find a *passage of the London Clay into the Bagshot Sands.*" I would only remark that nothing whatever of the nature of marl has occurred to me in connexion with any of the Bagshot beds of our district; indeed the amount of calcareous matter in all the beds is exceedingly small.

On the whole, No. 2 of the Walton-Common section is tolerably impervious; and, whether it is in contact with the Plateau-gravel, or with higher beds of the Bagshot series, there is generally a strong ferruginous pan at the top of it. Undoubtedly this is the bed which has to answer for some of the peculiar water which the Lower Bagshots are known to afford. The well-sinkers say that "people don't like 'blue-clay' water; it has got a skin like grease." This may of course, in some cases, refer to water at the top of the London Clay; but I am inclined to think that in the Oatlands district it mostly refers to the water of the "Blue Bagshots." A well-sinker, of the name of Gray, whom I saw lately, tells me that he sank a well on the slope between Oatlands Park and Lower Weybridge, and that at about 30 feet below the mouth of the well he went through a bed of coal in the "blue stuff." This bed of coal was $1\frac{1}{2}$ inch thick, and burnt readily: he calculates the position of this bed to be about 10 feet below the level of the river Wey. Hence there is a probability of organic contamination in many places where the "blue stuff" is developed.

No. 2 corresponds most probably with the Ramsdell Clay mentioned by Mr. Whitaker †, who observes, "that on a close examination it was also remarked that the Ramsdell Clay bore a kind of resemblance to the pipe-clays of common occurrence in the Bagshot Beds, and for this reason probably it is adapted for making tiles (a purpose for which London Clay is seldom suitable), being an impure

* Proc. Geol. Assoc. vol. viii. p. 144, and Q. J. G. S. vol. xli. p. 494.

† 'Geology of the London Basin,' p. 312.

or imperfect pipe-clay, intermediate in quality between the true Bagshot pipe-clays and the more sandy beds of ordinary London Clay." The same author mentions* that at a place called Hartley Row only one foot of sand intervenes between the Ramsdell Clay of the Lower Bagshots and the blue London Clay. This 1 foot of sand possibly is the attenuated representative of No. 1 of the Walton-Common section. The thickness of the Ramsdell Clay at Hartley Row is stated to be 8 feet, so that the total thickness of the two basal members of the Lower Bagshots is nearly the same at both places, only the distribution is different. When this No. 2 group has been exposed for some time, it is highly probable that browns and buffs will be the prevailing tints.

We next come to the consideration of No. 3, which represents the basal portion of the main mass of the Lower Bagshots as developed in this area. The lowest portions, just over the Blue Bagshots, are generally of a darker buff than those higher up, and, on the whole, rather larger in the grain, though smaller than Bagshots No. 1. Colour, when wet, like common brown sugar, feebly coherent, except where very small ochreous lumps exist. The elements of this sand are mainly those of No. 1 already described. The constituent granules, besides being smaller, are more equal and less clean. They average about 0.16 millim. in diameter. Little flakes of white mica are rather more obvious, and there is more argillaceous matter, generally spread in very thin sheets throughout the bedding. The green grains, both pale and dark, are also fairly abundant.

At the bridge, and for about 25 yards to the westward of it, this division of the Lower Bagshots has been cut out entirely. Presently we perceive little outliers of it cemented to the ferruginous base of the gravels by more or less of an iron-pan (see fig. 5). Traced towards the west, it is found increasing in thickness for a while, until cut out entirely by the first gap which forms the boundary of block C.

Plateau-gravel, &c. in Block C.—The superficial beds of this division are usually from 14 to 15 feet thick, showing a considerable increase over what obtains in the London-Clay area: they are also more sandy. For some part of the distance the Plateau-gravel reposes on the "Blue Bagshots;" and there is an appearance, as indicated in fig. 5, of a portion of this bed having been incorporated. Towards the end of the block, as we approach the first gap, large masses of reconstructed sand, with only a few layers of pebbles, constitute the lower portions of what we must still call the Plateau-gravel. These sands are mainly derived from the Bagshots, such as we see in this district; but they contain other elements in addition. It is not always easy to draw the line between the superficial beds and the unshifted Bagshots.

Block D. (Fig. 1.)

In this block the *Bagshot Beds* are represented by No. 3 alone, with the exception of a faint trace of the "blue beds" just at the

* *Op. cit.* p. 314.

commencement. They have been deeply eroded, and are cut down to the level of the line, and even slightly below it in three places, which may be called respectively No. 1 gap, No. 2 gap, No. 3 gap, going from east to west. The lithology here is of the usual character, a fine and equally grained "soft sand," faint yellow to buff, and even brownish or reddish at top, where much percolated. Slight clay laminations occur throughout, helping to show the bedding, which is pretty regular and current-bedded only for short distances. The colour-banding, as distinct from the bedding, follows the curves of the eroded surface, showing clearly that the reds are due to infiltration from above. This is, perhaps, better seen beneath the shallow basins than in those more deeply excavated. The average thickness of the Bagshots exposed in block D, may be taken at about 7 feet.

The Plateau-gravel of Block D.—Assuming the cutting to be about 26 feet deep here, a thickness of about 19 feet must be assigned as the average of the superficial beds; whilst, as we have seen, in some places they occupy the entire depth of the cutting. No. 1 gap is about 9 yards across. On the east side the "Blue Bagshots" are cut sharply off, and the superficial deposits in the bottom of the cavity conform, more or less, to the sides, which are lined with a layer of mixed flints and pebbles holding up a mass of reconstructed sand about 4 ft. thick, overlain by other masses of reconstructed sand with pebbles, showing a different stratification.

Such masses of sand are often disposed in nearly horizontal layers, between which much current-bedding is exhibited. At first, from their external resemblance to the Bagshot Sands *in situ*, I mistook them for these beds, fancying that tongues of gravel had been thrust between the divisional planes, or even in some instances that masses had been transported bodily. I think it is quite probable that in some cases my former interpretation may be the correct one; but, in a majority of instances, a close examination of the sands in the Plateau-gravel will show that they are coarser, more unequal in grain, and devoid of the clay laminations so characteristic of the beds on which they repose. Although the material is mainly the same, the one has been a turbulent, the other a comparatively quiet deposit. That section of the Plateau-gravel which lies between the first and second gaps consists, especially in the lower, though not quite the lowest parts, of immense masses of this kind of sand, which are often somewhat ferruginous.

Even here the actual base of the Plateau-gravel is for the most part occupied by beds in which the regular Tertiary flint pebble is largely represented. These gravels present a sort of rude stratification, especially conformable to the shallower depressions of the Bagshot surface, which, as a rule, they fill up in a series of concentric layers, sometimes loose, more often cemented by deep brick-red iron-oxide, with here and there a streak of black oxide of manganese above. Under these circumstances there is no difficulty in drawing the line between the Bagshot Sand and the Plateau-gravel: the contrast, in fact, is exceedingly sharp. The hollow about halfway between the first and second gaps is cut down to within three or four feet of the

permanent way. This is filled with bedded masses of flint and flint-pebble gravel, of a rich chocolate colour, which produce quite an imposing effect when contrasted with the fine and pale-coloured sediments of the underlying Bagshots.

It is, however, between the second and third gaps that the contrast of colour is the most marked. Here the hollows are filled with thick courses of brick-red gravels, the stain of which sometimes extends, in varying tints of paler red, through a portion of the underlying beds, until a line is reached where the percolation has been arrested. Beneath such a line the Bagshot Sands look almost white by contrast. When the section was fresh, these colours were really gorgeous, and quite astonished the navvies. The fact is that the vicinity of the third gap, at the western extremity of block D, marks the lowest point of erosion of the Bagshot Beds, which continue to rise beyond these limits. This part of the Plateau-gravel, therefore, must represent a line of underground drainage, a circumstance which helps to account for the accumulation of iron-pans towards the base; since the more soluble matters, chiefly salts of iron in this case, are sure to find their way to the bottom, and when a pan is once formed, the coating of the pebbles above it continues to increase.

The Plateau-gravel may be truly said to attain its maximum development at the third gap, which almost coincides in position with the boundary between Walton Common and Oatlands Park, the latter commencing just where our section terminates. Deducting a yard for "Top Sand," there must be 24 feet of gravel here. As usual, pebbly gravels, more or less conforming to the eroded surface and enclosing a certain proportion of false-bedded sand, fill up the principal hollow. Some of the masses of sand here may be fragments of the original beds, either torn off by currents or floated up by ice; but, if so, the structure has in most cases been considerably modified.

At this point we may roughly divide the Plateau-gravel into three vertical sections. The lower portion is such as I have endeavoured partially to describe. The middle portion is more sandy, having no doubt been largely derived from the Bagshot Beds of the adjacent district, but also containing coarser material. It is often fairly well bedded for short distances. The upper division is the most constant throughout the entire area. It is usually the least bedded of the three, has a greater proportion of large angular flints, cherts, &c. Sand occurs in masses and pockets, and is sometimes rather argillaceous and dirty, but always much coarser than the "soft sand" of the Bagshots. If there is bedding it is often much twisted, so that the apparent lines of stratification lie at all inclinations, and are sometimes curved or contorted. It is not contended that these divisions are by any means constant; but it is evident that the middle division is largely expanded throughout block D; and this circumstance helps to account for the unusual thickness of the Plateau-gravel hereabouts. The Metropolitan Convalescent Asylum (109 feet above O. D.) is 220 yards from the end of the section on the south side of the line; and here a well, said to be 30 feet deep, appears to have been sunk entirely in the superficial beds.

CONCLUDING REMARKS.

Having completed the description of the section through Walton Common, it only remains to say a few words relative to the neighbourhood. As regards the composition of the Plateau-gravel *generally* throughout the district, it would seem to conform in the main to the description already quoted from Prof. Rupert Jones's notice. The coarse brown quartzose sands are sometimes agglutinated and earthy, and bespeak an origin very different from that of the "soft sand" of the Bagshots of this neighbourhood, although much of this fine-grained material may also be noted. What few green grains there are, present a different appearance from those in the underlying Bagshots; cherts, derived mainly from the Lower Greensand, are fairly numerous; but Sarsen stones are decidedly rare, only three or four having come under my notice during the excavations; one of these might have been about 2 ft. 6 in. in length. No quartzites of any size have been noticed, and there is likewise a complete absence of the hard materials of the Northern Drift; everything bespeaks a local and southern origin, as all previous observers have already intimated. I must admit that the numerous brown flints are very apt to be regarded as possibly cherts; some are exhibited, they have in many cases lost all the usual characteristics of ordinary chalk flint, and some specimens are so polished externally as to resemble little Sarsen stones. There is one with a specimen of *Micraster*, which proves the true nature of this brown flint. They must have undergone some peculiar action. Indurated sandstones from the Lower Greensand are more abundant than actual chert; but there is a piece of *Pholas*-bored wood, now in the condition of chert, and some other curious forms.

Whilst on the subject of the contents of the gravel, I would direct attention to a hollow ferruginous box, as a sample of several similar ones, which occur as pseudo-pebbles at the base of the gravel in some places, and especially near the west end of the section. These boxes lie at the junction of the Bagshots with the gravel, and appear to represent clay-galls, torn from the loams of No. 3 (which occur in force further down the line), around which a deposit of brown oxide of iron has formed. The reticulations in one of the specimens exhibited represent, it is believed, casts of shrinkage-cracks. Sandy loams of various colours are found inside.

The Top Sand.—It would scarcely be right not to append a brief description of this all-pervading deposit, which plays such an important part in the economy of the Walton-Oatlands plateau. Supposing any one, desirous of ascertaining the nature of the soil in Oatlands Park, consulted a map of the solid geology, he would of course discover that it was situated on the Lower Bagshots. If the inquirer further wished to ascertain the nature of the *surface*-deposits, he would find them described as "Hill-gravel of doubtful age." But this Hill- or Plateau-gravel only exercises a secondary influence on the soil of Oatlands Park, since every plant desirous of reaching it must needs travel through a yard of most unfruitful

sand. This peculiarity explains why splendid forest trees, oaks, beeches, &c. flourish on a surface which you can scarcely coax into growing a radish. When once such trees get their roots into the slightly clayey gravel of the plateau they are safe; meanwhile innumerable firs with their wide-spreading roots are luxuriating in the Top Sand.

As regards its composition, it is essentially a mixed deposit, containing a few split flints, which become more abundant lower down, also numerous large and often rounded quartz grains, the presence of which serves to distinguish it at once from the "soft sand" of the Bagshots. On examining the finer portions under the microscope, it becomes probable that these latter, directly or indirectly, have contributed largely to its formation; but there is a greater preponderance of quartz together with rather more investment of the individual grain. The "green grains" are very scarce, but there are several granules of iron-oxide, some of which adhere to the magnet. Nearer the surface, where a carbonaceous investment discolours the granules, the sand has a blackened appearance, and this is what passes for soil in Oatlands Park.

By way of comparison with the section through Walton Common, I append a section in the village of Oatlands, close to the 100-feet contour:—

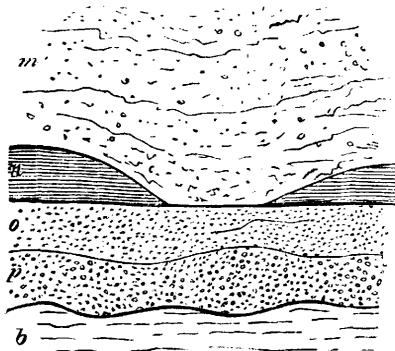
		ft.	in.
Top Sand, &c.	{	1. Discoloured sand with root fibres, and occasionally large flints	2 0
		2. Band of flints and flint pebbles in the sand	0 2
		3. Foxy sands, sharp in the upper part, but rather more earthy towards the base	1 0
		4. Line of flint much bleached: variable in thickness.	0 2
		3	4
Plateau-gravel.	{	Rounded and subangular flint-gravel in deep red sand, in buff-coloured paste, and at bottom in chocolate-coloured sand: bedding, where discernible, often twisted, sometimes nearly vertical	4 2
Total superficial beds		7	6

These rest upon the "soft sands" of the Bagshots of No. 3 type. The well here is 35 feet deep, and probably, like many of the wells hereabouts, does not go completely through No. 3 Bagshots, the water being held up by a pan in the sand, which is much preferred to going down into the "blue stuff." The water of this well is slightly chalybeate, but very good if not allowed to stagnate. It possesses considerable solvent action, I am inclined to think, on iron pipes, and has a very small solid residue on evaporation. Not long ago Mr. Gray, the principal well-sinker, whilst cleaning out one of the wells in the neighbourhood, had the misfortune to break the pan, when he forthwith lost all his water, and had to go many feet deeper before he got it again.

Railway-section near Haines' Bridge.—This is about $\frac{1}{2}$ mile further down the line than the end of Walton Common, and I went to inspect it on the 27th November, in order to make a rough com-

parison with the section already described. The superficial beds are still well developed, probably 14 feet, but the surface has been messed about so much that this estimate is given with reserve. The Lower Bagshots are still fine soft sands slightly laminated, but in the main resembling the No. 3 type. There is a considerable difference in the development of the Plateau-gravel. In the first place the erosion of the Bagshot surface is very slight—so slight, indeed, that I fancied at first that the gravels (*p* of fig. 7) were conformable and part of the Bagshot series. But closer inspection did not confirm that impression. Unless I am greatly mistaken, the basement-bed of the Plateau-gravel is a somewhat regularly bedded gravel series, but rather variable as to thickness. Certainly there

Fig. 7.—Section about 150 yards east of Haines' Bridge.



- Plateau-gravel. {
- m*. Chiefly sand with flints interspersed, a sandy phase of the ordinary Plateau-gravel.
 - n*. A sticky white loam, partly bedded, and rather of the nature of the lower beds of the Middle Bagshots of St. George's Hill.
 - o*. Coarsish brown sand, bedded, and with ferruginous layers.
 - p*. Flint-gravel with a large proportion of pebbles rather evenly bedded, not much sand.
 - b*. Lower Bagshots *in situ*.

are places where it seems quite to belong to the underlying Bagshot Sands, whilst there are others where the interpretation would be different. I ought to say that throughout the cutting I have never seen such a thing as a pebble in the Lower Bagshots. This should be mentioned, because in some places pebbles are stated to be abundant, though mostly perhaps in the Upper Bagshots. I should feel disposed to describe the section here as follows:—

The most curious feature here is the sticky white loam (*n*) which may be traced for a considerable distance on the left. Considering the mutable character of superficial deposits, the beds *p*, *o*, and *n* maintain themselves for some distance. In fact *p* seems to be nothing more than an unusually regular representative of the bedded

gravels, which are so frequently found at the base of the superficial beds on Walton Common. It must be borne in mind that Haines' Bridge is almost at the foot of the slope of St. George's Hill, on the top of which there is a large outlier of Middle Bagshots, and it is the wear of these, I imagine, which may have contributed to the formation of such a bed as *n*. There is nothing suggesting ice-action in this lower group, which seems to have preceded by some time the more confused and drift-like deposits overlying it, which were formed since *n* has been cut through, if one may judge from appearances. Hence at this point the Plateau-gravel is divisible into two series of slightly different age.

St. George's Hill.—It only remains to institute a comparison with the Plateau-gravel of St. George's Hill. The pit on the summit-level, or table-land, at present in work is situated about halfway between the north and south ends of the hill. This may be taken to represent an average sample of the most elevated sheet of gravel in the Weybridge district, and is probably about 250 feet above O.D. The longest face of the working is 45 yards, with a mean depth of a little under 9 feet. There is no "Top Sand" here, such as we have in Oatlands Park, only the upper part of the gravel becomes more sandy, as though the sand had worked up, and the flints had worked down rather—the wind, too, probably assisting this process, which seems very general in sandy gravels. The gravel rests on a slightly undulating surface. It is moderately sandy in places and includes a piece of argillaceous Middle Bagshots about a foot long. But the most striking feature in the section is a mass of brownish sand, 11 yards long and about 2 or 3 feet thick, occurring in the midst of the gravel in such a way as to suggest the idea that it had been floated bodily into that position.

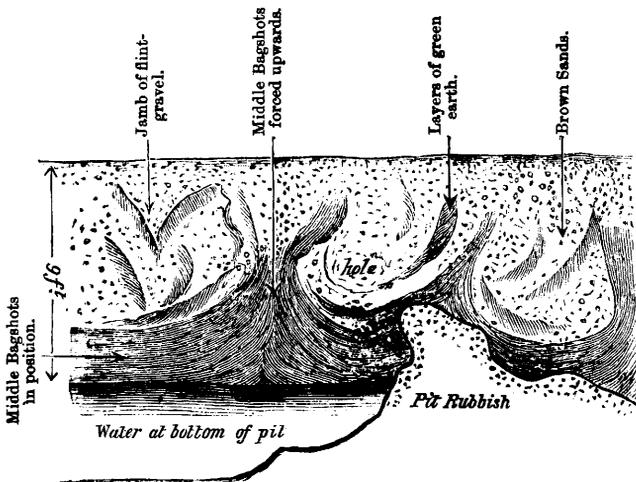
I think, however, that the strongest evidence of ice- or snow-action is to be found at the loam-pit on the north flank of St. George's Hill. It has before been stated that the two great gravel sheets of this district are (1) on the summit plateau, and (2) at the northern foot of St. George's Hill, the latter being, of course, what I have called the Walton-Oatlands sheet. It has also been stated that the *slopes* of St. George's Hill are clear of Plateau-gravel. But at the loam-pit there is a subordinate plateau or shelf just at the foot of the sharp rise which constitutes the final summit. This lies about 185 feet above O. D., and it contains a very interesting superficial deposit, which may fairly be ranked with the Plateau-gravel, although there is very little actual gravel in it.

Fig. 8 will serve to explain what I have called the "contorted series," as it is seen overlying the basement-beds of the Middle Bagshots at the place in question. The Middle Bagshots here consist of a buff laminated clay or clayey loam of a very tenacious character. The superficial beds are made up of green and brown sands and loams in a contorted arrangement mixed with tongues of the underlying pale buff laminated clays, which have been squeezed up in the manner represented; jombs of flint-gravel occur here and there, but not of large size; and flints generally are rather scarce.

Hence this deposit can only be called a "gravel" by courtesy. Specimens of the hardened beds of the Lower Greensand are of occasional occurrence.

Altogether this is an eminently local deposit, and seems to have been derived largely from the green sands and loams of the upper division of the Middle Bagshots, which ought to form the last 50 feet of St. George's Hill. It is not difficult to imagine that, when the climate was colder, the steep northern slope of St. George's Hill was occupied by a kind of *névé*, or a sliding mass of indurated snow. This, adhering to the green-sand beds, caused large masses of them to slide downwards, involving also a portion of the original plateau; hence the occasional jams of flint-gravel. That this was

Fig. 8.—*Contorted Series overlying Middle Bagshots, St. George's Hill.*



pushed over the clay beds of the Middle Bagshots is perfectly clear from the way in which these latter are squeezed up and involved in the superficial mass. At the same time we may admit that the contours are not quite the same now as when this deposit was formed, and that the deposit itself is merely a remnant of a much larger spread which may have occurred about this level.

Summary.—The section on the London and South-Western Railway above described shows:—

(1) That the "Top Sand" of Oatlands Park, in a modified form, extends at least as far as Walton Station, and covers the entire surface, though thicker over the Bagshot-Sand area than over the London-Clay area.

(2) That the valley-slope, west of Walton Station, consists of a curious mixture of gravel and clay, and that this "Mixed Series"

has relations with a long mass of yellow sand, the exact nature of which is somewhat doubtful.

(3) That the London Clay *in situ* appears very suddenly west of this mass of sand, and extends several hundred yards further to the westward than is shown on the Survey map (No. 8). In fact, as regards the line itself, the London Clay on this map is represented as terminating just where it should begin, *i. e.* about 320 yards west of Walton Station.

(4) That the Bagshot Beds near Sir Richard's Bridge succeed the London Clay unconformably, and that there is an argillaceous member of the basement series, which may be the same as the Ramsdell Clay of Mr. Whitaker.

(5) That the Plateau-gravel is abnormally thick towards the west end of the section, where the underlying Bagshots present irregular and deeply eroded surfaces; and that, in this region of its greatest development, something like three varieties may be distinguished, of which the middle one is the most sandy. The general composition of the Plateau-gravel of Walton Common and Oatlands Park bears out in the main the observations of previous authors.

(6) A comparison with other exposures in the neighbourhood serves to show the great variety of deposit which at present is classified under the head of "Plateau-gravel."

DISCUSSION.

Prof. PRESTWICH, speaking from memory of the original section, which he had examined when the railway line was being constructed, was inclined to argue more strongly than the author of the paper against the idea of there being an unconformity between the London Clay and the Lower Bagshot; nor could he find any distinct evidence of such unconformity in any other section in the district. He thought all the appearances described in the paper might be explained by a slight false-bedding, caused by the shoaling of the sea after the deposition of the London Clay, and the shifting and somewhat eroding currents of the shallower sea of the Lower Bagshot. He was, indeed, inclined, from recent observations which he had made, to regard the Lower Bagshot as the upper member of the London Clay. Although northern-drift rocks were not found in the Plateau-gravels of the district described by the author, yet such rocks were found at other points lower down the Thames in the same beds.

Prof. T. RUPERT JONES agreed with the author of the paper that the slight discordance in the dip looked like unconformity, but admitted, with Prof. Prestwich, that the appearance might be deceptive. He pointed out the extreme variability of the beds.

The Rev. A. IRVING agreed with the Author as to the distinctness of the bedding in the London Clay; but he differed from him as to the identity of the argillaceous bed at Walton-cutting with the Ramsdell beds of the Geological Survey. He thought the Ramsdell Clay belonged to the Middle and not to the Lower Bagshots. He

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remarked on the common occurrence of "pans" in permeable beds near the surface. He thought the "mixed gravels" of the Author resembled in construction those found around the edges of many of the plateaux in the Bagshot district.

Mr. CLEMENT REID thought that contortion of beds, like that described by the Author, occurs in districts where no ice-action has taken place, and he suggested that they might be due to the movement of a soil-cap like that of the Falkland Islands.

Mr. MONCKTON had carefully examined all the sections where unconformity might be detected, and found himself quite unable to arrive at any certain conclusion on the subject. He doubted whether the variable clays described were entitled to be called Ramsdell Clay, a name originally applied to beds in the Newbury district.

Dr. G. J. HINDE was able to recognize among the pebbles from the Plateau-gravel, flints with Hexactinellid Sponges from the Chalk, and portions of hard sponge-beds from the Neocomian strata to the southward at Godalming and Hindhead.

Mr. J. STARKIE GARDNER had seen the section in question, and was strongly inclined to believe in an unconformity between the London Clay and the Lower Bagshot. The former, he thought, was marine, and the latter, in this particular section, freshwater and fluvial, and therefore deposited at a much later date.

The AUTHOR agreed that the question of unconformability was a very difficult one to decide. He simply argued for unconformability on a small scale in this particular section. He thought that the fact of the Wimbledon gravels containing northern rocks was a proof of the difference of their age from the Oatlands gravel. He insisted on the difference between the London Clay and the argillaceous beds of the Bagshots. He did not insist on the identification of the clay at Walton with the Ramsdell Clay. He was inclined to agree with Mr. Clement Reid that the contorting of the beds, in the particular instance mentioned, was due either to a soil-cap or to moving masses of snow, though there were difficulties in accepting this interpretation.