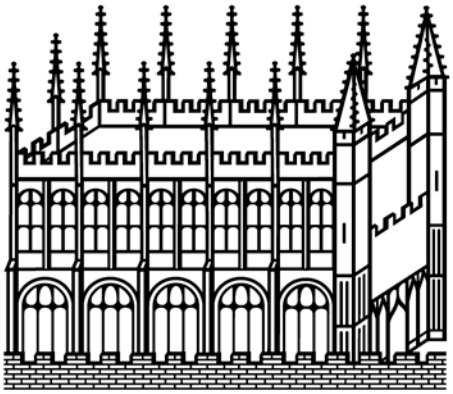
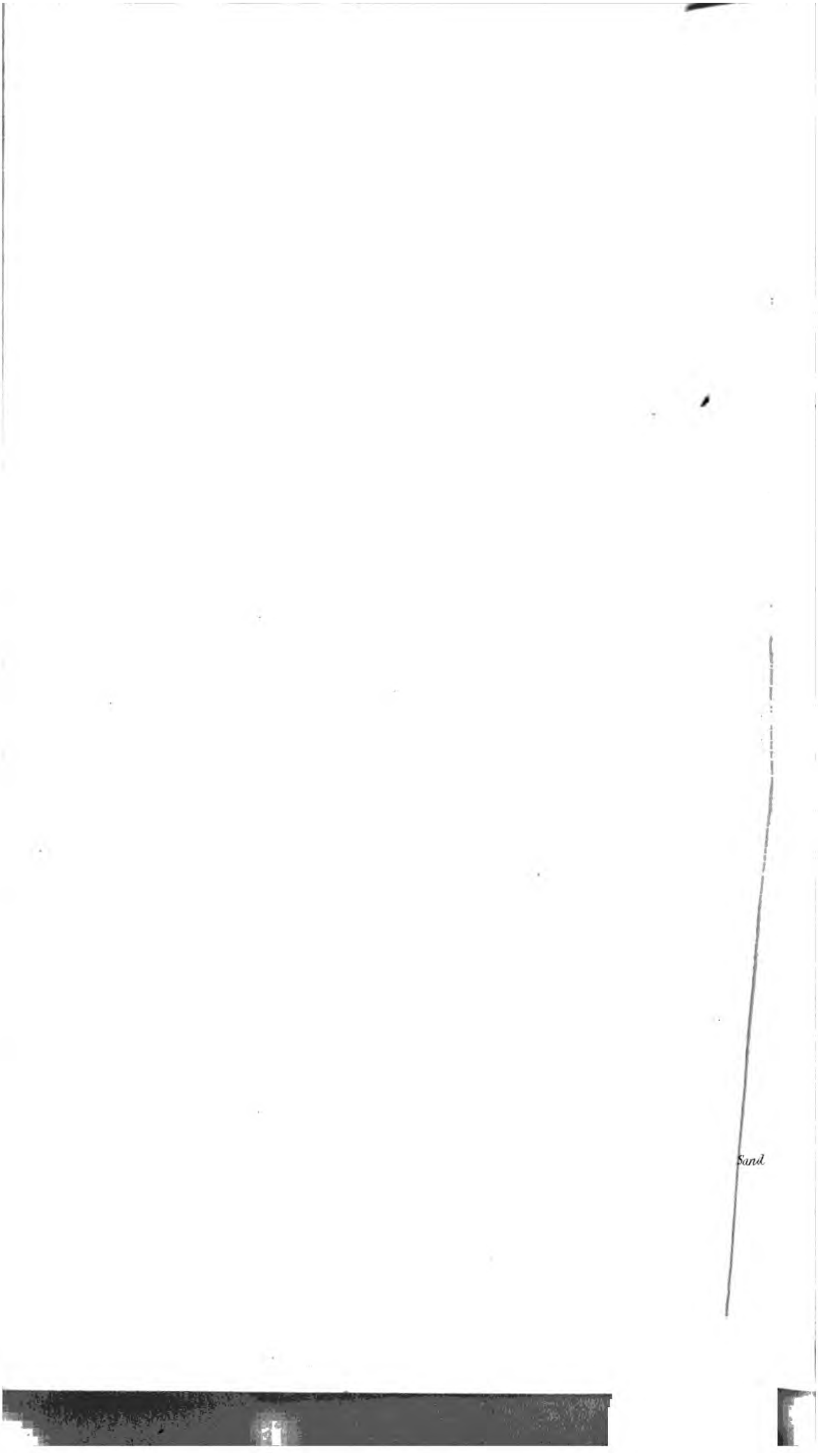


Manning 8° 63


Sand

13.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

GREAT BRITAIN

AND OF THE

MUSEUM OF PRACTICAL GEOLOGY.

THE GEOLOGY OF PARTS OF OXFORDSHIRE AND BERKSHIRE.

(SHEET 13.)

BY

EDWARD HULL, B.A., F.G.S., GEOLOGIST,

AND

WILLIAM WHITAKER, B.A., F.G.S., ASSISTANT-GEOLOGIST.

LISTS OF FOSSILS BY ROBERT ETHERIDGE, F.R.S.E., F.G.S.

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739.

NOTICE.

THE following Memoir is the thirteenth that has been published in illustration of the Maps of the Geological Survey of Great Britain, and I trust it will be admitted that the value of the Maps has been greatly enhanced by the explanations which accompany them. The rapid increase of the sale of our Maps, the number now sold being double that of former years, is the best proof that the importance of our labours is more and more recognized by the public.

RODERICK I. MURCHISON,
Director-General.

April 12, 1861.

THE Geological Survey of the district to which Sheet 13 and this Memoir refer was finished at the end of 1859, and the Map was published in June 1860. The Oolitic rocks were surveyed by Mr. Hull, the Cretaceous series by Mr. Hull and Mr. Bauerman, and the Tertiary lines by Mr. Aveline and Mr. Whitaker.

While the survey of the last-named strata was in progress, Mr. Prestwich, whose labours in the Tertiary rocks are so highly esteemed by geologists, kindly gave the Survey the use of his working maps; and, although there are some differences of detail between us, the subdivisions adopted by the Geological Survey are wholly based upon those established by Mr. Prestwich.

During, and after the completion of the survey, I inspected all the lines on the Map, and I believe they are as correct as the most careful observation could make them.

In this Memoir Mr. Hull describes the Oolitic and Cretaceous formations up to the base of the Chalk (Mr. Bauerman having been translated to the North American Boundary Survey). The Chalk itself and the Tertiary strata are described by Mr. Whitaker, who mapped nearly the whole of them.

The Index-Map accompanying the Memoir was reduced by photography, at the Ordnance Survey Office, from the ordinary One-inch Map, and afterwards transferred to stone. It is the first that has been published in this way to accompany a Memoir, and on its success may depend the continuance of the practice.

A. C. Ramsay,
Local Director for Great Britain.

Geological Survey Office,
1861.

THE GEOLOGY OF PARTS OF OXFORDSHIRE AND BERKSHIRE.

Physical Features.

The most striking feature in Sheet 13 is the escarpment of the Upper Chalk, which divides the district into two nearly equal portions, and, ranging through half its distance from west to east, and through the other half from south-west to north-east, is unbroken except where cut through by the Thames Valley.

Southward of this ridge the country presents the well-known features which characterise the Chalk, consisting of smooth branching ridges, producing deep valleys, mostly dry, and clothed with short herbage.*

The Chalk hills form the chief watershed of the district, and the streams that rise in them ultimately find their way into the Thames, although some of them begin their course in a northerly, and others in a southerly direction. The highest elevation is at White Horse Hill, near Wantage, the top of which is 893 feet above the level of the sea.

Northward of the escarpment of the Chalk the physical features consist of a succession of low terraces, presenting to the north and west their more abrupt flanks, and gently sloping down in the opposite direction. This succession of terraces is a true index to the stratigraphical structure of the district; for, on making a transverse section we find each terrace composed of a successive formation of limestone or else some rather firm siliceous rock, the intervening valleys being formed of clays. The scarped terraces are formed of Great Oolite, (beyond the limits of the map); of the Coral Rag, Portland Oolite, and iron-sand of Shotover, (which is only of local occurrence,) the Lower Greensand, and the Chalk, which, however, has lost much of its character as a table land by the subsequent formation of a vast number of ramifying valleys. The included flats are composed of Oxford Clay, Kimmeridge Clay, and Gault.

In the southern part of the district the wooded hills, formed by the combined escarpment of the Woolwich and Reading Beds and

* The sides of these ridges are generally steeper along their westerly flanks, whenever they happen to trend from north to south, showing that the action of the ancient sea was more vigorous when propelled from the westward, a phenomenon almost universal throughout England. This peculiarity of the chalk ridges is well shown by the shading on the Ordnance Map.—E. H.

the London Clay, rise above the Chalk and form a watershed, the drainage from which runs into the Thames, partly by an underground course, many of the streams being lost in "swallow-holes" (see p. 24).

The following is the succession of formations about to be described:—

GEOLOGICAL FORMATIONS.

- Post-Pliocene — Northern Drift: Gravel and Brick-earth.
- Eocene
  - Middle — Lower Bagshot Sand.
  - Lower
    - London Clay.
    - Woolwich and Reading Beds (Plastic Clay).
- Cretaceous series.
  - Upper
    - Chalk.
    - Upper Greensand.
    - Gault.
  - Lower
    - Lower Greensand and Freshwater Iron-Sands.
- Oolitic series.
  - Upper
    - Purbeck Beds.
    - Portland Stone. } Portland Sand.
    - Kimmeridge Clay.
  - Middle
    - Upper Calcareous Grit. } Coral Rag. } Lower Calcareous Grit.
    - Oxford Clay.
  - Lower — Cornbrash.

E. HULL.
W. WHITAKER.

CORNBRASH.

The lowest formation in the sheet is the Cornbrash, which occupies an area of one square mile at the north-west corner near Bampton. It is the highest member of the Great Oolite; and of all the Oolitic formations there is none more persistent, more uniform in lithological character, or more easily distinguishable by the fossil remains.

When reached some depth below the Oxford Clay, the Cornbrash always appears as a solid bluish rock; but when exposed to atmospheric influences it weathers into a rubbly, cream-coloured stone, seldom oolitic, and very fossiliferous. It breaks into small blocks, with uneven surfaces, and generally coated with calcareous tufa. Thin bands of marl are common, and the formation generally rests on a bed of cream-coloured or bluish marl, at the top of the Forest Marble. Sections may be observed in the road north of Black Bourton and at Marsh Hadden, and the following fossils occur in the neighbourhood:—

Ammonites macrocephalus, Pholadomya lyrata, P. ambigua? Myacites gibbosa, M. securiformis, Lima gibbosa, L. rigida, Avicula echinata, Terebratula obovata, T. globata? Echinobrissus clunicularis.

The thickness of the Cornbrash is from 6 to 8 feet, and water may generally be obtained at its base.

Oxford Clay.

This formation occupies a considerable area of low-lying ground extending northward from the ridge of the Coral Rag. It forms a bed for the river Isis, which at Oxford is 220 feet above the level of the sea. The thickness of this formation is considerable. From a boring at Wytham it was found to be upwards of 596 feet in depth. At St. Clement's Brewery it was pierced to a depth of 265 feet, below which "rock" was found (probably Great Oolite), which was penetrated to a depth of 135 feet.*

In composition the Oxford Clay is a nearly uniform mass of deep blue clay and shale, with occasional bands of nodular argillaceous limestone. Selenite and iron pyrites occur, but fossils are by no means plentiful.

As the district occupied by this formation is generally level, and covered over by the Estuarine or "Low-level" gravel (see p. 56), few sections occur. The ground is generally laid out in meadows and permanent pastures, for which the clayey subsoil is well adapted.

The characteristic fossil is *Gryphæa dilatata*, which occurs in the upper beds. According to Professor Phillips the lower beds yield *Ammonites Calloviensis;* the upper *Ammonites vertebralis;* and bones of *Plesiosaurus* occur throughout.†

Coral Rag and Lower Calcareous Grit.

These formations, either separately or together, form a steep-sided terrace, overlooking the valley of the Isis from Farringdon to Oxford, and east of that river produce the ridge stretching from Ifley to Headington Hill and Beckley. The upper surface of this terrace slopes gently toward the south at an inclination nearly corresponding to the dip of the beds, and is bounded in that direction by a flat and low tract of land formed of Kimmeridge Clay, except in the neighbourhood of Farringdon and Headington, where the ground rapidly rises from the upper surface of the Coral Rag. The terrace also extends towards the south-west, from Farringdon, by Highworth, Wooton Basset, and Purton, to Calne (in Sheet 34).

Lower Calcareous Grit.—This formation may be considered a subordinate member of the Coral Rag, though containing some fossils peculiar to itself, and being principally an arenaceous instead of a calcareous rock.

It consists of a series of soft variegated siliceous sands, alternating with calcareous grits and bands of siliceous limestone, with fossils. The beds of calcareous grit are very irregular, and frequently present the phenomena of "oblique lamination" or current-bedding. A good instance of this occurs near Kingstone Bagpuze, where the superposition of the Coral Rag and the Calcareous Grit may be observed.

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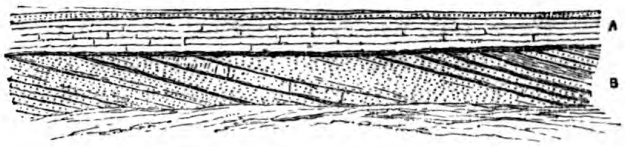
* From the text to the Geological Map of the Environs of Oxford, by Rev. A. D. Stackpoole, M.A.

† Quart. Journ. Geol. Soc., vol. xiv. p. 237.

Fig. 1.

QUARRY ¼ MILE EAST OF KINGSTONE.



A. Coral Rag - - Rubbly shelly limestone, with shells generally as casts. Few corals.

B. Calcareous Grit - Irregular beds of calcareo-siliceous rock, conglomeritic, fossils fragmentary, alternating with coarse brown siliceous sand, with pebbles of quartz, hornstone, &c. Beds obliquely laminated.

At Buckland the Calcareous Grit covers a considerable area. It consists generally of coarse fissile oolite, with fragmentary shells, and much false bedded; upon this rest a few feet of soft sands with bands of clay, which are immediately succeeded by the Coral Rag, as may be seen in a quarry east of Hatford.

These beds are also open to view at the following places:—Roads and quarries of Fyfield; quarry near the Abingdon and Farringdon road, west of Shippon; roads at Cumner; in the London road near Oxford; as also in many quarries of the Coral Rag.

The Lower Calcareous Grit varies in thickness from 20 to 80 feet, and in the bands of calcareous sandstone fossils are plentiful, though generally fragmentary. *Pinna* and *Ammonites vertebralis* occur in this bed near Oxford.*

Coral Rag or Coralline Oolite.—This is an ancient coralline sea-bed interposed between arenaceous deposits of the Lower and Upper Calcareous Grit. It is chiefly remarkable for the vast assemblage of Zoophytes, Echinoderms, and Annelids it presents, while the Molluscs are proportionably less plentiful, with a few exceptions. It stretches in a continuous band of variable width from Farringdon to Wheatley, and is everywhere overlaid by the Kimmeridge Clay, except in one locality, where we find a few feet of the Upper Calcareous Grit resting upon it. The place is situated near the Lamb Inn, west of Kingstone Bagpuze, where the beds are shown in a large quarry to be presently described.

To the north-east of Wheatley the Coral Rag and Calcareous Grit entirely disappear, nor do we find them again, with the exception of one point in the Fens,† till we approach the neighbourhood of Scarborough, in Yorkshire. The sudden disappearance of the formation at Wheatley is to be attributed to an unconformable *overlap* of the Kimmeridge Clay, for it is impossible to suppose that the Coralline Oolite, which at Wheatley quarries is at least 25 feet thick, could thin out within a distance of a few hundred yards.

As already stated the Coral Rag, with its associated beds, forms a terrace, rising abruptly above the low ground of the Oxford

* Phillips, Quart. Journ. Geol. Soc., vol. xiv. p. 237.

† A single point of Coral Rag peers up between Cambridge and Ely. (Phillips' 'Manual of Geology," p. 305, edit. 1855.)

Clay to the north, and sloping towards the south at an average angle of 1°. At Wytham Hill (Sheet 45 S.W.) it reaches an elevation of 583 feet. The land is generally laid out in cornfields.

At Farringdon the Coral Rag is of the usual character, consisting of irregularly bedded coralline limestone, with intercalated bands of clay. The rock is hard and "ragged," suggesting its name, and is much quarried for road-metal. The corals belong principally to the genera *Thecosmilia*, *Thamnastræa*, and *Isastræa*; and they generally lie in bands as they grew on the sea-bottom. Spines of *Cidaris*, *Serpulæ*, and the perforations of *Lithodomus inclusus* are of frequent occurrence, besides other fossils which will be found in the lists. Although the Coral Rag east of Farringdon overspreads a large area, its thickness does not exceed 10 feet. Sections occur at Shellingford, Stanford, and Hatford.

At Lyford there is a quarry immediately below the Kimmeridge Clay, and at the large quarry at the Lamb Inn we find the following section:—

SECTION NEAR THE LAMB INN, KINGSTONE.

		FT.	IN.
Upper Calcareous Grit -	Soft bands of variegated sand and clay - - -	5	0
Coral Rag - -	(a) Oolitic shelly limestone -	3	0
	(b) Loose pisolitic rock, very fossiliferous - - -	7	0
Lower Calcareous Grit -	Beds of hard calcareous grit and soft sands. Base unseen.		

The pisolitic character of the greater mass of the Coral Rag is very remarkable, and seems to be connected with the paucity of corals in this neighbourhood. The bed is very like the Pea-Grit of the Inferior Oolite, and is composed of flattened spherular concretions, fragments of grey limestone, small pebbles of Lydian stone and quartz. The fossils are generally fragmentary, and consist of *Pecten vagans*, *P. fibrosus?* *Ostrea*, *Trigonia costata*, *Lima rigida*, *Belemnites*, *Serpulæ*, &c. The pisolitic character is prevalent in the neighbourhood of Kingstone, and the strata lose their highly coralline character.

At Marcham, Garford, Sunningwell, and Bradley near Cumner, there are quarries, and in the latter districts the coralline character reappears. At Wytham Hill the Coral Rag reaches an elevation of 583 feet, and appears to be more than usually thick; the thickness, however, may be more apparent than real, owing to numerous slips of the strata round the flanks of the hill. The strata of Wytham Hill are isolated from the general mass by a narrow valley of Oxford Clay, in the line of the Oxford and Cheltenham road.

From North Hinksey to Rushmead Copse, near Radley, the Coral Rag forms a narrow indented band, gradually descending to the south, at a dip of 1° (approximately) till it reaches the bed of the Isis, where it is over-laid by Low-level or Estuarine gravel. Crossing the river at Sandford, it forms, in conjunction with the Calcareous Grit, a tabulated area, on which are built the villages of Ifley, Cowley, Temple Cowley, Headington.

Elsfield, Beckley, and Stanton St. John, the sites for which have been evidently chosen with reference to the advantages which such a position secures.*

At Headington the formation divides itself into a lower and upper series. The lower beds are of the more usual description, and are well shown in a quarry 100 yards south of the windmill near Workhouse Farm. They are formed of enormous quantities of fragmentary corals, besides *Conchifera* in great abundance. The corals are of the genera *Thecosmilia* and *Isastræa*, and are generally imbedded in thin coatings of clay. In this section the thickness of rock is 12 feet, and at the base we find the soft brown sands of the Lower Calcareous Grit. Further to the north-east we find the higher beds of the Coralline Oolite, well exposed in quarries at the base of the Kimmeridge Clay; they consist of coarse oolitic freestone, yielding large blocks of building stone, which has been largely used at Oxford for buildings later than the 15th century.† This freestone is 12 feet thick, which gives a total of 25 feet for the Coral Rag in this locality.

At Wheatley the beds are of a similar character, and have been extensively quarried; they form an anticlinal or dome, dipping under the Kimmeridge Clay in every direction from the centre. The beds are traversed by a fault running east 10° south, with a downthrow on the south side. At Forest Hill this fault brings the Lower Greensand against the Coral Rag, and the throw is about 30 feet. At Holton the strata are over-lapped by the Kimmeridge Clay.

Fossils from the Coral Rag, near Oxford.‡

CEPHALOPODA.

Ammonites perarmatus, Sow.
A. triplex, Sow.
Belemnites abbreviatus, Miller.

GASTEROPODA.

Cerithium muricatum, Sow.
Chemnitzia Headingtonensis, Sow.
C. melanoides, Phil.
Natica.
Nerinæa Goodhallii, Sow.
Pleurotomaria bicarinata, Sow.
Turbo funiculatus, Phil.

LAMELLIBRANCHIATA.

Astarte ovata, Smith.
Isocardia.
Lithodomus amygdaloides, Luid.
Modiola inclusa, Phil.
Pholadomya æqualis, Sow.
Gryphæa.
Lima læviuscula, Sow.
L. rigida, Sow.
Ostræa gregaria, Sow.
Pecten articulatus, Schlot.
P. lævis.§
P. similis, Sow.
P. vimineus, Sow.
Pinna.

ECHINODERMATA.

Cidaris florigemma, Phil.
Diadema pseudodiadema, Lam.
Echinobrissus scutatus, Gmel.

ZOOPHYTA.

Isastræa.

* Such as water-supply, elevation, and dryness. The last three villages are in the Sheet to the North, (45 S.E.)

† This stone is rapidly giving way in many of the more recent buildings, partly from defects in quality, partly from not having been always placed in the buildings as it lay in the quarry. The architects of an earlier period were more successful in the selection of their building stone. See "Geology of Cheltenham," Mem. Geol. Survey, note, p. 58.

‡ This list is in great measure taken from that of Prof. Phillips.

§ This species is on the authority of Prof. Phillips.

Kimmeridge Clay.

This formation extends along a band of country of variable width, from Farringdon to the north-eastern extremity of the district.

It consists of a dark blue or olive-green clay, sometimes sandy, and containing occasional bands of fossiliferous limestone.

Immediately south of Farringdon it is altogether concealed by the sponge-gravel of the Lower Greensand, and owing to the unconformity of these representatives of the Cretaceous and Oolitic formations, the Lower Greensand strata rest directly upon the Coral Rag. At the north side of Farringdon Clump it occurs as a narrow band, and is exposed to view in a brickyard. In the direction of Baulking another remarkable change in the succession of the strata occurs, in this case owing to the discordance of the Gault and Upper Greensand. This latter formation is overlapped, and the Gault rests directly upon the Kimmeridge Clay. This superimposition is continuous (as far as the evidence goes to show) to Culham, where, at the eastern side of the large excavations along the banks of the Isis, we find the following section:—

Section at Culham.*

		FT.
Gault	Blue laminated clay, with *Ammonites interruptus*	10
Lower Greensand.	Coarse sand and gravel of quartz and hornstone pebbles (sometimes absent)	1
Kimmeridge Clay.	Dark greenish sandy clay, with *Pinna granulata Cardium striatulum, Ammonites biplex*	15

The Lower Greensand, which is here only a few inches thick or altogether absent, is more than 5 feet at the western side of the pits, consisting of coarse siliceous gravel with current-bedding.

The superimposition of the Lower Greensand on the Kimmeridge Clay is very clearly shown at Brown Combe Hill, near Kennington. The upper surface of the clay is irregular and eroded.

At Headington Hill there is a fine exposition of the Kimmeridge clay, with *Exogyra virgula* resting upon the oolitic freestone of the Coralline Oolite. Near the centre of the section is a band of fossiliferous limestone, yielding *Rhynchonella inconstans*, and occasionally *Pliosaurian*, *Ichthiosaurian* and *Steneosaurian* bones. Crystals of selenite are aspersed frequently throughout the clay.

From Wheatley to Thame the upper limit of the formation is much obscured by a thick covering of drift gravel capping the higher grounds.

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* My attention was first called to this contact of the Gault and Kimmeridge Clay by Professor J. Phillips of Oxford.

*Fossils from the Kimmeridge Clay.**

	Shotover.	Culham.
Reptiles.		
Ichthyosaurus	×	×
Plesiosaurus	×	×
Pliosaurus	×	×
Steneosaurus	×	
Fish.		
Asteracanthus ornatissimus, Ag.	×	×
Hybodus acutus, Ag.	×	
H. leptodus, Ag.	×	
Ischyodus Egertoni, Buckl.	×	
Coprolites	×	
Cephalopoda.		
Ammonites biplex, Sow.		×
A. triplicatus, Sow.		×
Gasteropoda.		
Pleurotomaria reticulata, Sow.	×	
Lamellibranchiata.		
Astarte Hartwellensis, Sow.		×
A. lineata, Sow.	×	
Cardium striatulum, Sow.		×
Corbula†		×
Cucullæa		×
Thracia depressa, Sow.	×	×
Exogyra virgula, Defrance.	×	
Ostræa deltoidea, Sow.	×	
O. læviuscula, Sow.	×	
Pecten arcuatus,† Sow.		×
Perna		×
Brachiopoda.		
Discina Humphriesiana, Sow.	×	×
Rhynchonella inconstans, Sow.	×	

Portland Sand and Oolite.

The representatives of this formation are confined to the north-eastern portion of the district. Between the outlier at Bourton (Sheet 34) and the areas of Shotover, Garsington, and Milton, a distance of about 24 miles, the strata of this formation have been entirely swept away along the outcrop, though it is extremely probable that they may occur at intervals under the Cretaceous beds.

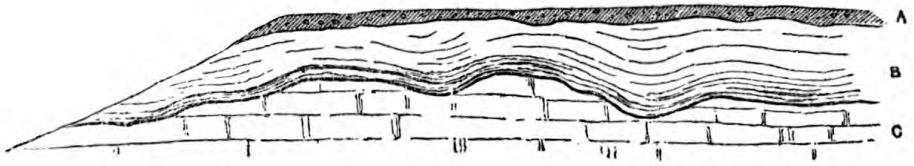
* This list has been made in a great measure from those given by Prof. Phillips in Quart. Journ. Geol. Soc., vol. xiv. p. 238, and vol. xvi. p. 310.

† From the bed of sand at the top of the Kimmeridge Clay.

The Portland beds form the lower zone of the Shotover range of hills, which may be considered as extending southward as far as Garsington and Cuddesden. Over the northern part of the hill it is seldom that the upper bed of limestone is visible, as the iron-sands of the Lower Greensand rest generally upon the yellow sand of the Portland; but at the southern part of the range the upper limestones occur in force, and when the survey was in progress, were very beautifully laid open in the new road which crosses the ridge north of Garsington, at which place the following section was taken (fig. 2).

Fig. 2.

SECTION ONE MILE NORTH OF GARSINGTON.



A. Soil.
B. *Lower Greensand* - Beds of variegated sands and clays, with lenticular bands of rich iron-ore, sometimes 6 inches thick.
C. *Portland Limestone* - White oolitic limestone, much eroded at the upper surface, containing *Trigonia clavellata, Nerinæa, Pinna, Ostræa expansa.*

Great Hazeley.—The second isolated area of Portland rock occupies the high ground west of Great Hazeley and Great Milton. The finest section occurs at the quarries of Great Hazeley, very faithfully described by Dr. Fitton,* and illustrated by a diagram which renders one here unnecessary.

SECTION AT GREAT HAZELEY.

		FEET.
Supposed Lower Greensand.	Top beds of concretionary and siliceous iron-ore occurring in lenticular and wavy layers, intercalated with and resting on grey and blue sandy shales and clays, with impressions of plants -	10
Portland Oolite -	1. White chalky limestone, hardest in its upper bed, which is sometimes eroded; with *Ostræa expansa*, &c. - - -	5
	2. Soft greyish sandy Oolite, with casts of *Trigonia*, and cavities of *Teredo*, &c. This bed contains small fragments of hornstone or Lydian stone, as at Bourton - - - - - -	3
Portland Sand -	Whitish siliceous sand; base not seen -	2

Sections are also visible at Great Milton, Little Milton, and Pegs Farm, where there is a curious bed 5 feet thick composed of broken shells and their casts much tossed about.

* Trans. Geol. Soc., 2nd series, vol. iv. p. 276.

Thame.—The Portland beds which, west of Thame, are overlapped by the Lower Cretaceous formations, east of that town expand to a breadth of more than a mile, and thence extend to Aylesbury.

The best sections are at Kingsey and in a clay-pit half a mile south of Thame itself. Here the Greensand seems to rest on Portland Oolite at one part of the pit, and on the Kimmeridge Clay in another, though I could not determine this satisfactorily. It is evident, however, that the Portland beds have been very much denuded. In another quarry north of Towersey we find the Gault resting directly upon Portland Oolite without the intervention of any beds of the Lower Greensand.

*Fossils from the Portland Beds of Shotover Hill.**

CEPHALOPODA.

Ammonites triplex, Sow.

GASTEROPODA.

Buccinum angulatum, Sow.
B. naticoides, Sow.
Cerithium Portlandicum, Sow.
Natica elegans, Sow.
Nerinæa.
Trochus giganteus.†
Turritella excavata.†

LAMELLIBRANCHIATA.

Astarte cuneata, Sow.
Cardium dissimile, Sow.
Lucina Portlandica, Sow.
Pholadomya.
Trigonia gibbosa, Sow.
Ostræa expansa, Sow.
Pecten lamellosus, Sow.
Perna.

Purbeck Beds.

These have been recorded by Dr. Fitton‡ as occurring in at least two localities, viz., Combe Wood and Cuddesden. They are so irregular, and uncertain in their superficial extent, that it is almost impossible to represent them on the Maps of the Ordnance Survey. As the sections of Dr. Fitton leave nothing to be added, I reproduce, in a somewhat curtailed form, those which he has recorded.

SECTION AT COMBE WOOD, SHOTOVER HILL.

1. Reddish loamy soil, passing into Lower Greensand.
2. *Lower Greensand* { 1. Ferruginous sand. 2. A thin bed of tough clay, which follows the deep erosions at the top of the underlying bed.
3. *Purbeck Beds* - { Stone, and soft rubbly matter ("Malm") with *Cypris*, *Mytilus* (two species), *Modiola*, *Paludina elongata*, *Planorbis?*
4. *Portland Oolite* - With *Trigonia* and *Perna.*

* This list, with the exception of one species, *Lucina Portlandica*, is the one given by Prof. Phillips.

† From the bed of sand at the top of the Kimmeridge Clay.

‡ Trans. Geol. Soc., 2nd series, vol. iv. p. 275.

SECTION AT GARSINGTON.

		FT.	IN.
1. Loamy soil - - - - - - -		2	0
2. *Lower Greensand*	1. Ferruginous brown sand with patches of green sand - - 2. A band of yellow ochre - - 3. A band of tough clay polished by motion under pressure -	8	0½
3. *Purbeck Beds*, "An agglomerate of stone and softer marl-like matter (Malm)" -	1. "Light greenish-grey marl" - 2. "Firmer pieces of stone," with *Paludina*, *Mytilus*, and *Cypris* 3. "Larger pieces of uniform limestone," with *Paludina*, *Mytilus*, and *Cypris* - - - -	4	0
4. *Portland Oolite.*			

LOWER GREENSAND.

Farringdon District.—The remarkable sands or fossiliferous gravels near this town have been very fully described by several authors,* and though their geological relations were at one time a point of considerable difference of opinion, it is now very generally allowed that they are referable to the age of the Lower Greensand.

These beds form a band of hilly ground extending from Alfred's Hill to Farringdon Clump; this latter being, however, isolated from the main mass. Along this line the strata appear to have been thrown into a trough, the axis of which lies nearly north and south, passing between the Furze Hills and Coles Pits, and further south by Fernham Copse. This synclinal arrangement is clearly born out by the evidence regarding the dip of the beds. Thus at the quarry of sponge-gravel north of Little Coxwell the dip is east at 6°. At Furze Hills, Fernham, and Alfred's Hill, along the western outcrop, the dip is also in the same direction, and from this point the beds begin to bend round to the southerly dip. Along the eastern outcrop we find the gravel, in the quarry south of Farringdon, inclining to the south-west; and judging by the general position of the beds at Coles Pits, and in the old gravel-pit on the top of the hill south of the Sands Farm, the same dip is continued. South of this position the beds are overlapped by the Gault, and no more appear till we reach Culham.

The beds at Farringdon are divisible into two groups, the lower being the fossilliferous gravel and conglomerate; the upper, clays and sands with iron-bands.

The gravels are finely exposed in two quarries south of the town; and are there about 45 feet in thickness. The greater proportion of the rock is composed of fragmentary *Sponges*, *Bryozoa*, *Echini*, and *Mollusca*, the remainder being formed of small pebbles of quartz, slate, and hornstone, rounded and

* Mr. Godwin-Austen, Quart. Journ. Geol. Soc., vol. vi. p. 454 *et seq.*; Mr. D. Sharpe, ibid. vol. x. p. 176.

waterworn. The whole of these constituents are bound into a firm gravel by a calcareo-ferruginous cement. At Fernham the same beds occur in the form of a hard quartzose conglomerate, in which the pebbles of quartz are frequently an inch in diameter, and the fossils less numerous than in the quarries near Farringdon. At the top of the hill south of the Sands Farm there is an old quarry, in which these beds of fossiliferous conglomerate were formerly worked. From the blocks which are scattered about, it appears to be remarkably fossiliferous, and very firmly cemented. In it I found *Cardium*, *Cucullæa*, *Rhynchonella*, *Actæon*, *Arca* (interior cast), *Lima*.

The iron-sands and clays are very well shown along the Wantage road, south of Farringdon Clump, at Furze Hill and Alfred's Hill. They appear to overlap the gravels from Alfred's Hill westward; the bands of iron-ore, which are principally developed at the upper part, contain marine shells, as *Leda scapha*, and *Venus parva*, though they strongly resemble those of Shotover Hill, near Oxford, of which the enclosed fossils are of fresh-water origin.

Fossils of the Farringdon Gravels.

AMORPHOZOA.

Spongia peziza, Goldf.
Manon marginatum, Shill.
M. macropora, Sharpe.
M. porcatum, Sharpe.
M. Farringdonense, Sharpe.
Scyphia foraminosa, Goldf.
S. furcata, Goldf.
Jerea Desnoyeri, D'Orb.
Verticellites anastomosans, Mant.

ECHINODERMATA.

Salenia punctata, Ag.
Diadema dubium, Gras.
Cidaris, spines, &c.

ANNELIDA.

Serpula gordialis, Schloth.
S. plexus, Sow.

BRYOZOA.*

Domopora tuberculata, D'Orb.
Ceriocava ramulosa, Goldf.
Heteropora cryptopora, Goldf.
Ceriopora polymorpha, Goldf.
Entalophora Mendonensis, D'Orb.

BRACHIOPODA.

Terebratula depressa, Lam.
T. Nerviensis, D'Arch.
T. Boubei, D'Arch.
T. Rœmeri, D'Arch.
T. revoluta, D'Arch.
Terebratella Menardi, Lam.
Rhynchonella latissima, Sow.
R. depressa, Sow.
R. nuciformis, Sow.

LAMELLIBRANCHIATA.

Ostræa macroptera, Sow.
O. vesicularis, Lam.
Exogyra conica, Sow.
Pecten interstriatus, Leym.
Lima Farringdonensis, Sharpe.

GASTEROPODA.

Natica nodosa, Geinitz.

CEPHALOPODA.

Nautilus lævigatus, D'Orb.

In the direction of Oxford this formation composes four distinct areas, Chawley Hurst, Cumner Hurst, Boar's Hill (which includes Powder Hill and Broom Hill), and an outlier north-east of

* Numerous genera of this class occur here, but sparingly distributed.

Sunningwell, of whose limits towards the east it is impossible to speak with certainty. The character of the deposit in these areas is nearly similar. The beds consist of coarse siliceous sand, cemented compactly by peroxide of iron. Besides the small pebbles of quartz there are others of indurated ribbon slate and Lydian stone. The ferruginous matter is sometimes in excess, and forms bands of siliceous iron-ore.

A good section occurs at Broom Hill, where the Lower Greensand may be observed filling in and covering the eroded surface of the Kimmeridge Clay.

Fossils have not been found over this area, so that it is impossible to state whether these beds are referable to the marine gravels of Nuneham or to the freshwater sands of Shotover, but in mineral character they have a greater resemblance to the former.

The next area to be described extends from Culham to Toot Baldon, and as far south as Clifton Hampden. Along their northern edge the beds form an elevated ridge or escarpment, overlooking the valley of the Isis, and at Nuneham Park presenting features of considerable beauty.

The principal sections are those of Culham (already described), the cutting of the Oxford Branch Railway, the natural cliff which gives the name to Clifton Hampden, and the road-cutting at Toot Baldon. At this place marine shells (*Ammonites Deshayesii* and *Terebratula sella*) of the Lower Greensand period were found,* which are extremely valuable in determining the condition under which these beds were deposited. I am disposed to consider the whole of the beds which I have now described as being of marine origin, and, at least in this particular, differing from the "iron-sands" of Shotover Hill, now to be described.

Freshwater Iron-Sand of Shotover Hill and Combe Wood.—These remarkable beds have been the subject of essays by several authors, who all agree as to their freshwater origin, but are not so certain regarding their geological date; some being inclined to refer them to the Hastings Sands or Wealden beds, and others to an estuarine condition of the Lower Greensand.† Considering the isolated position of these sands, the question cannot be decided on stratigraphical grounds; but after a careful consideration of the bearings of the case, and recollecting the strong lithological resemblance of the iron-sands to the Lower Greensand, both of Sussex, and nearer still of Furze Hill, it has been considered as the safer course to consider them provisionally as exhibiting exceptional conditions of the Lower Greensand, and as such they are coloured on the map of the Geological Survey.

Mineral character.—These beds are stated by Professor Phillips to be about 80 feet in thickness on Shotover Hill. They consist

* By Prof. Ramsay, Mr. Etheridge, and the author, during a tour of inspection.

† Holloway, Phil. Trans. xxxii.; Conybeare, Geol. Eng. and Wales, pp. 136 143; Strickland, in Dr. Fitton's Memoir, Geol. Trans., 2nd series, vol. iv., pp. 274, 275, where the author states that the freshwater shells were first noticed by the Rev. H. Jelly, of Bath. Lastly, Phillips, Quart. Journ. Geol. Soc., vol. xiv. p. 236, where the reader will find a very clear recapitulation of the subject up to the present time.

in the lower part of a series of fine-grained, soft, variegated sands, with partings of white clay and beds of ochre. The upper beds are more ferruginous, with irregular masses of siliceous iron-ore, and the whole is capped (according to Mr. Conybeare) by beds of highly siliceous grit, 6 feet thick. The fossils are preserved only in the iron-beds. As it is impossible to suppose that they were originally confined to such portions, the peroxide of iron has therefore here acted as a preservative agent. Fragments of coniferous wood are of frequent occurrence in the topmost beds, and of the shells only the moulds and casts remain.

Professor Phillips, in his description of these beds, remarks as follows:—"The layers of these cherts, sandstones, geodes, clays, "loam, and ochre are very irregular in extent and thickness, yet "not in such a way as to suggest more than gentle current-"action. There is very little false-bedding; the layers are mostly "undulated, and the concretionary tendency of the oxide of iron "has produced ramifying and geodic masses much harder than "the rest."*

These iron-sands are distributed over a bed of older rocks, which has been subjected to previous disturbances and denudation. Thus in the direction of Garsington, Cuddesden, and Combe Wood, they repose on beds of the Purbeck or Upper Portland series; at Horsepath and Cowley Common, on Portland Sands; and at Littleworth and Wheatley, directly on the Kimmeridge Clay.

Apparently the same beds occur in small detatched portions resting on the Portland Oolite at Great Milton, and at Great Hazeley,† though I was unable to find fossils there.

Between Albury and Thame the country is deeply covered by Northern Drift, and the occurrence of iron-sand at the base of the Gault is rather indeterminate; but beds similar to those of Great Hazeley occur at Moreton, and in the brick-pit south of Thame, where they are of irregular thickness.

Fossils from the Freshwater Sands of Shotover Hill.‡

Paludina elongata, Sow.	*Cyrena media*, Sow.
P. subangulata.	*Unio Stricklandii.*
P. Sussexiensis, Mant.	*U. subtruncatus*, Sow.
P. another species.	*Cypris.*

The Gault.

Unlike the Lower Greensand, the Gault extends in one unbroken band across the sheet. The ground which it forms is generally flat and marshy, owing to which the sections are few, and fossils are only locally plentiful.

In the railway-cutting at Baulking, on the west side of the bridge, a section of 25 feet in depth, and nearly 100 yards long, was examined by me in 1860 when the bank was undergoing repair.

* Quart. Journ. Geol. Soc., vol. xiv. p. 239.
† See page 11, fig. 2.
‡ This list is taken from Prof. Phillips' paper above quoted.

The beds consist of sandy micaceous shales, with bands and nodules of argillaceous iron-ore, interstratified with blue clay. I was unable to find any traces of organic life;* the beds have an easterly dip.

Between Baulking and Culham, the Gault is in conjunction with the Kimmeridge Clay along its lower boundary, and its upper limit is shown by the terrace of Upper Greensand, which produces a marked and picturesque feature from Woolstone to Didcot.

At Culham Brickworks the Gault is seen reposing at one place on the Lower Greensand, and at a short distance eastward on the Kimmeridge Clay; it here contains *Ammonites interruptus, Belemnites, Nucula;* the beds consist of blue shale.

The base of the Gault from Great Hazeley to Thame is very uncertain, owing to the overspread of Drift, but a section occurs in the brickyard south of that town.

The thickness of the formation in the neighbourhood of Dorchester is probably 250 feet.

Fossils from the Gault at Culham.†

CEPHALOPODA.

Ammonites lautus, Sow.
A. serratus, Park.
Belemnites minimus, List.

GASTEROPODA.

Dentalium decussatum? Sow.
Rostellaria.
Solarium conoideum, Sow.

LAMELLIBRANCHIATA.

Nucula pectinata, Sow.
Inoceramus concentricus, Park.
Pecten quinquesulcatus.
Plicatula pectinoides, Sow.

CIRRIPEDIA.

Balanus.

ZOOPHYTA.

Cyclocyathus.

Coniferous Wood.

UPPER GREENSAND.

This formation extends in a belt of variable width across the map in a direction parallel with the Gault.

Throughout the greater part of its course it forms a series of terraces with steep flanks, rising about 100 feet above the plain of the Gault. Of these terraces the most prominent are those of Kingstone Lisle, Charlton, Milton Hill, Berwick Prior, and Adwell. The formation of these terraces is due to the unequal degrees of hardness of the lower and upper portions of the Lower Greensand.

The lower beds are the least characteristic. They consist of a series of whitish calcareo-siliceous strata, in which particles of

* The same cutting was examined by Mr. Godwin-Austen some years previously, who bears record to its unfossiliferous character; Journ. Geol. Soc., vol. vi. p. 460.

† This list is taken from Prof. Phillips' paper on "Some Sections in the Strata near Oxford," Quart. Journ. Geol. Soc. vol. xvi., p. 309. In a thin ferruginous pebbly bed at the base of the Gault, considered by Prof. Phillips to represent the Lower Greensand, *Pecten orbicularis*, and an *Exogyra* (like *E. haliotidea*) have been found.

silicate of iron are sparingly diffused. They are also micaceous, and ferruginous along the joints, and might at a distance be easily mistaken for chalk. The bedding is even and regular.

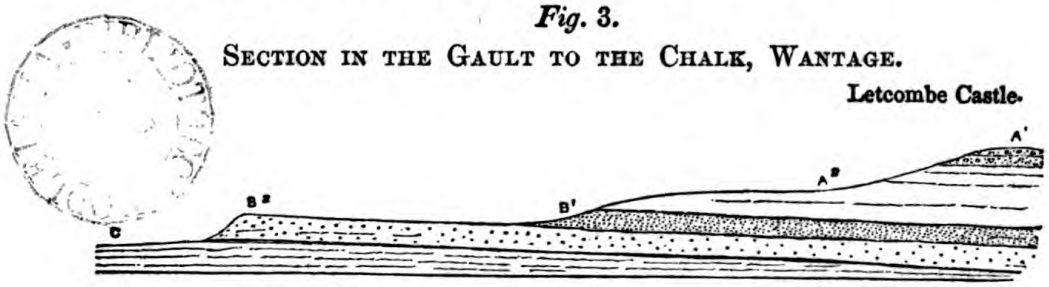
The upper beds are more distinctive, consisting of soft, dark green sands, with strings of calcareous matter. Amongst the particles of sand small grains of silicate of iron are very abundantly disseminated, and to them the green colour is due. The thickness of this part of the formation is about 20 or 30 feet, and the beds may be well seen at Kingstone Lisle, Wantage, West Lockinge, just under the Chalk Marl, in the Roman Portway at Ardington Field, at Hendred, and Aston Tirrel, between Berwick Prior and Brightwell Baldwin, between Easington and Wheatfield, and from South Weston to Chinnor, at the eastern edge of the map.

It is owing to the superimposition of these soft sandy beds, upon the more compact series at the base of the formation that the tabulated character of this part of the district is due. The upper soft series has formed a zone of less resistance to marine denudation, and has given facilities for undermining the Chalk. The upper surface of the terraces are generally free from these soft beds, which are usually found close under the ridge of the Chalk, and the terraces are composed of the lower pseudo-cretaceous beds.

The general arrangement of these beds will be better understood by an examination of the section (fig. 3) drawn through the neighbourhood of Wantage.

Fig. 3.

SECTION IN THE GAULT TO THE CHALK, WANTAGE.



A¹. Upper Chalk with flints. B¹. Upper bed of Greensand.
A². Lower Chalk. B². Lower bed of Greensand.
C. Gault Clay.

The Upper Greensand increases in thickness in an easterly direction as far as the Thames valley. At Woolstone the thickness is not more than 60 feet, but towards Didcot it is at least double this amount. To the east of this Sheet the formation gradually thins away. Fossils are scarce.

Besides the sections already mentioned, there are those in the railway-cuttings at Didcot and South Moreton, and in the Oxford road south-east of Tetsworth, and many others of less note.

E. HULL.

CHALK.

The range of flat-topped hills forming the Chalk escarpment makes the most marked feature in the district and map. Near White Horse Hill, at the western edge of the map, the

escarpments of the Chalk and Upper Greensand are combined, but a little to the east they separate, and still further in the same direction the Chalk has an upper and lower escarpment, though not in so marked a manner as noticed in the Memoir illustrating Sheet 34 (p. 37). The strike is west and east from "White Horse" Hill to the Thames, whence it runs in a north-easterly direction to Chinnor at the edge of the map.

This rock is remarkable for the undulating country which it forms, the long dry valleys, formed for the most part by denudation, and the hills being alike covered with short grass that is always fresh and green.*

In the district under notice there is comparatively no great extent of the "downs" formed by the bare Chalk, but to the north of Lambourne and around East Ilsley there is a fine open tract used as training grounds for race-horses. To the south of those places, and up to the edge of the escarpment on the eastern side of the Thames, there is a thick and irregular capping of clay-drift over the Chalk, and the country is there well wooded.

This soft, white, earthy limestone, which has the characters of a deposit formed in a deep and open sea,† and in a great measure by animal agency, may be divided into:—

1. The Upper Chalk, with flints; and
2. The Lower Chalk, without flints.

The *Lower Chalk* is usually of a darker colour than the Upper, and in it there are occasional thin bands of marl. The whole of the chalk-country below the great escarpment consists of this division, which extends far up that escarpment, and also along the large valleys that have been worn through it.

There is a fine section of the Lower Chalk on the Great Western Railway at the Wallingford Road Station. The bedding is flat, but slightly waved. The following fossils have been found there:—

Ammonites varians, Sow.
A. Rothomagensis, Brong.
Turrilites tuberculatus, Bosc.
Arca.
Inoceramus mytiloides, Mant.
Lima.
Pecten Beaveri, Sow.
Plicatula inflata, Sow.
Rhynchonella compressa, Lam.

To the west of Wallingford there are three outliers of Lower Chalk on the Upper Greensand, at Sinodun Hill, Brightwell Barrow, and Cholsey Hill; to the north of Watlington are three more, at Gilton Hill, to the north of South Weston, and to the north-west of Pyrton.

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* Chalk takes up water quickly and holds it long: "it is probably this strongly absorbent and retentive quality of chalk that renders the bare chalk downs so dry and yet so constantly verdant;" Prestwich's "Water-bearing Strata of the Country around London," p. 62 (note). Perfectly dry chalk will absorb a third of its weight of water without losing its apparent dryness.

† For information on the mode of deposit and extent of the Chalk, see a paper by Mr. Godwin-Austen, in the Quart. Journ. Geol. Soc., vol. xiv. p. 259; and Lyell's "Manual of Geology," 5th edition, p. 242.

A thin but remarkably constant bed, to which, on account of its hardness, I have given the name of "Chalk-Rock,"* forms a boundary between the Lower and Upper Chalk.

It consists of hard chalk, usually cream-coloured, with lines of irregular-shaped cream-coloured calcareo-phosphatic nodules, darker than the containing rock, and generally greenish externally. It never (in the district under notice, at least,) contains flints, nor are any found below it, whilst a line of them often lies on its upper surface. It is much jointed, breaks with an even fracture, and rings when struck with the hammer. In this district it has a thickness of from 3 to 7 feet; but to the S.S.W. of Marlborough, on the slope of one of the hills overlooking the Pewsey Valley (Sheet 14), I have seen about 12 feet of it, the bottom not being then exposed. It may be seen capped by rubbly chalk, generally without flints, in the neighbourhood of Ilsley. On the northern side of the valley, about two miles to the west of West Ilsley, there are two sections. To the east of Cuckhamsley Knob it is capped by about 8 feet of rubbly chalk, also hard, and has a dip of 3° about 30° west of south. In a pit to the north of the same place there is in parts 20 feet of the upper bed of chalk, in which I noticed an *Ananchytes* and flints; the "rock" is quarried in blocks, and is used for road-making purposes. Three-quarters of a mile to the east of East Ilsley there is a small pit showing 10 feet of rubbly chalk over the "rock."

In a large chalk-pit on the eastern side of the Thames, near Hart's Old Lock, above Pangbourn, there is the following section:—

		FT.
Upper Chalk	Chalk with flints, breaking into large blocks Line of flints - - - -	about 40
Chalk-Rock	Hard chalk, cream-coloured at top, over 3 feet Do. do. do., with hard cream-coloured nodules, over 3 feet	over 6
Lower Chalk	Chalk - - - over 3 feet Marly band, 2 or 3 inches thick. Chalk, breaking into large blocks, greatest thickness seen - over 15 feet	over 18

The bedding is rather waved; there are no flints in the rock nor below it.

In sinking a well at Soundes Farm, near Nettlebed, the chalk-rock, 3 feet thick, was reached at a depth of 245½ feet, and I was told that at Joyce Grove it was found at from 270 to 280 feet from the surface. As both these places are some distance below the outlier of the Tertiary beds, which caps Nettlebed Hill (see p. 42), this will give a thickness of about 300 feet to the Upper Chalk. In the neighbourhood of Henley-on-Thames this bed is often met with by well-sinkers, who call it "rock:" they have to

* See "Catalogue of Rock Specimens in the Museum of Practical Geology," 2nd edition, p. 296. I have given a general account of this bed, in a paper read before the Geological Society while this Memoir was in the press, which will be printed in the 17th vol. of the Society's Journal.

blast it, on account of its hardness, in order to get through it. On the eastern side of the turnpike-road, about a quarter of a mile to the south of Middle Assenton, there is a chalk-pit in which this bed may be seen. Its level is much above that of the bottom of the valley, and gives evidence of some disturbance. There are dips in three directions, the sharpest being down the slope of the side of the main valley:—

2° to 2½° about N.W.
4° - 25° N. of E.
10° - 25° S. of W.

Where the change of dip takes place, and along the line of sharpest dip, the rock is much shattered (in the lines of jointing, which are vertical to the plane of bedding).

In the valley branching from the above at Lower Assenton the Chalk-rock may be seen in a road-section, with a dip of over 10° in a direction of 20° W. of S.

In a large chalk-pit one mile to the north of Henley the section corresponds with that near Pangbourn; it is,—

Chalk with flints.
Line of flints.
Chalk-rock, about 4 feet thick.
Chalk, with a marly band, but without flints.

The bedding is, on the whole, flat. The rock contains the usual nodules, and also decomposed iron-pyrites. I found in it some pieces of *Inoceramus* and *Terebratula*. The upper boundary of this bed is usually sharply defined, the lower one not so; I would therefore regard it as the top bed of the Lower Chalk rather than as the bottom of the Upper.

From the above sections it appears that the Lower Chalk occupies the bottom of some of the deeper valleys, and that along the chief valley of the country, that of the Thames, it runs as far up as Pangbourn, and again occurs, as an inlier, at Henley, some height above the river.

The *Upper Chalk* is remarkable for containing layers of flints nearly always in the planes of bedding. Flint sometimes occurs in continuous bands of regular thickness, but more generally in beds of irregular-shaped nodules. The former condition may be well seen in the cutting on the Great Western Railway at Pangbourn, where there are many thin beds of flint, some less than a quarter of an inch in thickness; and in the neighbourhood of Courage (at the western end of the main mass of the Tertiary beds), where, in a pit at the Grange and at two others a little further northwards, there may be seen, about 7 feet from the top of the chalk, a line of flint 3 or 4 inches thick, forming one unbroken solid bed.

At Maidenhatch Farm, between Bradfield and Pangbourn, there is a chalk-pit showing above 20 feet of rubbly chalk, with *scattered blocks of chalk* and irregular lines of flint overlying ordinary chalk. A similar bed of apparently reconstructed chalk may be seen in a pit to the south of Tilehurst, where it is capped by

the bottom-bed of the Reading Beds (see p. 39), so that the reconstruction must have taken place before the deposition of the latter formation.

In places where the Chalk is covered by the Reading Beds or drift, "chalk-wells" are sunk through the overlying beds into that rock, in order to dress the fields with it. Though soft, chalk has been extensively used in building, most of the old churches in chalk-countries being built of it. Few stones could have worn better as far as internal work is concerned; but in external work it is generally found to have suffered much. In some old churches, as at Tilehurst and Sonning near Reading, there may be seen a variety of chalk, which I have never met with in any section, remarkable for the occurrence in it of irregular veins of a dusky tint, as in many marbles.

The Upper Chalk, as before noticed, is about 300 feet thick in this district; the Lower is probably about 500 feet. The general dip is south and south-east, at an angle so low that to the eye the strata generally appear almost horizontal.

TERTIARY BEDS—EOCENE.

In the southern part of this district the main mass of the Tertiary beds rises above the Chalk and extends, with a general east and west strike, from the neighbourhood of Oare, by Bucklebury, Englefield, and Reading, to Sonning, forming a long, well-wooded, and for the most part unbroken range of hills.

Irregularly scattered over the surface of the Chalk, sometimes even on the edge of its higher escarpment, there are many outliers of the Lower Tertiary beds, the relics of strata that once covered the Chalk, the removal of which by denudation is also the cause of the irregular boundary between those formations.

Lower Eocene.*

These strata consist of three formations:—

London Clay.
Woolwich and Reading Beds (Plastic Clay).
Thanet Sand.

The lowest of these, the Thanet Sand, being absent, the next above rests immediately on the Chalk.

Reading Beds.—The oldest name of this set of beds is the "Plastic Clay," which, as it often consists largely of sand and of pebble-beds, is open to objection. Mr. Prestwich† therefore gave it the name of the "Woolwich and Reading Series." In this Memoir, for shortness, the name "Reading Beds" will be

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* For a general account of these beds, and of the Drift gravels, see Mr. Prestwich's "Ground Beneath Us:" London, Van Voorst, 1857. For a special account of each formation, see the same gentleman's papers in the Quart. Journ. Geol. Soc. vols. iii., vi., viii., and x.

† Quart. Journ. Geol. Soc., vol. x.

used. The last is, indeed, the more fitting here, as in this district the formation differs widely in character from the estuarine beds on the south-east of London.

The Reading Beds are defined by Mr. Prestwich* to consist "of mottled clays, tenacious, free from carbonate of lime, and "with a prevailing red base, and of sharp, light-coloured, "quartzose sand, more or less mixed with greensand and with "flint-pebbles."

The clays are of many colours, blue, slate-coloured, plum-coloured, crimson, red, brown, white, and green; and the sands are almost as varied, being brown, orange, yellow, buff, green, white, and crimson. Loams, or mixtures of clay and sand, also occur. In this district flint pebbles are comparatively rare in this formation.

These beds rarely occur in two places in the same order; in some parts consisting almost wholly of clays, in others of sands. However in this, the western end of the "London Tertiary District," there seems to be a *general* order of succession; although, through the frequent absence of a bed or beds, the series is usually described, at least in this district, as quite without order, with the sole exception of the "Oyster-bed" just above the Chalk. The following is a typical section, showing the most complete series of these beds in the country now treated of.

A. Basement-bed of the London Clay. (See p. 49.)

B. Reading Beds.
1. Clay; usually plastic, and of no great thickness.
2. Sands; usually thick, of various colours, often with subordinate beds of clay.
3. Plastic Clays; usually thick, of various colours, (mostly mottled); sometimes with subordinate beds of sand.
4. Sands; the same as No. 2.
5. Bottom-bed; clay and sand.

C. Chalk.

Of Bed No. 5, the most remarkable of the whole, some further remarks are needed. The occurrence of the "Oyster-bed" at the base of this formation has been noticed by most observers; but the almost equal persistence of the roughly-laminated, dark, dull-coloured clays associated with it, and like it often containing green grains, seems to have escaped attention. To these, with the "Oyster-bed," the name "bottom-bed" may be given, as they never occur elsewhere than at the base of the formation. The bottom-bed may be well seen near Courage, Yattendon, Theale, and Reading (pp. 26, 27, 37, 39). It consists of bluish-grey and brown clay, and dull brown and green sand or loam, generally with green grains throughout, more especially in the lower and more sandy part, in which, moreover, there are often beds of green-coated flints and of oyster-shells. It is remarkable for, 1, its persistence and uniform character; 2, its marked difference in look and structure from the beds above it; 3, as being the only part of the Reading Beds, in the western division of the London district,

* Quart. Journ. Geol. Soc., vol. x. p. 75.

in which fossils have been found.* Oyster shells (often associated with shark's teeth) are the only molluscan remains that have been hitherto noticed.† I have, however, observed that when a good section is exposed the "bottom-bed" is found to contain casts of shells, chiefly bivalves.

The following is a list of the fossils found in it in this district:‡—

	Brickyard, near Theale.	Railway-Cutting, Reading.	Castle Kiln, Reading.
Fish-teeth	-	-	×
Cerithium Lunnii? Mor.	×	—	—
Arca	×	-	×
Nucula	-	×	×
Cardium Laytoni, Mor.	-	×	×
Cyrena tellinella, Fér.	-	×	×
C. cordata, Mor.	×	—	—
Psammobia	× ?	-	×
Ostrea tenera, Sow.	-	×	—
O. pulchra, Sow.	-	×	—
O. Bellovacina, Sow.	×	—	—
Bryozoon	-	-	×

Note.—The crosses show that the fossils have been found at the localities thus marked.

"*Swallow-Holes*," that is, caverns which swallow up streams that run into them, are common in this district. They are here formed by streams which, rising in the higher ground, flow down the escarpment of the Tertiary beds, until they reach the more pervious and jointed Chalk, into which they sink, or until they come within a short distance of that rock, when they work their way into it through the few feet of the softer overlying beds. In the course of time, through the chemical action of the carbonic acid in the water and the mechanical action of the water itself, funnel-shaped basins are worn out in the chalk and the beds above, the operation being made more easy by any pre-existing fissures. These hollows are generally thickly overgrown with vegetation. The streams may often be seen running through them, though sometimes they merely flow into a small pool, the level of the water in which remains the same, notwithstanding the constant flow.

These swallow-holes always occur, in this district, at or near the junction of the Reading Beds and the Chalk, and they are therefore of much use in drawing the line between those formations, especially where there are no sections.

* With the exception of the local "Plant-bed" at Reading. See p. 40.

† I should state that Mr. Prestwich has noticed the occurrence, near Newbury (in Sheet 12), of "traces of fossils which require further examination."—Quart. Journ. Geol. Soc., vol. x. p. 87; and that Mr. Rupert Jones tells me that he has for some time been aware of the existence, above the "Oyster-bed" at the same place, of a bed containing cast of shells of the genus *Nucula*. Mr. Prestwich also records the occurrence, in the same section, of "a few bones of *Chelonia*, minute spine of *Echinoderm*, a few *Foraminifera*, and *Cythere Mulleri*."

‡ This is the first notice of the occurrence in the London Basin of shells, of species belonging to the Woolwich shell-beds, to the west of Guildford, in Surrey. The specimens were collected by Mr. R. Gibbs, the fossil-collector of the Survey, and myself.

In valleys, along the bottom of which there is but a small thickness of the Reading Beds above the Chalk, it is usual to find a succession of swallow-holes.

The Reading Beds often fill "*pipes*" in the Chalk. These are irregular funnel-shaped hollows, caused by the action of carbonated water on the Chalk, and then filled by the sinking in of the softer overlying beds. This sinking in is sometimes gradual and sometimes rather sudden. I have heard of hollows being formed in fields, in parts where the surface of the ground was even the day before. Some pipes may at one time have been swallow-holes. In opposition to the above, the chemical theory of the formation of pipes, Mr. Trimmer held that they were formed by the mechanical action of stones and pebbles set in motion by water, and thus wearing out hollows in the Chalk. This view, however, does not so well agree with the facts of the case as does the former one. For a full account of both, see Prestwich, Quart. Journ. Geol. Soc., vol. xi. p. 64, and Trimmer, vols. i. p. 300, x. p. 231, and xi. p. 62. The beds of brick-earth, gravel and clay that often overlie the Chalk and the Tertiary beds (see p. 54) very often fill pipes, indeed nearly always when resting on the Chalk.

The junction of the Reading Beds with the Chalk in this district is generally seen to be even, although there are occasional small pipes; but viewed in the mass, these beds are slightly unconformable to the Chalk. In the smaller outliers, where the Chalk is more thinly covered, and therefore less protected from the chemical action of carbonated water, pipes are both larger and more numerous; many of the smallest outliers being indeed nothing but large pipes. Where the bottom-bed is thick, the underlying Chalk is generally riddled, to a depth of 6 to 12 inches, with a net-work of tubular cavities, once the habitations of boring molluscs, and now filled with the green sand of the bottom-bed. The plastic clays are much used for the manufacture of tiles, draining-pipes, and coarse pottery, especially at Reading. The white sand is sometimes employed in the manufacture of glass, whilst the other sands are used for building purposes, and are mixed with the clays for brickmaking The bottom-bed is generally useless for economic purposes. The thickness of the whole series varies in this district from about 40 to 70 feet, the average being about 50 feet.

Main Mass.

The most westerly point of the main mass of the Reading Beds in this district is on the southern edge of the sheet south of Courage Common. From this point, the boundary-line runs in a general north-easterly direction, but in a very irregular manner, to Hampstead Park Wood, near Hampstead Norris, and gradually rises to a higher level as it trends northwards, showing that the general dip is in a contrary direction.

"Along a new road down the hill to Whitefield Farm the following section was exposed:"*—

	Light greenish clay.	
Basement-bed of London Clay.	Orange and light-coloured sandy clay Bed of large rounded flints - -	4 or 5 feet.
Reading Beds -	Yellow sand. Yellow sand and light-coloured clay.	

For some distance northwards from this there are few sections, but the boundary-line is shown by swallow-holes (see p. 24).

In the large extent of country which they occupy in the neighbourhood of Courage, Hermitage, and Oare, these beds consist chiefly of sand, the higher parts however being capped with mottled plastic clay, as may be seen on the hills to the north of the first place, and on the slope of those to the south of the second. "In sinking a well near the new church at Courage, 30 to 40 feet of sand, with clay in some places, was found above the Chalk.

"Three-quarters of a mile S.S.W. of Hermitage the following beds were passed through before reaching the Chalk:—

	FT.	IN.
Sand - - - - - -	9	0
White clay - - - - -	3	0
Sand - - - - - -	2	0
Clay - - - - - -	4	0
Sand - - - - - -	1	0
Flinty bed - - - - -	0	6
	19	6

"The above information was obtained from well-sinkers. Near the last section there is a pit showing about 20 feet of white, with a little yellow, sand; and at a brickyard higher up the hill there is red mottled clay, light green clay and yellow sand.

"At the brickyard, a quarter of a mile south-west of Oare, there is the following section:—

London Clay and its basement-bed, consisting of:— Brown sandy clay, with a bed of ironstone, with a few inches of blue shaly clay at the base,—about 10 feet.	
Reading Beds	Green, yellow, and white clay. Thin bed of bright red clay. Red, white, and yellow sands.

"In sinking a well in the brickyard, 45 feet of sand and clay were passed through before the Chalk was reached. At another well, lower down, the Chalk was covered by 27 feet of red, white, and yellow sand, with a stony bed (bottom-bed) at the base."†

The Chalk comes to the surface along the bottom of the large valley south of Courage. On both sides, the "bottom-bed" may often be seen, as in the road nearly half a mile to the east of Red Farm, where it is almost black, being full of very dark green grains; or below Fisher's Green, on the east and south of

* From the Note-book of Mr. Aveline. † Ibid.

Courage; and at the Grange. At this last place there is a section showing some remarkable parallel-sided pipes of the bottom-bed in the Chalk. The beds are:—

	FEET
Yellow and white clay - - - - (about)	2
Greenish-brown sand, with oyster shells in the lower part -	3

In the sand filling the pipes there are no shells.

Along the western side of this valley there are also swallow-holes. The lowest part of its prolongation northwards, from the east of Courage to Copyhold Farm, consists of the "bottom-bed" alone; so that the Chalk is but a few feet from the surface of the ground. This is also the case for some distance between Fisher's Green and Hermitage.

From Hampstead Park Wood, the Reading Beds follow the line of the Frilsham and Bradfield valley along its western and southern slope, as far as Englefield, gradually sloping down to a lower level southwards. In a road-cutting about a third of a mile west of Everington, the bottom-bed, consisting of bluish-grey clay with flints at the base, without green grains, and only eight inches thick, may be seen, with yellow sand above it.

In a chalk-pit near Birch Farm, there is yellow sand above the Chalk; the junction is irregular, and the bottom-bed absent. In the lower ground, between Frilsham and Oare, the Chalk is often but thinly covered.

"In sinking a well at the farm, a quarter of a mile to the south-east of Well House, 20 feet of sand and clay were passed through before the Chalk was reached. Eastward from this to Bradfield, the boundary-line, which is hidden by Drift, is indicated by the occurrence of numerous and large swallow-holes, there being but few sections.

"At Bushnell's Green, one mile east of Bucklebury, there is white sand.

"Less than three-quarters of a mile from Bradfield, on the road to Englefield, there is a brickyard; here there are crimson, green, and blue mottled plastic clays, with a little light-coloured sand. Half a mile to the south-west there is a pit in yellow sand. On the hill slope west of Englefield there is, below the brickyard, red mottled clay; and below this, yellow and white sand and clay Over half a mile to the north of the same place, there is a pit showing yellow and white sand with ironstone. Thence, the boundary-line, which is much hidden by the thick bed of gravel spreading over all the surrounding country, appears to run into the alluvium of the Kennet south-west of Theale."*

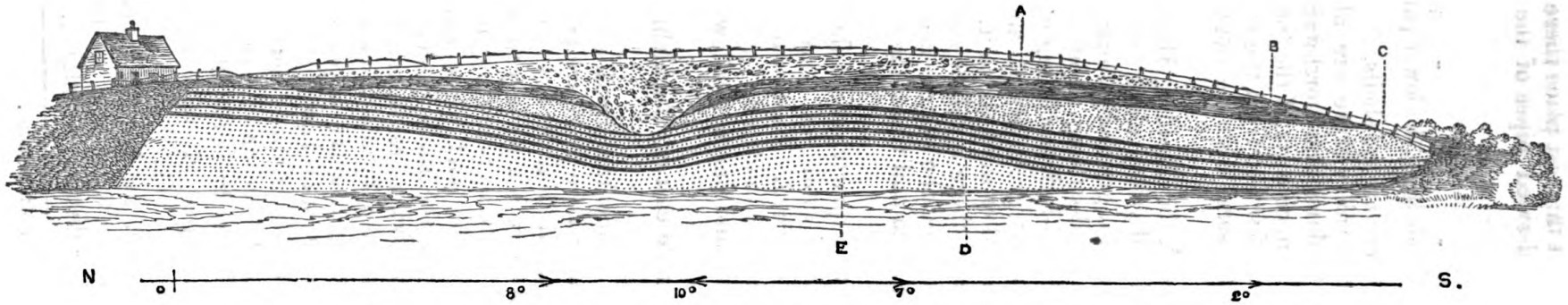
The country on the south of the Kennet, between this and Reading, is a gravel-flat, in which there are no sections showing the beds beneath the gravel. From the general southerly dip, and from the fact that the gravel-pits fill with water, it seems probable that the substratum is not chalk.

South of Reading the alluvium of the Kennet hides the junction with the Chalk. At Rose Kiln there is a section above 90 yards in length, showing waved or disturbed bedding.

* From the Note-book of Mr. Aveline.

Fig. 4.

SECTION OF THE WOOLWICH AND READING BEDS AT ROSE KILN, SOUTH OF READING.



Note.—The figures show the amount of the dip at the points above them. The 10° should be a little more to the right.

			FEET
	A.	Drift gravel and clay, 22 feet deep in the pipe.	
Reading Beds	B.	Pale blue and green clay, mottled with brown, passing into	7
	C.	Light-coloured sands, chiefly white	
	D.	White, pale green, and brown sands, alternating with beds of clay, for the most part mottled with red, crimson, or rich lilac	8
	E.	Buff sands, showing lines of bedding	18
			33

In the same brickyard the section is much hidden further northwards; but the following beds may be seen:—

Pale green clay, partly mottled with red and brown.
Mottled blue, brown, and red plastic clay.
Mottled blue and brown sandy clay.

At Waterloo Kiln the beds seen are:—

	FEET
Light blue and brown mottled clay.	
Crimson and green clay, the former chiefly in three bands; about	12
White sand, passing into yellow and light brown sands, not sunk through, about	15

At Katesgrove Kiln the section is not so clear as when it was measured by Dr. Buckland forty-five years ago.*

At the upper part of this large section the following may be seen:—

Gravel.

Basement-bed of the London Clay.	Brown and bluish mottled sandy clay, with a little ironstone, containing casts of shells and lines of greenish sand.
	Dull brownish sand and loam, with layers of ironstone, and sometimes of clay; at one part two beds of shells in greenish sand.

Crimson mottled plastic clay of the Reading Beds.

The beds below are hidden at this spot; but near, at a lower level, there are:—

1. Light-coloured sands, with two beds of crimson plastic clay, and light-coloured mottled clays interspersed.
2. Green plastic clay.

The section does not now extend to the Chalk; but from Dr. Buckland's description it is clear that the bottom-bed is here present. Mr. Rofe† noticed above the oyster-bed 17 inches of clay, parted by small seams of selenite crystals, and overlaid by sand.

From Reading the Tertiary escarpment runs in a north-easterly direction as far as Sonning, along the slope of the hills forming the southern side of the Thames valley. The junction with the Chalk is much hidden by gravel; but in the southern part of the Reading Cemetery, and in the gravel-pit to the south of it, sand is found beneath the gravel. In a chalk-pit between the turnpike-road and the Great Western Railway, near the thirty-fourth mile-stone on the latter, there is the following section:—

		FEET
	Flint-gravel	8 or 10
Reading Beds.	1. Blue and red mottled plastic clay; only seen at one part	1
	2. Bottom-bed, chiefly consisting of clay; at the base green-coated flints, rounded and angular — about	4
	Chalk; the uppermost 8 or 9 inches full of the holes of boring molluscs.	

* Trans. Geol. Soc., 1st series, vol. iv. p. 278.
† Trans. Geol. Soc., 2nd series, vol. v. p. 127.

The junction with the Chalk is rather uneven.

In sinking a well at Holme Park Farm the Chalk was not reached after sinking 30 feet, when the work was stopped. Below the wood on the west of the farm there is sand.

In the gravel-pit at Sonning there is, at one part, between the gravel and the Chalk, a small trough of the bottom-bed.

In making the cutting for the Great Western Railway near Sonning a good section was exposed, now quite hidden, but of which an account has been given by Mr. Prestwich ;* from which it appears that the clays are greatly in excess of the sands.

Outliers.

In treating of these the plan of working from the west eastwards will still be adhered to; but, owing to the irregular manner in which they are scattered over the extensive undulating Chalk-country, it will also be convenient to adopt a north and south arrangement, subordinate to the former. The larger and more important outliers are distinguished by a name taken from some place on or near them.

In this district there are 75 outliers of the Reading Beds, of which eight are capped by London Clay or its basement-bed. The greater number of these rise above the level of the surrounding chalk-country; but many of the smaller ones are in hollows worn out in the Chalk, and therefore they present no physical feature from which their presence might be inferred; consequently there may be many of these small patches unnoticed, especially as they are generally much covered with Drift.

There are three valleys which divide this chalk-country into four natural districts; these valleys are:—

1. The Lambourne valley; 2. The Compton and Frilsham valley; and, 3. The Thames valley.

1*st District.—South-west of the Lambourne Valley.*

Along the range of hills extending from Farncombe Down to Chilton Foliat there are eight small patches of the Reading Beds; and as those hills are for the most part thickly covered with Drift clay, there may be more.

The most northerly of these outliers, on the top of the hill just to the south of Farncombe Down, is doubtful, owing to the quantity of "brick-earth" (see p. 55) which occurs there. The Tertiary clay, seen in a small pit to the north of the brickyard, is much mixed up with the brick-earth.

At the so-called "Burying Ground" the sections in the brick-yard show brown and light sands and bluish plastic clay, in parts capped with brick-earth.

In Wall's Copse there is an old pit, now a pond, from which light-coloured sand has been got; with the sand there is a little pale bluish plastic clay. This small patch is in a hollow in the Chalk.

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* Quart. Journ. Geol. Soc., vol. x. p. 88.

At Hill's Farm there is a small outlier of sand.

Just north of Harkwood there is a pit about 10 feet deep, showing a little blue plastic clay above light-coloured sand. This pit lies a little way down the slope of the hill, and must be in a basin worn out in the Chalk, unless there be some small disturbance.

South of Liquid Farm there is an old pit in sand and plastic clay, also on the slope of the hill.

To the south-west of this there is another old sand-pit, the working of which was abandoned, I was told, on account of the workmen meeting with a bed of hard rock, probably greywether sandstone in place. This outlier is also in a hollow in the Chalk.

In none of the above did I see or hear of the Chalk having been reached through the sands and clays, nor was any junction to be seen; but at Straight Soley an irregular junction of the bottom-bed with the Chalk may be seen in the small road-cutting. There is white sand in a pond just by. This outlier is in a basin.

Over two miles eastward of this last, on Shefford Woodlands, sand was dug in a field near the road; but the pit has been filled up.

At Hopgrass Kiln, south of the Kennet, there is a small but remarkable outlier, evidently in a basin worn out in the Chalk after the deposition of the overlying beds, like a huge "pipe." The clays and sands here have been, and still are, much worked for the manufacture of bricks and tiles, and there are many sections. The dips, ranging from 5° to nearly 90°, are convergent, whilst in a chalk-pit just to the south of the chief section the lines of flints are horizontal. The following is the section:—

		FEET
1.	A little light-coloured mottled plastic clay.	
2.	Coarse brown sand, with thin seams of brown clay in very small pieces (possibly the remains of fossils), and bands of black sand and soft sandstone - -	6
3.	*a.* Brown and pink clay - - - 0·5 feet *a.* Whitish plastic clay - - - 0·5 „ *b.* Pale grey loam - - - 1·0 „ *b.* Line of ironstone. *c.* Brown and buff loam and sand, with a line of ironstone below the middle - 1·5 „ *c.* Line of ironstone. *d.* Whitish plastic clay - - - 1·5 „	5
4.	Dull purplish-brown clay, stiff but not plastic, much like London Clay, about - - - -	7
5.	White sand, not sunk through, with occasional seams of pale clay in the upper part, at one part at least as much as - - - - - -	8
	Total - over	26

It is not likely that the white sand lies immediately above the Chalk, so that the thickness of the Reading Beds at this place may be safely estimated at 30 feet. This outlier does not rise above the level of the surrounding Chalk.

At Haycroft Copse, south of Wickham, there is a small outlier of sand, of an olive-green colour towards the bottom. This sand occurs plentifully in this neighbourhood, and lies immediately on the Chalk; indeed, it is the only part of the bottom-bed here present.

Just west of the above, at Elcot Green, there is a strip of sand, almost joining the large Wickham outlier. A great part of this consists of the bed of olive-green sand alone.

The Wickham Outlier.—The long line of hill between Wickham and Newbury (in Sheet 12) is thickly capped with the Reading Beds, which in one place appear to be overlaid in their turn by London Clay; indeed, the Tertiary beds, in this case, form the hill, as they rise on all sides somewhat steeply above the level of the surrounding Chalk.

At the cross roads at Hoe Benham, to the south of Wickham Heath, a trace of the bottom-bed may be seen, and a few chains higher up the valley there is a large swallow-hole. In a field on the western side of the hill above this the bottom-bed was exposed in sinking a chalk-well; higher up there is sand. Between this and Wormstall Farm, south of Wickham, there are several swallow-holes, and near that farm, and to the west of it, the olive-green sand of the bottom-bed occurs in some abundance in the fields; and, as it is for the most part bare of Drift, gives a good boundary-line. The hill on which Wickham church is placed seems to consist almost wholly of sand, with a few flint-pebbles in parts, as noticed by Mr. Prestwich,* the white sand to which he alludes being, however, underlaid by the olive-green sand noticed above.

Mr. Prestwich† calculates that the thickness of the Reading beds at the Wickham brickyard is not less than 60 feet. The pits in it give the following general section :—

Drift gravel of rounded and sub-angular flints and fragments of sarsen-stones in coarse sand, filling up hollows in	
Basement-bed of London Clay.	Mottled clay, with a few flint-pebbles at the base.
	A line of rounded flints of various sizes, most of the smaller ones being white.
Reading Beds.	Yellow sand with a little light-coloured clay.
	Crimson green and dark blue mottled clays.
	Grey and white sand.
	Olive-green sand (bottom-bed).
Chalk.	

The sections are not clear, and the thickness of the beds cannot be seen.

The olive-green sand is also to be seen in the fields north-east of the brick-yard. Hence the boundary-line trends irregularly in a south-easterly direction; it is much hidden by Drift, but there are swallow-holes in many of the valleys.

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* Quart. Journ. Geol. Soc., vol. x. p. 124.
† Ibid., p. 86.

2nd District.—Between the Lambourne and Compton Valleys.

On the "downs" to the north-east of Lambourne there are thin outliers of sand: one at Washmere Hill, another two miles to the north of that place; and a larger one capping the high ground between Letcombe Bowers and Great Fawley. To the west of Farnborough there are three outliers, of which the largest and central one appears to be brought in by a fault at its northern end. To the west of the village the high ground consists of Chalk, covered with stiff brown clay with flints (see p. 54), whilst for some distance along the slope of the hill to the north of and opposite to Farnborough Copse, there is yellow sand (of the Reading Beds) at a much lower level than the Chalk just by on the north, probably indicating a downthrow on the south. This long strip of sand extends southwards to Woolley Park.

In a small pit just to the north of this outlier there is a little of the bottom-bed above the Chalk.

There also seems to be a little sand on Brightwaltham Common, but it is much hidden by gravel.

A mile and a half to the north-east of Shefford is another outlier. In a field at its western end there is a small section showing an irregular junction of the bottom-bed, here very thin, with the Chalk. In the wood there is a small sand-pit; and there have been others. There is also a little brick-earth here. Half a mile south of Southend, near Chaddleworth, there is a small patch of yellow sand.

South of Leckhampstead Street is another, partly on the slope of the hill, and capped with gravel.

South of this, between Rowbury Copse and Rowbury Farm, is a larger and thicker outlier, also of sand, apparently faulted at its southern end, as the Tertiary sand is at a much lower level than the drift-covered Chalk just to the south, and the line of junction between them is at the foot of the rise.

Half a mile further south, above Court Oak Farm, there is a small pit, showing orange, yellow, buff, and white sand and pale mottled clay, evidently filling a hollow in the Chalk. About three-quarters of a mile W.N.W. of North Heath Common, there is a road-section showing the green clayey sand of the bottom-bed above the Chalk; and just to the west of the common is another small outlier of sand. Both of these are much covered with Drift.

The Winterbourne Outlier.—To the west of this village is an outlier of considerable thickness and marked feature, apparently consisting almost wholly of sand. The Tertiary beds are thickly covered with flint-gravel, and, therefore, are but little seen; there is, however, a sand-pit at "the Borough," another just west of Winterbourne, and a third on the top of the hill, about halfway between them. The sand is of the usual colours, brown, buff, yellow, and white.

At Hour Hill, south-east of Boxford is a smaller, but equally well-marked, outlier of sand.

A mile to the south of Winterbourne there is another small sand hill, at the northern part of which I saw the bottom-bed exposed in a chalk-well.

At Chieveley there is an outlier, consisting chiefly of sand. Along the turnpike-road south of the twenty-second milestone, there is a section showing light-coloured sands and clays; and in the valley to the west pipes of the bottom-bed may be seen.

The Snelsmore Outlier.—The long hill stretching from the south of Chieveley to Donnington consists of the Reading Beds, capped in parts by London Clay, the whole thickly covered with flint-gravel. Along the western side of this outlier there are occasional swallow-holes, but no good sections. At the northern end, where the Chieveley outlier almost joins it, there are traces of the bottom-bed with sand above it. Along the eastern side of the hill there are more swallow-holes, "Swilly Copse" probably deriving its name from "swilly," a provincial term for swallow-hole. Above Kitchel's Farm there is a pit in brown and light-coloured sands, and another about three-quarters of a mile further south. At Donnington Kiln there is the following section:—

Gravel.	Light brown and grey mottled sandy clay, with flints, mostly rounded, but a few sub-angular, and ironstone at the base.
Basement-bed of the London Clay.	A line of large rounded flints, remarkable for their "*rottenness*" (falling to pieces when tapped but lightly).
	Brown and light-coloured sand and mottled clays (Reading Beds).

The Beedon Outlier.—East of Gidley Farm there is brown sand, which appears to extend in a thin narrow strip over the highest part of Beedon Common; but, owing to the extent to which the sand has been washed down over the surface of the Chalk, the boundary-line is uncertain. The Chalk rises almost to the top of Beedon Hill, where it is capped by the Reading Beds, which dip to the south. At the brickyard by the turnpike-road the beds do not seem to have any order, with the exception of those immediately above the Chalk, which are:—

	Brown sand.
	Layer of Ironstone.
Bottom-bed.	Clay, with green grains, 8 inches to 1 foot.
	Brown and greenish-grey sand, passing downwards into clay; with a few flints, some of the smaller ones rounded, the larger not, about 2 feet.
	Layer of ironstone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches.
	Chalk, slightly coloured brown at top by the iron in the bed above.

Above these there are variously coloured sands, showing false bedding, and containing bands of iron-sandstone and ironstone, and occasional flints; and clays, equally varied in hue, with traces of vegetable remains. The junction with the Chalk is evidently very irregular. In the fields on the slope of the hill towards

Beedon, pipes of the bottom-bed are met with in making chalk-wells; they often descend some depth into the Chalk. At the eastern end of the outlier, in an old sand-pit in the corner of Langley Park, *Greywether Sandstone in place* may be seen. The sand has been dug away from around the stone, which is seven feet thick at the spot where it is most exposed; the bottom is not seen, but it is clear that there is yellow sand beneath; the top is very little below the surface of the ground. Throughout nearly its whole thickness the stone is made up of an aggregation of balls of sandstone, from the size of a pea to that of a plum; at the lower part these are comparatively soft and easily broken; they are of a yellow colour, and the spaces between them are filled with the ordinary yellow sand of the Reading Beds; higher up they are harder and of a duller colour, the sand between them is also hardened; near the top they are hardly to be seen, the stone being uniform throughout, and the top surface is exactly like that of any ordinary "Greywether." At one part there is a hollow concretion of iron-sandstone, like those found in the sands of the Reading Beds.

That this mass of stone was not placed in its present position by man is clear from its size, the extreme length and breadth being respectively about 12 and 5 paces; moreover, the lower part is comparatively soft, and would give way to the pressure to which so heavy a body would necessarily be subjected in order to move it.

There seems to be some slight disturbance affecting this outlier, which consists chiefly of sand, the Chalk being at a very high level at Beedon Hill, whilst to the west the Reading Beds slope down to a lower level.

Almost joining the above in Langley Wood there are two smaller outliers of sand; east of these is a hillock of the same, and half a mile to the east of the "Three Crowns" another. At Ashfield Farm there is a patch of sand almost divided into two by a depression in the middle, along which the Chalk is very near the surface of the ground.

Just east of this is a larger outlier, extending from Oareburyhill Wood nearly to Prior's Court, and also consisting almost wholly of sand, which may be seen in the roads near the former place.

South of the last, near Prior's Court, there is a small sand outlier.

North of Oare there is a strip of sand, but barely separated from the main mass and the Oareburyhill outlier.

At Four Elms, N.N.E. of Oare, there is a little brown sand, but there is no evidence of its extending any distance.

The boundary-lines of all these outliers, between Beedon and Oare, are much hidden by drift gravel and drifted sand.

In the valley south of Courage there are two outliers, but little separated from each other or from the main mass, chiefly composed of sand. In the northern one, in a chalk-pit by the road to the south of Courage, there is a section of the bottom-bed, which

is here over 5 feet thick, and consists of slightly laminated grey clay and clayey sand, with green grains scattered more or less throughout; at the base there are green-coated flints and oyster shells, much broken up. The junction with the Chalk is even, and shows a slight dip in a south-easterly direction.

At the southern end of the other outlier there is a little of the bottom-bed, filling pipes in the Chalk. In making chalk-wells in these outliers much iron-sandstone has been found in the sand.

3rd District.—Between the Compton Valley and the Thames Valley.

There is a small outlier on the high ground between Warren House (in the fields around which farm yellow sand is turned up by the plough) and Unwell Wood, in the western part of which sand is also found.

South of this, at Bower Farm, there is a small thickness of the bottom-bed, with yellow sand above, in a hollow in the Chalk.

In the small wood, a quarter of a mile to the north of Pibworth Farm, near Aldworth,* there is a sand-pit on the slope of the hill, here again in a hollow in the Chalk. In a saw-pit at the cross roads near the farm there is brown and light-coloured sand, and pale blue and lilac clay, apparently drifted from the Reading Beds.

In Common Wood, on the hill to the south-west of Streatley, there is a patch of sand.

South-west of Aldworth there is an outlier of yellow sand, extending from Black Wood to Hartridge Lye Wood.

At Upper Basildon there is a thicker outlier, consisting of both sand and clay, much hidden by gravel.

The Frilsham Outlier.—The hills between Frilsham and Stanford Dingley are formed by a large mass of the Reading Beds, with a thick and extensive capping of London Clay. On the north it is just possible that this may join the Yattendon outlier. In the road near Frilsham House the bottom-bed is partly exposed, and above it are loams and mottled plastic clays. Thence to Frilsham the boundary-line is much hidden by Drift gravel and clay, though yellow sand may be seen occasionally; but it may be traced by the swallow-holes which occur in most of the hollows. On the slope of the hill east of Frilsham there is a spring of clear water, said to be constant, thrown out from the loamy basement-bed of the London Clay, by a bed of crimson-mottled plastic clay immediately beneath. In a well, at a house on the road south of this, light-coloured sand was found above the bottom-bed. In the brickyard close by there are several small pits, one of which shows the junction with the London Clay, a large mass of which has slipped down over the lower beds. Beneath the basement-

* In Aldworth church are eight tombs of the De la Beche family, the last member of which, Sir Henry T. De la Beche, was the founder and first Director-General of the Geological Survey. In the "Architectural Topography of Berkshire," it is stated, that "the series of tombs of the De la Beche family, with their canopies, at Aldworth, are probably the finest in the kingdom in a mere parish church."

bed of the London Clay there is crimson and green mottled plastic clay. The bottom-bed is not seen here, but the sand above it is well developed, being as much as 20 feet thick; the upper part is buff, the lower and greater part white, and above it there is clay.

Just south-east of Hawkridge* there is a chalk-pit, showing 2 or 3 feet of light-coloured sand, and about a foot of clayey sand, with green grains (bottom-bed) above the Chalk. Just west of the other Hawkridge there is yellow sand a little above the Chalk. At Rusdens there is sand, and, at a higher level, mottled clay.

By the road south of Hawkridge Farm there is some of the green sand of the bottom-bed, and also at the higher part of the large chalk-pit near the same place. North of this the boundary-line is much hidden by Drift; but sand may be seen near the farm; at Dods, where there is a swallow-hole; and around Maslin's wood. At the meeting of the three roads, half a mile south-east of Frilsham House, there is the following section:—

	FEET.
Light-coloured sand - - - -	3 or 4
Bottom-bed, greenish thoughout, the lower half of a brown colour, the bottom 6 inches darker than the rest - - - - -	about 6
Chalk, with holes made by boring molluscs.	

The Chalk seems to be but little below the surface for some distance up the valley running hence to Hawkridge Wood. There are here many swallow-holes, and the stream supplying one of them has cut itself a deep channel in the lower part of its course. High up the valley there is crimson mottled clay throwing out water, probably from the basement-bed of the London Clay. Lower down there are shallow pits in sand and plastic clay.

The Yattendon Outlier occupies the high ground between that place and Bradfield, and is capped in two places by London Clay. The projecting portion of the Reading Beds on which Yattendon stands consists of the bottom-bed with a capping of sand; a long section of the former may be seen on the road south of the village, and it is also exposed in a chalk-pit on the road to Manstone Farm.

In Lye Wood there is sand, and at its southern end, in an old chalk-pit now overgrown with trees, the bottom-bed is just visible. It contains green-coated flints, one that I found being a cast of a *Galerite*.

At and near Burnthill Common there is sand, capped with gravel on the higher ground; and also at Strouds. South of the latter place, by Birchland and Hockley Woods, the boundary is obscure; but there are swallow-holes, which serve as guides. In the fields north of Heath Wood there is sand a little distance above the Chalk; and along the road to Bottom Farm there is a section of the bottom-bed consisting of some feet of bluish-grey clay and sand with green grains, with pebbles in the lower part. This bed is also to be seen in the fields west of the road. There

*The more northern of the two places to which this name is given on the map.

is much gravel here, especially on the higher ground. The section noticed by Mr. Prestwich* as remarkable for showing "a patch of angular chalk fragments and flints resembling ordinary gravel," 20 feet below the top of the Reading Beds, does not now exist.

At Old Pit, west of Bradfield, there is sand above the Chalk, and in the valley further west is a swallow-hole. At the southern end of Hanger Copse there is a trace of the bottom-bed, and in the woods there is sand; at the old brickyard to the east of Yattendon the former is seen to be of considerable thickness, and in it I found an internal cast, in iron-pyrites, of a small *Nucula*. At King's Wood there is light-coloured sand and clay above the bottom-bed.

The Tilehurst Outlier.—The triangular area included by the valleys of the Thames and of the Kennet on two sides, and on the third by that of the system of brooks joining those rivers from Pangbourn to Theale, consists of a large outlier of the Reading Beds thickly capped with London Clay, and surrounded by a band of Chalk, broad on the north and north-west, but narrow on the south.

At the north-western end the boundary is doubtful, owing to the great thickness of gravel there. Along the road above Sulham sands and clays may be seen; sand is also found in the wood to the south of this.

At the brickyard north-east of Theale there is the following section:—

			FT.	IN.	FT.	IN.
1.	Light-coloured sands, about		-	-	5	0
2. Bottom-bed.	*a.*	Blue and orange-coloured mottled clay	1	3	6	5
	b.	Blue and yellow clayey sand	1	0		
	c.	Light blue clay, rather sandy, especially at the upper part, where there are many blackish grains	1	6		
		Blue and brown clay (irony)	0	8		
	d.	Clayey sand, with green grains; green-coated flints at the base	1	0		
	e.	Yellowish-brown sand, at the lower part clayey, and with green grains and green-coated flints	1	0		
3.	Chalk, with holes of boring molluscs.					
					11	5

The dip given by the junction, which is very regular, is 2° in a direction 30° E. of S.

In both parts of *c.* there are a few indistinct casts of small bivalves and a great many small flat radiating impressions, apparently casts of selenite crystals.† In *d.* there are many casts of fossils; but the best were found in *e.* (see p. 24.)

Along the road above the brickyard there is sand with iron-sandstone and clay.

* Quart. Journ. Geol. Soc., vol. x. p. 87.

† A like fact has been observed in another part of this formation, not here present, at Counter Hill, Lewisham. See Quart. Journ. Geol. Soc., vol. x. p. 123.

Between Theale and Reading there is much of the valley-gravel, which hides the boundary-line; but sand may often be seen. Clay generally occurs at a higher level.

At the brickyard west of Calcot Park there is:—

	FEET
1. Red, blue, and brown mottled clay, from - -	4 to 6
2. Light-coloured sands, chiefly white, bottom not seen - - - - - -	12 or 14

The upper part of the latter contains a slight admixture of clay, so that it is very tough and may be quarried in blocks, which harden by exposure; the lower part is fine sand. I saw here a small block of sandstone, of a light and somewhat varied colour, evidently out of the Reading Beds. The junction of the clay and sand dips in a westerly direction, down the slope of the valley-side.

At the brickyard S.S.E. of Tilehurst the order of the beds, as well as it could be made out, is as follows:—

Basement-bed of London Clay.
- Brown and pale blue mottled sandy clay.
- Brown sand.

Reading Beds -
- Light-coloured sands.
- Laminated iron-sandstone, 2 to 5 inches.
- Dark brown sand.
- Light-coloured sands.

In a pit lower down there are more of the last, with a little light-coloured clay; and, according to a well-sinker, there is a great thickness of sand above the Chalk.

In a chalk-pit about a quarter of a mile south of this there is a junction of the bottom-bed, partly in pipes, with apparently reconstructed chalk (see p. 21).

Near Southcot there is much sand. Between this and Coley Kiln the Reading Beds almost join the alluvium.

At Coley Kiln there is about 15 feet of variously coloured clays, with a very slight admixture of sand, above the same thickness of brown and light-coloured sands, with a very slight admixture of clay. The bedding is clear and even.

At Castle Kiln the following section was obtained from two pits, one above the other. Beds Nos. 1 and 2 were much hidden.

	FT.	IN.	FT.	IN.
1. Mottled clay; crimson, blue, and brown.				
2. Light brown and white sand, with a thin seam of mottled clay - - - about	-	-	5	0
3. Pale green and brown mottled clay, with bands of crimson clay - - - - -	-	-	3	6
4. White, grey, and yellow sand, with a few blocks of iron-sandstone; at the base a few inches of bright orange sand - - - - -	-	-	20	0
5. Bottom-bed. *a.* Blue clay, laminated by thin seams of sand - - - -	1	0		
b. Clayey sand, with green grains -	1	0		
c. Sand, „ „ -	1	3		
d. Bluish-grey and brownish clay, sandy towards the base; with green grains and grains of yellow sand, and a few green-coated flints	1	3	4	6
			33	0

Chalk—junction horizontal and very even.

For the list of fossils found in the bottom-bed, see p. 24.

In the railway-cutting west of Reading there was, at the northern end, in 1858, a long and good section, now quite hidden. Here, above the Reading Beds, there is gravel, composed almost wholly of flints, 12 feet in extreme thickness, except in a large pipe more than twice that depth.

All the beds above the bottom-bed were very irregular; there were many wedge-shaped masses, and much waved bedding. Combining different parts of the section, the following general order was shown:—

1. Brown and blue mottled clay; a few feet.
2. Variously coloured sands, with occasional seams and wedge-shaped masses of clay from 20 to 30 feet.
3. Bottom-bed, consisting of—
   - *a*. Bluish-grey and brown clay, roughly laminated - - - - - 1 foot
   - *b*. Dark bluish-grey laminated clay; sometimes sandy; casts of shells - - - 1 „
   - *c*. Clay like *a*; casts of shells - - 1 „
   - *d*. Dark sands, mostly clayey; throughout of a greenish tint, owing to the presence of green grains; casts of shells and beds of oyster shells; green-coated flints at the base - - - - - 5 „

   } 8 feet.

   Chalk, with holes of boring molluscs.

The junction is even, though slightly waved, and the bottom-bed slightly varied in structure in different parts. For the list of fossils, see p. 24.

This section is at the same spot as that given by Mr. Prestwich (Quart. Journ. Geol. Soc., vol. x. p. 88), that is, on the western side of the cutting to the north of the Bath road. Since the time when Mr. Prestwich saw the section the cutting has been much widened in this part, which will account for any difference from the section given above. The large pipe of gravel noticed by that gentleman was still to be seen; but I could not find any specimens of the leaves which he found in such numbers in layers of light grey and greenish sandy clay in the middle of the sands. The section is now turfed over.

In an old chalk-pit west of Groveland Farm, the bottom-bed occurs. Around here there is much sand.

In the brickyard at Northcot not worked since (1857) the beds seen are:—

		FT.	IN.
London Clay.	Brown and pale blue mottled clay, with green grains in the lower part - - -	2	4
Basement-bed of the London Clay.	Sand and loam, brown and pale violet and bluish-grey - - - - - -	5	8
	Brown irony sand, with casts of shells, chiefly at the base, in an irregular band of soft iron-sandstone - - - - -	3	3

		FT.	IN.
Reading Beds.	1. Crimson plastic clay, slightly mottled with blue	1	0
	2. Alternations of light-coloured sands, loams, and clays ; with a little crimson clay in the lower part ; sands predominating ; bottom not seen over - - - - -	30	0

Along the adjoining road, and that leading to Kentwood Farm, there is a cutting showing light-coloured sands and clays.

At the brickyard south of Kentwood Farm, the section is small and indistinct; the ordinary mottled plastic clay may, however, be seen, and also a bed of fine white sand, from 3 to 4 feet thick. In a chalk-pit by the road west of the farm, there is a very irregular junction of the bottom-bed with the Chalk.

Further westward there is much gravel, but sand may be seen in places. In the road, about half a mile south of Stoneham Farm, there is some crimson plastic clay, probably the top bed of the series.

4th District.—North of the Thames.

It will be convenient to describe firstly those outliers on the top of the Chalk escarpment; secondly, those some little distance from it; and lastly, those on the hills skirting the Thames.

1. North of Whitchurch there is an outlier, described by Mr. Prestwich* as consisting of "mottled clays, associated with a "thick bed of white quartzose sand, ranging close to the edge of "the chalk escarpment from Woodcot Common to near Coomb End "Farm." Light-coloured sands may be seen at various places in the southern part of this outlier. To the north there is nothing to be seen but gravel, except on Woodcot Common, where there is mottled clay in the brickyard.

At Nuffield, there is a small patch of sand forming the highest part of the hill. In a small shallow pit by the road-side, near the church, there is iron-sandstone in place. It is flaggy and rubbly, the interstices being filled with red and brown clay and brown sand. Sand has been dug here for brickmaking.

In Burwell Copse there was, in October 1858, a small sand-pit, in which was shown from 8 to 10 feet of drift sand (clayey, coarse, of a dull brown colour, with angular and sub-angular flints scattered through it), above buff and yellow sand of the Reading Beds. In this latter was a collection of irregular-shaped but partly rolled flints, some showing clear traces of a green coating. This pit is not at the very top of the escarpment, but on its gentle slope; it is therefore possible that the outlier may extend farther than is shown on the map. Still there is no evidence that it does, and it is probably nothing more than a large pipe. In a pond about three-quarters of a mile to the north-east of the above, there is a little yellow sand.

On Watlington Hill there was also a small pit, nearly filled up, showing light brown sand and clay with rounded flints, chiefly in the clay, capped by soil with flints. The clay may also be seen along the road up the hill; it is drift, but the sand belongs to

* Quart. Journ. Geol. Soc., vol. x. p. 127.

the Reading Beds. This patch again is on the slope of the escarpment, but not far from the top. Just within Shotridge Wood, below the top of the hill, there is a pit, 10 or 12 feet deep, in light-coloured clay and sand, and in the latter there are small blocks of greywether sandstone. There is Chalk near by, at a higher level, so that this patch must be in a hollow.

Between Portobello and Cow Leaze Wood, in some old chalk-wells in the fields on the eastern side of the road, white and light brown sand lies beneath drift clay and loam. In pits on the other side of the road, by Hailey Wood, there are many green-coated flints, (derived from the bottom-bed) and a few pieces of iron-stone scattered through the drift-clay with unrolled flints : most of the flints seem to have had some of the green colouring-matter washed off. From this it is evident that the Reading Beds have barely been denuded from the hill. On the common to the north of Stokenchurch turnpike there is evidence of a small patch of the plastic clay of the Reading Beds filling a pipe in the Chalk.

At Stoke Row, about five miles west of Henley-on-Thames there is a small marked outlier. On the north-west there appears to be some disturbance, much obscured however by Drift. In the chief pit supplying the kiln the beds are very irregular. There are here light-coloured clays and sands, and some white sand, with many flints, large and small, rounded and angular, sometimes in lines, sometimes in patches, chiefly in the clay, and a few small quartz pebbles. Below these is blue and red mottled plastic clay.

The Nettlebed Outlier.—This well-marked outlier, which s capped by London Clay, forms the conical hill above Nettlebed, the top of which is one of the highest points in the district. There are here three brickyards and a pottery-kiln, but none of the sections are large. The following general section is obtained from many pits:—

Gravel.

London Clay and its basement-bed (see p. 52), 20 to 25 feet.

Reading Beds.

1. Greenish clay, only seen at one place, and then not thick.
2. Brown, white, and crimson sands, several feet.
3. *a.* Plastic clay, variously coloured, with sandy clay and a little sand ; several feet.
   b. White or very pale green sandy clay (fire-clay), and sand.
   c. Plastic and sandy clays, brown, blue, and crimson.
4. Sands.
5. Bottom-bed ; probably thin.

The last is not now to be seen, but its presence is evident from Mr. Prestwich's section.* However, at the brick-yard by the road, to the north-east of the windmill, the lowest bed which had been reached may belong to it. It consisted of green clay with angular flints, none being green coated, but some looking as if they were fresh from the Chalk. Of the sandstone noticed by Mr. Prestwich, I could see nothing (Nov. 1858) ; but I was told

* Quart. Journ. Geol. Soc., vol. x. p. 89.

that blocks of sandstone were found in the sand. In the valley to the north of the windmill the Reading Beds occur low down on the western side, whilst on the other side the chalk is at a higher level, indicating a downthrow on the west. The occurrence of London Clay at the brickyard to the north-west of the windmill, and at a much lower level than the patch of the same formation on the top of the hill (see p. 52) gives further proof of this fault. I could not make out the patch or pinnacle of Chalk that comes to the surface on the downthrow side of the fault.

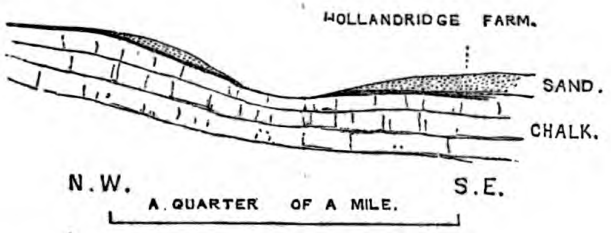
The Reading Beds here must be fully 50 feet thick, and they are very irregularly bedded. Nowhere else have I seen in them such a thickness of the greenish-white sandy clay,* so valuable for the making of draining-pipes, &c., nor of pure white sand. The boundary-line is everywhere hidden by drift.

On the turnpike-road to the west of the church there is a pipe of light-coloured sand.

On Maidengrove Common there is an outlier, the boundary of which is doubtful, owing to a thick capping of brick-earth and gravel. By the brickyard at Russell Water there was to be seen (1858) light brown loam (brick-earth), with small rounded and angular flints, chiefly at the base, overlying the buff and white sand of the Reading Beds. The Chalk had not been reached after sinking 18 feet; whilst in making the kiln, close by and at a higher level, that rock was found to be only 8 feet from the surface and still higher up the hill it is free from Tertiary beds, as if there were some disturbance. On the Common there are many small pits, in which are variously coloured sands and clays beneath the Drift. There seems to be another disturbance, in the valley on the north-east, as on that side the Reading Beds are found at a much lower level than to the south-west, and in a small chalk-pit there is a dip of 8° in a direction 25° east of north, *i.e.*, down the slope of the valley.

Extending half a mile southwards from Hollandridge Farm is a small outlier of sand, also apparently disturbed at its northern end; as along the road to the north-west of the farm the Chalk rises to a higher level than the sand just by; moreover the crest of this chalk-rise is capped by a small patch of sand, which extends down part of its sharp southerly slope, as shown in fig. 5.

Fig. 5.



* I was told that this, together with the associated clays, had been found 40 feet thick.

There is a larger outlier extending over Turville Common and Summer Heath to the brickyard at Southend. The boundary-line is much hidden, especially on the eastern side. At the northern end of Turville Common, and on Summer Heath there is sand, with a little clay. At the Southend brickyard the pits were almost filled up when the survey was made. The top beds are drift, consisting of light-coloured mottled clay and loam, with subangular and rounded flints, and lie unevenly on the mottled clays and light-coloured sands of the Reading Beds. In the more northerly pit the Chalk was said to have been reached at a depth of 15 feet; in the other pit close by, to the south, it was not reached after sinking 22 feet, showing a considerable dip to the south. The same was the case at another place more to the east and at a lower level, whilst just to the south,—that is, in the direction in which (according to the dip) the Chalk should be deeper, — there is a pit showing that rock, horizontally bedded, at the surface, indicating the probable presence of a fault, with a downthrow on the north.

On the hill above Ibstone there is a small patch of sand, to the north of which the Chalk rises to a higher level, as at Russell Water and Hollandridge Farm. In Parkwood there is a sand-pit, in which is found brown, yellow, buff, and white soft sand, with small patches of crimson and pale blue clay, and rounded flints in places.

The high ground between Kimble Farm and Cockleys is capped with sand. A quarter of a mile westward of the former place there is in a small pit mottled clay and loam, and brown sand, both with flint-pebbles; the former is Drift, the latter belongs to the Reading Beds. Along the eastern edge of the plantation skirting Stonor Park, there is sand beneath the Drift, and at the south-eastern corner of the Park are some small pits showing the following beds:—

1. Drift. { Brown and light-coloured loam with a little red clay. / Clayey gravel, almost wholly made up of rounded flints of various sizes.
2. Brown and light-coloured sand of the Reading Beds.

At Cockleys, to the east of and below the farm, there is a small sand-pit. The Chalk was not reached at a depth of 8 feet, although it comes to the surface close by at a higher level. At Bosmore there is a hillock of brown and yellow sand, with a little ironstone and iron-sandstone, and very many flint-pebbles, and there is also Drift with flint-pebbles, but this is clayey. Sand has been dug here to a depth of about 25 feet, the Chalk not being then reached; the pit has since been filled up.

At Lower Wood End there is another hillock consisting of light-coloured sand, with rounded flints and much ironstone, and some coarse iron-sandstone.

At Stirrup Farm, a mile to the north of Mapledurham, in making a pond, yellow sand was found beneath the Drift.

West of this, at Chause Heath, is an outlier, the boundary of which is quite hidden by gravel. Just above the "Pack-saddle" there is crimson mottled plastic clay ; and in sinking chalk-wells in the fields near, about 20 feet of gravel, loam, and clay have been found above the Chalk.

The Caversham Outlier.—This outlier is brought in by two faults at its eastern end. It consists almost wholly of clay, and is much covered with gravel. Down the road from Rose Hill to Chalkhouse Green, the bottom-bed may be seen. At Caversham Grove water is obtained by sinking a few feet through the gravel, proving that there is clay underneath. On the southern side of the by-road, to the south of this, there was formerly a small brickyard, where I was told that there was clayey green sand (bottom-bed) beneath 4 or 5 feet of clay. In the valley running up to Emmir Green there is a swallow-hole, and at the southern part of the Green there is a spring of clear water, probably thrown out from the gravel by an underlying bed of clay ; and there is a similar spring by the roadside up Caversham Hill. In Caversham Park there is mottled plastic clay some distance below the house, and sand at a higher level eastward, whilst the hills on the eastern side of the valley consist of chalk, at a much higher level than the Tertiary beds in the Park ; thus indicating a fault with a downthrow on the west. In sinking two wells on the north of the house sand was found below the gravel, and water was obtained after sinking through about 7 feet of the sand. At Rose Hill, in the southern brickyard, there is a section showing the London Clay (see p. 53 and fig. 6), thrown down by the fault against the variously coloured mottled plastic clays of the Reading Beds, and over the whole there is an irregular capping of drift gravel and reddish loam. In making a chalk-well on the eastern side of the fault, about 40 feet of clay was passed through before the Chalk was reached, and immediately above the latter there was about 3 feet of clayey green sand (bottom-bed), with oyster shells at the base. In the other brickyard the depth to the Chalk is about the same.

To the north of the brickyards there seems to be a second fault, at right angles to the former, with a downthrow on the south ; for at Chambers' Green the Chalk comes to the surface, whilst at the brickyards, which are at a slightly lower level, it is 40 feet from the surface. Moreover, along the by-road from Chambers' Green down the hill there is mottled plastic clay, at a much lower level than the Chalk to the north. The boundary-line from this part to the park is much hidden by Drift, some of which consists of loam and clayey sand very much like the Reading Beds.

The Binfield Heath Outlier.—In sinking a chalk-well at the Binfield Heath brickyard the Chalk was reached after passing through about 20 feet of the Reading Beds, in which, as at Rose Hill, there was but little sand. Immediately above the Chalk

was a clayey green sand. When the survey was being made there was a small section showing three beds of mottled clay with a dip gradually increasing from 5° to 15°, adout 20° west of south, in which direction, however, the Chalk comes to the surface at a higher level, proving the existence of a fault with a downthrow on the north-east (see fig. 6). In a chalk-pit just below the kiln there is a dip of 5° east, that is in a contrary direction to that of the Reading Beds, on the downthrow side of the fault. In sinking a well at a house on the high road, opposite the road leading to the brickyard, plastic clay was again found at a lower level than the Chalk to the south-west, and to the south of this there is clay and sand on the eastern side of the valley, whilst the other side consists of Chalk, giving further evidence of a fault. This fault appears to be ended on the south, at Dunsden Green, by another at right angles to it, as at that place there is sand at a lower level than the Chalk just to the south, which is contrary to what would be expected from the general dip of the beds in this district, and probably, therefore, indicates a downthrow on the north.

The northern boundary of this outlier is quite hidden by gravel, by which indeed the greater part of it is covered, but sand may be seen occasionally. In the valley to the north of Shiplake Row there are swallow-holes, and in sinking a well between that place and the Bottle and Glass 30 feet of sand and clay were passed through without reaching the Chalk. To the east of Shiplake Row there is mottled clay, and, lower down the hill, sand, which is also found farther to the south, where the boundary-line is marked by swallow-holes. Between Hampstead Farm and Dunsden Green there is sand, and along the eastern side of the main fault clay may often be seen, and occasionally sand also.

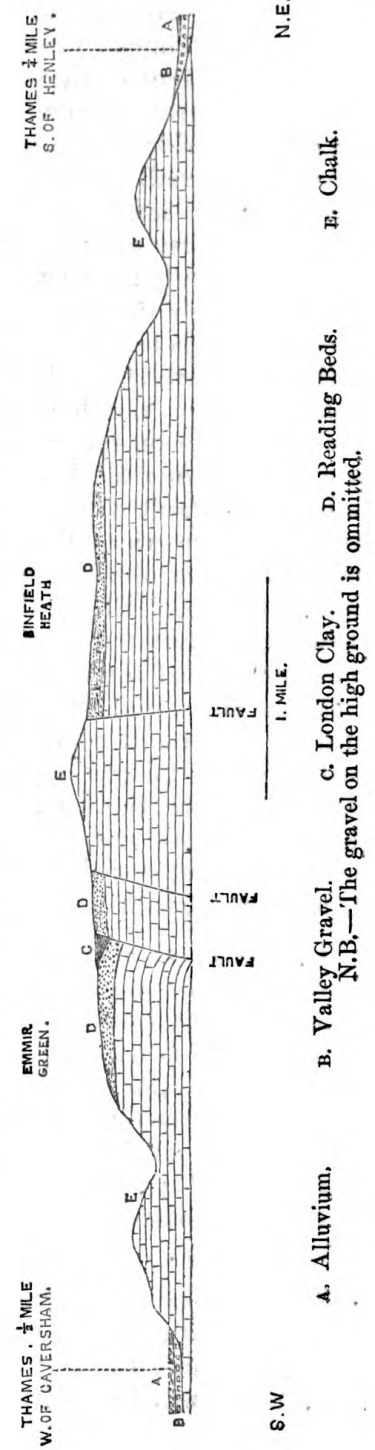


Fig. 6.—Diagram-Section from Caversham to Henley (Six miles).

South of High Wood there is a little sand on the flank of the hill. This small patch may extend farther northwards than is shown on the map; but the ground, covered by surface deposits, is so thickly wooded as to made it very uncertain.

The accompanying diagram-section (fig. 6) through the hills between Caversham and Henley will make the structure of that district more easily understood.

Greywethers.

The occurrence of those remarkable blocks of hard light-coloured sandstone known as Greywethers, Druid Stones, or Sarsen Stones, on the denuded surface of the Chalk, has been noticed by Professor Ramsay, in a Memoir illustrative of Sheet 34 of the maps of the Geological Survey. They occur in a similar manner to the north-west of Lambourne, a great part of which town is built of fragments of them. In many cases they have been moved from their original position. "Around Middle Farm, Knighton Bushes, Weathercock Hill, and Hare Warren they are plentiful. The following are the dimensions, in feet, of some of the larger stones:"*—

4 × 2 × 3·5	= solid content	28	cubic feet.
3 × 2·5 × 1	„	7·5	„
4 × 4 × 2	„	32	„
8 × 3·5 × 2	„	56	„
5 × 3 × 3·5	„	52·5	„
6·5 × 6·5 × 2	„	84·5	„
8 × 8·5 × 5	„	340	„
8 × 5·5 × 1 to 2	„	about 66	„
10·5 × 2 × 2	„	42	„
9 × 5 × 2	„	90	„
12 × 6 × 1	„	72	„

From this it will be seen that the majority have a thickness of about 2 feet, as if they had come from one and the same bed of sandstone. I have noticed a similar correspondence in general thickness in the stones, many hundreds in number, covering the bottom of one of the valleys to the west of Marlborough (in Sheet 34).

Eastward of Lambourne there are often blocks of sandstone on the Chalk, but no large collections of them, as in the country to the west. They seem to occur in vast numbers only where the Chalk is quite bare, their number decreasing where that rock is covered with Drift.

" Around the village of Wickham there are a great number of Sarsen Stones, all of which have been moved from their original position. Some of the blocks contain flint pebbles. I ascertained that they were all got from the neighbouring fields, and were in no case brought up from a lower level, so that they must have originally rested on some of the highest parts of the Reading Beds, if not on the top of them; the Wickham outlier (see p. 32) being very thick. This does not accord with

* From the Note-book of Mr. Aveline.

Mr. Prestwich's suggestion, that they belonged to the white sand at the lower part of this outlier.* I think, moreover, that had these stones been formed from the white sand, some of them would still be left in place, and being so hard would make some feature, and be seen on the sides of the ridge. A large flat stone near Wormstall Farm must be nearly two tons in weight."†

Mr. Prestwich‡ has come to the conclusion that the greywethers once formed a part of the Reading Beds, for the following reasons: 1. That their distribution is in accordance with the range of the Lower Eocene Tertiaries, rather than with that of the Bagshot Sands, to which they have been referred; and having thus limited their age to the Lower Eocene period, 2. That there is no good evidence of their belonging either to the basement-bed of the London Clay or to the Thanet Sand, and, therefore that they must belong to the intermediate Reading Beds. This conclusion is supported by the facts that the occurrence of the greywethers is proportional to the development of the sand-beds in that formation; "that the lithological structure of each variety "is respectively in accordance with the mineral components "forming the strata (of the Reading Beds) in the immediate "vicinity of the places where these rock-blocks are found;" and that sandstone has been noticed in place in the Reading Beds. Admitting the force of these arguments, I cannot but think, however, that it is very probable that some, perhaps very many, of the greywethers have once formed a part of the Bagshot Sands (which formation is known to contain beds of sandstone in places), more especially at the western end of the London Basin, where the Lower Tertiaries are thinner than elsewhere, and where, consequently, the Bagshot Sands, had they ever spread over that country, would have been least separated from the Chalk. That very many of these stones are of the age of the Reading Beds I do not doubt, having seen a large mass of sandstone in place in those beds, just above the Chalk, at Beedon Hill (see p. 35).

Blocks of "pudding-stone," or greywethers containing flint-pebbles, are of more rare occurrence in this country than those of simple sandstone. They may be seen in the neighbourhood of Nettlebed and at Wickham. Blocks of iron-sandstone are frequently found; these generally contain flints of various sizes, rounded and angular, and small quartz-pebbles. Small pieces of wood are the only fossils found in them, and the same have been noticed in the greywethers.

London Clay.

This formation,§ unlike the preceding one, is remarkable for uniformity of mineral character throughout its entire mass. It

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* Quart. Journ. Geol. Soc., vol. x. p. 124. † From the Note-book of Mr. Aveline.
‡ Quart. Journ. Geol. Soc., vol. x. p. 123.
§ See Prestwich, Quart. Journ. Geol. Soc., vol. iii. p. 354, and vol. x. pp. 401, 435.

consists of stiff brown and dark bluish-grey clay, with irregular lines of concretionary masses of clayey limestone, known as *septaria*, and of ironstone. Fossils are plentiful in some places, in others, absent; they give evidence of a warm climate; and, as they are similar throughout the whole thickness of the deposit it is clear that the bed of the sea in which they lived must have subsided slowly. That the clay was deposited at no great distance from the shore is inferred from the presence of remains of plants and animals that flourished on the land.

At the base of this thick mass of clay, there is mostly found a bed of a more sandy nature, generally containing rounded flints, often of very large size, and fossils, for the most part belonging to the London Clay, but some of which occur in the underlying Tertiary formations; to this Mr. Prestwich * has given the name of the "Basement-Bed" of the London Clay. In this district it varies from about 4 to 12 feet in thickness, and consists of light brown loam, with occasional beds of shells and green sand, and brown sand, sometimes passing into soft iron-sandstone containing casts of shells. In places there are flat tabular masses of limestone, often almost wholly made up of fossils, and at the base there is nearly always a bed of rounded flints.

This bed usually rests on an uneven surface of the Reading Beds, showing that the latter were subjected to the eroding action of water before its deposition.

The main mass of the London Clay caps the Reading Beds to the south of Reading, but the line of junction is hidden by gravel.

At the section at Katesgrove Kiln, the "basement-bed" is exposed, and the following fossils have been found in it:—

Natica labellata, Lam.
Natica.
Calyptræa trochiformis, Lam.
Fusus.
Scalaria.†
Cytherea obliqua, Desh.
Cardium.
Cardium nitens, Sow.†
Pectunculus brevirostrum, Sow.
Modiola ?
Ditrupa plana, Sow.†

From Reading the boundary-line of the London Clay runs in a north-easterly direction, parallel with that of the Reading Beds. At the brickyard to the east of Redlands House,‡ the following beds may be seen:—

Drifted clay and gravel.

London Clay.—Bluish-grey and brown stiff clay; the lower part rather sandy, and with a little ironstone; about 12 feet; passing into,

Basement-bed.—Brownish sandy clay, with a few small flint-pebbles and lines of ironstone (with fossils), more sandy towards the base, in fact passing into clayey sand. About 6 feet from the top there is a bed of shells, 5 feet below which is another bed, and between the two a few scattered shells. Not sunk through; greatest thickness about 12 feet.

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* Quart. Journ. Geol. Soc., vol. vi. p. 252.

† Not found by the Survey, but recorded by Mr. Prestwich (Quart. Journ. Geol. Soc., vol. vi. p. 266).

‡ Called "Red Lane House" on the map.

There are lying about some rather flat masses of limestone, which comefrom the lower part of the basement-bed. The fossils found here were:—

Natica.	*Cytherea obliqua*, Desh.
Fusus.	*Mytilus.*
Cardium.	*Ostræa.*
Pectunculus brevirostrum, Sow.	*Ditrupa plana*, Sow.

At the brickyard about half a mile to the east of the above the pits give the following general section:—

Brown London Clay.
Basement-bed :—Brownish Loam. The upper part clayey, and with much ironstone, containing casts of fossils; the lower part more sandy, and with a bed of greenish sand.

The beds below this are not seen; but there are lying about many flat slabs of limestone, very full of fossils. I was told that these were found a little lower down, and that below them there was "iron-mould," (that is dark brown iron-sand). In the limestone slabs there are the following fossils:—

Natica.	*Cytherea.*
Calyptræa.	*Cardium.*
Fusus.	*Pectunculus.*
Pleurotoma?	*Ditrupa plana*, Sow.
Cancellaria?	

Some of the slabs are almost entirely made up of the last fossil.

The cutting on the South-Eastern Railway, at Upper Early, is in London Clay, of a blackish-blue colour, capped by gravel.

Along the greater part of the Sonning cutting the Reading Beds are capped by this formation, the whole being covered with gravel. The sides of the cutting are now turfed over; but the section has been described by Mr. Prestwich.* The line of junction may now be traced by the increased thickness and rankness of the vegetation, caused by a line of springs, thrown out from the sandy basement-bed by underlying plastic clay. To the north of the railway everything is completely covered by gravel, so that the boundary-line is uncertain.

Outliers.—On the Wickham outlier (see p. 32) there is a patch of London Clay, above the brick-yard, consisting of a few feet of the basement-bed in a very confused state. There may be other patches, but hidden by the gravel, which thickly covers this outlier.

The Snelsmore outlier (see p. 34) is capped by three patches of London Clay, the most northern and largest of which extends from Philips Hall Wood, to the northern end of Snelsmore Common. There is another just above Donnington kiln (see p. 34), and a third at the southern end of the common, where some of the basement-bed, like that at the kiln, may be seen above the sand of the Reading Beds. These outliers may extend

* Quart. Journ. Geol. Soc., vol. vi. p. 266.

farther than is shown on the map, the hill being very thickly covered with gravel, which renders the boundary-line doubtful.

Along the road between Round and Spring Woods, to the east of Snelsmore, there is a section of the basement-bed, which consists of brown loam.

The high ground of Courage Common consists of London Clay, which extends southwards along the tops of the hills to High Wood and to Red Farm. On the western slope of High Wood the basement-bed was exposed in making a road (see p. 26). The conical hill at the northern end of the Oarebury Hill outlier (see p. 35) is capped by London Clay.

At Oare there is a large outlier, of which there is a section at the brick-yard (see p. 26).

At Furze Hill, on the hill above Little Hungerford, and at the northern end of Grimsbury Forest there are small patches.

The range of hills from Coldash Common to Mare Ridges consists in great part of this formation, much hidden however by gravel. "The height of the ground above the sections in the "Reading beds is sufficient to show that the London Clay is "present; and brown clay is generally found when the gravel is "sunk through."* Moreover the Bagshot Sands are found under the gravel on the very top of the hill. "Between Hill "Foot Farm and Chapel Row, to the south-east of Bucklebury, "some brown sandy clay and stiff blue clay may be seen."*

To the west of Englefield there are two brickyards in the London Clay. At the northern one there is mottled brown and pale blue sandy clay, from 12 to 15 feet thick, with but little gravel above it; whilst at the other there is a thickness of 8 or 10 feet of the last, over bluish-grey and brown clay, with concretions of clayey ironstone containing casts of fossils (*Pectunculus terebratularis, Modiola Mitchelli.*) The basement-bed has been reached through the clay at one of these brickyards.† Separated from this large mass there is a small outlier at Ridge Hill Wood, to the west of Bucklebury.

The outlier of the Reading Beds near Frilsham, as before noticed, is capped with London Clay, the boundary-line of which is much hidden by gravel, as well as by the thick woods on the high ground. The basement-bed is exposed in the road-cutting to the west of Frilsham House; it contains flint-pebbles and ironstone, is underlaid by mottled clay, and dips to the south. On the hill above Frilsham, by the spring before mentioned (p. 36) there are the remains of a small brick-yard, with a shallow section in brown London Clay. Along the road higher up a few rounded flints occur in the clay. In the brick-yard farther southward (see p. 36), by the hedge at the highest part, there is a little of the basement-bed above red mottled clay; and lower down, in a mass that has slipped over the Reading Beds, are two small sections of the same,

* From the note-book of Mr. Aveline.
† Quart. Journ. Geol. Soc., vol. vi. p. 266.

which consists of light brown loam, with a few scattered flints (rounded and sub-angular), and pieces of ironstone. In the eastern part of this irregular-shaped outlier there are no sections; but in the fields on the north-east of Rusdens, there are many of the large rounded flints of the basement-bed. Just above the kiln nearly a mile to the south of Yattendon, there is mottled light-brown and grey sandy clay passing into the basement-bed, consisting of the usual brownish loam. The bottom of this was not shown. On the hill, half a mile to the east of Yattendon, there is London Clay; and to the north of Standford Dingley is another patch, covered by gravel, the only section in it being on the road by Ilsley Wood, where the light brown loam of the basement-bed may be seen.

The London Clay on the Tilehurst outlier may in parts have a thickness of 100 feet; but, owing to the quantity of gravel over it, there are but few sections. By the road, some way above the Theale brick-yard, there is a small section in stiff brown clay. The basement-bed seems to be present at the brickyard below Tilehurst (see p. 39), and at Northcot there was (in 1858) a good section of it (see p. 40). At the last place the following fossils were found in the iron-sandstone at its base:—

Pyrula.	*Pectunculus terebratularis.*
Cassidaria.	*Cytherea obliqua*, Desh.
Rostellaria.	*Cyprina.*
Natica.	*Ditrupa plana*, Sow.
Fusus.	

In making a ditch along the road up the hill to the west of this brick-yard, the iron-sand of the basement-bed was again found to be underlaid by plastic clay, causing a flow of water. At Prospect Hill, to the east of Tilehurst, there is London Clay.

The top of Nettlebed Hill (see p. 42), nine miles from the nearest point of the main mass, is formed of London Clay. Just to the west of the windmill the following beds may be seen:—

		FT.	IN.
1. London Clay	Light brown clay, partly mottled with pale grey, with thin lines of ironstone, and a few small flint-pebbles; darker towards the base, and passing into:—		
2. Basement-bed	*a.* Dull brown clay, occasionally greenish internally, laminated by very thin seams of sand, with a few small flint-pebbles and a little ironstone - - - 4 or	5	0
	b. Dull grey and brown loam, with layers of chocolate-coloured clay in parts; at the base a thin bed of green sand, with a few small flint-pebbles; water is thrown out from this - - - about	3	0
	c. Seam of ochreous clay - - - } about		
	d. Brown sand, with thin lines of ironstone }	1	0
	e. Line of rounded flints, many very large.		
3. Reading Beds -	(See p. 42).		

In the ironstone in the London Clay I found a cast of a small bivalve (*Leda ?*), and in that of bed *a.* a cast of a *Natica*

The divisions of the basement-bed are not clearly marked, and probably are not the same for any distance. There are lying about some pieces of flat sandy laminated limestone, not more than 2 inches thick, which probably belong to the basement-bed. The junction of the London Clay and the Reading Beds shows a dip of about 6° in a direction 20° to 25° S. of E.

At the brickyard on the downthrow side of the fault, to the north-west of the windmill, and at a much lower level, the following section was exposed:—

	FT.	IN.
1. Drifted clay and loam, in parts with many flint-pebbles, filling hollows in		
2. London Clay, about - - - - 2 or	3	0
3. Basement-bed:—Brown loam, with a few seams of clay, and a little ironstone, but no flints or green sand, about -	8	0
4. Light-coloured sand of the Reading Beds just visible beneath. The dip shown by the upper part of the basement-bed is from 5° to 15° a little to the west of south.		

At Rose Hill, Caversham, the London Clay is brought in by the fault (see p. 45), and is mostly of a bluish-grey colour, but partly brown, and containing *septaria* (with fossils) and ironstone.

The basement-bed is not seen in the section; but I was told that in sinking in the orchard just by, and at the same level as the Reading Beds in the brickyard, below about 30 feet of blue clay, there was a sort of loam, with a little green sand and with shells. I saw some of the shells, which belong to the basement-bed. This gives further proof of a downthrow on the west. Some of the *septaria* lying about are very full of *Ditrupa plana*, and probably come from the same bed. *Pectunculus brevirostrum* is also abundant, and there are *Pinnæ* and *Pholadomyæ*.

Middle Eocene.

*Lower Bagshot Beds.**

These beds, which rest immediately on the London Clay, consist of yellow and white sands with a few beds of clay. In this district they occupy but a small space, and occur in no great thickness. Their most northerly point is at Oare Common, where the small outlier of London Clay is thinly capped by brown sand.

"The small areas occupied by the Lower Bagshot Beds at the southern margin of this district are the northernmost parts of a large outlier extending from Coldash Common to Chapel Row, a distance of about 4 miles from west to east. The larger part of this outlier, which for the most part forms heath-land, is comprised in the adjoining Sheet (12) to the south. Those parts of it indeed that are shown on Sheet 13 present few features deserving especial notice. They occur on the summit of the high ground forming Coldash and Bucklebury Commons, and incline towards

* For a general account of the Bagshot Beds, see Mr. Prestwich's paper, Quart. Journ. Geol. Soc., vol. iii., p. 378.

the south at a small angle, corresponding with the gentle inclination of the surface of the ground in that direction.

"On Coldash Common the Bagshots are altogether hidden by drift-gravel. The sands of these beds, however, where displayed in the road-cuttings at Chapel Row, at the descent of the hill towards Hill-foot Farm, assume at the lower part a darker colour, and become more ferruginous than those forming the larger part of the outlier, and than those, somewhat higher in the series, which may be seen in a pit by the side of the road from Chapel Row over Bucklebury Common, at the north-western corner of Heath Copse, in the adjoining map (Sheet 12).

"The boundary of the outlier (of which the areas in Sheet 13 are parts) is very irregular, conforming itself to the contour of the ground, which forms a very serrated outline, as will be seen on reference to the map.

"The junction with the London Clay is shown by the damp nature of the soil, generally marked by the growth of rushes; and by springs, which are caused by water that filters through the Bagshot Sands and the overlying gravel, reaches the underlying impermeable London Clay, and flows out to the surface at the outcrop of the last.

"As is the case with the Lower Bagshot Sands elsewhere, no fossils have been found in them in this district." *

Although the Bagshot Beds are here but of small actual importance, yet their presence is theoretically of much moment; for it is by that that one can judge of the thickness of the London Clay—that thickness being, of course, the vertical distance between the bottom of the Bagshot Beds and the top of the Reading Beds. It is thus shown that at Coldash and Bucklebury Commons the London Clay, which near London is more than 400 feet thick, does not reach a greater thickness than 80 or 100 feet, and that at Oare Common it has dwindled down to less than 20 feet.

This westerly thinning of the London Clay has been noticed by Mr. Prestwich;† but it seems to be greater than he has supposed: indeed, still further westward, in Savernake Forest (Sheet 14), the thick bed of clay of the neighbourhood of London is represented solely by a part of its "basement-bed;" a pebble-bed a few inches thick being all that there separates the Bagshot Sands from the sands and clays of the Reading Beds.

W. Whitaker.

Post-Pliocene.

Clay with Flints.—The Upper Chalk in this district is for the most part covered by a stiff brown and red clay, with large unworn flints. This lies very irregularly on the Chalk, filling pipes in that rock (see p. 25). At its base there are generally a few inches of black clay, also with flints, in this case black-coated. This surface clay

* From the Note-book of Mr. Bristow.
† Quart. Journ. Geol. Soc., vol. x. p. 407.

often contains pieces of ironstone and iron-sandstone, possibly derived from Lower Tertiary beds. These are plentiful on the hills to the south of Lambourne, where they sometimes contain fragments of fossil wood. Further eastward quartz-pebbles are found in the clay, and in the fields near Lower Bowden and Holme Farms, on the west of Pangbourn, there are many pebbles of quartz-rock, quartz, and other old rocks, supposed to have once formed part of the New Red Conglomerate. This clay is not found in the bottom of the chalk valleys which seems to show that they were worn down to their present form after its deposition; but it often extends some way down their sides, showing that the valleys were, at all events, partly formed before that period. As far as I have seen it *the "clay with flints" never occurs off the Upper Chalk.*

Brick-Earth.—Above the "clay with flints" there is occasionally a loam or sandy clay, known as "brick-earth," which seems to have been formed from the waste of the sand and plastic clay of the Reading Beds denuded from off the Chalk-country; in fact, by a natural process like the artificial one by which those sands and clays are now mixed in order to get an earth fit for brick-making. There is brick-earth on the hills to the south of Farncombe Down (see p. 30), to the north-west of Farnborough, to the north-east of Shefford (see p. 33), and above Watlington, and on Maidenhatch and Stokenchurch Commons. At the last place it is mottled (brown, red, and pale blue), and contains small angular flints. In other places it often contains rounded flints also, and sometimes quartz-pebbles. It lies very irregularly on the surface of the Chalk, filling large pipes, lined with the black bed of the "clay with flints," and often with the brown clay also. It often looks rather like the mottled clays of the Reading Beds; but it is more sandy and not plastic, and when mottled red, as is usually the case, it is duller than the crimson-red of the plastic clays. Whilst the clay with flints does not extend over the Tertiary beds, the brick-earth occasionally does.

Gravel.—The Drift of the northern portion of this Sheet is similar in every respect to that already described in the Cotteswold Hills, and the country around Woodstock. It may be divided into at least two members, of which the high-level gravel is the older, the low-level gravel the younger.

The *high-level gravel* caps the summits of many of the hills, while it at the same time descends some distance along the slopes. Thus it occurs in Wytham Hill at an elevation of more than 500 feet, and at Bagley Wood. In these localities it is composed of pebbles of quartz-rock well rounded and apparently similar to those which form the Conglomerate Beds of the New Red Sandstone. There are also grits and flints, though in less abundance. The same deposit is also very thickly spread over the district lying between Wheatley and Thame, rendering very obscure the junction of the Lower Cretaceous beds with the Kimmeridge Clay.

In the southern part of this district gravel is found chiefly on the Tertiary beds, but it occurs also on the Chalk. This gravel consists chiefly of flints, but contains also many fragments of Greywethers

(see p. 47), and a few quartz-pebbles; the flints are in all states,—angular, subangular, and rounded. The Wickham, Winterbourn, and Snelsmore outliers (see pp. 32–41) are thickly covered with gravel. At the first place "the gravel on the top of the "ridge is formed of smaller fragments than that at the base."* On Snelsmore Common the gravel is mixed with white gritty sand in the upper part, and in the lower with brown clayey sand, the two sands being alike in other respects; the junction is uneven, and along it there is an irregular black line. The probable cause of this difference, is, that rain has sunk through the gravel, carrying with it the clay and colouring-matter of the matrix and decayed vegetable matter, which latter it has deposited at a certain depth, thus forming the black line. The action of decaying vegetation may have assisted in bleaching the upper part of the gravel.

On the main mass of the Tertiary Beds at Courage Common there is much gravel, and also on the hills from Coldash Common to Englefield. "Around Bradfield and Englefield there are not "so many greywether-fragments as in the gravel further east-"ward."* On the Frilsham and Yattendon outliers (see pp. 36, 37), on the hills between the latter place and Pangbourn, and on the Tilehurst outlier (see p. 38), there is also gravel, and it is plentiful on the high grounds on the Oxfordshire side of the Thames, as far as from three to five miles to the north of the river.

The *Low-level Gravel* of the northern part of the district is distinct from the above both in composition and in the position it occupies. It is very plentifully spread over the flat tracts which border the Thames and Isis, though extending considerably above the highest floods of these rivers. This gravel is formed chiefly of local rocks. Thus, in the neighbourhood of Oxford, along the valley of the Isis, opposite Sandford and east of Abingdon, as well as at Clifton Hampden, and Dorchester, it is composed principally of pebbles of oolitic limestone, water-worn and mixed with others probably derived from the high-level gravel. When traced southward it passes into the flint-gravel of the Thames valley, with which it appears synchronous.. The oolitic gravel is plentifully supplied with mammalian remains, chiefly of fossil elephants.

The low-level gravel of the valleys of the Thames and Kennet and the brooks flowing into them is scarcely, if at all, to be distinguished from the high-level gravel of the southern part of this district, and probably consists of the latter re-arranged. The high-level gravel must have been in great part deposited before the country was denuded to its present form, whereas the low-level gravel is probably one of the effects of that denudation.

The valley-gravel is perhaps the more ochreous of the two, and sometimes blocks of ferruginous conglomerate occur in it, as in the broad valley between Pangbourn and Theale. This gravel often extends some way up the slopes of the gently rising hills.

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* From the Note-book of Mr. Aveline.

In the bottom of the dry valleys in the Chalk there is often a gravel composed of angular flints, generally large, and blocks and pieces of Greywethers, sometimes in a chalky matrix.

Alluvium.—The alluvium, or modern river-deposit, of the Thames, consists mostly of silt. That of the Kennet is more peaty; that of the brook running through Bucklebury and Bradfield consists, to the east of the latter place, of peat and peaty clay above silt; and along one of the small watercourses running through this alluvium the bottom is covered with spherical calcareous concretions, from half an inch to an inch in diameter.

E. HULL.
W. WHITAKER.

Note.—After the survey of the district to which this Memoir refers had been finished, and when the map to the east (Sheet 7) was far advanced, it was settled that the low-level gravel should be mapped in that Sheet. In order to make the lines in the two Sheets fit it was needful to map part of the gravel at the eastern edge of Sheet 13 (after it had been published). The area coloured as alluvium on the western side of the Thames, near Henley, consists wholly of gravel, which stretches up the Assenton valley to a little above Middle Assenton, and also runs for a short distance up the smaller valley of Harpsden. On the southern side of the Thames, north-east of Sonning, some gravel is included in the alluvium, and again on the southern side of the Kennet, west of Reading. It is hoped that when the duties of the officers of the Survey will allow of it, the mapping of the low-level gravel may be continued westward into this Sheet.—A. C. RAMSAY.

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