CHAPTER VIII.

BERKSHIRE AND PART OF THE THAMES VALLEY.

By H. J. OSBORNE WHITE, F.G.S.

THE following article contains a short general account of the geology of Berkshire and parts of the adjoining counties, illustrated by local stratigraphical details which are drawn, as far as possible, from Excursion Reports of the Geologists' Association.*

On the south, west, and north-west, the limits of the country with which the writer has been asked to deal are, practically, those of the county of Berks; but on the north-east, the Chiltern Hills of Oxfordshire and of a small portion of Buckinghamshire are included; while the villages of Coleshill and Taplow in the last-named county, and the towns of Maidenhead and Wokingham, in Berks, mark the position of the boundary on the east. As the south-eastern part of Berkshire, including Bracknell and Sandhurst, belongs mostly to the "Bagshot District," its description is left to Mr. H. W. Monckton, who has, geologically speaking, made that district his own.

The area above defined lies within the basin of the Thames, and includes, besides a lengthy section of that river, a great part of the Kennet and of the Ock, and the lower reaches of the Loddon. The Chalk upland of the Berkshire Downs and the Chilterns extends across it with an eastward to north-eastward trend, and separates the Oxford lowland from the Vale of the Kennet and the low ground between Reading and Windsor. The Secondary and Tertiary Strata here exposed have an aggregate thickness of about 2,000 ft., and, as their prevailing dip to the south-east makes a larger angle with the horizon than does the average slope of the ground in the same direction, they appear at the surface in descending order towards the north-west. Thus, the traveller crossing this part of the country, with his face set in the latter direction, leaves behind him the woods and sandy commons on the Eocene formations, and, mounting the long incline to the crest of the Chalk downs, sees, between the declivity at his feet and the rising ground of the distant Cotteswolds, an undulating plain on the Gault, Kimeridge, and Oxford Clays, broken by hills of Corallian limestone and Aptian sand.

* Except where there are indications to the contrary, the references given in the footnotes to this article relate to Excursion Reports published in the PROCEEDINGS of the Geologists' Association.

JURASSIC.

The Oxfordian Series, which is the oldest formation exposed in Berkshire, comprises the following stages and zones:

"[STAGES.]"	ZONES.	LEADING LITHOLOGICAL CHARACTERS.
OXFORD CLAY.	<i>Ammonites cordatus</i> [<i>Cardioceras cordatum</i>]	Clays with occasional septaria and ironstone-nodules.
	<i>Am. ornatus</i> [<i>Cosmoceras ornatum</i>]	Clay, and shaly clay, with pyritic fossils (sub-zone of <i>Am.</i> [<i>Quenstedtoceras</i>] <i>lamberti</i> .)
KELLAWAYS BEDS.	<i>Am. calloviensis</i> [<i>Keplerites calloviensis</i>]	Alternations of clays and sands with concretionary masses of calcareous sandstone (Kella- ways Rock).
		Clay (Kellaways Clay)."*

In the northern part of the county the series has a thickness of between 400 and 500 ft. The upper beds alone occur at the surface, where they form the lower slopes of the southern side of the Thames Valley, between Buscot, near Lechlade, and South Hinksey, near Oxford. Being of little economic value, they are seldom worked, and the Geologists' Association seem to have seen no sections that call for notice here.

Corallian.—The Oxford Clay passes up into sandy beds which form the inferior, or Lower Calcareous Grit, division of the Corallian rocks. The sands are usually of a buff or brown tint; often exhibit oblique bedding, and are, in places, cemented into thin bands and detached "doggers" of calcareous oolitic sandstone, in which fossils are well preserved. Small pebbles of quartz, lydite, and other material are of common occurrence, and in the lower parts of this division, or stage, there are some beds of clay.

The upper stage, "which, on the whole, is more variable in character, comprises a series of limestones, oolitic, pisolitic, and shelly, with beds of coral-rag and occasional sandy and clayey beds.

* See H. B. Woodward. *Mem. Geol. Survey*, "The Jurassic Rocks of Britain." vol. v, p. 8.

"The Corallian Beds may thus be grouped as follows:

UPPER CORALLIAN.	{ Upper Calcareous Grit, Upper Coral Rag and Ironstone . Coral Rag and Coralline Oolite . }	{ Zone of <i>Ammonites</i> [<i>Perisphinctes</i>] <i>plicatilis</i> .
LOWER CORALLIAN.	{ Lower Calcareous Grit . . }	{ Zone of <i>Ammonites</i> <i>perarmatus</i> . [<i>Aspid. perarmatum</i> ."]*

In northern Berkshire, however, the Upper Calcareous Grit seems to be wanting, although it is present at Highworth, in the adjoining part of North Wiltshire. In the former district the Corallian varies from 60 to 100 or more feet in thickness. The outcrop-surface, extending across that part of Berkshire from Faringdon to Abingdon, is marked by a low hill-range of the cuesta type, which presents a distinct, and, in places, a steep scarp-face to the north, and falls away, very gently, into the White Horse Vale to the south.

The Coral Rag, and the highest beds of the Lower Calcareous Grit, are well exposed in shallow but extensive quarries around Marcham, Stanford, and Shellingford, to the west of Abingdon. The Association visited two quarries between Marcham and Shippon in 1892, when the more southern working showed:

"UPPER CORALLIAN (zone of <i>Ammonites</i> [<i>Perisphinctes</i>] <i>plicatilis</i>).	{	Red earthy soil.	ft. in.
		5. Rubbly coral-rock and clay.	4 0
		4. Rubbly oolite and marl, with fossil-bed at base, tapering away westwards.	2 6
		3. Laminated clay and shelly sand	2 6
		2. Oolitic and shelly limestone, fossil-bed, tapering away eastwards, and replaced by rubble and pebbles of oolite, etc.	0 ft. 6 in. to 1 0
"LOWER CORALLIAN (Lower Calcareous Grit, or zone of <i>A. perarmatus</i> [<i>Aspidoceras</i> <i>perarmatum</i>]).	{	1. Sands with bands and doggers of cal- careous sandstone	5 0

"From bed 3, *Ammonites* [*Perisphinctes*] *plicatilis*, *Belemnites abbreviatus*, *Lima pectiniformis*, *Ostrea gregaria*, *Trigonia*, *Echinobrissus scutatus*, *Pygaster*, and Lignite were obtained.

"The uppermost band of the Lower Calcareous Grit yielded *Natica marchamensis*, a form found also in bed 2.

"No examples of *Ammonites perarmatus* [*Asp. perarmatum*] were found, as the lower beds were not much worked.

"The President [the late J. F. Blake] remarked that some of the finest examples of that fossil were obtained from a pit farther north. These occurred generally in the form of casts, the shell and septa having been dissolved away, so that the casts of the chambers were in a loose form or linked together; hence the original name of '*Ammonites catena*.'†

* H. B. Woodward, *op. cit.*, p. 71.

† G. J. Hinde and H. B. Woodward, vol. xii, 1892, p. 337.

In the pit near the Lamb Inn, west of Kingston Bagpuize, the Upper Corallian Beds were seen to be "very variable in character, and there was evidence in rolled pebbles of oolite, some of which were bored by *Lithodomi*, and encrusted with *Serpulæ*, of reconstruction at more than one horizon and of pauses in deposition. The lowest bed presented a pisolitic aspect.

"The section has been described by Messrs. Blake and Hudleston.* The most fossiliferous portion was described by them as the '*Trigonia*-bed,' which comprises several layers of hard shelly limestone, partially oolitic, which merge downwards into the pisolitic bed, and yield *Ammonites* [*Perisphinctes*] *plicatilis*, *Belemnites abbreviatus*, *Trigonia meriani*, *Perna mytiloides*, *Gervillia aviculoides*, *Hinnites velatus*, *Trichites*, *Pecten fibrosus*, &c.

"The Lower Calcareous Grit beneath consisted of yellow sands with hard layers and nodular masses of calcareous sandstone. Altogether, the beds seen included Nos. 1, 2, 3, and perhaps the base of 4"—as noted in the section at Marcham.†

The Stanford and Shellingford sections, south-west of the above, were examined by the Association in 1907. A quarry at the western end of the former village shows:

- "5. Dark loamy soil, in which prehistoric implements have been found—1½ ft.
4. Coral Rag—Broken corals and echinoderms, with the interstices filled with clay—4 ft.
3. Coralline Oolite—Hard, blue-hearted, flaggy rock with a few small pebbles of quartz, chert, and lydian stone, the flagstones alternating with occasional layers of coarse rubbly oolite—5 ft.
2. Coarse oolitic sand—6 inches, passing down into
1. Lower Calcareous Grit—Yellow sand, false-bedded in places, about 3 ft. shown. Water at bottom of quarry.

"The relative proportions of the hard and soft layers of Bed 3 vary somewhat when traced along the face of the quarry, but the composition and thickness of the other beds, of the coral bed in particular, remain very constant. The coral bed appears to form the subsoil over some extent of country hereabouts, and was formerly much used for road metal. . . ."‡

"Although [on the occasion of the above-mentioned visit] but little time was allowed for collecting, a fair number of fossils were obtained, including, from Bed 2, *Exogyra nana*, *Ostrea* (a medium-sized form), *Belemnites abbreviatus* (worn and covered with small oysters). From the hard crystalline matrix of Bed 3 specimens could only be extracted with difficulty, but *Gervillia aviculoides*, *Trigonia perlata*, and teeth of *Lepidotus maximus* were noted. The Corals in Bed 4 were chiefly belonging to the genera *Thecosmilia*, *Thamnastræa*, and *Isastræa*, in

* *Quart. Journ. Geol. Soc.*, vol. xxxiii (1877), p. 304.

† *Hinde and Woodward*, vol. xii, 1892, p. 330.

‡ *Ll. Treacher*, vol. xx, 1907, pp. 115, 116.

rather poor condition, associated with *Cidaris florigemma* (tests and spines), *Pseudodiadema versipora*, *Lithodomus inclusus*, *Littorina muricata*, and *Pecten articulatus*. No division between the palæontological zones could be detected owing to the lack of the zonal Ammonites in place, but a fragment of *A. perarmatus* [*Asp. perarmatum*] was found among the oolitic débris of Bed 3.*

The section seen in the quarry at the cross-roads about half-a-mile north-east of Shellingford is much the same as that at Stanford, "except that the quarry being situated higher up the dip-slope the bottom is free from water, and it can be worked to a greater depth. The lower sands are more current-bedded, and, like the overlying oolite, contain a good deal of wood. Bed 3 is rather thicker than at the last quarry, and there are more of the rubbly oolitic layers and much pisolite."†

"Additional fossils were *Pygaster umbrella*, *Echinobrissus scutatus*, *Belemnites nitidus*, *Myacites*, *Avicula*, *Pecten lens* and *Lima laeviuscula*. In one part of the quarry the coral bed (4) is largely made up of stiff clay, a small piece of which, when washed, yielded many perfect specimens of *Thecidium ornatum*, spines of *Cidaris spinosa*, and Asteroid ossicles. Two claws of *Goniocheirus cristatus* and a tooth of *Pliosaurus* complete the list. No Ammonites were seen in place, but the workmen had put by specimens of *A. perarmatus* [*Aspidoceras perarmatum*], *A. cordatus* [*Cardioceras cordatum*], *A. [Perisphinctes] plicatilis*, and *A. [Perisphinctes] varicostatus*, all apparently from Bed 3."‡

The Kimeridge Clay "consists of dark grey and black shaly clay, with much selenite in places. The clay weathers brown at the surface. The beds are, as a rule, darker, and in mass more shaly, than the Oxford Clay, and the layers of septaria are more persistent and more frequent."§ The shales are apt to be bituminous, and there are occasional bands of shaly limestone. Stratigraphical divisions are not well marked, but the following zones and sub-zones are recognisable:

" ZONES.	SUB-ZONES.
<i>Ammonites biplex</i> , [i.e., <i>Olcostephanus pallasianus</i> .]	<i>Discina latissima</i> .
	<i>Exogyra virgula</i> .
<i>Ammonites</i> [<i>Amæboceras</i>] <i>alternans</i> .	<i>Ostrea deltoidea</i> .

* *Ibid.*, loc. cit.

† *Ibid.*, loc. cit.

‡ *Ibid.*, loc. cit.

§ H. B. Woodward, *Mem. Geol. Survey*, "The Jurassic Rocks of Britain," vol. v p 151.

|| *Ibid.*, p. 152.

"Near Woolstone, south of Faringdon, Professor Hull reckoned that the Kimeridge Clay had a thickness of nearly 300 ft., but in the neighbourhood of Oxford the thickness does not exceed 100 ft."*

At the Chawley brickyard, north of Cumnor Hurst, the Association saw, in 1904,† a good section of the upper beds, which have there yielded, among other fossils, *Olcostephanus pallasianus*, *Modiola bipartita*, *Protocardia striatula*, *Thracia depressa*, and the greater part of a skeleton of the Iguanodon-like reptile *Camptosaurus prestwichi*.

The Portland Beds seem to be confined in Berkshire to the small outlier of Bourton, south of Shrivenham. They are there represented by chalky oolite and hard blue fossiliferous limestone, assigned to the Portland Sands by Sir A. Ramsay.‡

A thin bed of sandy limestone, containing *Astarte hartwellensis*, is seen beneath the Gault at Culham brickyard, on the Oxfordshire bank of the Thames below Abingdon.§

CRETACEOUS.

Between the Portland Beds and the rocks which overlie them in North Berks there is a stratigraphic hiatus of considerable importance. Excepting some local irregularities, the Oolitic strata were laid down in conformable succession, but in Cretaceous times these rocks (and with them some freshwater deposits of Wealden age, found in Oxfordshire and Buckinghamshire) were slightly flexed and faulted, and subsequently planed down by erosion, which may have been largely subaërial. It thus happens that the oldest member of the Cretaceous system so far recognised in Berkshire, namely, the marine Lower Greensand, rests upon the Jurassic rocks unconformably, and although in this county it seems to be generally in contact with some part of the Kimeridge Clay, it completely oversteps that formation, and passes on to the Corallian, at Faringdon.

The Lower Greensand (Aptian) is the most inconstant of the Secondary rocks found at the surface in Berkshire and Oxfordshire, even its outcrop lacking continuity.

About Sutton Courtenay, near Abingdon, on the east, it is represented by a small thickness of coarse, reddish, ferruginous, pebbly sands, which, at Culham, just across the Thames, have yielded *Exogyra sinuata*.||

North of Abingdon, outliers of the same sort of material

* *Ibid.*, p. 166.

† Vol. xix, 1905, p. 57.

‡ "Geology of Parts of Wilts., etc.," Explanation of Sheet 34, *Mem. Geol. Survey* (1858), p. 27.

§ Vol. xviii, 1904, p. 303.

|| C. G. E. Dawkins. *Geol. Mag.*, dec. 5, vol. iii, 1906, p. 94, and *Proc. Geol. Assoc.*, vol. xviii, 1904, p. 300.

occur in the higher ground at Boars Hill, Cumnor Hurst, and Chawley, and are, at times, well exposed in the brickyard at the last-named place.*

South-west of Drayton the pebbly sands die out, and the Selbornian clay (Gault) appears to rest directly upon the Kimeridge clay along the line of the Great Western Railway between Steventon and Uffington Stations. North of Uffington Station, however, the sands emerge from beneath the Gault, and, thickening rapidly, run out northward in a sort of promontory, which rises well above the surrounding country in Furze Hill near Fernham, and terminates in a little plateau immediately to the south of Faringdon. To the east and to the west-south-west of Faringdon detached masses of the same formation occur in the hills of Faringdon Clump and Badbury, on the edge of the Corallian escarpment.

The late C. J. A. Meÿer, who was, in his day, the chief authority on the Faringdon Beds, recognised the following stratigraphical divisions:†

3. Sands, with chert and ironstone,

2. Red Gravel,

1. Sponge Gravel,

resting partly on the Kimeridge Clay, partly on the Corallian beds (see Figs. 35, 36).

Although the junction of the Sponge and Red Gravels is not visible, and the superposition of the latter upon the former has been questioned, the above grouping has been generally accepted by later observers. The total thickness of the Faringdon Beds is estimated at from 70 to 100 ft.

1. The Sponge Gravel, which Meÿer regarded as "unquestionably the oldest" of the local Cretaceous deposits, is well exposed, for a depth of about 30 ft., in Little Coxwell Pit‡ (*a* in sketch map, Fig. 35), and in a newer working called Bowler's Pit (*b*), north-east and north of Little Coxwell village. It consists of coarse, buff to red-brown sand, containing many pebbles and sub-angular stones of quartz, dark siliceous rocks, shale, and limestone, mingled with a multitude of twig-like bryozoa, calcareous sponges, oysters, brachiopods, echinoderms, and other fossils; its aspect resembling that of the Coralline Crag of East Anglia.

Though friable on the whole, this gravelly sand is frequently cemented by calcite into doggers and bands of very hard sparry limestone; and it exhibits, in Little Coxwell Pit, a well-marked oblique bedding (inclined to the north-east), which simulates a dip.

Among the many indigenous organisms found in the Sponge

* Vol. xix, 1905, p. 37.

† "Three Days at Faringdon," *Geologist*, vol. vii, 1864, p. 5.

‡ So named on the 6-inch Ord. Map, Berks. viii. Known also as The Windmill, Panting's, Ballard's, Hickman's, and Purbrick's, Pit.

Gravel there may be mentioned: *Nautilus* sp. (large), *Lima parallela*, *Ostrea halioidea*, *Rhynchonella depressa*, *R. nuciformis*, *Terebratula sella*, *Entalophora*, *Domopora*, *Idmonea*, *Siphodictyum*, *Pellastes wrightii*, *Trematopygus davidsoni*, *Cidaris faringdonensis*, and the Sponges *Raphidonema faringdonense*, *R. contortum*, *Tremacystia anastomans*, *Peronella ramosa*, and *Corynella foraminosa*.

Lamellibranchs, other than the Ostreæ, are not common, and

FIG. 35.—SKETCH MAP SHOWING THE POSITIONS OF THE PRINCIPAL SECTIONS IN THE LOWER GREENSAND NEAR FARINGDON, BERKSHIRE.—H. J. O. White

Scale: 1 in. = 1 mile.

The Geological Boundaries are taken from the 1-inch Geological Survey Map, Sheets 13 and 34, Old Series.

Explanation of Shading.—Lower Greensand, dotted; Kimeridge Clay, cross-hatched; Corallian, unshaded; Oxfordian, parallel lines.

it is doubtful whether the single gasteropod (*Natica nodosa*) recorded by D. Sharpe* was found in the Sponge Gravel or in the Red Gravel.

Bones and teeth of reptiles and fish, worn ammonites and belemnites, corals, etc., derived from the Kimeridge Clay, Corallian, and, probably, other formations, are abundant.

2. The Red Gravel consists of the same sort of materials as the Sponge Gravel, but it is more deeply stained by iron oxide—the prevailing tint being a rich, dark, brown-red. The sand also is coarser and the pebbles more numerous. The prin-

* Quart. Journ. Geol. Soc. vol. x (1854), pp. 181, 193.

cipal sections are at Faringdon Pit (*c*)*—about 20 ft. deep, and an unnamed pit (*d*), about a quarter of a mile to the east. In both excavations, but particularly in the latter, the Red Gravel contains light-coloured bands resembling Sponge Gravel. According to Mr. Ll. Treacher,† the contemporary faunas of the two "Gravels" are nearly the same, the difference being mainly one of numerical proportion. Thus, *Trematopygus davidsoni* and the large *Nautilus*, mentioned above, are much more conspicuous in Faringdon Pit than in Little Coxwell Pit, where, until quite recently, they were supposed not to occur.‡ At least one form of gasteropod, a large *Pleurotomaria*,§ occurs in the Red Gravel, and seems to be fairly common in Faringdon Pit. Derived fossils are readily found, a belemnite resembling *B. nitidus* of the Kimeridge Clay being notably abundant in the quarry marked (*d*) on the sketch map.

The junction of a deposit of Red Gravel with the overlying cherty sands was formerly exposed in a small roadside pit (*e*, Fig. 35) on the western slope of Badbury Hill. At this spot Meÿer, and, subsequently, a party of the Geologists' Association,|| observed:

[SANDS WITH CHERT.]	{	"Light-coloured and ferruginous sand, with slabs and fragments of chert, apparently the débris of higher beds	ft.
		<i>a.</i> Fine ash-coloured sand, <i>regularly stratified</i> , very like the sands with clay beneath the ironstone of Furze Hill	14
[RED GRAVEL.]	{	<i>b.</i> Dark brown and ferruginous sand, with a mixture of small pebbles, Bryozoa, Terebratulæ, &c., regularly stratified	4
		<i>c.</i> Ditto, ditto, with two or more bands of hard calcareous concretions, each about eight inches in thickness.	5

"This last was the lowest stratum exposed, but from the appearance of the soil the pebbly sands extended somewhat lower."¶

Here, as at Faringdon Pit, the Red Gravel contained "*Rhynchonella nuciformis* in abundance, *R. latissima*, *R. depressa*, *Terebratella menardi* [*T. truncata*], *Terebratula tornacensis*, *T. depressa*, more rarely; and, in addition, a few specimens of *Terebratella oblonga*, Sow."**

The concretionary bands at the base of this section contained *Avicula rauliniana*, *Pecten rauliniana*, *P. orbicularis*, *Exogyra conica*, var., and *E. haliotoidea*, "shells which occur in the 'Bar-

* Otherwise Boucher's, East, and Red Gravel, Pit.

† To whom the writer is much indebted for assistance in the preparation of this sketch of the Faringdon Beds.

‡ See remarks by E. C. Davey, "The Neocomian Sponges, etc., of Little Coxwell, near Faringdon" (London: Dulau and Co.) (not dated), p. 6.

§ Ll. Treacher, vol. xx, 1907, p. 120.

|| Vol. iv, 1876, p. 549.

¶ Meÿer, *op. cit.*, pp. 6 and 7

** *Ibid.*, *op. cit.*, p. 7.

gate Stone' and 'Pebble Beds' of Godalming."* Sponge (or Red) Gravel was formerly to be seen in a pit at Fernham, two and a half miles south of Faringdon.

3. The sands with chert and ironstone form the higher part of the main Lower Greensand ridge of Fernham and Furze Hill; also the higher part of the Badbury mass, and, apparently, the whole of the outlier of Faringdon Clump. The character of the lowest layers of this division, at Badbury, has already been noticed. On the south-eastern slope of the Clump, and near the old brickyard, a small pit (*f*, Fig. 35), opened at a higher horizon, showed, in 1907, about 12 ft. of evenly-bedded light sand and slightly-glaucous cherty sandstone, alternating with thin seams of grey laminated clay. Certain of the harder portions of the sandstone contain abundant "small spicules of siliceous sponges, like those figured by Dr. Hinde as belonging to the genus *Geodia*. A sample of the clayey material when washed yielded many pieces of shells, one small *Terebratula* and a fragment of the Bryozoan *Petalopora cunningtoni*,

* *Ibid.*, *op. cit.*, p. 7.

First published in the *Proc. Geol. Assoc.*, vol. xii (1892), fig. 2, p. 332. With Mr. Jukes-Browne's permission, the title, legend and certain other explanatory portions of the figure have been altered to meet the requirements of the present article.

Gregory, all completely silicified.”* The beds here seem to be devoid of carbonate of lime, and form in this respect, as well as in their general appearance, a very marked contrast to the rough, calcareous “Gravels” of the lower divisions.

At Alfred’s Hill, south of Furze Hill, the upper sands have yielded remains of *Exogyra* and a few other forms; and in bygone times bands of ironstone in this division were worked in a group of little bowl-shaped excavations known as Cole’s Pits (g, Fig. 35), east of Little Coxwell. The inferred relations of the Faringdon Beds to one another, and to the underlying Jurassic rocks, south of Faringdon, are indicated in the accompanying section (Fig 36).

Selbornian.—Mr. Jukes-Browne has shown† that the Selbornian Series outcropping on the southern side of the Vale of Whitehorse, in Berkshire, comprises the following beds in descending order :

MALMSTONE AND UPPER GAULT	{	ft.	
(zone of <i>Ammonites</i>	{	Soft green sand . . .	16 to 25
[<i>Schloenbachia</i>	{	Sandstone and Malmstone . . .	35 to 80
<i>rostratus</i>).	{	Soft grey silty marl . . .	50
LOWER GAULT			
(zone of <i>Am.</i>	{		
[<i>Hoplites</i>] <i>inter-</i>	{	Grey micaceous clay . . .	140 to 170
<i>raptus</i> and <i>A.</i>	{		
[<i>Hoplites</i>] <i>lautus</i>).	{		
			Approximate total thickness, 245 to 315 ft.

There is a gradual passage upward from the Upper Gault marls to the beds which the Geological Survey has mapped as Upper Greensand, “and the line drawn between them [on the Survey maps] does not coincide with any special horizon.”‡ In Berkshire there are numerous small exposures of portions of the Selbornian, but they are lacking in general interest, and but few of them have been visited by the Geologists’ Association. In 1904 some of the members were shown small patches of Lower Gault occupying hollows in the Lower Greensand at Chawley Works brickyard, near Cumnor.§ From these masses of clay, which are much disturbed, Prof. Sollas obtained fragments of *Hoplites interruptus*; and during the Association’s visit a few phosphatic nodules, of a type found at the base of the Gault at Culham, were noticed.

Exposures of the Upper Selbornian malmstone (or firestone) were examined at Lockinge Clump, near Wantage, in 1877,|| and to the south of Castle Hill, near Little Wittenham, in

* Treacher, vol. xx, 1907, p. 117.

† *Mem. Geol. Survey*, “The Cretaceous Rocks of Britain,” vol. I, 1900, pp. 266 to 274.

‡ *Ibid.*, p. 271.

§ Vol. xix, 1905, p. 57.

|| Vol. v, 1877, p. 137.

1903;* while in 1888 fossiliferous Greensand, at the top of the formation, was seen in the railway cutting north of Burghclere Station (Hants),† on the southern boundary of the area reviewed in the present article.

Chalk.—This important member of the Cretaceous System is most in evidence in the well-known upland of the Chilterns and the Berkshire Downs. Its full local thickness—about 800 ft.—is not developed beneath the summit or crest of the upland, for the higher beds of the formation are wanting there, and come in, gradually, on the southern or dip slope, the surface of which has, on the whole, a lower inclination than the planes of bedding.

To the south of the line of the Kennet-Thames, between Kintbury and Maidenhead, the Chalk disappears beneath the Eocene strata in the trough of the London Basin, to reappear in the Sydmonton Hills, farther south. In the railway cuttings through these hills, near Burghclere, the Association seem to have seen an almost complete section of the formation, in 1888.‡

The larger divisions of the Chalk which are usually recognised are the Lower, Middle, and Upper Chalk; the second and third, jointly, being the equivalent of the "White Chalk" of Dr. A. W. Rowe.

(a) The Lower Chalk (Cenomanian) of Berkshire and Oxfordshire varies in thickness from about 80 feet in the former county to 240 feet in the latter. It consists of:—

	ft.
2. Zone of <i>Holaster subglobosus</i> .	{ Grey marls with a bed of white chalk, sub-zone of <i>Actinocamax plenus</i> 2 to 3
	{ White and grey chalk about 75
	{ Totternhoe stone 2
1. Zone of <i>Ammonites</i> [<i>Schloenbachia</i>] <i>varians</i> .	{ Marly and blocky chalk about 135
	{ Glauconitic marl ("Chloritic marl") 2 to 5

The good exposure of the Glauconitic Marl and part of the overlying beds (with *Schloenbachia varians*, *Turrilites bergeri*, and other fossils), to be seen in the lane leading northward from Lockinge to Wantage-road,§ was most probably one of the sections visited by the Association during their excursion to Wantage and Hendred in 1877.||

A cutting on the Newbury and Didcot railway, near Chilton, visited in 1889,¶ showed nearly 40 feet of chalk about the junction of the *H. subglobosus* and *A. varians*-zones. The Totternhoe

* Vol. xviii, 1904, p. 306.

† Vol. xi, 1889, p. xv.

‡ Vol. xi, 1889, p. xv.

§ A. J. Jukes-Browne, *Mem. Geol. Survey*, "The Cretaceous Rocks of Britain," vol. II, 1903, p. 167.

|| Vol. v, 1877, p. 137.

¶ Vol. xi, 1889, p. lxxxiii.

Stone is there represented by 2 ft. of hard grey rock with many phosphatic nodules and fossils. Mr. Jukes-Browne observes that certain hard beds seen in this section contain sponge spicules and minute globules and aggregates of colloid silica.*

(b) The Middle Chalk (Turonian) of this part of the country has a thickness of 150 to 200 ft., made up as follows:—

2. Zone of <i>Terebratulina</i> .	{ Pale greyish-white chalk, with thin seams of marl, and a few scattered flints near the top	ft. 100 to 140
1. Zone of <i>Rhynchonella cuvieri</i> .	{ Nodular greyish and white chalk, with a hard band, (Melbourn Rock) about 8 ft. thick, at the base	60

A small opening in the Melbourn Rock on Blowingstone Hill, above Kingston Lisle,† appears to be the only section in the lower (*R. cuvieri*) zone observed by the Association in Berkshire.

Poorly-fossiliferous *Terebratulina*-chalk was seen in a small pit at Fognam Barn, north-west of Lambourn,‡ in 1905, and in a quarry near East Woodhay (Hants) in 1902.§ On three occasions|| Association parties have inspected the highest beds of this zone in the sections at Henley Park (Oxon), or Medmenham (Bucks), in the Henley inlier; and portions of the same beds were seen near Mice Farm, West Wycombe, in 1907.¶

(c) The Upper Chalk (Senonian) of Berks, Oxon, and Bucks has an estimated maximum thickness of 420 ft., and comprises the following zones:—

5. Zone of <i>Actinocamax quadratus</i> .	{ White chalk with flints (lowest parts alone represented)	ft. 50 ?
4. <i>Marsupites testudinarius</i> .	{ Ditto, with relatively few flints { <i>Marsupites</i> -band <i>Uintacrinus</i> -band	{ 35 to 70
3. <i>Micraster cor-anguinum</i> .	{ Ditto, with many flints	. 220 ?
2. <i>Micraster cor-testudinarius</i> .	{ Ditto, nodular at base, many flints	. 50 ?
1. <i>Holaster planus</i> .	{ Greyish-white, lumpy and nodular chalk. Flints less abundant. Chalk Rock (sub-zone of <i>Heteroceras reussianum</i>) at or near base	. 20 to 30

The Chalk Rock is worked for road metal in numerous shallow quarries near the summit of the Berkshire Downs, between Whitehorse Hill and East Ilsley; and one or more good sections near Cuckhamsley Knob or Barrow were examined by the Association in 1877**, and again in 1889.†† The Rock there is

* A. J. Jukes-Browne, *op. cit.*, vol. ii, p. 170.

† Vol. xix, 1905, p. 228.

‡ *Ibid.*, p. 226.

§ Vol. xvii, 1902, p. 394.

|| Vol. xii, 1891, p. 204; vol. xvi, 1899, p. 253, and vol. xviii, 1904, p. 415.

¶ Vol. xx, 1907, p. 101.

** Vol. v, 1877, p. 137, *et. seq.*

†† Vol. xi, 1889, p. lxxiv.

of the normal type: a hard, cream-coloured limestone with scattered grains of glauconite and layers of green-coated nodules. Its thickness is about 10 ft. In the highest layer of green nodules, at the top of the Rock, the characteristic fossils are (in places) abundant, and include *Heteroceras reussianum*, *Baculites bohemicus*, *Pachydiscus peramplus*, *Scaphites geinitzi*, *Cerithium cuckhamliense*, *Pleurotomaria perspectiva*, *Cuspidaria caudata*, *Trapezium trapezoidale*, and other forms.*

Equally clear but less fossiliferous sections of the same bed, and of the nodular beds above it, have been seen in the pits on the borders of the Middle Chalk inliers of Henley and Marlow, in the Thames Valley. The well-known pit at Henley Park,† and the quarries at Medmenham,‡ Remenham,§ and Marlow Waterworks|| show the junction of the *Holaster planus* and *Micraster cor-testudinarius* zones; and the changes which the test-features of *Micraster* undergo with the changing horizon can be well studied in all these exposures.

Portions of the thick zone of *Micraster cor-anguinum*, which forms the uppermost stratum of the Chalk over the greater part of the Berkshire Downs and the Chilterns, have frequently been seen during the Association's excursions to the country west of London.

In the Taplow Court and Boxford sections these beds are slightly phosphatic, and contain one or more bands of hard chalk. A noteworthy fossil obtained from this zone at Boxford is a valve of *Exogyra sigmoidea*, a handsome species of rare occurrence in the English Chalk.

With the exception of the interesting development at Taplow, the zone of *Marsupites testudinarius* is confined to the south-western part of the Chalk country noticed in this article; the main mass of the zone lying to the south of the Kennet, between Savernake and Newbury, with a few detached and nearly-detached masses on the lower slopes of the Berkshire Downs, to the north of that river. The Association saw a small section in the lower, or *Uintacrinus*, sub-zone at Shaw Kiln, near Newbury, in 1879 and 1888¶; and another, in the *Marsupites*-band, on the eastern slope of Borough Hill, Winterbourne, in 1906.** In the Winterbourne section the *Marsupites*-chalk is flintless, and contains much phosphatic matter, approaching in these and other characters the better-known and more richly phosphatic deposit of Taplow.

The old quarry in which the last-mentioned deposit is exposed was visited in 1892,†† when most of the members of the party

* A. J. Jukes-Browne, *Mem. Geol. Survey*, "The Cretaceous Rocks of Britain," vol. iii, 1904, p. 204.

† Vol. xii, 1891, p. 204, and vol. xviii, 1904, p. 415.

‡ Vol. xvi, 1899, p. 253.

§ *Ibid.*, loc. cit., and vol. xviii, 1904, p. 418.

|| Vol. xix, 1905, p. 157.

¶ Vol. vi, 1879, p. 185, and vol. xi, 1889, p. xiii.

** Vol. xix, 1906, p. 352.

†† Vol. xii, 1892, p. 406.

were able to secure specimens of the belemnoid *Actinocamax granulatus*,* which occurs in such extraordinary profusion in the upper part of the excavation. The section there is :

ZONE OF <i>Marsupites testudinarius</i> .	Marsupites band.	5. White chalk, very hard and slightly phosphatic at the top, becoming soft and strongly phosphatic at the base. <i>Act. granulatus</i> , <i>Ostrea lateralis</i> var. <i>striata</i> , <i>Scalaria</i> cf. <i>decorata</i> , etc.	16	ft.
		4. Brown chalk, richly phosphatic. <i>Marsupites</i> , <i>Act. granulatus</i> , <i>Echinocorys scutatus</i> (stunted pyramidal and sub-gibbous forms), <i>Ostrea vesicularis</i> , <i>O. wegmanniana</i> , etc.	8	
	Uintacrinus band.	3. White chalk, with borings filled with brown chalk; hard at top, fossils scarce. <i>Echinocorys scutatus</i> (pyramidal form), etc.	16	
		2. Brown chalk, richly phosphatic. <i>Uintacrinus</i> , <i>Actinocamax verus</i> , <i>Ostrea semiplana</i> , etc.	4	
		1. White chalk, hard at top, soft below, and passing down into normal flinty chalk. Borings filled with brown chalk in the upper part. <i>Micraster cor-anguinum</i> , <i>Inoceramus cuvieri</i> , <i>Conulus albogalerus</i> , etc.	17†	
	ZONE OF <i>Micraster cor-anguinum</i> .			

Teeth of fish are fairly abundant in the brown beds.

The only flints seen occur low down in bed (1). It is not improbable that the poorly-exposed upper part of bed (5) belongs to the zone of *Actinocamax quadratus*.

The zone of *Actinocamax quadratus* has, so far, been identified in only two places, namely, Borough Hill, west of Winterbourne, and Kintbury. In the Winterbourne pit, mentioned above, a few feet of slightly phosphatic and glauconitic chalk, with a thin rock-band at the base, occur between the *Marsupites*-beds and the soil. In the rock, and in the gritty chalk just above it, guards of *Act. granulatus* and tests of *Echinocorys scutatus* (of depressed pyramidal and ovate or sub-gibbous forms) are abundant, and with them occur *Offaster pillula*, and teeth of *Lamna* and other fish. In a pit at Laylands Green, south-east of Kintbury, the Association saw, in 1902,‡ about 20 ft. of sparingly-flinty white chalk, which has since been referred, on ample evidence, to the lower part of the *Act. quadratus*-zone.§

Although the *Quadratus*-beds of Winterbourne and Kintbury have a very small areal range, there can be little doubt that they are the relics of a once widespread sheet of high-zonal Chalk, which was swept away by subaërial or marine agencies, or both, before the Eocene strata were deposited.

* Called "*Belemnitella quadrata*" in the excursion report.

† Condensed from the account by H. J. O. White and Ll. Treacher, *Quart. Journ. Geol. Soc.*, vol. lxi, 1905, p. 461.

‡ Vol. xvii, 1902, p. 388.

§ Ll. Treacher and H. J. O. White, *Proc. Geol. Assoc.*, vol. xix, 1906, p. 389, and H. J. O. White, "Geology of the Country around Hungerford, etc.," *Mem. Geol. Survey*, 1907, p. 39.

EOCENE.

As a result of the wide-spread erosion mentioned above, the sands and clays of the Lower Eocene rest upon the Chalk unconformably. Occasionally rather pronounced, this discordance is, on the whole, of a gentle type, and in the area here discussed there appears to be no single section large enough to show it. A divergence of the bedding-planes of the Chalk from the basal surface of the Reading Beds has, however, been observed in a large excavation at Harefield,* about ten miles north-east of Taplow (see chapter i, p. 24).

The Reading Beds, which form the oldest member of the Eocene system found in Berkshire, have, by reason of the number and accessibility of exposures, received the "lion's share" of the Association's attention. The Series consists chiefly of coloured clays and sands, with which there are associated impersistent beds of pebbles, and—more rarely—of sub-angular gravel. At the base there is a loamy, glauconitic "bottom-bed," containing green-coated flints, bands of oyster-shells, and scattered sharks' teeth. This Bottom-Bed is a salt or brackish-water deposit; the rest of the series—unfossiliferous save for bits of lignite, silicified wood, and impressions of leaves—appears to be of fluvial and lacustrine origin. The thickness of this formation varies from 60 feet, or less, to about 90 feet.

Brickyard sections at Reading have been visited by the Association on many occasions, the last excursion to the neighbourhood having been arranged in connection with the Geological Society's centenary celebration, in 1907.† Good exposures of the lowest beds and their junction with the Chalk were seen in the Waterloo and Coley Hill brickyards, south of the town, in 1876,‡ and at Jesse's (otherwise Hill's or Grovelands) pit, south of Elm Lodge, in 1898. The last-named pit showed:

"DRIFT.	{	Gravel, very coarse, sub-angular, with many large quartzites		14 to 16 feet.	
		Sand, buff and white, much false-bedded		8 to 10 feet.	
READING BEDS.	{	BOTTOM BED.	{	Clay, bluish grey, stratified	2 to 2½ feet.
				Oyster-bed	6 to 12 inches.
				Clay, laminated, grey, with green sand	1½ feet.
				Sand, green, with clay, and Oysters, green-coated flints at base	3 to 4 feet.
CHALK, with tubular holes formed by boring molluscs, the holes filled with green sand."§					

* W. Whitaker, *Mem. Geol. Survey*, "Geology of London," vol. i, 1889, p. 195.

† Vol. xx, 1907, p. 200.

‡ Vol. iv, 1876, p. 519.

§ J. H. Blake, vol. xv, p. 305.

"In this excavation an impersistent line (about ten yards in length) of sub-angular green-coated flints occurred in the lower part of the buff sands overlying the 'Bottom Bed.' . . The oysters mostly consisted of *Ostrea bellovacina*, Lam., many with both valves united. There were also a large number of oysters, identified by Messrs. Sharman and Newton as *Ostrea gryphovicina*, Wood, several good specimens of which were obtained on this occasion. The largest specimens of *Ostrea bellovacina*, with both valves united, occurred near the base of the 'Bottom Bed,' and continued upwards for about 3 to 4 feet in the glauconitic, olive-coloured green sand. Mr. Treacher obtained from the upper Oyster-bed in this pit the following fossils: *Corbula*, *Cytherea*, *Leda*, *Nucula*, *Modiola elegans* (?), Sow., *Tellina* (?), *Cerithium*, *Dentalium*, and *Odontaspis* (*Lamna*) *contortidens*, Ag."*—a small Woolwich-Beds fauna. It is of interest to note that the examples of mollusca from this bed preserved in Mr. Treacher's museum at Twyford are much below the normal size.

Extensive sections of the sands and mottled clays which overlie the Bottom Bed, and form the bulk of the Reading Series, have frequently been examined by Association parties in the Waterloo pits and in the neighbouring excavations of Katesgrove (Bob's Mount), while other good exposures have been inspected at Coley Hill; in the Mock Beggars brickyard at Earley, east of Reading; at Collier's Brick and Tile Works; Collier's Brick Kilns; Westwood Kiln and Norcot Kiln—the last four being situated to the south of the Oxford road, Reading. In most of these workings the junction with the overlying London Clay is, or was formerly, shown. In a part of Collier's Brick and Tile Works situated on the north side of the Rookery in Prospect Hill Park, there was seen, in 1898:

" LONDON CLAY.	Basement Bed, lower part only.	4 to 5 feet.
READING BEDS.	Mottled crimson, grey, and other variegated clays, about 30 to 40 ft. Buff and white sands, false-bedded in places (continuation of those seen in Mr. Jesse's pit) not bottomed.	
		about 10 ft. exposed."

In places the buff sands were cemented by calcareous matter into blocks that looked like sarsen-stone.†

The Waterloo pits afford the best local exposures of the Reading "leaf-beds"‡—a name given to a group of finely-bedded yellow sands and grey clays, in which the clays contain numerous impressions of the leaves and stems of plants doubtfully referable to *Laurus*, *Aralia*, *Salix*, *Acer*, and other genera. Here, and in

* J. H. Blake, vol. xv p. 305.

† *Ibid.*, p. 306.

‡ Vol. ix, 1885, p. 212; xiv, 1896, p. 411; xvii, 1902, p. 382; xx, 1907, p. 203.

other parts of Berkshire, the leaf-beds appear to be confined to the lower portion of the Reading Series.

In the country to the north and north-east of Reading the Association saw the leaf-beds well exposed at Knowl Hill Brickworks* ; the mottled clays at the same place, at Rose Hill† near Caversham, and at Ruscombe‡ ; and the Bottom Bed at the entrances to underground chalk-quarries at Warren Row§ and at Nettlebed.|| At Nettlebed a number of clear sections of the beds forming the Lower Eocene outlier were seen in the pits below the windmill. Sections in other outliers on the Chiltern Hills have been visited at Lane End,¶ Fawley,** and Penn.†† The Reading Beds of Lane End are remarkable for containing a thick mass of flint-pebbles in their lower part, and irregular bands of flint and quartz gravel, with lumps of clay, in their upper layers, just below their contact with the overlying formation. Among other features of interest possessed by this outlier are the fine swallow-holes of Moor Common, and the dislocation of the *graben* type which has “keyed” a large block of Eocene strata into the Chalk, to the south-west of Lane End village.

West of Reading, the complete section of the Series—including “leaf” and “oyster beds”—shown at Shaw Kiln (Clay Hill), ‡‡ near Newbury, has twice received attention. Very coarse sands, near the middle of the Series, were seen in Winterbourne Wood§§; the upper beds and junction with the London Clay in the brickyards at Pebble Hill, Kintbury,||| and at Hollington,¶¶ near East Woodhay ; and, lastly, the contact of the Bottom Bed with the Chalk, on the Newbury and Winchester Railway, between Highclere and Burghclere Stations.***

The London Clay consists of stiff, dark blue-grey and brown clay, with layers of concretionary masses of impure limestone, known as cement-stones and septaria. The formation is of uniform character, except near the top, where it is sandy, and at the bottom, where there is a glauconitic and pebbly “Basement-Bed.” Its thickness at Wokingham, on the south-east, is nearly 300 feet, but diminishes, north and north-westwards, to about 200 feet near Reading, to about 20 feet at Oare Common, north of Newbury, and, it is believed, to a few inches in Savernake Forest.

The sandy beds at the top and bottom are commonly dug for bricks, and are much more often exposed than the intervening clay. Good sections of the Basement-Bed have been examined

* Vol. xvii, 1902, p. 181.

† Vol. xvii, 1902, p. 177.

‡ Vol. xii, 1891, p. 206.

** Vol. xviii, 1904, p. 416.

†† Vol. vi, 1879, p. 186, and xi, 1889, p. xiii.

||| Vol. xvii, 1902, p. 389.

‡ Vol. xix, 1905, p. 136.

§ Vol. xvii, 1902, p. 180.

¶ Vol. xvi, 1899, p. 252, and xx, 1907, p. 102.

‡‡ Vol. xv, 1898, p. 312.

§§ Vol. xix, 1906, p. 351.

¶¶ Vol. xvii, 1902, p. 394.

*** Vol. xi, 1889, p. xv.

by the Association, on many occasions, in the yards at Reading. In 1898 a pit at Norcot Kiln displayed:

"DRIFT."	{	Gravel, pebbly; flints, quartz, many rounded quartzites derived from Triassic conglomerates, Lydian stone, etc.		about 6 ft.	
		Clay, mottled brown and grey		5 to 10 ft.	
LONDON CLAY.	{	BASEMENT-BED.	{	Sand and clay interstratified with white and black flint-pebbles in brown sand (in lower part), and casts of shells in ferruginous sand at and near base	9 ft.
READING BEDS.	{	Clay, mottled crimson and grey		7 to 10 ft.	
		Sands, buff and white		about 13 feet had been exposed.*"	

A diagram of the section formerly to be seen at the top of the Katesgrove pits in Bob's Mount is given in Fig. 37.†

FIG. 37.—SECTION IN THE KATESGROVE BRICKFIELD, READING.—H. W. Monckton.

1. LONDON CLAY	{	Dark brown and yellow clay passing down into—
2. BASEMENT-BED OF THE LONDON CLAY.	{	i. Brown sandy clay with a layer of shells.
		ii. Layer of nodules.
		iii. Sandy grey laminated clay.
3. READING BEDS	{	Mottled red and yellow clays.

From the shell-bed—still exposed in 1907—members of the Geologists' Association collected, on a former visit, the under-mentioned fossils:

" <i>Odontaspis (Lamna)</i>	<i>Cardium laytoni</i>
<i>Aporrhais sowerbyi</i>	<i>Cytherea tenuistriata</i>
<i>Buccinum</i>	<i>Modiola elegans</i>
<i>Fusus errans</i>	<i>Nucula bowerbankii</i>
" <i>speyeri</i>	<i>Ostrea bellovacina</i>
<i>Natica</i>	<i>Panopæa intermedia</i>
<i>Pleurotoma terebralis</i>	<i>Pectunculus brevirostris</i>
<i>Trochus</i>	<i>Ditrupa plana.</i> " ‡

* J. H. Blake, vol. xv, 1898, p. 307.

† H. W. Monckton, vol. xx, 1907, p. 205.

‡ J. H. Blake and H. W. Monckton, vol. xiv, 1896, p. 412.

At Mock Beggars Brickyard, near Earley, the Basement-Bed of the London Clay is of about the same thickness as at Bob's Mount, and is fossiliferous throughout. "Septarian nodules of argillaceous limestone, containing many shells and much lignite and iron pyrites, were observed in the bed, and the annelid *Ditrupa plana* was found to be exceedingly abundant in the lower part."^{*}

Other sections of the Basement-Bed, resembling more or less closely those noticed above, have been inspected at Nettlebed† and Lane End,‡ to the north and north-east of Reading; while in the neighbourhood of Newbury, to the west and south-west, the same part of the formation was seen at Shaw Kiln,§ Donnington Kiln,|| Pebble Hill,¶ and Hollington.** At Lane End, Nettlebed, and Shaw there is an unconformity at the junction with the Reading Beds. On the other hand, at Hollington, near East Woodhay, where both the top and the bottom of the London Clay were shown in 1902, there appeared to be a passage into those beds.

Bagshot Series.—Of the Eocene strata overlying the London Clay, in the southern parts of the area under consideration, but little has been seen during the Association's excursions. The Lower Bagshot Beds, which rest, in most places conformably, upon the London Clay, consist of light-coloured sands with seams of pipe-clay and some thicker beds of grey and liver-coloured laminated clay. The sands are often micaceous and usually distinctly stratified, and contain—especially near the base of this division—a few pebbly layers, which here and there expand into thick banks of shingle. The full thickness of the Lower Bagshot is about 100 ft.

Sands of this age were seen in sections at Silchester†† and at Inkpen Common‡‡; and exposures of the pebble-beds were noticed at Pebble Hill, near Kintbury,§§ and at Hollington Brickworks.||||

The Middle Bagshot or Bracklesham Beds (about 40 ft. thick) are composed of brown and grey laminated clay in the upper part, and of yellow and olive-green loams and sands in the lower. The bedding is well marked, and pebbly layers are few and nowhere thick. In the green glauconitic loams near the middle of these beds marine mollusca and sharks' teeth are fairly common. The Association seems to have seen no sections worthy of notice in this area.

* Blake and Monckton, vol. xiv, 1896, p. 414.

† Vol. xii, 1891, p. 206.

‡ Vol. xvi, 1899, p. 252; xx, 1907, p. 102.

§ Vol. vi, 1879, p. 185; vol. xi, 1889, p. xiii.

|| Vol. xi, 1889, p. xiv.

¶ Vol. xvii, 1902, p. 389.

** Vol. xvii, 1902, p. 395.

†† Vol. xvi, 1900, p. 514.

‡‡ Vol. xvii, 1902, p. 390.

§§ Vol. xvii, 1902, p. 389.

|||| Vol. xvii, 1902, p. 394.

The Upper Bagshots consist of buff and yellow sands, with little sign of bedding except at the base, where there is a thin, persistent bed of flint pebbles. The few fossils observed are rusty casts of marine mollusca belonging to species more or less characteristic of the Bartonian of Southern Hampshire.

A pit in slightly-fossiliferous sand of this age was shown to the Association, near West Street, Highclere, in 1888.* The small patch of sand in which it was opened is the westernmost outlier of the Upper Bagshot so far recognised in the London Basin.

PLIOCENE (?), PLEISTOCENE, AND HOLOCENE.

The Drifts, or Superficial Deposits of this area belong to the classes for which the Geological Survey has adopted the following names: Clay-with-Flints, Pebble Gravel, Plateau Gravel, Valley Gravel (including Brick-earth), and Alluvium (including Tufa).

The Clay-with-Flints is a brown to red-brown clay containing broken, little-worn flints and other material, both coarse and fine. It varies greatly in thickness and in composition. In most places it appears to be a mixture of the less soluble constituents of the Chalk with clay, sand, and stones derived from Eocene and later sediments formerly overlying that rock. No particular age can be assigned to it. Pipes or pot-holes filled with Clay-with-Flints have often been seen, in section, in chalk-pits visited by the Association, but this drift calls for no further notice here.

Pebble Gravel.—The deposits coloured as Pebble Gravel on the drift-maps of the Geological Survey are composed mainly of rounded stones in a sandy or loamy matrix. The pebbles are mostly of flint and quartz—the latter of small size—but other materials (*e.g.*, sub-angular and angular flints, bits of sandstone, pebbles of quartzite and of compact dark siliceous rocks) are almost always to be found, and in places are abundant.

This drift occurs in small scattered patches, resting unevenly upon the Lower Eocene outliers, and, less frequently, upon the Chalk, in the Chiltern Hills and in the eastern part of the Berkshire Downs. Near Henley, a few patches occur on the hills of Bowsey and Ashley, to the south of the Thames.

Deposits of the simpler, flint-and-quartz, type—usually the more remote from existing main lines of drainage—are probably merely subaërial accumulations of the coarser detritus of the Reading Beds and other Tertiary strata. Examples of such deposits have been seen by the Association at Nettlebed,† Tyler's Hill, near Penn,‡ Coleshill, near Amersham,§ and Fawley;||

* Vol. xi, 1889, p. xiv.

† Vol. xii, 1891, p. 206.

‡ Vol. xv, 1898, p. 312.

§ Vol. xv, 1898, p. 312.

|| Vol. xviii, 1904, p. 416.

the last being situated close to the edge of the Thames Valley. The more complex gravels, of the kind seen on Bowsey Hill,* and in Common Wood, Streatley,† appear to be mixtures of the simpler, local, pebbly drift with some of the foreign siliceous material which is so largely represented in the quartzitic type of Plateau and Valley Gravel described below. The Bowsey gravel (and that on the neighbouring Ashley Hill) is thicker, and looks less disturbed, than any of the other deposits of the pebbly drift to be seen in this part of the country. It may well be a river-gravel of Pliocene age.

Plateau Gravel.—The beds bearing this name are coarse, gravelly drifts, which form or cover expanses of even, gently-inclined ground lying between the valleys. In this area they occur at various altitudes up to about 400 ft. above the level of principal streams in their vicinity.

Taking the character of their constituent stones as the basis of classification, the several deposits are found to fall into three divisions :

(1) In the first are gravels consisting mainly of flints, together with pieces of sarsen-sandstone, ironstone, and small pebbles of quartz. The Plateau (and other) Gravels of the Kennet basin are of this type. The best sections seen by the Association were at Snelsmore Common,‡ Basford Hill,§ Winterbourne Wood,|| all near Newbury ; and at Inkpen¶ and Silchester** Commons. At the second and third localities a few eoliths were found in stratified gravel, about 150 ft. above the level of the Lambourn. The drift dug on Inkpen Common is a stiff clay, containing angular flints and blocks of sarsen, and exhibiting a sort of flow-structure. It may be mentioned that this flinty clay, which has a considerable development on the Eocene Beds to the south of the River Kennet, is sufficiently firm at Burghclere Common to allow loose gravel to be mined beneath it.

(2) The second type of Plateau Gravel contains, in addition to materials of the kinds present in the first, a great deal of chert and cherty sandstone, derived from the Lower Greensand of the Weald area, to the south-east. This drift characterises the country drained by the Loddon-Blackwater river-system, and by the small brooks running directly to the Thames farther east. It receives further notice in the article on the geology of the Hampshire area (chapter xii, page 292).

(3) The third type is more widely distributed than the first and second, and while resembling them in consisting to a large

* Vol. xvii, 1902, p. 178.

† Vol. xi, 1889, p. xiv.

|| Vol. xix, 1906, p. 351.

† Vol. xiv, 1895, p. 176.

§ Vol. xix, 1906, p. 351.

¶ Vol. xvii, 1902, p. 390.

** Vol. xvi, 1900, p. 513.

extent of flints in various stages of attrition, differs from them in containing abundant pebbles and cobbles of red and grey quartzite, of tourmaline-grit, and of a variety of other siliceous rocks from the Midlands. Near the course of the Thames, between Wytham, near Oxford, and the gap in the Chalk Downs at Goring, gravel of this quartzitic type occurs in patches and small spreads on the summits of hills—such as Cunmor Hurst,* Boars Hill, and the Sinodun Hills†—which rise out of the Oxford plain. To the east of Goring, however, it forms broad, and often well-stratified, sheets, which overspread the Chalk on the lower slopes of the Chilterns, and cap some of the hills of Eocene strata on the opposite side of the Thames.

In the course of their excursions, members of the Geologists' Association have inspected these deposits at and near Caversham,‡ at Bob's Mount,§ and at Norcot on the Tilehurst plateau,|| near Reading; at No Man's Hill and Fawley, near Henley;¶ at Bockmer, above Medmenham;** at The Hockett, near Bisham,†† and at Loudwater,‡‡ south-east of High Wycombe.

From pits in this gravel north of Caversham (notably at Toots Farm) many Palæolithic tools have been obtained. At No Man's Hill and Benham's, north of Henley, gravels referred to the Plateau Series occur in well-marked terraces high up on the west side of the Thames Valley (see Fig. 38).§§

The presence of chert-stones, of the Loddon basin type, in many of the deposits of Plateau Gravel that border the valley of the Thames below (*i.e.*, down stream from) the embouchure of the River Loddon, near Twyford, is but one of several cogent reasons that can be adduced in support of the now generally-accepted theory that the Plateau Gravel, in the main, is of fluvial origin. Such an origin, however, cannot, with any show of probability, be assigned to the tough, stony clay of Inkpen and Burghclere Commons. The present writer has suggested||| that this drift was formed under "extra-glacial" conditions; and he thinks that it is, in any case, an outcome of those processes of superficial creep and flow for which the attractive name "solifluction" ¶¶ has lately been invented.

The drifts of the Plateau-Gravel group are probably, for the most part, of Pleistocene age, although some may date back to the Newer Pliocene.

* Vol. xix, 1905, p. 57.

† Vol. xviii, 1904, p. 305.

‡ Vol. ix, 1885, p. 209, vol. xix, 1905, p. 135, and vol. xx, 1907, p. 206.

§ Vol. ix, 1885, p. 212, and vol. xiv, 1896, p. 412.

|| Vol. x, 1888, p. 494, and vol. xvii, 1902, p. 382.

¶ Vol. xii, 1891, p. 205, and vol. xviii, 1904, p. 414.

** Vol. xvi, 1899, p. 253.

†† Vol. xv, 1897, p. 102.

‡‡ Vol. xv, 1898, p. 311.

§§ Vol. xviii, 1904, p. 415.

||| *Mem. Geol. Survey*, "Geology of Hungerford," etc., 1907, p. 92.

¶¶ J. G. Andersson. *Journal of Geology* (Chicago), vol. xiv, 1906, p. 94.

The Valley Gravel, excepting some deposits interbedded with the Recent flood-loams, is of Pleistocene age. In its constituents it usually resembles the neighbouring spreads of Plateau Gravel, from which, indeed, its higher deposits are indistinguishable. The lower beds of Valley Gravel frequently contain mammalian remains and many fragments of Jurassic and Cretaceous limestones which are seldom preserved in the higher and older drifts. Valley Gravel, and its associated brick-earth, occurs in terraces of limited extent, and in sloping sheets, on the sides of the larger valleys. It occurs also in the bottoms of the valleys, and underlies much of the Holocene alluvium; rising, here and there, through the flood-loams in low "whale-

FIG. 38.—DIAGRAMMATIC VIEW AND SECTION OF THE THAMES VALLEY NORTH OF HENLEY.—*H. J. Osborne White.*

a. Middle Chalk.	4. Terrace Gravel. No Man's Hill, 315 feet.
b. Upper Chalk.	5. Terrace Gravel. Remenham, 180 feet.
i. Pebble Gravel on Reading outlier, 520 feet O.D.	6. Rubble Drift Fans.
2. Terrace Gravel. Benham's, 400 feet.	7. Valley Gravel and Alluvium. [Level of the river here is a little above 100 feet O.D.]
3. Terrace Gravel. White Hill, 340 feet.	

back" shoals which—in their dimensions and in the height they attain above modern flood-limits—testify to the greater volume of the local streams in late Pleistocene times.

Well-marked terraces are to be seen on the Berkshire bank of the Thames, between Maidenhead and Cookham,* and at Remenham, near Henley† (Fig. 38); also on both sides of the same river at Reading, and of the Kennet, at Newbury. Along the Thames above Reading terraces and sloping spreads of gravel are found at Cholsey and Culham, between Abingdon and Radley, and at Oxford. Gravel of a low-level terrace, near Culham Station, in the last-mentioned part of the valley, was examined by the Association in 1903.‡ Concretions of tufa and many worn fossils derived from the Jurassic rocks outcropping farther up the valley were observed in it.

Numerous palæoliths have been obtained from the gravel

* Vol. xv, 1897, p. 101, and vol. xix, 1905, p. 156.

† Vol. xii, 1891, p. 205, vol. xvi, 1899, p. 253, and vol. xviii, 1904, p. 418.

‡ Vol. xviii, 1904, p. 300.

of a terrace about 75 ft. above the Thames south of Cookham,* and fine examples occur in a disturbed clayey gravel on the Eocene Beds at and around the Ruscombe brickyard;† while at Grovelands, in the western suburbs of Reading, stratified gravel of a terrace about 80 ft. above local river-level has yielded thousands of worked flints, together with remains of mammoth, rhinoceros, red deer, and other mammals.‡ The lower layers of the Grovelands gravel contain chalk pebbles and derived fossils from the Oolites and the Lias. Between the Grovelands terrace and the Thames, and about 22 ft. above the latter, there is a small but thick deposit of coarse, chalky gravel in which teeth of hippopotamus have been found. Here implements are notably scarce.§

Among the latest of the Pleistocene beds in the Berkshire area is a gravelly drift, consisting largely of chalk-rubble, and occurring on the lower slopes and the bottom of Thames Valley and of some of its branches. In places, as at Fawley and near Hambleden, north of Henley,|| it forms distinct fans, spreading out from the mouths of the minor valleys (Fig. 38). Bones and other hard parts of reindeer, elephant, rhinoceros, and hippopotamus have been found in it at Hurley Bottom, south-east of Marlow.¶ Sections of another deposit of this chalky drift, occurring on the floor of the Pang Valley, near Chilton, were seen by the Association in 1889.** Here, remains of mammoth, rhinoceros, and reindeer have been obtained, together with land and fresh-water mollusca.††

In many of the combs that dissect the Berkshire Downs there is a similar drift containing large blocks of sarsen or greywether sandstone. At Ashdown Park, in one of the upper branches of the Lambourn Valley, hundreds of these boulders, encrusted with lichen, project through the turf.‡‡ The age of the sandy strata of which they are remnants is uncertain. A few miles distant, to the south-east, there are Eocene sands that look capable of bearing sarsens, but they contain none where they are exposed in pits.

Alluvium.—The Holocene or Recent deposits of the marshes and water-meadows bordering the larger streams consist chiefly of calcareous loams and clays, with subordinate beds of sand, gravel, shell-marl, and peat. Except in the stream-banks, which are usually too low to afford good sections, this drift is seldom

* Vol. xv, 1897, p. 101.

† Vol. xvii, 1901, p. 176.

‡ Vol. ix, 1885, p. 209; vol. xvii, 1902, p. 382. Note: The Grovelands deposit is grouped with the Plateau Gravels in the Geol. Survey Map, Reading district, Sheet 268.

§ Vol. xvii, 1902, p. 381.

|| Vol. xviii, 1904, p. 417.

¶ *Mem. Geol. Survey*, "Geology of London," vol. i, p. 389.

** Vol. xi, 1889, p. lxxxiii.

†† A. J. Jukes-Browne, "Geology of Upton and Chilton," vol. xi, 1889, p. 198, and Prestwich, *Quart. Journ. Geol. Soc.*, vol. xxxviii, 1882, p. 127.

‡‡ Vol. xix, 1905, p. 226.

exposed, and Association parties have had few opportunities to examine it.

Fine gravel, containing a great deal of local Lower Greensand grit and Oolitic material, was seen in shallow pits at the Barley Mow Inn, opposite Clifton Hampden, in 1903;* and small sections of the peat and marl, so largely developed in the Kennet Valley, were examined in pits at Newbury in 1879.† The Alluvium at and near Newbury has yielded many implements and other "artifacts" of Neolithic, Bronze, and early Iron age; also human skulls and bones, teeth, or horns of elk, red-deer, roebuck, bison, mammoth, wolf, beaver, marten, badger, etc., together with fifty-two species of non-marine mollusca.‡ Remains of some of the above mammals were found also in the peaty clay of Plummary Ditch, Reading.§ Neolithic flakes were observed on the fields around the sarsen cromlech of Wayland Smith's Forge during the Association's visit to the Berkshire Downs in 1905.||

* Vol. xviii, 1904, p. 304.

† Vol. vi, 1879, p. 188.

‡ "Geology of Hungerford," *Mem. Geol. Survey*, 1907, p. 107.

§ Vol. iv, 1876, p. 523.

|| Vol. xix, 1905, p. 227.