GEOLOGISTS' ASSOCIATION, LONDON.

ON THE LOWER GREENSAND OF GODALMING.

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THE town of Godalming, in Surrey, standing near the western extremity of the "Wealden area" of the South of England, may be seen by examining a geological map to occupy a position on the out crop of the Lower Greensand at about an equal distance from the rise of the chalk and Wealden strata.

Taking Godalming as a centre, the district to which this paper will chiefly refer, embraces an area extending—on the south, from Hascomb to Hindhead, and on the north, from St. Martha's Hill on the east of Guildford to the western extremity of the Hogsback. Of this district Dr. Fitton says (Geol. Trans. 2nd ser., Vol. IV) :—"The tract on the south and west of Guildford and thence to Hindhead, forms one of the most extensive surfaces of the Lower Greensand to be found in England." In its physical aspect this district exhibits considerable variety; hills and valleys, bare heaths and woodland succeeding each other with great abruptness. To the geologist, this diversity in the external appearance of the country is of much service, by showing, in the direction of its hills and valleys, its close connection with the adjacent Wealden area; and in its differences of barrenness and fertility as clearly indicating the nature and distribution of the rocks beneath.

The general rise of the strata of this part of Surrey is to the south, towards the central axis of the Wealden elevation. But this southerly rise is slightly interrupted in the Godalming district by a line of fault and a small intermediate axis of elevation, which traverse the country westward from Guildford in the line of the "Peasemash" and the valley of the Wey; and it is owing to this circumstance that so large a surface of the Lower Greensand is exposed in the vicinity of Godalming.

A line of section traced from north to south through Godalming, and continued for about four miles in each direction, will be found to intersect almost the entire Cretaceous series of the south of England. On the north the chalk is seen emerging from beneath the Woolwich beds of the Tertiary formation at an angle of from 10 to 30 degrees, and rising into the well-known ridge of the Hogsback. The *Chalk-Marl*, *Upper Greensand*, and *Gault* rise with almost equal rapidity along the foot of the Chalk, and are followed in turn by the higher beds of the *Lower Greensand*, which rise at nearly the same angle. At a short distance from their outcrop the Greensand strata become nearly horizontal, and reach the transverse valley of the Wey, near Godalming, with a northerly dip of only about 7 degrees; south of the Wey the strata are either horizontal or dip south and south-east for a short distance, but presently rise again in approaching the Wealden. So that along the line of the Greensand escarpment, between Hascomb and Hindhead, the dip is always more or less northerly.

NOTE.—The term "Lower Greensand" is used throughout this paper in its original sense, namely, as descriptive of a series of deposits which occur in the South of England, between the Gault and the Weald Clay. It represents the upper (Aptien), middle, and *part of* the Lower "Neocomien" of foreign authors.

No. 1.—SECTION THROUGH GODALMING, FROM NORTH TO SOUTH.

NOTE.—The “fault” shown in this Section as occurring near Compton is greatly exaggerated, and though certainly existing at this point, might have been better represented by a sudden bend or anticlinal. (*m*)

The *thickness* of the Lower Greensand of this part of Surrey has not as yet been satisfactorily ascertained: Dr. Fitton has given 350 to 400 feet as its probable thickness; Mr. Godwin-Austen, no less than 800 feet. But this last appears to be rather an excessive measurement. Its probable thickness in the vicinity of *Guildford* may be from 450 to 500 feet; but from the scarcity of well-sections, it is impossible to decide with certainty.

The frequent recurrence of sandpits, quarries, and lane-sections around Godalming has, however, enabled me to trace, with tolerable certainty, the position and succession of the various groups of strata. And from these and other sources I have been enabled to construct a section of the entire series of the Greensand from the Gault to the Wealden.

Commencing from below, or in the order of deposition of the beds, this section shows the Lower Greensand of Godalming to consist of the three following principal groups of strata.

	Thickness.
1. Argillaceous beds ; with concretions of shelly limestone near the base	... about 50 ft.
2. Sands ; with occasional bands of loose sandstone near the middle, and of argillaceous matter near the top... ..	... about 250 ft.
3. A series of sandy deposits, which in themselves admit of a triple subdivision—A. B. C., in Section 2	
A consists of a <i>stratum</i> , or <i>strata</i> , of coarse sand and pebbles, which abruptly separates the upper group (3) from the sands beneath	... from 1 to 20ft.
B consists of light coloured sand, containing concretions of limestone, locally called <i>Bargate-stone</i> and <i>Chert</i>	... 20 to 40ft.
C consists, mainly, of ferruginous sand ; with veins and concretions of ironstone (<i>carstone</i>)	... 100 to 140ft.

The upper group (3) has, therefore, an average thickness of about 160 feet, and the *total* thickness of the *Godalming* Greensand may be fairly estimated at from 450 to 500 feet.

I will now proceed to describe these groups more in detail; beginning as before with the lowest group.

1. The *lowest* subdivision of the Greensand—the *Atherfield-clay* of Fitton, is wholly unexposed in the immediate vicinity of

NO. 2. - VERTICAL SECTION OF THE LOWER GREENSAND OF GODALMING.

SCALE—80 Feet to the Inch.

Godalming. By careful observation its outcrop may, however, be traced clearly enough along the base of the southern escarpment of the Greensand from Hindhead to Hascomb, and also along the sides of the Peasemarsch Valley, between Guildford and Godalming. But it is in one locality only in this district—namely, on the banks and in the bed of a stream (the Ravensbourne) near East Shalford that I have succeeded in obtaining fossils from this division.

The occurrence of the *lower portion* of the Greensand strata at East Shalford was, I believe, first observed by Mr. Godwin-Austen—as recorded in Vol. IV. of the “Proceedings of the Geological Society in 1841,” and on account of its position and peculiar suite of fossils was described by that author, as an addition to the then known rocks of the British Cretaceous series, and “as the probable equivalent of the *Neocomien* of Leymerie and D’Orbigny.”

The succession and arrangement of the strata, as exhibited at East Shalford, is nearly as follows :

				ft.	in.	
* Dark greyish sandy clay (in stream). Possibly the lowest bed. Thickness not ascertained.						
A.	Yellowish sandy clay, with concretions of shelly limestone	...	...	1	0	Perna, &c.
B.	Greyish sandy clay	...	...	...	8	
C.	Greenish sand, with concretions of limestone	...	...	1	4	Perna, &c.
D.	Ferruginous sandy clay, with concretions	...	...	2	0	Univalves numerous
E.	Clay, ash coloured	...	...	...	7	0
F.	Stiff clay, yellowish and ferruginous	...	...	12	0	No fossils
G.	Argillaceous beds—obscure	...	...	40	0	Iron Pyrites
Total about 64 feet.						

Organic remains abound in the concretions near the base of this division.

The following list, containing upwards of a hundred species of Mollusca, obtained from this locality, will be found to include most of the species which occur in the “Crackers-rock” and “Atherfield clay” of the Isle of Wight.

FOSSILS FROM EAST SHALFORD (*Atherfield-beds*).

Zoophyta—

- Chisma furcillatum*, Lons.
some doubtful forms.
Holocystis elegans, Lons.
Brachycyathus Orbignyianus, E.
and H. (Duncan) new to Eng-
land.

Annelida—

- Serpulæ*. Two or three species.

Echinodermata—

- Toxaster complanatus*, Ag.

Brachiopoda—

- Lingula* (A small species, allied
to *L. ovalis*).

- Terebratula sella*, Sow.

- Rhynchonella lata*, D'Orb.

Mollusca. Monomyaria—

- Anomia asperrima*, D'Orb.

- Anomia pseudo-radiata*, D'Orb.

- Anomia lævigata*, Sow.

- Avicula depressa*, Forbes.

- Avicula Cottaldina*, D'Orb.

- Avicula ephemera*, Forbes.

- Exogyra subplicata*, Leym.

- Exogyra* (allied to *E. conica*) =

- Ostrea Tombeckiana*, D'Orb. (?)

- Gervillia anceps*, Desh.

- Gervillia alæformis*, Sow.

- Gervillia solenoides*, Deffr.

- Gervillia linguloides*, Forbes.

- Ostrea Leymeriei*, D'Orb.

- Ostrea* (allied to *O. vespicularis*).

- Ostrea Couloni*, D'Orb.

- Gryphea*, sp.

- Pecten Robinaldinus*, D'Orb.

- Pecten interstriatus*, Leym.

- Pecten* (smooth, elongated).

- Pecten Cottaldinus*, D'Orb.

- Pecten striato-punctatus*, Rœm.

- Pecten quadricostatus* (?) Sow.

- Pecten quinquecostatus*, Sow.

- Perna Mulletii*, Desh.

- Perna* sp.

- Pinna* (two species).

- Plicatula asperrima*, D'Orb.

(Mollusca). Dimyaria—

- Arca Austeni*, Forbes.

- Arca Raulini*, D'Orb.

- Arca Carteroni*, D'Orb.

- Arca Dupiniana*, D'Orb.

- Arca Robinaldina*, D'Orb.

- Arca consobrina*, D'Orb.

- Arca cornueliana*, D'Orb.

- Arca securis*, Leym.

- Astarte numismalis*, D'Orb.

- Astarte carinata*, D'Orb.

- Astarte subacuta*, D'Orb.

- Cardium Raulinianum*, D'Orb.

- Cardium subhillanum*, Leym.

- Cardium* (two or more species).

- Cardita fenestrata*, Forbes.

- Corbula striatula*, Goldf.

- Corbula punctum* (?) Phill.

- Corbula truncata*, Sow.

- Cucullea*, sp.

- Caprotina*, sp.

- Gastrochena dilatata*, Desh.

- Lithodomus oblongus*, D'Orb.

- Dimyaria*.

- Leda scapha*, D'Orb.

- Lucina* (two or more species).

- Modiola equalis*, Sow.

- Modiola Carteroni*, D'Orb.

- Modiola bella*, D'Orb. (?)

- Modiola*, sp.

- Mytilus lanceolatus*, Sow.

- Mytilus*, sp.

- Nucula Cornueliana*, D'Orb.

- Nucula planata*, Desh.

- Nucula*, sp.

- Panopea Neocomiensis*, D'Orb.

- Panopea plicata*, Sow.

- Panopea*, *Prevostii* (?)

- Pholadomya*, sp.

- Pholas*, sp.

- Solecurtus Warburtoni*, Forbes.

- Tellina angulata*, Desh.

- Tellina inæqualis*, Sow.

- Tellina Vectiana*, Forbes.

- Thetis major*, Sow.

- Thetis minor*, Sow.

- Trigonia dædalia*, Park.

- Trigonia alæformis*, Park.

- Trigonia caudata*, Ag.

- Trigonia ornata*, D'Orb.

- Trigonia*, sp.

- Venus Brogniartiana*, Leym.

- Venus Orbigniana*, Forbes.

- Venus parva*, Sow.

- Venus Vectensis*, Forbes.

- Venus ovalis* (?)

- Venus striato-costata*, Sow.

Gasteropoda.

- Acteon marginatus*, D'Orb.

- Acteon affinis*, Sow.

- Avellana incrassata*, Sow.

- Avellana globulosa*, D'Orb.

- Cerithium Clementinum*, D'Orb.

- Cerithium Lallerianum*, D'Orb.

- Cerithium Neocomiense*, D'Orb.

- Cerithium Marrollinum*, D'Orb.

- Cerithium turriculatum*, Forbes.

FOSSILS FROM EAST SHALFORD (*Atherfield-beds*) continued—

Emarginula Guerangeri, D'Orb.	Rostellaria glabra, Forbes.
Emarginula, sp.	Rostellaria, sp.
Eulima albensis, D'Orb.	Scaloria, sp.
Eulima, spec. nov.	Scaloria, spec. nov.
Fusus, sp.	Tornatella elongata (?)
Fissurella, spec. nov.	Trochus albensis, D'Orb.
Littorina rotundata, Sow.	Turbo munitus, Forbes.
Littorina, sp.	Turritella Dupiniana, D'Orb.
Phasianella, sp.	Neritopsis Robineausiana, D'Orb.
Pterocera, sp.	Ammonites, sp.
Rostellaria macrostoma, Sow.	Ammonites, sp.
Rostellaria Robinaldini, D'Orb.	

NOTE.—Several of the above-mentioned species have not been hitherto recorded as occurring in England.

2. The strata for the succeeding 200 or 250 feet—which will include both the *Kentish-rag* and the *Middle*, or *Argillaceous division* of Fitton—require but little notice. They consist, for the most part, of sand, finely and regularly stratified, and may be briefly described as follows:—

	Thickness.
A. Ferruginous sandy beds (sometimes containing Iron-stone)	... about 40 feet.
B. Light coloured sands passing into loose sandstone	... about 60 feet.
C. with thin layers of chert, occasionally interspersed	... about 40 feet.
D. Ash-coloured and greenish sands, at times slightly argillaceous	... about 100 feet.

The *lower* portion of these beds is partially exposed in a lane section below St. Martha's Chapel, near East Shalford, and also in lanes about Whitley and Hambledon.

The *upper* portion is more frequently exposed. It may be seen in a road-section at Rock Place, near Godalming; in the railway cutting near the New Godalming Station; in a small quarry at Littleton, near Guildford; and also, *partially*, below St. Martha's Chapel, near East Shalford.

List of Fossils from the *middle* sand-group (*Hythe* and *Sandgate beds*), of Godalming—

Ostrea macroptera, Sow.	} From a lane below St. Martha's Hill.
Rhynchonella parvirostris, Sow.	
Terebratula Meÿeri (?) Walker	
Terebratula sp.	

Fossils from the *middle* sand group of Godalming, *continued*—

Exogyra sinuata, Sow.	}	From Railway Cutting near New Godalming Station.
Exogyra, var. (subsinuata (?))		
Ostrea Tombeckiana, D'Orb.		
Ostrea, sp.		
Belemnites, sp.		
Ammonites, two or three species.		
Ancyloceras (?)		
Waldheimia tamarindus, Sow.	}	From the upper 50 feet of the sand-group near the Railway Bridge, Godalming.
Plicatula Carteroniana, D'Orb.		
Plicatula, sp.		
Ostrea Tombeckiana, D'Orb.		
Ammonites, sp.		
Belemnites jaculum, Phill.		
Belemnites, sp.		
Belemnites, sp.		

Casts and impressions of the following species occur in a layer of Phosphatic nodules at about 50 feet from the top of this division.

Hammites, sp.	}	From road side cutting near the Railway Bridge, Godalming
Ammonites (a small, flat species)		
Tornatella albensis		
Trochus decussatus		
Scaloria, sp.		
Avellana incrassata		
Cerithium, sp.		

It seems probable that fossils were *originally* abundant in many of these sand beds; for I have frequently, by close examination, detected casts or impressions of shells in many strata which were at first sight wholly devoid of fossils.

The strata hitherto described—including the whole of the lower and middle divisions in Section 2—appear to have been deposited quietly and continuously. The beds, whether of sand or argillaceous matter, passing into each other gradually and almost imperceptibly. And though the *prevailing organisms* of the *lowest*, or Atherfield clay-strata *do not pass upwards*, some few fossils of the *middle* or Kentish-rag series, are occasionally met with in the lower deposits. Throughout the whole of the period occupied in the accumulation of these deposits we have, therefore, no evidence of disturbing influences affecting either the ocean-bed or the adjacent land-surfaces, beyond the probable

shifting of oceanic currents, and the gradual abrasion of the different rock-surfaces from which these strata have been derived.

In the deposits immediately succeeding those which I have last described, we seem, however, to find evidence of *considerable*, and *more than local* disturbance. And I wish particularly to call attention to this fact as one of much importance in the history of our Cretaceous rocks.

3. Resting immediately upon the finely stratified deposits of the middle subdivision of the Greensand, there occurs at Godalming—and, as I shall be able to show, in many other localities—a stratum (or strata) of coarse sand, and small subangular pebbles; which appears to represent a *break* in the hitherto continuous deposition of the Greensand, and to constitute, at the same time, a well-marked *basement-bed* to the Upper division of the Lower Greensand.

The *lower layers* of this pebbly stratum, or *Pebble-bed*, as I have elsewhere called it, are usually the coarsest in composition; and appear in places to rest unconformably* upon the sands beneath, or even occasionally to fill up small pockets or depressions in the underlying sand-beds, as if resting on an unequally eroded surface. The *upper layers* contain fewer and smaller pebbles, and pass, more or less gradually, into the gritty sands of the Bargate-stone group above.

The thickness of this *Pebble-bed* varies considerably; ranging, in the district around Godalming, from a few inches to 10 or 12 feet.

Taken as a whole, the *Pebble-bed* and the superincumbent *Bargate-stone* and *Carstone strata* must be regarded as forming but one group or series of deposits. But, for the sake of convenience, I shall describe them separately.

*At Rock Place, near Godalming, the *Pebble-beds* are clearly unconformable to the sands below.

One of the most instructive sections of this upper sand-group that I have met with is displayed in a small quarry and lane-section near Littleton, on the south-west of Guildford, on the side of a lane which intersects an elevated ridge of Greensand in its rise from beneath the Chalk.

In this section the junction of the Pebble-beds with the sands below, and their upward passage *into* the *Bargate-stone* may be clearly seen, as well as the passage of the *Bargate-stone* itself into the Ferruginous sands above.

SECTION NEAR LITTLETON.

		ft.	in.	
Middle Division.	1	Light coloured sand coarse and very fine alternating in thin layers	10	0
	2	Ash coloured and greenish sand regularly stratified, containing in its upper layers some of the larger pebbles from the bed above, which appear to have sunk into it subsequently to the deposition of the sand	1	6
				{ In this bed I have found several masses of ironstone, much like " <i>clay-ironstone</i> ", perforated by boring shells. Casts of <i>Ammonites</i> and small shells, in fragments.
Pebble beds.	1	A layer of subangular pebbles, some of them as large as a walnut	0	4
	2	Light coloured sand falsely stratified	1	6
	3	Light coloured sandstone, falsely stratified	2	0
	4	Layer of small subangular pebbles in sand	0	8
	5	Greyish clay, coarsely laminated	0	6
	6	Light coloured sand, falsely stratified	3	0
	7	Light coloured sandstone	2	0
	8	Brownish sand and pebbles (small and numerous)	1	6
	9	Sand and sandstone	1	0
	10	Sand and small subangular pebbles	1	0
Bargate-stone.	1	Light coloured sand, with Bargate-stone in thin layers	20	0
				{ <i>Avicula pectinata</i> , <i>Exogyra</i> , &c.

NOTE.—The *Pebble-beds* in this section appear to thin out rapidly towards the South-east.

In a quarry on the same ridge of Greensand, about a quarter of a mile west of St. Katherine's Chapel, the Pebble-beds are seen to *alternate with* the lower layers of the Bargate-stone.

In the vicinity of Godalming there are several sections of the Pebble-beds and Bargate-stone. Some of which it will be well to notice.

North of Godalming, on the side of a lane leading from Farncombe to Hurtmore, we have the following section :—

		ft. in.	
Pebble-beds.	* Light coloured sands, belonging to the middle division of the greensand		
	1 Dark brown sand, coarse and very loose, full of small metallic flakes of ferruginous matter ...	4 0	Scales of Fishes.
	2 Ash coloured sand and thin layers of clay	1 0	{ Terebratula tamarindus, Ter, extensa, &c.
	3 Grey, yellowish, and brown sand in alternate layers; with sub-angular pebbles of quartz and a dark coloured shiny stone ...	6 0	{ Teeth of Fishes (several species). Casts of Ammonites, &c.
	4 Grey, yellowish, and brown sand, with small pebbles	2 0	
	5 Coarse, loose sand, mottled and veined with light coloured markings	4 0	Wald. tamarindus.
	6 Layers of coarse ash coloured sand and small pebbles	3 0	{ Terebratulæ, 3 or 4 species.
	7 Coarse, whitish and green sand, with minute pebbles of quartz, &c., and containing broken and single valves of Terebratulæ ...	4 0	
		24 0	
Bargate-stone.	* Layers of greenish sandstone ...	0 9	Exogyra conica, var.
	* Greenish sand	0 9	
	* Coarse sandstone	0 9	Avicula pectinata.
	* Greenish sand	5 0	{ Spines of Echinus, Serpula, &c.
	* Light coloured sand with concretions of Bargate-stone ...	7 0	

In an old quarry or sandpit on the side of a lane at Tuesley, South of Godalming, there is the following section.

SECTION AT TUESLEY.

		ft.	in.	
	Greenish sand, finely stratified ...	6	0	
	Whitish sand ...	2	0	
Pebble-beds.	1 Light coloured sandstone, with pebbles ...	1	0	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> Terebratella Fittoni. Terebratula Extensa. Teeth of fishes. Wald, Rhomboidea. </div> </div>
	2 Coarse, brownish sand, with pebbles ...	0	6	
	3 Light coloured sand, with numerous minute pebbles ..	0	9	
	4 Light coloured sand, slightly ferruginous ...	0	3	
	5 Light coloured sand, and sub-angular pebbles ...	0	3	
	* Light sand with sandstone ...	12	0	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> Teeth of fishes, &c. Terebratulæ, Fragments of Ammonites, Teeth of Fishes and Saurians. Ammonites (fragments of). Teeth, &c. </div> </div>
				2ft. 9in.

The beds 1 to 5, contain many small fossils, but they can only be found by examining the beds very closely.

At Rock-Place, on the left hand side of the road leading towards Busbridge, there is a tolerably good section exhibiting about 30 feet of the *middle* division of the Greensand, consisting of light coloured sand, regularly stratified, with the Pebble-beds resting on the top. Higher up the road the Pebble-beds may be traced beneath the Bargate-stone, of which many distinct bands (about 12 or 14) may be observed.

Other sections might be mentioned in which the Pebble-beds are exposed, but enough has been said to show the nature of the deposits. I must now add a few words as to its composition and fossil remains.

Mineralogically the Pebble-bed consists of coarse quartzose sand and waterworn fragments of many kinds of rock.

It is also partly made up of extraneous fossils, namely—fragments of casts of *Ammonites*, and other small Univalve and Bivalve shells; teeth of *Saurians*; teeth and scales of *Fishes*;

fragments of *Pentacrinites*, &c. Some of these have been recognised as fossils of older rocks—such, for instance, as *Ammonites Lamberti* and *A. crenatus*, of the Oxford Clay. Others, and amongst them all the small univalve and bivalve shells, I have been wholly unable to identify. Yet, with exception of the several species of *Brachiopoda* and two or three species of *Pecten* and *Exogyra*, which will be presently mentioned as also occurring in these beds, the whole would appear to be *extraneous* (*Oolitic* and *Liassic*), fossils which had been drifted into their present position at the time of the deposition of the strata in which they now occur.

The fossils *proper* to the Pebble-bed in this district include the following species:—

<i>Pecten Rauliniana</i> , D'Orb.	<i>Waldheimia rhomboidea</i> , Walker.
<i>Pecten orbicularis</i> , Sow.	<i>Waldheimia pseudo-jurensis</i> , Leym.
<i>Pecten</i> sp.	<i>Waldheimia mutabilis</i> (?) Walker.
<i>Exogyra Tombeckiana</i> , D'Orb.	<i>Terebratula depressa</i> , Lam.
<i>Exogyra</i> , sp.	<i>Terebratula extensa</i> , Meyer.
<i>Gryphea</i> , sp.	<i>Terebratula microtrema</i> , Walker.
<i>Terebratulina chrysalis</i> , Schloth.	<i>Terebratula Tornacensis</i> (?) D'Arch.
<i>Terebratella oblonga</i> , Sow.	<i>Rhynchonella</i> , two or more species.
<i>Terebratella Fittoni</i> , Meyer.	<i>Serpulæ</i> .
<i>Terebratella Menardi</i> , Lam.	Spines of Echinoderms.
<i>Waldheimia tamarindus</i> , Sow.	

Of the *twelve species* of *Terebratulæ* mentioned above no less than *nine* have been only recently recognised as British Lower Greensand species. Most of them are either figured or described in the I. and V. Vols. of the "Geol. Magazine."

The *derivative* or doubtful fossils of the Pebble-bed consist of the following:—

Casts of 6 or more small species of *Ammonites*.
 Casts of 6 or more small Univalves.
 Casts of 12 or more Bivalves.
 Fragments of *Pentacrinite*.
 Teeth and scales of *Fishes*, including examples of the following genera,
 viz., *Saurichthys*, *Lepidotus*, *Hybodus*, *Picnodus*, *Gyrodon*, *Acrodon*,
Notidanus, and *Lamna*.
 Teeth of *Saurians*.

These teeth and scales are usually much waterworn, but not always so, as examples of many of the above may be found in

an almost perfect condition. The fact of their occurring *in any condition* in the Lower Greensand *of this district* is of considerable interest. For if, as appears to be the case, they are really *drifted* fossils, it is clear that the rocks from whence they were derived cannot have been far distant from the places where these fossils are now found. And it must be remembered that teeth of the genus *Saurichthys*, of which two if not three species occur in the Pebble-beds, are not known to occur elsewhere in England in beds younger than the Triassic "bone-bed," of Austcliff and Axmouth.

4. Sections of the *Bargate-stone* group may be seen 'in many places around Godalming, as at Hascomb, Busbridge, and Tuesley on the south; and near Compton, Hurtmore, and Northbrook on the north and west, where small quarries have been opened to meet local demands for building or road material. Bargate-stone has also of late years been somewhat extensively quarried on Holloway Hill, immediately above the town, where a good section may usually be seen. Dr. Fitton's description of the sands and stone beds of Holloway Hill, written in 1827, fully answers to what may be observed there at the present time.

I should mention, however, that Dr. Fitton was mistaken in regard to the *position* of the stone beds of Holloway Hill, which he says (Trans. Geol. Soc., vol. iv., p. 106) "*may with some probability be assigned to the lowest part of the Greensand formation.*"

The stone beds of Holloway Hill form part of the Bargate-stone series, and, as such, belong unquestionably to the *Upper* division of the Greensand, as correctly stated by Sir R. Murchison, in 1825 (Trans. Geol. Soc., 2nd ser., vol. ii., p. 101), and are *not* in any way the equivalent of the "Kentish-rag."

The mineral composition of the Bargate-stone group of strata is very variable. For although consisting, for the most part, of

sand and layers of concretionary limestone, some of the beds include bands of pebbles and thin seams of clay (an impure Fullers-earth), while in others limestone gives place to sandstone and Chert. The stone also varies considerably in the same quarry. Sometimes it is a hard and compact limestone of a greyish colour, scarcely to be distinguished from the better sort of Kentish-rag, and containing as much as 70 per cent. of lime. At other times it is loose and rubbly, containing much argillaceous matter, and frequently towards the lower part it consists of a conglomerate of coarse sand and pebbles, held together by a strong calcareous cement.

Fossils are extremely scarce in the Bargate-stone around Godalming, and in some quarries are not to be found at all.* Most of the specimens enumerated below are from a quarry a few hundred yards to the west of St. Katherine's Hill, near Guildford.

Fossils from the Bargate-stone.

Serpula, two species	Exogyra Tombeckiana, D'Orb.
Serpula or Dentalium	Exogyra undata, Sow.
Policipes, sp.	Exogyra haliotoidea, Sow.
Spines of Echinoderms (3 or 4 species.)	Ostrea pectinata, Goldf.
Spines of Cidaris (muricated.)	Ostrea sp.
Fragments of Bryozoa (6 or 7 species), including fragments of <i>Vertipora anastomosans</i> , hitherto found only in the sponge gravels of Farringdon	Ammonites Nutfieldensis.
Brachiolites, sp., nov.	Ammonites, 2 or more species.
Trochosmia, spec. nov.	Nautilus radiatus.
Avicula pectinata, Sow.	Magas (?)
Avicula Rauliniana, D'Orb.	Terebratulina striata, Wahl. var. (T. chrysalis, Schloth).
Pecten orbicularis, Sow.	Terebratula depressa, Lam.
Pecten Dutemplii, D'Orb.	Terebratella oblonga, Sow.
Pecten Rauliniana, D'Orb.	Terebratella Davidsoni, Walker.
Pecten, sp.	Terebratella Fittoni, Meyer.
Plicatula Carteroniana, D'Orb.	Terebratella Menardi, Lam.
Gryphea canaliculata, Sow.	Terebratella trifida, Meyer.
Gryphea, sp.	Waldheimia tamarindus, Sow.
	Waldheimia rhomboidea, Walker.
	Waldheimia mutabilis, Walker.
	Rhynchonella, 2 or 3 species.

These fossils, although few in number as compared to those of the *lowest beds* of the Greensand, are of great interest, because

* NOTE.—It is only fair to state as a caution to those who might otherwise be tempted to visit Godalming, that the fossils of the district are extremely difficult to find, because the beds containing them are not worked.

mostly characteristic of the horizon to which they belong. The small species of *Avicula*, *A. pectinata*, Sow. is especially a *Bargate-stone* fossil. It occurs abundantly on the same horizon at Nutfield, Reigate, and Folkstone, but is not found at a lower level in the Greensand.

5. Sections of the *highest strata* of the Greensand of this district, that is to say, the beds *from the Bargate-stone upwards to the Gault*, may be seen at St. Martha's and St. Katharine's Hills, near Guildford; at Crooksbury to the west of Puttenham, and in several other places around Godalming.

Wherever exposed these beds are seen to consist of sand composed almost entirely of quartz. The sand sometimes occurs white, but is more frequently stained by peroxide of iron, and is then of a dull yellow or red colour. In many places the iron has combined with the sand in tubular masses and layers of various thickness, and when thus combined it forms a hard and almost imperishable stone, known here, as also in Norfolk, by the name of *Carstone*.

Thin layers of tough blue clay sometimes occur in the lower part of this sand group, and often form the base of a layer of *Carstone*.

As far as I have been able to observe these *upper ferruginous sands* are now, and probably always have been, entirely destitute of fossils; and it is perhaps worthy of remark that wherever these sands occupy the present surface of the ground recent Mollusca—*Helix*, *Pupa*, &c., are rarely to be seen. And this is the more noticeable as recent Mollusca, both of land and fresh water species, are otherwise extremely abundant in the vicinity of Godalming; their distribution appearing, however, to be more dependent upon the nature of the soil than on that of the prevailing vegetation. Of land shells no less than 41 species occur in this neighbourhood. Of these *four* species—*Helix pomatia*, *H. caperata*, *Zonites purus*, and *Balea perversa*—appear to be confined

to the Chalk; 32 species occur almost equally on the Chalk and on the outcrop of the Bargate-stone; two species—*Zonites excavatus* and *Helix fulva*—I have found only on purely sand-beds, and one species, *Azeca tridens*, on the outcrop of the Atherfield clay. While, therefore, the number of *shell-bearing* Mollusca now living on the soils formed by the Chalk and Bargate-stone respectively is nearly equal (the preponderance being in favour of the latter), the outcrop of the *intermediate* sand-bed is found to be characterised by their almost total absence; and it would be useless to search for specimens on Highdon Hill to the south of Godalming, or on Crooksbury Hill, near the western extremity of the Hogsback, or on any of the wide heaths or moor-lands towards Hindhead, where the *Carstone beds* cover the surface. I may also observe that the small streamlets which rise among these sand-beds are almost equally destitute of Mollusca.

CONCLUSION.

Having described, as fully as space will allow, the nature and arrangement of the rocks and fossils of the Lower Greensand of Godalming, I must now say a few words as to their resemblance to those of the Greensand of other more or less distant localities.

1. The lowest beds of the Greensand of the Godalming district correspond in position, and very nearly in their mineral composition, with the well-known Atherfield clay and Crackers-rock of the Isle of Wight. Its numerous and characteristic fossils also *nearly* agree—species for species—with those which occur at Atherfield.

2. The succeeding 200 or 250 feet of strata, which at Godalming consist, as has been stated, almost entirely of sand, and which, from the difficulty of subdivision, I have included in a single group in section 2, are represented at Folkstone by two very different sets of strata, known respectively as the *Hythe* and

Sandgate-beds. And it is in this case curious to observe the difference in the mineral structure of these two groups as seen at Folkstone and Godalming. The Hythe-beds, as is well seen in the quarries at Hythe and Maidstone containing a very large proportion of *limestone* (Kentish-rag), which is well-nigh absent in the west of Surrey, being but feebly represented by some thin layers of chert and sandstone. While the argillaceous Sandgate-beds, of Sandgate, have almost wholly disappeared.

It would be a mistake, however, to suppose that either of these groups have *thinned out* in their passage westward, from Folkstone to Godalming. That such is not the case can be fairly proved by the comparative thickness of the strata. And it is merely one instance among many of the gradual passage *in a lateral direction* of limestone, or argillaceous strata into sandstone or sand.

3. The "Pebble-bed" of the Lower Greensand of Godalming may be traced *eastward* along the outcrop of the Greensand towards Folkstone; appearing near Dorking, below the "Fuller's-earth" at Nutfield, and also near Sevenoaks and Maidstone. At Folkstone it is but feebly represented; but it may be seen clearly enough at Redcliff in the Isle of Wight, where, as I have lately seen, it occurs as a band of rounded and sub-angular pebbles of quartz, &c., associated with waterworn fragments of wood and bone and various *drifted* fossils.

To the *west* of Godalming the Pebble-bed finds its equivalents in the "Sponge-gravel" of Farringdon, in Berkshire, in certain beds near Devizes, and probably, further northwards, in the recently discovered *Phosphate-beds* at Upware, near Cambridge; and in the lower beds of the Greensand of Hunstanton in Norfolk.*

I have been thus careful in defining the equivalents of the

* *Vide* papers in "Geol. Mag.," Vol. IV., page 309, by J F Walker, F.G.S., &c.; and "Geol. Mag.," Vol. IV., page 456, by Prof. Morris, F.G.S., &c.

"Pebble-bed" *eastward* and *westward* of Godalming, because it follows that the equivalents of the succeeding "Bargate-stone" and "Carstone-strata," whatever their mineral composition may chance to be, must necessarily *also* belong to the highest subdivision of the Greensand, namely, to the "Folkstone-beds," or "*Ferruginous division*" of Fitton.

From what is at present known with respect to the original distribution of the Greensand, it does not seem probable that either the "Atherfield clay," or the "Hythe," or "Sandgate-beds" ever extended *in the South of England* beyond the limits of the Wealden area; and I am inclined to assign all the known outliers of the Lower Greensand of England (with exception of a *portion* of the Lincolnshire and Yorkshire series) to the age of the *Folkstone-beds* or *highest subdivision* of the Greensand of Fitton.

A comparison of the fauna of the highest and lowest (Folkstone and Atherfield) divisions of the Godalming Greensand exhibits the remarkable fact that these two divisions have not a single species in common. This is no doubt exceptional, as the corresponding beds in the Isle of Wight have many species common alike to the two groups. But it is worth notice, because it tends to prove, even more strongly than the thickness of the intermediate deposits, what a vast period of time must have passed away during the accumulation of the Lower Greensand of the South of England. And it is hardly too much to suppose that we possess, both in the Atherfield and Godalming Greensand strata, a very considerable portion of the "Neocomien" series of France and Switzerland.