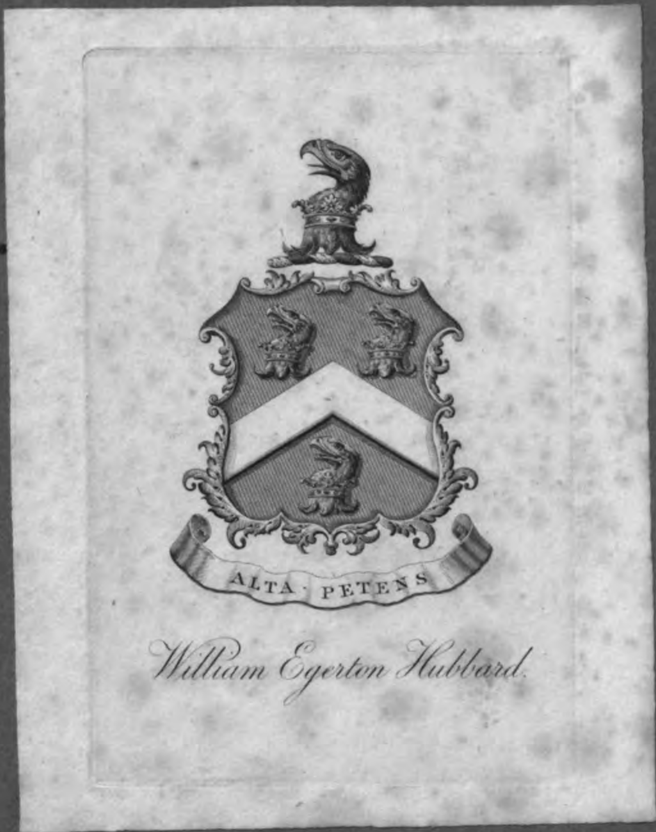
ALTA · PETENS
William Egerton Hubbard.

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William Lonsdale Esq. – Geol.l Society

OBSERVATIONS

ON SOME OF

THE STRATA

BETWEEN THE

CHALK AND OXFORD OOLITE,

IN THE

SOUTH-EAST OF ENGLAND.

— from his friend.
W.H.F.

BY

WILLIAM HENRY FITTON, M.D. F.R.S. &c.

[*From the Transactions of the Geological Society of London, Second Series, Vol. IV.*]

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CONTENTS.

APPENDIX.

ERRATA ET CORRIGENDA.

Page 106, line 5, *for* No. 1.) illustrates *read* No. 1. and X. b. fig. 1. illustrate

—— 107, — 17, *after* No. 1. *insert* and Plate X. b. fig. 1.

—— 108, Note *, *for* Section, Plate X. a. No. 1. *read* Sections, Plate X. a. No. 1. and X. b. fig. 1.

—— 111, line 3 from bottom, *for* at *read* from

—— 112, — 23, *for subcristatus* read *cristatus*; *and add* Plate XI. fig. 23.—See Appendix A. p. 337.

—— 113, — 15, *for Hamites* aculeatus *read Hamites* spiniger

—— — — 9 from bottom, *add the words* also at Blackdown, Devon, Plate XVIII. p. 242.

—— 119, — 9 from bottom, *for* Siphonaria, *read* Siphonia

—— 130, — 20, *for* XXI. f. 7. *read* XXIII. fig. 7.

—— 131, — 14, for *Trochus*, read *Pleurotomaria*

—— 138, The thickness of the beds represented in the *Wood-cut* differs in some respects from those of the *List*, p. 139; the latter are the more correct.

—— 143, line 22, *dele* is

—— 153, — 3, *for* striata *read* gigantea

—— 164, — 3, *for* fig. 2. *read* fig. 3.

—— — — 4, *for* No. 5. *read* No. 6.

—— 167, — 11 from bottom, *for* (b.) *read* (β.)

—— — — 9 from bottom, *for* (b.) *read* (β.)

—— — — 9 from bottom, for *fluviorum* read *vivipara*

—— 168, — 1, *for* (2. b. and 2. e.) *read* 2. β. and 2. ε.

—— — — 8, *for* 12 *read* 10?

—— — — 11, *for* 2. a. *read* 2. α.

—— — last line, *add* p. 186, *read* (95.) p. 186.

—— 181, line 15, *for* Pippingford *read* Peppingford-Park

—— — — 21, for *Odontopteris* read *Sphenopteris*

—— 182, — 13 from bottom, *for* No. 6. *read* No. 7.

—— 195, — 14, 15, 17, from bottom, for *Gryphæa* read *Exogyra*

—— 203, — 3, for *Seligrimus* read *Selliguinus*

—— 204, — 2, *insert* "*Anomia* convexa. Plate XIV. fig. 7. Shore East of Shanklin Chine. See p. 338."

—— — — 25, after *Ostrea* carinata *insert* "Ostrea retusa, Plate XIV. fig. 4.; from Atherfield, in the Lower greensand."

—— 214, last line, for VIII. *read* IX.

—— 225, line 14, *dele* and

—— 230, — 9, *for* XX. *read* XXII.

Page 231, line 24, *for* tricristata *read* triserrata

—— 234, — 6, *after* thus: *insert* "(see Plate X. a. No. 11, and X. b. fig. 9.)"

—— 241, — 19, 2nd column, } *for* Stutchburiensis
—— 342, — 2, from bottom, } *read* Stutchburianus.
and Descript. of Pl. XVIII. fig. 1. }

—— 242, — 9, first column, *for* megastrema *read* megatrema

—— — — 5, second column, *add the words* "also from Eastware Bay, in Kent; see p. 114, line 32."

—— 252, — 15, *for* 4 feet to 7 feet *read* 4 to 7

—— 259, — 19, *for* in *read* or

—— 260, — 8, *for* Berston *read* Benston

—— 262, — 26, *for* South *read* North

—— — — 32, *for* between Gin Cross *read* from Gore Cross

—— 273, — 6 from bottom, *for* Aptychus *read Trigonellites*

—— 292, — 23 and 30, *for* Aptychus *read Trigonellites*

—— 297, — 10 from bottom, *dele the semicolon after* suboolitic

—— 298, — 20, for *Potamides carinatum* read *Potamides*? (a new species.)

—— 300, — 5 from bottom, *for* 286 *read* 206

—— 302, — 19, for *Aptychus* (Von Meyer),—read "*Trigonellites*, (Parkinson); *Ichthyosiagones*, (Rüppell); *Aptychus*, (Von Meyer.)"

—— 303, — 5, *for* 206. *read* 286.

—— 304, — 16 from bottom, *for* masses *read* matter

—— — — 24, *for* masses *read* matter

—— 305, — 9, *dele the word* "chalk"

—— 309, — 4, *note* †, *for* R. C. *read* C. B.

—— 316, — 6 from bottom, for *Aptychus* read *Trigonellites*

—— 324, — 8, *for* (168.) p. 326. *read* (167.) and (168.) pp. 326. and 329.

—— 339, — 9, for *gigantea read* striata

—— 352, In the reference connected with *Pentacrinites scalaris*, for fig. 2. *read* fig. 4.

Tables 353, After *Gastrochæna*, insert "sp. doubtful.—In perforations in dicotyledonous (silicified) wood;—*Gault*, east of Folkstone."

—— 355, In the reference *Cytherea* subrotunda, *for* Pl. XXII. 2. *read* Plate XVII. 2.

—— 355, After *Cyclas media* insert "C—— *media*, a gibbose variety, Pl. XXI. fig. 11. (*Hastings-sand*; Sussex, 177.—*Purbeck strata*, S. Wilts, 259.)"

—— 358, *note*, *dele* ?? *after the word* adjective

In this volume are

Fitton Observations
on Strata, South East England
p. 103 – 388 Contents – 384
Map South East England & Coast of France 206.

Murchison Geological Sketch
North Western Extremity
Sussex – adjoining parts
of Hants & Surrey
p 97 – 107 – Map &c

Hopkins – Weald District
& Bas Boulonnois
p 1 – 51

Fig. 1

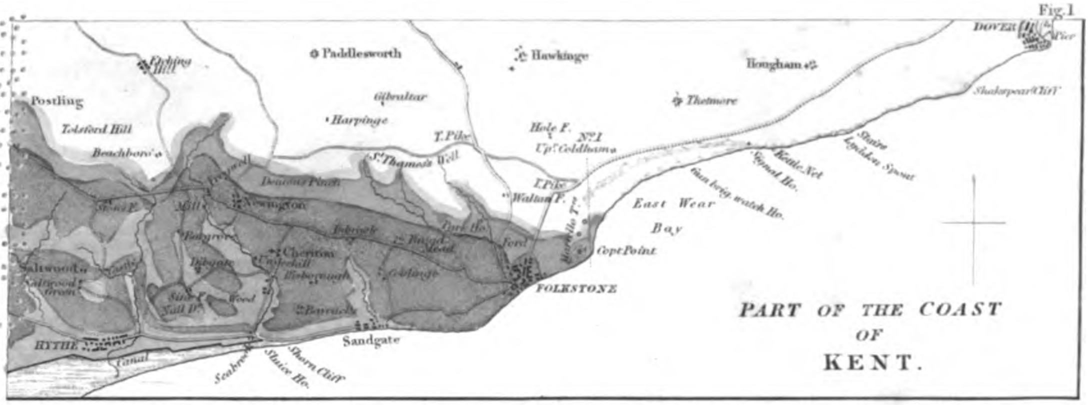


Fig. 2

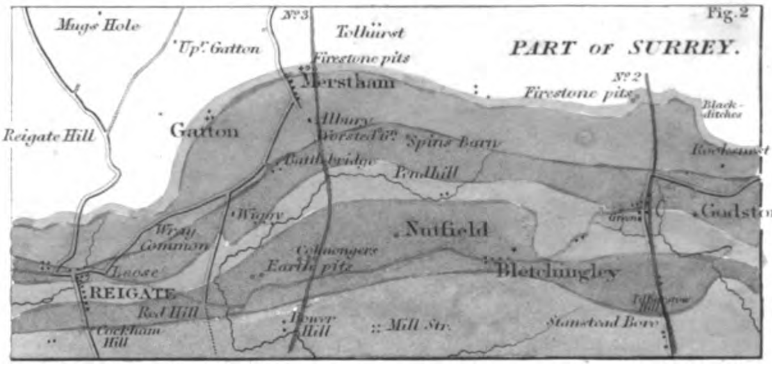
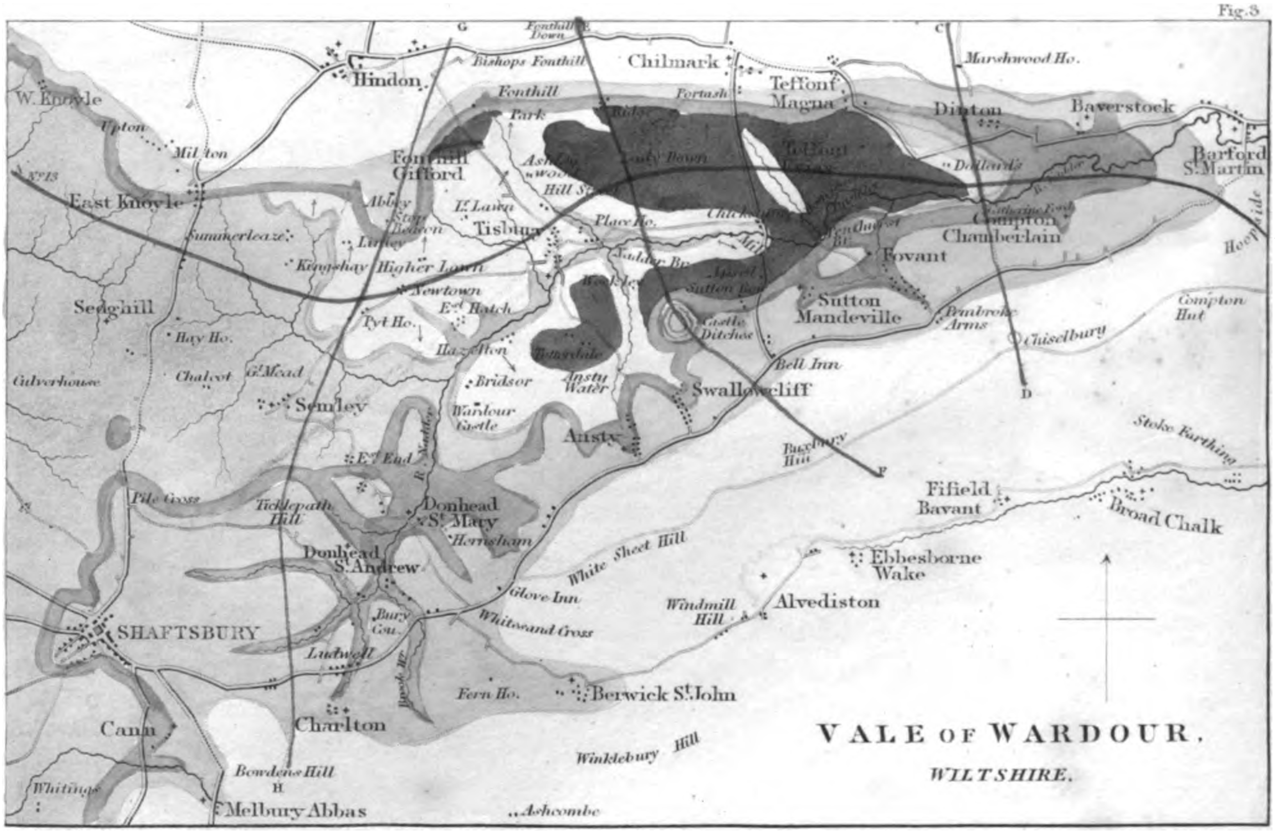


Fig. 3



Chalk	Lower Greensand Fig. 1 & 2	Hastings Sand Fig. 3	Kimmeridge Clay & inferior beds
Upper Greensand	Lower Greensand Fig. 3	Purbeck Strata	Lines of Section
Gault	Weald Clay Fig. 1 & 2	Stone / Sand — Portland	Anticlinal line Fig. 3. A.B.

Scale
1 0 1 2 3 4 Miles

IV.—*Observations on some of the Strata between the Chalk and the Oxford Oolite, in the South-east of England.*

BY WILLIAM HENRY FITTON, M.D., F.R.S. P.G.S., &c.

[Read June 15, 1827.]

(1.) IN a paper published in the Annals of Philosophy for November and December 1824*, I gave an account of the order and characters of the strata which occur beneath the chalk on the coast of part of the Isle of Wight and of Dorsetshire, and stated some reasons for supposing that a similar arrangement would be found to exist in the interior of England.

The principal objects of that paper were; *First,* to distinguish as a separate group, the series of strata now called the Lower Green-sand;—which had previously been confounded either with the beds containing green particles immediately below the chalk, or with the sandy and ferruginous strata conspicuously exhibited on the coast at Hastings, and then called "Iron-sand." *Secondly,* to indicate more clearly than had been done before, the peculiar characters of the group, which succeeds in a descending order to that just mentioned, and is remarkably distinguished by its fossils from the strata immediately in apposition with it, both above and below. For this latter group, which includes the Weald clay, the sand of Hastings, and the Purbeck limestone, and is well entitled to a separate denomination, I have adopted the name of "*Wealden,*" proposed by Mr. Martin, in his valuable memoir on the West of Sussex†.

(2.) The objects of the inquiries which have produced the following pages were, to compare some portions of the series of strata between the chalk and the Oxford oolite, in different parts of the South-east of England; to ascertain the existence of the Wealden in the interior; and, if possible, to determine its boundaries.

* Annals of Philosophy; New Series, 1824, vol. viii. pp. 365, 458, &c.

† "Memoir on a Part of Western Sussex": 4to, London, 1828.

In stating the result of this investigation, I shall give a series of sections of the strata below the chalk, at places which I have myself examined *, beginning on the coast near Folkstone, and following the outline of the chalk thence to the sea on the N. West of Norfolk. The relative situation of these places is shown in the map annexed to this paper †. The intermediate country, in general, I have not examined in detail, and some points of importance I have never seen; but those who may have opportunities of continuing the inquiry, will find, I hope, no difficulty in connecting their observations with mine.

(3.) The series of strata about to be described extends from the Chalk down to the Oxford oolite or coral-rag, and is composed of alternating but irregularly distributed beds of Sand, Clay, and Stone.

Among the sandy strata, it is important to discriminate not only between the Lower green-sand and that of Hastings, but to distinguish both from a third group, consisting principally of sand abounding in green particles, which lies beneath the Portland stone.

Clay, of several varieties, occurs in all parts of this series; but three groups, constituting the Gault, the Weald-clay, and the Kimmeridge-clay, derive peculiar importance from their generally occupying valleys, or depressions, at the foot of the escarpments of the Chalk, the Lower green-sand, and the Portland stone, respectively, and thus producing conspicuous natural features in the tracts where this succession is observable.

The stone of the tracts under consideration is either limestone; indurated sand-rock; chert; or siliceous matter intimately mixed with carbonate of lime, in the form of grit,—which has commonly a concretional structure, and seems to pass into continuous beds only by the approach and ultimate union of the concretions.

But the most remarkable distinction, in the suite described in this paper, arises from the great difference of character in the organized remains which the principal groups include. The fossils of the chalk and green-sands and those of the Portland stone, are all marine, and the species numerous. But in the *Wealden*, between the lower green-sand and the Portland stone, although the fossils are abundant as to quantity, the species are comparatively few, and by far the greater part of them belongs to fresh water. The whole of the phenomena, in short, presented by this remarkable assemblage of beds, are such as to accord with the hypothesis of their having been deposited in fresh water communicating with the sea.

* Plates X. a, and X. b.

† Plate IX.—The detail, upon a larger scale, will appear in the new edition of Mr. Greenough's Geological Map of England.

(4.) Combining these sources of distinction, the following arrangement and subdivisions may be adopted, the nomenclature of which, however exposed to criticism, is now probably too well established to be changed without inconvenience*.

Chalk	*Upper.*	Fossils, marine: species numerous.
	Lower.	
	Marly.	
Green-sand	*Upper green-sand.*	
	Gault.	
	Lower green-sand.	
Wealden	*Weald-clay.*	Fossils, for the greater part, of fresh water: species few.
	Hastings sands.	
	Purbeck strata.	
Part of the Oolitic Series	*Portland stone.*	Fossils, marine: species numerous.
	Portland sand.	
	Kimmeridge and Weymouth clay and sand.	
	Oxford oolite (Coral rag).	

(5.) I proceed now to describe the Sections of these strata, beginning with the coast of Kent; and I shall connect with each section a list of such fossils as I have either found myself, or obtained on good authority from the places mentioned. The whole of the shells in these lists have been examined and named by Mr. James Sowerby, by whom also the drawings of the supposed new species were made, and the annexed engravings executed†. It is right to mention this explicitly, both that I may take the opportunity of expressing my acknowledgments for Mr. Sowerby's valuable and assiduous cooperation,—and that, being myself but very slightly acquainted with Conchology, I may place the portion of the following pages which relates to that subject on better authority than my own.

Vicinity of Folkstone, *Kent.*

(6.) The small map, (Plate VII. fig. 1.,) reduced from the Ordnance Survey, represents the country in the immediate neighbourhood of Folkstone and

* I have stated in another place (Annals of Philosophy, vol. viii. pp. 461, 462,) some objections to the employment of names for geological strata, which refer to characters not essentially connected with the structure or position of the objects to be designated. But the term green-sand, however faulty, besides the universal use of it in England, has been adopted both in Germany and France;—where, however, it may be regarded, in some measure, as free from the disadvantages of a significant name.

† Plates XI., *et seq.*

Sandgate,—the relative position of this tract being shown on the general map, (Plate IX.). The View (Plate VIII.), for which I am indebted to the kindness of my friend the Rev. J. D. Glennie of Sandgate, shows the actual appearance of the coast from Eastware Bay to Hythe; and the section (Plate X a. No. 1.) illustrates the succession of the strata, on a part of the shore which is not distinctly visible in the more direct view from the sea.

(7.) The chalk cliffs in the vicinity of Dover have been described in detail by the late Mr. William Phillips*; and the presence of the upper green-sand which had escaped the notice of Mr. Phillips, has been pointed out by Mr. De Basterot†. These, with Mr. Conybeare's more general description‡, and Mr. William Smith's coloured map of Kent, are the only modern geological illustrations of this part of England with which I am acquainted. But there is a publication of much earlier date,—Packe's "Chart of East Kent," with its explanatory memoir entitled ΑΓΚΟΓΡΑΦΙΑ, printed in 1743, which, though not strictly geological in its immediate object, points out very correctly the connexion between the external features and the disposition of the strata in the tract to which it relates, and contains such excellent views in physical geography as to demand especial notice in this place§.

(8.) As the chalk rises, in proceeding from Dover towards Folkstone, the upper beds disappear; the cliffs represented in the view and section consisting entirely of the lower members of that stratum. The rise of the marly chalk above the sea level occurs about a mile and a half to the east of the escarpment of Folkstone hill, and the place is well marked by the breaking out of a very copious and perennial spring, called "Lydden Spout," which issues from the top of these marly beds||;—a situation probably corresponding to that of the springs which everywhere appear in the interior, along the foot of the chalk range. Near the "Spout" the cliff is about 450 feet high; the upper part consisting of very white chalk, with a bed of flint nodules, the rest of chalk without flints, gradually assuming a greyer hue as it descends. About the middle of the cliff a thick bed has acquired by exposure a rough and darker surface, by the aid of which it can be traced towards the west;

* Geol. Trans., First Series, vol. v. p. 16.

† Geol. Trans., Second Series, vol. ii. p. 334.

‡ Outlines of England and Wales, p. 119—184.

§ A more full account of this valuable work, which had been previously mentioned by Mr. Conybeare, will be found in a tract on the Progress of Geology in England, by the author of the present paper:—London and Edinburgh Philosophical Magazine for 1832, vol. i. p. 447, &c.

|| A new species of Tornatella, named by Mr. Sowerby *elongata*, was found in the chalk marl at this place, by the Rev. G. E. Smith. See Plate XI. fig. 1.

and on the shore there are numerous detached masses, composed of round portions of grey marly chalk united by a yellowish-brown cement. The shore itself, at this place, is a firm floor of light bluish grey marl, the beds beneath being of a still darker hue. The vertical face of the cliff retires from the sea about 2000 paces west of Lydden Spout; and the intermediate shore, thence to Copt Point, is occupied by a mass of ruin, which has fallen from above, in consequence of the rise and erosion of the soft argillaceous beds beneath. The sudden transition to this ruinous under-cliff from the vertical face of chalk is very remarkable. A stratum abounding in green particles, intimately mixed with marl, appears at low water, in several detached places on the shore west of Lydden Spout, and is succeeded by the blue clay of the gault, which continues to Copt Point, where it rests upon the sand and grit of lower green-sand:—the prominence of the Point itself, and of the shore to the west of it, being evidently produced by the greater firmness and durability of the latter stratum.

The succession of the beds is best seen in the retiring portion of the shore, immediately on the north of Copt Point, (see Plate X a. No. 1.) A small outlier of the lowest chalk, with green-sand beneath it, is there exposed at the summit of the rounded hill on which stands the Martello Tower No. 3. Copt Point itself consists almost entirely of gault, which tops the low cliff thence to the village of Folkstone. The lower green-sand, rising gradually from the Point, occupies the whole cliff west of the village; and being continued without interruption, through Sandgate and in the heights above Hythe, its outcrop turns from the coast into the interior, at Aldington Corner. Finally, the Weald-clay, rising on the shore beneath Shorn Cliff, occupies the greater part of the heights and sloping ground on which the town of Hythe is placed, and extends about four miles farther to the west, where it gives place to the Hastings-sands.

In my obervations on this part of the coast, I shall confine myself to the beds below the chalk; referring for a detailed account of that stratum to Mr. W. Phillips's paper, already mentioned.

(9.) *Upper Green-sand.* The upper green-sand near Folkstone, is but a scanty representative of the formation, as it occurs in the Isle of Wight, Surrey, Western Sussex, and some other places in the interior; its total thickness probably not exceeding five-and-twenty or thirty feet, and the stony strata and concretions of chert being altogether wanting. Its rise upon the shore is concealed; and the stratum is first seen in its proper situation beneath the Martello Tower No. 2. A small outlying portion about fourteen feet in thickness, occurs beneath a cap of grey chalk marl about eight feet thick, at the top of the hill on which the Tower No. 3. is placed*; and in this place the stratum consists of a soft marly sand, traversed in every direction by stem-like cylinders, which have within them cores of darker green matter. It also contains some irregular masses of a bright brown or orange hue; but the greater part is composed of grey calcareous marl, like the lowest chalk, so thickly interspersed with green particles as to exhibit only their colour.

The fossils which I found in this stratum were few in number, and indistinct: the only species that could be ascertained was the *Pecten orbicularis*†, one of the characteristic shells of the lower chalk and upper green-sand in Hampshire and Western Sussex.

(10.) The green matter, which abounds in this stratum near Wissant, on the opposite coast of France, has been examined by M. Berthier‡; who found it to consist principally of silica and protoxide of iron, with ten per cent. of potash. For the purpose of comparing the green-sands of different places and formations, my friend Dr. Turner, Professor of Chemistry in the London University, was good enough to examine some specimens from the upper and lower green-sands of Folkstone, of the Vale of Wardour, and the Boulonnois, and also particles of the same kind which abound in the sand and concretions beneath the Portland stone, in the Boulonnois, and in England. I subjoin the result of this examination§, whence it appears that in all these cases the

* See Plate VIII. and the Section, Plate X a. No. 1.

† Mineral Conchology, tab. 186.

‡ Cuvier and Brongniart, *Environs de Paris*, 2nd edit. 1822, p. 249. See also *Annales des Mines*, iv. 1819, p. 623.; and v. 1820, p. 197.

§ The following passages are transcribed from the notes with which Dr. Turner has favoured me upon this subject.

"The colouring matter of green-sand sometimes appears in the rock of its ordinary green tint, and sometimes in grains of so deep a green that they seem black. The former generally occurs in sand, or where the sandstone is porous, and in this state an ochreous appearance is often observed, due to the green particles being partially decomposed, and their iron having passed into a higher state of oxidation; whereas the black-looking grains are met with in highly calcareous sandstone, where the texture is too firm to admit of the percolation of water. From either kind of rock the green matter may be obtained by washing with water and subsidence, since the colouring matter subsides less readily than grains of quartz, and more readily than calcareous and argillaceous substances. For the purpose of analysis it is best procured from those calcareous sandstones where the cement predominates, as in the neighbourhood of Hythe and Folkstone in Kent. On reducing such samples to powder, washing away the finer particles with pure water, and separating any adhering carbonates by dilute muriatic acid, the colouring matter is left, mixed only with small grains of quartz. It then always appears in the form of earthy particles of a deep green tint.

"The green matter, when not previously weathered, is very feebly attacked by concentrated acids, green matter is of the same nature. A slight examination of the green particles, which Sir John Herschel had previously the goodness to make for me, intimated the same results.

(11.) *Gault.* The rise of this stratum on the shore is also obscured by ruins of the superior beds; but it is visible in detached points, at low water, in Eastware Bay, and forms the greater part of the cliff at Copt Point, where many of the more beautiful specimens of the Gault fossils, seen in collections, have been obtained. It appears also below the outlier of the upper green-sand already mentioned (Plate X a. No. 1.); and occupies nearly the whole of the grassy and ruinous cliff between the base of the Martello Tower No. 2, and the sea. Its total thickness is about 130 feet, and it may be divided into

even by the nitro-muriatic. It gives out water when heated, and becomes brown from its iron passing into the state of peroxide. As it has been supposed to owe its green colour to the presence of phosphoric acid, it was carefully examined, with the view of detecting that acid, if present. It was accordingly fused with carbonate of soda, the alkaline filtered solution neutralized by nitric acid, and evaporated to dryness, and the neutral solution tested by nitrate of silver and nitrate of lead. Of two samples of green-sand, thus examined, one was found to be quite free from phosphoric acid, and traces only were detected in the other. The former was also free from lime, and the latter contained but a small portion. It is hence obvious, that neither lime nor phosphoric acid are essential constituents of the colouring matter of green-sand, and their presence must be regarded as casual.

"In order to determine the chemical constitution of the colouring matter, I collected some green particles from the calcareous sand of Eastware-bay, near Folkstone, removing all foreign matter as far as possible, by washing with water and dilute acid. The only impurity which I could detect after this treatment consisted of small grains of quartz, the quantity of which varied in different samples.

"A portion of green particles thus purified, very free from oxidation, and dried at 212° Fahr. lost 7·0 per cent. of water when heated to redness.

"Another portion of the same sample was fused with carbonate of soda, and the earthy ingredients subsequently separated and weighed in the manner usual in such analyses.

"A third portion was heated with carbonate of baryta, and examined for potash, traces of which were readily found. According to the total result, the green particles consist of

		[M. Berthier's analysis of the green particles from near Havre gave the following proportions:—	
"Silica	48·5	Silica	50·0
Black Oxide of Iron	22·0	Protoxide of Iron	21·0
Alumina	17·0	Alumina	7·0
Magnesia	3·8		
Water	7·0	Water	11·0
Potash	traces	Potash	10·0
	"98·3		99·0.]

"It is superfluous to speculate on the precise atomic constitution of the green particles, since they were not obtained in a state of perfect purity. The ingredients which appear to be essential, two portions. The upper part immediately succeeding the upper green-sand contains green particles; and thence, for some feet downwards, it is harsh and sandy. The lower portion consists of a smooth, uniform, very plastic clay, of a light bluish grey colour, much in request for the fabrication of tiles and common pottery. It is in this part of the cliff at Copt Point, that the perfect and beautifully iridescent Ammonites, Inocerami, Hamites, and other fossils, have been obtained. From the Point the stratum rises gradually to the west, forming the summit of the hill, about 108 feet in height, on the east of the town of Folkstone; and some traces of it also exist at the top of the next cliff, on which the church stands. From the coast the gault can be traced in a corresponding situation in the interior, along the foot of the chalk escarpment; its presence being everywhere indicated by a depression of the surface, and by the marshy aspect of the soil, which generally produces rushes and is strongly contrasted with that both of the chalk above, and of the lower green-sand beneath.

It is not improbable that in the Isle of Wight and some other situations where the fossils of the gault are rare, the upper and more sandy portion only of this stratum may exist. At Cheriton Tile-works near Folkstone, the workmen expressly state that it is the lower part only of their pits which affords the shells.

(12.) Throughout the gault, but chiefly in the inferior portion, concretions of iron pyrites are found, generally approaching to a globular or cylindrical figure, and of a radiated crystalline structure within, or in long thin vermicular rods, which at first sight might be taken for vegetable stems. On the opposite coast of France, near Wissant, the pyrites is so abundant in the gault as to have given origin, some years since, to a manufactory of sulphate of iron*; but near Folkstone the quantity is comparatively inconsiderable.

both from the quantity in which they occur, and their constancy in the colouring matter of green-sand from different localities, are silica, alumina, oxide of iron, magnesia, and water. I should hence consider the green matter as a hydrated silicate of alumina, magnesia, and black oxide of iron, and as being, in all probability, the true green earth, or earthy chlorite of mineralogists. The analyses of chlorite hitherto published are so discordant as to prove, either that different compounds have been examined under the same name, or that the specimens under examination were very impure. The essential ingredients, however, appear to have been the same as in the subject of my analysis.

"Though the foregoing description applies more immediately to the colouring matter of the green-sand from the vicinity of Folkstone, I have obtained similar results on examining that from Hythe and several other places. Indeed, from the examination of many samples of green-sand collected by Dr. Fitton from various localities in England and France, I believe the colouring matter to be precisely the same in all."

* See *Annales des Mines*, 1819, p. 623.

(13.) Other nodules and irregular masses are also found throughout this stratum, which resemble coprolite in their chemical composition, though no traces of animal structure are apparent in them. These are often associated with pyrites, and traversed by veins of that substance, as in septaria. Internally they are in general of a dark brownish hue, and the fracture is even or splintery, like that of some varieties of chert. The form of these nodules is sometimes very like that of coprolites; but though portions of shells are sometimes found within them, I have not detected any fragments of bone or scales of fishes. The surface of some of the detached masses is eroded, as if by worms; to the action of which, therefore, they were probably exposed before they were enveloped in the clay. In other cases they are of a very irregular figure, surrounding or incorporated with fossil remains, especially of Ammonites, the interior of which is filled with matter of the same kind.

Concretions of this description occur not only in the gault of different places, but are also numerous in the bottom of the lower green-sand at Atherfield in the Isle of Wight; and a mass found by Mr. Lyell in the crag at Southwold in Suffolk, which is mentioned by Dr. Buckland*, appears to have been of similar character. The concretions of the gault in Kent evidently agree with those of Havre and Wissant, analysed by M. Berthier, and found to contain about 57 per cent. of phosphate of lime, with a considerable portion also of carbonate of lime†. It can hardly be doubted that they are derived from the remains of animals, though no traces of bony texture are now perceptible; and it is not improbable that they may have been the contents of the intestines of marine animals, which fed upon each other, though not in all cases moulded into the form of coprolite.

The abundance of phosphate of lime, especially in submarine strata, will not appear surprising, when it is recollected that not only the bones, spiculæ and scales of fishes afford that substance in large quantities, but also the covering of the Echinodermata, and of crustaceous animals, in a smaller proportion ‡.

* Geological Transactions, Second Series, vol. iii. p. 234, note.

† Dr. Prout, soon after his examination of the Coprolites, of which Dr. Buckland has given an account in the Geological Transactions (Second Series, vol. iii. p. 237 &c.), was good enough to examine some of the concretions from the gault of Kent and the Vale of Wardour, and from Atherfield, and found them all to contain phosphate of lime, united with carbonate of lime and oxide of iron, in different proportions, the dark-coloured varieties containing the largest proportions of the phosphate. They all, likewise, yielded, more or less, the peculiar smell given out by coprolites when dissolved in muriatic acid. Dr. Turner has since examined other specimens, from the gault beneath Blanc-nez, and at Lottinghen on the east of the Lower Boulonnois, and finds them to indicate a similar chemical composition.

‡ Hatchett "On Shell and Bone, &c."; Philosophical Transactions 1799, p. 323, and 1800, p. 373.

(14.) The following is a list of the fossils of the gault in this neighbourhood, in my own collection, and in those of Mr. Hills, of Court-at-street near Lympne, of Mr. Sowerby, and some other of my friends. I take the present opportunity of expressing my obligation, especially to the Rev. Gerard E. Smith and Mr. Hills, for their kindness in supplying me with all the new species of their collections, many of which are figured in the plates annexed to this paper. Lord Greenock also has been so good as to allow me to have drawings taken from some specimens collected by himself.

List of Fossils from the Gault, *in the vicinity of* Folkstone, *Kent**.

Ammonites auritus. Fleur de Luce pits near Folkstone. F.
A. Benettiæ. Leacon Hill, about two miles S.W. of Charing, Kent. S.
A. Beudantii. (Brongniart; Env. de Paris, tab. vii. fig. 2.) Cheriton. F.
A. ? circularis. Pl. XI. f. 20. Burham near Maidstone. So.
A. crenatus. Pl. XI. f. 22. Tile-works at Cheriton. F.
A. dentatus. (Syn. *A. serratus*, Parkinson.) Leacon Hill. S. Fleur de Luce. F.
A. inflatus. Folkstone. F.
A. lautus. Leacon Hill. S. Folkstone. Min. Conch.
A. minutus. Folkstone. Min. Conch.
A. proboscideus. Folkstone. Min. Conch.
A. Selliguinus. (Brongniart; Env. de Paris, tab. vii. f. 1.) (Syn. *A. lævigatus* ? Min. Conch.) Cheriton, near Folkstone. F.
A. splendens. (Syn. *A. planus* ? Mantell.) Leacon Hill. S. Tile-works, Cheriton. F.
A. subcristatus. (Brongniart; Env. de Paris, tab. vii. f. 10.) Fleur de Luce near Folkstone. F.
A. symmetricus. Pl. XI. f. 21 and 23. Clay-pits near the Fleur de Luce, Folkstone. F.
A. tuberculatus. Leacon Hill. S. Fleur de Luce pits, near Folkstone. F.
A. varicosus†. Folkstone. M. C.

* In this and the subsequent lists of fossils, the names are disposed in alphabetical order, for facility of reference. The new species are in Roman type, the rest in Italics. A systematic list of all the genera and species of the several lists will be given at the close of these pages.

In the statement of localities, the capital letters after the names of places denote the persons to whose authority the occurrence of the several species is referred; H. signifying Mr. Hills, of Court-at-street near Lympne; S., the Rev. G. E. Smith, A.M.; So., Mr. Sowerby; G., Henry H. Goodhall, Esq.; F., the Author of this paper. The letters M. C., or Min. Conch., denote the Mineral Conchology of Messrs. Sowerby; Geol. Soc., the Museum of the Geological Society.

† Mr. Parkinson has mentioned other species of Ammonites; *A. ornatus*, from Folkstone and Cambridge, *A. pansus*, from Folkstone and West Malling, Kent (Geol. Trans., First Series, vol. v. pp. 57 and 58). The *A. serratus* of Parkinson is *A. dentatus* of Sowerby.

Auricula inflata. Pl. XI. f. 11. Copt Point? S.

Belemnites attenuatus. Leacon Hill. S. Near Folkstone. F.

B. minimus. (Syn. *B. Listeri.*) Folkstone. F.

Cardium? decussatum. Copt Point. S.

C. (species doubtful). Indistinct specimens, apparently different from *C. decussatum.*

Caryophyllæa. Folkstone. F.

Corbula striatula. Folkstone. Min. Conch.

Corystes? Mantell, Sussex. Pl. 29. fig. 13. Near Folkstone. S.

Cytheræa parva. (Syn. *Venus parva*; M. C.) Eastware Bay and Leacon Hill. S.

Dentalium ellipticum. Copt Point. S.

Exogyra conica. Near Hythe. H.

Gastrochæna (species doubtful). Found in perforations of dicotyledonous wood. East of Folkstone. S. and F.

Hamites aculeatus. Pl. XII. f. 4. Copt Point. H. and S.

The Rev. G. E. Smith's observations on the new points in the structure of this genus will be found hereafter, with Mr. Sowerby's description of the species figured in the Plates annexed to this paper. The figures in Pl. XII. are from drawings by Mr. Smith.

H. armatus. Near Folkstone. F.

H. attenuatus. Pl. XII. f. 3. Copt Point.

H. compressus. Fleur de Luce near Folkstone. F.

H. gibbosus. Fleur de Luce near Folkstone. F.

H. elegans. (Parkinson, Geol. Trans. v. p. 58.) Folkstone. S.

H. intermedius. Leacon Hill, and Fleur de Luce pits. F.

H. maximus. Leacon Hill. S. Fleur de Luce. F.

H nodosus. Near Hythe. H.

H. rotundus. Pl. XII. f. 1 & 2. Copt Point. S.

H. tenuis. Near Folkstone. F.

Inoceramus concentricus. Beautiful specimens of *I. concentricus* and *sulcatus*, with various Ammonites, retaining the pearly lustre of the shell, are found in great numbers about the middle of the cliff at Copt Point. F. Folkstone; W. Malling, Kent; and Cambridge: (Parkinson, Geol. Trans. v. p. 57, 58.) Also at Leacon Hill. S.

I. Cripsii? Mantell, Geol. Sussex, Pl. 27. f. 11. Near Sandgate.

I. sulcatus. Folkstone; W. Malling, Kent; and Cambridge: Parkinson.

Modiola bella. Pl. XI. f. 9. Near Hythe. (Lower Green-sand?) H. and F.

Murex calcar. Folkstone? F.

Natica canaliculata. (Syn. *Ampullaria canaliculata*, Mantell.) Pl. XI. f. 12. Near Folkstone. S. and F. The specimen *a*, *b* is filled with brownish (coprolitic?) phosphate of lime.

Nucula bivirgata. Pl. XI. f. 8. Eastware Bay. H. and G. Leacon Hill. S.

N. ovata. Mant., Geol. Sussex, Pl. 19. f. 26. 27. Folkstone. Mantell.

N. pectinata. Copt Point and Leacon Hill. S. Fleur de Luce pits and Cheriton. F. W. Malling, Kent; and Cambridge: (Parkinson, Geol. Trans. v. p. 59.)

Nucula? undulata. Copt Point? S.

Ostrea macroptera? Fleur de Luce near Folkstone. M. C. and F.

Panopæa plicata. (*Mya plicata*, Min. Conch.) Near Folkstone. M. C.

Pentacrinus. Pl. XI. f. 4. Copt Point. H.

Plagiostoma elongatum. Folkstone. Specimens have been found 1¼ in. wide, ¾ in. deep, and ½ in. thick. G.

Pleurotomaria Gibsii. (*Trochus Gibsii* of Min. Conch.) Copt Point and Leacon Hill. S.

Plicatula pectinoides. East of Folkstone. S.?

Pollicipes lævis. Pl. XI. f. 5. Copt Point, Folkstone. H.; with the following species:—

P. rigidus. Pl. XI. f. 6*. Copt Point. H.

P. unguis. Pl. XI. f. 5*. Copt Point. H.

Pyrula?† Smithii. Pl. XI. f. 15. Copt Point. S.

Rostellaria buccinoides. Pl. XI. f. 17. Eastware Bay. G.

R. calcarata. Near Folkstone. S.

R. carinata. Pl. XI. f. 19. Eastware Bay. S.

R. elongata. Pl. XI. f. 16. Copt Point, Folkstone. H.

R. marginata. Pl. XI. f. 18. Copt Point. H.

R. Parkinsonii. Copt Point and Leacon Hill. S.

Serpula antiquata. Near Beachborough, Folkstone. M. C. (Upper Green-sand?)

S. articulata. Folkstone. M. C.

S. rustica. Eastware Bay. M. C. (Upper Green-sand?)

Solarium conoideum. (Min. Conch.) Pl. XI. f. 14. Near Folkstone. S. and F.

S. ornatum. Pl. XI. f. 13. Fleur de Luce near Folkstone. S. and F.

Spatangus argillaceus. (Phillips, Geol. of Yorkshire, Pl. II. f. 4.) East of Folkstone.

Teredo? In fossil Dicotyledonous wood, Leacon Hill. S. Folkstone, and Cambridge: (Parkinson, Geol. Trans. v. p. 58.)

Terebratula biplicata. Folkstone (in gault?). S.

T. sella. Near Folkstone (in gault?). S.

T. sulcata. Folkstone, and Cambridge: (Parkinson, Geol. Trans. v. p. 59.)

Tornatella? affinis. Plate XVIII. fig. 9. Eastware Bay. S.

Trochus Gibsii? See *Pleurotomaria Gibsii.*

Turbinolia Kœnigii. Leacon Hill. Very abundant. S.

Turritella (species doubtful). Folkstone. S.

Venericardia tenuicosta. Pl. XI. f. 7*. Eastware Bay. H.

Venus parva. See *Cytheræa.*

V.? tenera. Pl. XI. f. 7. Copt Point near Folkstone. H.

† In naming this genus, and some others mentioned in this paper, respecting which doubts may be entertained, Mr. Sowerby appears to have been influenced by a desire to produce all the information which the specimens could afford, conceiving that even if the names be erroneous, the figures may still have some value as objects of future comparison.

Wood, dicotyledonous. East of Folkstone. Perforated by Gastrochæna; near Folkstone. S. Sometimes surrounded with pyrites. Mr. Parkinson states that "fossil "wood occurs plentifully in the marl (gault) of Folkstone; lying chiefly at the "bottom of the stratum, on the green-sand." Geol. Trans. v. p. 59.

(15.) *Lower Green-sand.*—The uniform surface of this stratum, extensively shooting out beyond the chalk, forms a conspicuous feature of the country, which is well seen from the ascent of Folkstone Hill on the road to Dover*. The analogy in this respect to the appearance of the sands at the Blackdown Hills in Devonshire, is obvious and striking. The Bagshot sands, above the chalk in Surrey, also exhibit long and uniform platforms, the section of which presents a linear and almost horizontal top, with a rapid escarpment at both extremities.

(16.) One of the principal circumstances in the internal structure of the Lower Green-sand at Folkstone, is the distinctness with which it is divided into three groups; and this subdivision probably occurs wherever the formation is fully developed in the South-east of England. It is clearly seen in Surrey; I have evidence from Mr. Martin of its existence in the West of Sussex; Mr. Lonsdale believes it to hold also near Devizes in Wiltshire; and though I did not become acquainted with it till after I had examined the Isle of Wight, I have little doubt that it will be found there also.

a. The first of these subdivisions may be characterized as consisting principally of sand, white, yellowish, or ferruginous, with concretions of limestone and of chert, frequently in false stratification. It forms commonly a flat, but sometimes an irregular hilly surface, rising from the valley of the gault, and bearing a dry, barren soil.

b. The second member abounds in green matter, is retentive of moisture, and contains comparatively little stone: it occupies a flat and marshy tract, between the first and third divisions.

c. The third and lowest member contains a greater proportion of calcareous matter, and includes some of the principal beds of stone bearing the name of "Kentish Rag"; which commonly form a prominent ridge at its outcrop, adjoining the valley of the Weald†.

* From Folkstone Hill the ridge of Fairlight Down, near Hastings, is a very striking object: its range is evidently parallel to that of the chalk outcrop, as might be expected in the axis of elevation of the tract by which it is surrounded.

† In Mr. William Smith's Geological Map of Kent, two ranges are indicated, by darker colours, in the tract between the coast and Maidstone; one running parallel to the chalk, from Sandgate through Ashford and Bursted to Penenden-Heath, on the N.E. of Maidstone; the lower, less regularly, from Hythe along the verge of the Weald Clay. These lines, I have no doubt, indicate a subdivision like that mentioned in the text: but in the explanatory table of the map, the stone of the tract thus coloured is said to be the Portland-rock.

The situation and relative space occupied by these subdivisions near Folkstone, are shown in the small Map, Plate VII. fig. 1., and in the View, Plate VIII.

(17.) *a.* The uppermost subdivision is about seventy feet thick. It rises upon the shore on the west of Eastware Bay; and some of the firm siliceous beds which it includes near the top, coming up from the sea a little to the east of Copt Point, are continued in the cliff thence to the west of Sandgate; between which place and Folkstone distinct sections are disclosed. The greater part of the country from Folkstone, through Cheriton, to Newington is occupied by this bed, and the heights of Dibgate and Sine Farm, where it finally disappears, are capped with it.

(18.) Where the sand emerges from beneath the Gault, it is often loose, and of a white or buff colour; but at the immediate junction there occurs, in many places, a course, from six inches to a foot in thickness, of concretions of pyrites, often investing fragments of silicified coniferous wood, of a dark brown colour. The composition of this bed resembles, in several respects, that of the Blackdown sands in Devonshire, the stone which it includes consisting principally of siliceous spongy concretions, like the whetstone of that place. The most instructive specimens are to be found in the loose decomposed masses on the shore. In the vertical faces of the cliffs, the surface exposed by fracture and falling away is at first clean and uniform, no traces of the stratification appearing; but after a time the sand crumbles from the surface, while the stony portions remaining fixed, become prominent.

The whole of these cliffs consists, in fact, of sand and conglomerates more or less firm, produced by the agglutination of the loose materials which formed the original submarine deposit. The strata vary in texture and composition, from the state of sand to that of very hard limestone or chert, of various shades of grey and brown; the latter passing into chalcedony, with which the cavities are sometimes coated*. The transition from the sand into compact stone is sometimes very rapid; in other specimens the gradations are almost insensible.

(19.) The principal components of these conglomerates are the following:

1. Quartz, in rounded fragments, from the bulk of a large pea to the minutest visible size, of several shades of grey and white, varying from transparent to nearly opake, and in some instances passing into chalcedony.

2. Small, worn fragments of quartzose jasper, red, or greenish; with flat surfaces, in some cases, indicating stratification.

* It is remarkable, that notwithstanding the abundance of siliceous matter in the concretions near Folkstone, few or none of the petrifactions are formed of it; while at Blackdown in Devonshire most of the shells in this formation are casts in chalcedony.

3. Fragments, frequently much larger than those above mentioned, of very compact, dark brown, black, or grey flinty slate. Sometimes the appearance of these fragments is internally that of hornstone, approaching to jasper.

4. Fragments, often angular, or slightly rounded, of schistose granular quartz, or sandstone, interspersed with very minute particles of mica; not effervescent; its colours varying from smoke grey to greenish.

5. Near Ashford, in the ferruginous sand at the top of the formation, fragments are found of brown hematitic iron ore; but much less abundantly than in the corresponding part of the section at Redcliff, near Sandown, in the Isle of Wight, and at other places.

6. Near the top of the sands, in the blocks of decomposed stone, upon the shore, lumps are found, from the size of a walnut downwards, of a dark brown substance, externally spongy, and of irregular surface, and within having the fracture and appearance of the phosphate of lime described in Section (13)*. In these brown masses are also some grains of quartz, and small portions of shell. This occurrence of phosphate of lime, both in the gault and at the upper part of the lower green-sand, is an additional proof of the continuity of their deposition.

(20.) The stone of the more uniform beds ("Kentish-rag,") has great variety of characters, from those of a granular or sparry compound to compact limestone, some specimens of which might be taken for that of older formations. In many cases, the calcareous cement is so crystalline, that light is reflected continuously from extensive surfaces, although the face of the fracture is thickly set with small pebbles of quartz; in other cases the stone is a dense conglomerate, composed of quartz grains with a small proportion only of the cement. All the varieties contain disseminated grains of the green matter above described in section (10); which is frequently so abundant as to give its colour to the stone. In many of the rolled fragments on the shore near Folkstone, this constitutes more than half the compound, the remainder being decomposed carbonate of lime, inclosing grains of quartz and flinty slate. In the more advanced state of decomposition, the mass has the appearance of mortar; and, in most cases, the stone effervesces copiously with acids, the green particles remaining undissolved.

The chert of this upper stratum is frequently of a dark grey colour, and

* The specimens here referred to were sent me from the shore immediately on the west of Folkstone, by my friend the Rev. J. D. Glennie; but there can be no doubt of their having fallen from the adjacent cliffs. Among the darker masses mentioned in the text were portions of the claws of an Astacus. On the shore hereabouts plicated Terebratulæ were found in nodules of arsenical pyrites.

very like chalk flint. In some specimens, this dark variety adjoins, with scarcely any gradation, a light grey, or white siliceous agglomerate, in which the original sandy structure is still discernible; while in the adjacent darker chert the fracture is flat-conchoidal and splintery, with the glimmering lustre of hornstone, all trace of the grains having disappeared;—as if a sand of wax had been consolidated by gentle softening, in a heat not sufficient for its liquefaction. In its passage to chalcedony, the siliceous matter often assumes a white colour, the aspect being nearly that of porcelain, and it becomes translucent when moistened.

(21.) A section of the upper part of this member (*a*) of the lower green-sand, in the cliff about midway between Folkstone and Copt Point, was as follows:

Top of the Lower Green-sand.

	Feet.	Inches.
Bluish grey clay (*Gault*), a few feet in thickness, at the top of the cliff: then—		
1. At the junction of the clay and sand is a bed consisting of pyrites in lumps, more or less decomposed; about	1	0
2. Grey quartzose sand, with numerous green particles	4	0
3. Sand, in which lines of false stratification are conspicuous	1	6
4. Similar, but coarser sand	2	6
5. Sand, yellowish, slightly concreted, irregular in thickness; much more solid in the eastern part of the cliff; about	3	0
6. Sand	2	0
7. Irregular siliceous concretions	0	9
8. Sand, nearly as above, with a few dispersed concretions	3	0
9. Irregular concretions, like No. 7	1	6
10. Sand, with a few scattered concretions	3	0
11. Irregular concretions, in sand; more dispersed	2	0
12. Sand, as above	4	0
13. Concretions	0	3 to 6
14. Sand; as above, but finer; about	5	0
15. About four courses of concretions, with sand between	3	6
16. Sand;—to the foot of the cliff	4	0
Total; about	38	0*

The concretions of Numbers 5, 7, 9, 11, 13, 15, consist of siliceous spongy stone, like the whetstone of Devonshire, varying from a loose friable mass, to the consistency of chert. In many instances the surface has the form of cylindrical stems.

* The height of the cliff at this place is really not more than thirty feet; but the *proportions* are nearly as above given.

(22.) In another section of this part of the stratum, at one of the quarries about midway between Risborough and the east of Sandgate*, the detail was thus:

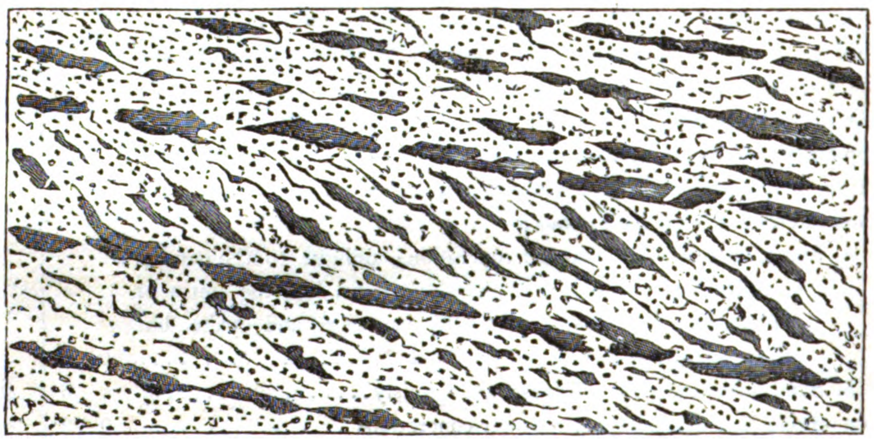
Surface of the hill.	Feet.	Inch.	Feet.	Inch.
1. A group, consisting of alternate courses of sand and irregular siliceous concretions:—			about 3	0
a. Sand, with a few interspersed concretions	0	3		
b. Stone, in irregular spongiform concretions, including fragments of Oysters or Gryphites, and passing into grey, compact chert, which in some instances graduates into chalcedony;—retaining, however, traces of the original sandy structure. The concretions include also minute fragments of calcareous matter, so that the surface effervesces in detached points; about	0	2		
c. Sand; loose, somewhat coarse, consisting principally of grains of quartz	0	6		
d. Stone; in loose spongy concretions, white, opake, and in some places more compact within, like chalcedony; not effervescent.	0	4		
e. Sand; coarse, dark brown, not effervescent; a great part consisting of grains of translucent quartz	0	6		
f. Stone; in roundish, flattened concretions. A conglomerate of granules of quartz, with some portions of flinty slate, and dark green specks, cemented by sparry carbonate of lime: from 2 inches to	0	8		
g. Sand; dark greenish grey, not effervescent, including casts of Ammonites in pyrites	0	4		
h. Stone	0	2		
i. Sand; dark greenish grey, gritty, not effervescent	0	4		
2. A bed of siliceous and porous concretions, nearly continuous; very like the whetstone of Blackdown; not effervescent			0	2 to 4
3. Beds of sand, partially concreted, somewhat coarse, soft, effervescing copiously, and including concretions of cherty stone. The false stratification of this part of the cliff is very conspicuous			3	0
4. Stone, alternating with sand: thus:—			about 4	0
a. Stone, in somewhat compact concretions, oblique to the general stratification, including cylindrical portions, like the stems of Siphonaria; the greater part siliceous, white and opake, but effervescing in detached spots; about	0	9		
b. Sand, greenish grey, effervescing copiously..................	0	6		
c. Stone, in loose, spongy, irregular concretions	0	9		
d. Sand, loose, greenish grey, effervescent	0	6		
e. Stone, in spongiform concretions, like 1. *b.* above, passing into chert	0	4		
f. Sand, like *d.*	0	9		
g. Stone, in spongy concretions; as at Blackdown	0	4		

* See the Map, Pl. VII. fig. 1.

5. Sand, with concretions; greenish grey, uniform, not effervescent. At the bottom of this bed is a course of concreted sand passing into stone, with seams oblique to the general stratification. The stone is in some places opake and white, like chalcedony, including however minute dark green particles: the looser pieces are spongy, like the Blackdown whetstone..	about 3	0
6. Sand and stone: thus:—		
a. Sand, resembling that of No. 5, but of darker colour		
b. Stone. A dark grey, compact, fine-grained, conglomerate of calcareous spar and grains of quartz, in some places traversed by thin veins of spar	about 3	0
c. Sand, resembling *a*, uniform, not effervescing................		
d. Stone; a compact conglomerate, including small portions of dark flinty slate..		
Total .... about	16	0

In another quarry, immediately beneath this one, the composition was apparently the same; but the beds of chert were more numerous.

(22.) The false stratification above alluded to, or the subdivision of the beds by lines oblique to the general course of the stratification, is a prominent circumstance in the upper part of the lower green-sand in this neighbourhood. It is observable in several places on the road from Hythe to London; and was very well exhibited in the sides of the road through the hill between Sandgate and Folkstone, where the sketch subjoined was taken.



In the beds, of which a portion is here represented, not only the lines of division, but the concretions within the strata exhibit the oblique arrangement; and in some instances, the larger cherty masses, the general direction of which is that of the prevailing stratification, send out offsets in the direction of the false strata, as expressed in the sketch. There is no appearance of variation in the circumstances under which the different strata were deposited, although some of those traversed by the lines above described alternate with others, in which no traces of them, or scarcely any, are to be seen.

(23.) The concretional masses described in the preceding sections give rise to some questions of great interest in geology. There can be no doubt that all these strata were originally deposited in the state of sand and gravel; but in the quarries of East Kent all stages of gradation can be perceived, from distinctly separated concretions of stone*, to others so nearly uninterrupted, that the next step into perfect continuity can be easily conceived. The sands below the Portland-stone the coral-rag and the inferior oolite, afford examples of the same character: and in all these cases the concretions must have been formed after the deposition of the sand which includes them, and probably beneath a great depth of compacted materials. In such a mass, shut off from the free access of air and change of temperature, there is no obvious reason for disturbance of the affinities which maintained the original form of the components, except the decomposition of the animal and vegetable remains diffused among the stony substances; yet here we have not only solid limestone, where nothing but loose sand and gravel were before, but firm siliceous concretions, pervading, and so identified with, the separated particles of the quartzose sand, that the whole is nearly homogeneous. If the decomposition of the organized substances, continually acting throughout very long periods of time, be not sufficient to produce the whole of these effects, perhaps it may be supposed that electricity is the cause which sets free the elements, and disposes them to combine anew†.

(24.) The second, or middle subdivision (*b.*) of the lower green-sand, first

* Concretions nearly globular occur, in the uppermost yellowish sands, at Parkhouse, near Folkstone.

† In preparing nitric acid in a chemical laboratory where I was attending some years ago, the glass retort broke towards the close of the operation, and a quantity of the concentrated solution of bisulphate of potash oozed out through a very fine crack into the surrounding sand. On removing the retort some time afterwards, a large part of the sand was found to be agglomerated into beautiful concretional masses, like bunches of grapes, the greater portion of which, of course, was sand, and the cementing substance the crystallized salt. The masses of gravel frequently found cemented by carbonate of lime, or of iron, in consequence of the escape of the carbonic acid which had held those substances in solution, is an example of another mode of concretion. In the first of these two cases the loss of heat, in the latter the escape of a chemical solvent, has obviously been the cause of the consolidation. But the case mentioned in the text is distinct from both.

Dr. Turner justly remarks, respecting substances usually considered as insoluble, that "although "the weight of such bodies is not perceptibly diminished by trials conducted in the laboratory, "during a short interval of time, and with small quantities of water, the effect of the same operaappears upon the shore on the west of Folkstone, at a point immediately beneath the church*, which is well marked by the breaking out of a spring. It is there conformable to the strata described in the preceding sections, and the whole of it has risen to some feet above the sea, on the east of Sandgate, where rocks of the subjacent group (*c.*) make their appearance on the shore. This second stratum forms the middle of the cliff above and behind the village of Sandgate, but thins off and disappears in the heights on the west of Nail-Down, where some outlying portions of the superior sand (*a.*) cap the summit of the hills. Its thickness appears to be from 70 to 100 feet: it abounds in green matter, and in some places in pyrites; from the presence of which substances (though in what manner is not obvious), or perhaps of some portions of clay, it acquires a retentive property; so that the soil over it is marshy, and ponds are frequent upon its surface. The tracts, therefore, which it occupies, have in some cases in the interior been erroneously supposed to belong to one of the beds of clay subjacent to the green-sand.

(25.) The boundaries of this middle bed, where it is disclosed by the streams having cut through the incumbent sands, are sufficiently indicated on the map. In following up the streams towards Inbrook and Frogwell, the contrast of the two strata is very conspicuous, the junction of this retentive middle group with the sands above being indicated by the breaking out of springs†; and a line drawn through the heads of the streamlets thus arising would be throughout at distances from the outcrop of the chalk nearly proportioned to the inclination of the strata.

(26.) The presence of this stratum occasions frequent falls of the incumbent sand beds, and has given origin to an under-cliff covered with vegetation, which extends from Folkstone to Sandgate. The sections therefore are obscured; but enough is visible to prove that it contains no prominent beds of stone, and that concretions are comparatively rare in it. Near its junction with the stony strata beneath, the consolidated sand affords several characteristic fossils; and about the middle of the heights over Sandgate‡, a line of ferruginous nodules has been found, inclosing fossils, like those of

"tion, as performed on the great scale in the mineral kingdom, during hundreds and thousands of "years, and with unlimited quantities of the menstruum, might be, and doubtless was, very different."—'Report of a Lecture on the Chemistry of Geology'; Lond. and Ed. Philosophical Magazine, 1833, vol. iii. p. 24.

* See the View, Plate VIII.

† It is not impossible that the site here mentioned may correspond to that of the Sandrock spring, in the Isle of Wight. A ferruginous spring, I was informed, does exist in the vicinity of Sandgate.

‡ In the grounds of Encombe, the seat of Mr. Dawkins. The place is indicated in Plate VIII.

Shanklin Chine in the Isle of Wight, and of Parham Park in Western Sussex.

(27.) The following sections, at a prominent point of the cliff, between Sandgate and Folkstone, include a portion of the first or upper member of the lower green-sand (*a.*), with the upper part of the middle stratum (*b.*).

Section of the Cliff between Folkstone and Sandgate.

(*a.*)

	Feet.	In.	Feet.	In.
1. Sand, with numerous courses of concretional stone, and traces of false stratification			about 10	0
2. A prominent group of sand and concretional stone;				
a. Stone. Firm, uniform, fine-grained, sparry, conglomerate, with minute, dark green particles. Some of the blocks on the shore, apparently fallen from this bed, consist of close-grained splintery limestone, somewhat sparry, including minute dark grains, disseminated in small proportion. They afford excellent specimens of the 'Kentish 'rag'.	about 2	0	6 to 8	0 to 0
b. Sand, including concretions of chert; about	2	0		
c. Stone. Loosely concreted conglomerate, including shells, effervescing copiously; when decomposed looks like mortar	about 2	0		
3. Several courses of sand and concretional stone;				
a. Sand.		?	altogether about 8	0
b. Thin course of concretional cherty stone, nearly continuous. The chert passes into chalcedony, and the spongy portions include shells	0 to 0	4 to 6		
c. Sand, with spongy concretional stone, approaching to that of Blackdown, but looser		?		
d. Sand.		?		
e. A bed of siliceous masses, like the stems of Siphoniæ; about .	0	6		
f. Sand.		?		
g. Greenish grey concretional stone, in irregular masses........		?		
		about	25 feet.	

(*b.*)

	Feet.	In.	Feet.	In.
4. Greenish grey and yellow sand, including various concretions;				
a. Sand.. about 5 or	6	0	between 40 and 50	0 / 0
b. Very large concretional nodules, consisting of greenish sand, slightly consolidated		?		
c. Sand, without prominent beds of stone; about..............	40	0		
Total	from 70 to 80 feet.			

Beneath is the plateau of the under-cliff, supporting ponds, and producing rushes; probably thirty-five to forty feet in thickness, down to the sea:—of part of which the section is as follows:—

(*b*.)

	Feet.	In.
1. Yellow sand; face nearly vertical, from a recent fall	4 to 6	0 0
2. Dark smoke-grey, crumbling, sandy clay, or cohesive sand, greenish at the bottom	about 8	0
3. A band of firmer green-sand, splitting horizontally into very thin layers, from the interposition of lighter-coloured sand, which seems to occupy the place of thin cylindrical stems or twigs. In this bed the hammer leaves a mark of a vivid green colour, but the general hue is dark greenish grey. It consists of very minute particles of quartz, intimately mixed with a large proportion of the silicate of iron, soft, and of a full green colour; not effervescent, except in minute spots. The gradations from this compound through all shades of colour and consistence, to brown, and even yellow, sand, are imperceptible	about 0	9
4. Dark greenish grey sand, apparently continuous with, and passing into, the tenacious matter of the lower beach	about 6	0
Total, about	20 feet.	

The bottom of this group is concealed by the loose gravel of the beach.

(28.) A striking characteristic of the middle group (*b*.) is the great diversity of hue and consistency which it assumes under different circumstances. The colour when dry is frequently a rusty yellow;—but in other states, connected perhaps with the different degrees of oxidation of the iron, or with the decomposition of the pyrites, which it frequently contains, it is of a dark greenish hue, and passes rapidly from the consistency of loose dry sand to a tough cohesive mass. In these respects it resembles the middle portion of the cliffs in the Isle of Wight.

Near the bottom, immediately above the stone of the group (*c*.), this middle stratum consists of a dull greenish, sandy, and mud-like substance, apparently a mixture of clay with the green particles, which becomes plastic, and almost black in water. In these dark sands, near Seabrook, are decomposed fragments of petrified coniferous wood*.

(29.) The third group (*c*.) of the Lower green-sand first rises on the shore

* The Rev. G. E. Smith informs me, from Sir John Tylden, that the high tides in the spring of 1833 having laid bare the strata, the latter had an opportunity of observing the lowest bed, of what he not unaptly calls the 'Blue Division,' on the shore between Shorn Cliff and the village of Sandgate. "It is," he says, "very marly, and includes a great quantity of wood and pyrites, "and in places resembles the gault of Eastware Bay." The "very marly" beds may probably be the equivalent of the Fuller's earth of Surrey, &c., which has not, that I know of, been distinctly seen in this part of Kent.

beneath low-water mark, about midway between Folkstone and Sandgate: and the projection of the land to the south, immediately on the west of Folkstone, and thence to Sandgate, appears to have been produced by the firmness of the barrier which this solid base of the cliff opposes to the sea. It becomes visible again above high-water mark, about a furlong west of Sandgate, is seen in detached places along the shore under that village, and rising above the beach at Shorn Cliff, beneath which place the Weald clay makes its appearance, can be traced readily in the heights to the westward, being opened in several places for stone.

(30.) From Hythe this group of strata forms the escarpment of the cliff, as far as Aldington Corner, where it turns inland, towards the north-west; and thence, along the valley of the Weald clay, a similar barrier of stone forms the boundary of the green-sand formation. The line of coast, from Copt Point to near Aldington, not being exactly parallel either to the *strike**, or to the dip, but oblique, the inclination of the stone beds appears in the coast section to be less than the truth; and where, as at Lympne, between Hythe and Aldington, the escarpment becomes parallel to the strike, the strata appear to be horizontal.

In the progress of this lower ridge to the north-west, from near Aldington Corner to a hill above Singleton Green on the south of Great Chart, there is a remarkable interruption of the escarpment, where the line of heights retreats towards the north; so that the streams which take the opposite directions,—westward to supply the Medway, and northward to join the branches of the Stour which pass through Ashford, are there nearly united†. An obvious explanation of this effect might be, that the concretions of stone were wanting in this portion of the strata, so that the sands thus unsupported were more easily carried away.

(31.) The relations of this lowest bed to the remaining groups are very well displayed in the ground between Seabrook and Saltwood, especially in the road leading from Dibgate to Sine Farm, and thence to Hythe. On the

* I adopt this term, suggested by Professor Sedgwick, to express the course of the intersection of strata with the plane of the horizon, in preference to *direction*, commonly employed;—the latter term being ambiguous in its application.

† In Packe's "Map of East Kent" above referred to, this is called "a Grand Inosculation," and is thus described: "From this quarry of rag, east of Chart Magna, to the other quarry of the "same, west of Aldington, the Weald of Kent and the Ashford Vale meet, and are upon very "gentle ascents towards each other, inosculated by the extremities of the valleys insensibly into "one another, the stone hills receding to Ashford, Wilsborough, Sevington and Mersham, the soil "of both being the same deep clay; and these stone hills are the true philosophical boundaries of "both these regions."

west of Sine Farm the upper stratum is no longer found, the middle and sloping portion of those hills consisting of the greener beds (*b.*), with a cap of the upper sands (*a.*) on the top. An outlier of the middle stratum resting upon the lowest (*c.*), forms the summit of the ground between Saltwood Castle and Hythe.

Springs break out both from the top of the Weald clay below this group of stone, and from the cohesive sandy clay above it; a considerable thickness of the latter being interposed between these stone beds and the sands which cap Sine Farm and Nail-Down Hills.

(32.) Though in a general view the rise of this and the other members of the lower green-sand accords with that of the chalk, the dip being at a small angle to the east of north, the beds of stone which are uncovered at low tides, upon the shore under Sandgate, dip at an angle of not less than 40° towards the north-west. This place, therefore, would appear to have been the site of some disturbance*.

At the west end of the cliff also, between Sandgate and Folkstone, the beds at the bottom of this lowest group dip inland, or towards the north, at an angle of about 40° or 45°, and the *strike* is from about 5° to 8° north of west, to the south of east, the vertical thickness being less than sixty feet.

Sir J. Tylden mentions, that in a quarry close to the brook at Underhill, the strata are so highly inclined as to be almost perpendicular; "curving," he says, "something like the flints in the chalk at the Isle of Wight, as if "they had been forced up." No traces of such disturbance met my observation on the coast; but this fact is deserving of notice, from the distinct proofs of elevation observable in a part of the series which corresponds to that here referred to, at Brasted, in West Kent, as will be mentioned hereafter. (38.)

(33.) The lower group seems, generally, to contain more calcareous matter than the upper divisions; and this in some specimens is splintery limestone, almost void of quartz, with but little of the green substance interspersed, in very minute grains. In such cases small portions might be taken even for mountain limestone. The concretions are commonly traversed by contemporaneous veins of calcareous spar, at right angles to the surface, and intersecting each other, one set being parallel to the *strike*, and the other nearly at right angles to it; they divide the mass, therefore, into pieces approaching

* It is not improbable that in this and other cases, where extensive subsidence has taken place, as at Eastware Bay and the back of the Isle of Wight, the occurrence was not confined to the period during which the sea has stood at its present level. If the level were ever higher than it is now, this would account for the ruins of the upper beds of the cliffs, which are frequently observable in the sea, beneath low-water mark.

to rhomboids; and sometimes, as in Septaria, they are thick in the middle of the beds, thinning off towards the top and bottom.

(34.) Some of the best sections of the group (c.) are to be found in the quarries about Seabrook*. In one of these the order was thus:—

	Feet.	In.
1. Very green-sand, alternating with courses formed principally of stem-like or vermicular branches of whiter sand, and including ferruginous patches. The petrifactions of this bed are very numerous. *Gryphæa sinuata* in great abundance.		
2. A group of stone beds; separated by yellowish calcareous sand and clay, called "Hassock" by the quarry-men. The upper portion especially abounds in petrifactions. The beds of stone are 18 inches to 2 feet in thickness: they are concretional, but nearly continuous.		
The total thickness visible is about	12	0

(35.) The lower beds are extensively worked in quarries, both for building and lime-burning, at Pluckley on the north-west, and at Great Chart on the south-west, of Ashford; and generally along the outcrop west of Aldington Corner, where the Weald-clay comes very near to the stony strata, a few feet only of sand rock being interposed. The line of junction is almost everywhere marked by the coming out of springs. The beds are nearly horizontal; and though the stone occurs in continuous masses, of sufficient size to answer well for building, these are evidently concretional. The interior of the blocks is frequently of a blueish colour, containing throughout minute dark grains: the exterior crust is brown.

(36.) The following is a list of the fossils which I have obtained or collected from the Lower Green-sand of this neighbourhood; in which, however, those of the three groups are not always distinguished: the statement of localities containing all that I find upon this point in my notes.

Fossils of the Lower Green-sand, *in the vicinity of Folkstone.*

Ammonites furcatus. Pl. XIV. f. 17. Lowest beds near Hythe. F.

A——— *Monile.* Between Sandgate and Folkstone. S. and Min. Conch.

A——— *Nutfieldiensis.* Hythe. Also Nutfield, Surrey. Min. Conch.

A———. Fragments of a very large new species occur in greenish "rag," at the bottom of the lowest beds of stone, in the quarries above Hythe. H.

Anomia lævigata. Pl. XIV. f. 6. In Kentish rag, near Sandgate. S. and So. Lympne. H.

* Those near Court-at-Street, which have furnished so many fossils to the collection of Mr. Hills, I have not examined.

Anomia radiata. Pl. XIV. f. 5. Near Sandgate. S.

Astacus. (Claws of a small species.) Near the contact of the gault and green-sand. F.

Astarte obovata. Near Hythe. H.

A——. Fragments, apparently of three different new species, but too indistinct to be determined, were found at Lympne. H.; and Sellinge. S.

Astrea. Folkstone. Geol. Soc.

Avicula pectinata. Pl. XIV. f. 3. In siliceous rag, near Risborough. F.

A——. A smooth species, probably new. Upper sand beds, between Sandgate and Folkstone: in concretional siliceous stone, passing into chert. F.

Belemnites. (Species doubtful.) Indistinct specimens in the quarries at Hythe. F.

Cardium? dissimile. A cast. Quarry near Ivy Cottage, Sandgate. Lowest beds of lower green-sands. F.

Corystes. (Species doubtful.) Lower green-sand, near Hythe. H. and S.

Cucullæa costellata? Near Seabrook. F.

C——— *decussata*. Quarry near Ivy Cottage, Sandgate. S. Also near Court-at-Street. H.

C——— *glabra*. Quarry near Ivy Cottage. F.

C———. New species; indistinct. Ivy Cottage. F. Near Seabrook. S.

Cidaris scutiger, (Goldfuss.) Court-at-Street. H.

Cyathophyllum, (Goldfuss.) Folkstone. Geol. Soc.

Cyprina angulata. (Syn. *Venus*. Min. Conch.) In soft greenish calcareous sand rock of the middle group; shore between Folkstone and Sandgate. F. Quarries above Hythe, and near Lympne. H.

Echinus. (Species uncertain.) Court-at-Street. H.

E——— arenosus. Pl. XIII. f. 1. Quarry near Hythe.

Exogyra lævigata. Court-at-Street. H.; and vicinity of Sandgate, near Seabrook; F. (Perhaps the full-grown state of *Chama conica*?) Mr. Sowerby.

Gastrochæna ———? Near Sandgate. S. Quarries above Hythe. H. In the shell of an Ostrea; in compact stone, full of dark green particles.

Galerites subuculus, (Goldfuss.) Near Hythe. S.

Gervillia aviculoides. (*Perna*. M. C.) Court-at-Street. H. Also in the lowest group of stone, near Sandgate and Seabrook, and in the quarries above Hythe. F.

G———. A new species? Court-at-Street. H.

Gryphæa sinuata. Near Court-at-Street. H.; and Sandgate. F.; also near Ashford. Min. Conch.

Hamites gigas*. Quarry, west of the Pesthouse, Sandgate. S. Also Lympne. H.

H—— *grandis?* From Lympne. H.

H—— Hillsii. Pl. XV. figs. 1. and 2. Quarries near Hythe. H. Court-at-Street, near Lympne. This species is named from Mr. Hills, whose collection has thrown great light on the fossils in his neighbourhood.

H—— *nodosus*. Near Hythe. H.

* The character and relations of the Hamites are still so obscure, that the species are here given with considerable doubt.

Isocardia similis. From Sandgate. F.

Lima semisulcata. Pl. XI. f. 10. (*Plagiostoma semisulcatum* of Nillson; *Petrif. Suecana.* Tab. IX. f. 3. p. 25.) In the Kentish rag, near Court-at-Street; small specimens. H. Vicinity of Hythe. Miss A. Smith.

Lingula ovalis. Lowest green-sand, near Sandgate. S.

L—— ? truncata. Pl. XIV. f. 15. Near Hythe. S.

Lucina ? Near Court-at-Street. H.

Lutraria? Lympne. H.

Madrepora, Goldfuss, (*Pocillopora*, Lamarck). Folkstone. Geol. Soc.

Modiola alæformis. Near Court-at-Street. H.

M—— *aspera* ? From Hythe. F.

M—— lineata. Pl. XIV. f. 2. Vicinity of Hythe. H. and F.

M—— *parallela.* Near Maidstone. Min. Conch.

M—— ? Casts. Near Lympne. H.

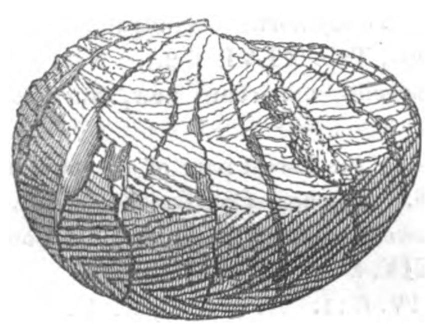
Mya plicata. (See *Panopæa.*)

Nautilus elegans. Near Hythe. H. and F.

N—— *inæqualis.* Folkstone. Min. Conch.

N—— *simplex.* Very much compressed. Probably from the lower part of the middle green beds, near Sandgate. F.

N—— plicatus. Near Lympne. H. Some specimens 8 inches high, and 8 in diameter. The zigzag markings on the outside are very characteristic.



N—— *undulatus.* Lympne. H.

Nucleolites carinatus. (Goldfuss, Tab. XLIII. f. 11.) Court-at-Street, H.

Nucula ovata. Near Lympne. H. and F.

Ostrea carinata ? Near Court-at-Street. H.

O—— *macroptera.* Folkstone. F.

O—— (Species doubtful.) A very thick shell. From the upper sand beds, near Sandgate. S.

O—— (Species doubtful.) Shell thin. In the upper beds. S.

Panopæa plicata. In the green middle beds, near Ivy Cottage, Sandgate. F. In a mass of deep-green colour, near Court-at-Street. H.

Panopæa ? rotundata. Pl. XIII. f. 2. Near Court-at-Street. H.

Pecten obliquus. Near Court-at-Street. H. In firm greenish rag: quarries above Hythe. H. and F.

Pecten orbicularis. Lowest group of stone beds; near Hythe. F.

P—— quinquecostatus. Upper sand, between Sandgate and Folkstone. S. Also in the lowest group, near Court-at-Street. H.

Pectunculus umbonatus. Middle green beds, Ivy Cottage, Sandgate. F.

Pentacrinus. Stems and branches. Between Sandgate and Folkstone, in calcareous sandstone. S. Also found in a quarry near Lympne. H.

Perna tetragona. Near Lympne. H.

Pholadomya. A fragment. Near Court-at-Street. H. Perhaps the same with specimens found near Pulborough by Mr. Martin.

Pholas?? giganteus. Pl. XIV. f. 1. Near Court-at-Street, Lympne. H. and G.

P—— priscus. Sandgate. Middle green beds, behind Lord Darnley's house. S.

Pinna? crassa. New species. The specimens are large, but indistinct. Court-at-Street. H. and S.

Plagiostoma elongatum. Lowest beds, near Court-at-Street. H.: and Folkstone. M. C.

Plicatula pectinoides. Near Court-at-Street. H.

Pollicipes radiatus. Pl. XI. f. 6. Near Lympne. H.

Rostellaria. (Species doubtful.) Near Court-at-Street. H.

Serpula antiquata. Near Folkstone. M. C.

S—— variabilis. Pl. XXI. f. 7. Near Court-at-Street, in hard green Kentish rag. H.

Siphonia. (Parkinson.) Stems. Upper beds of the lower green-sand; in spongy siliceous concretions. Valley north of Sandgate. S.

Spatangus retusus. (Goldfuss, Tab. XLVI. f. 2.). Near Sandgate. S. F.

S——. Three other species, apparently new, but indistinct. Near Court-at-Street. H.

Sphæra corrugata? Casts in the lowest part of the middle sand. Quarry near Ivy Cottage, Sandgate. S. Also near Court-at-Street. H.

Terebratula biplicata. Lowest group of the sands, near Court-at-Street. H.

T—— convexa. Pl. XIV. f. 12. Near Hythe. H.

T—— elegans. Pl. XIV. f. 11. Near Lympne. H.

T—— elongata. Near Court-at-Street. H.

T—— Faba. Pl. XIV. f. 10. Between Folkstone and Sandgate. S.

T—— Gibbsiana. Near Sandgate and Folkstone. S.

T—— latissima? Near Hythe, and Court-at-Street. H.

T—— oblonga. Near Hythe. F.

T—— ovalis. Middle stratum, between Sandgate and Folkstone; and near Ivy Cottage, Sandgate, S. and F.: also in the lowest group, Court-at-Street. H.

T—— ovata. Quarry above Hythe: young and small. S.

T—— prælonga. Pl. XIV. f. 14. Near Ivy Cottage, Sandgate; and shore between Sandgate and Folkstone. S.

T—— quadrata. Pl. XIV. f. 9. Near Hythe. H. and S.

T—— Sella. Near Court-at-Street. H.: and quarries near Hythe; very numerous, in clusters. F. Also at Chart, Kent. Min. Conch.

T—— Tamarindus. Pl. XIV. f. 8. Near Hythe. S.

Terebratula. Two or three other species, probably new. Near Hythe. S.

Thetis major. Lowest beds of the middle group, near Ivy Cottage, Sandgate. S. and F.

Trigonia alæformis. Near Court-at-Street. H. Ivy Cottage, Sandgate. Middle beds of the lower green-sand. F. Also near Seabrook. G.

T——— clavellata. Seabrook. S. Also about Court-at-Street. H.

T——— elongata. (var. of *T. costata.* Min. Conch.) An imperfect specimen. Near Court-at-Street. H.; and Ashford, Kent. Mantell.

T——— nodosa. Near Seabrook. S.

T——— spinosa. (Minch. Conch.) Near Seabrook. S. Also near Pulborough. Mr. Martin.

T——— spinosa var. Pl. XIII. f. 3. Shorn Cliff, near Sandgate. G. and F.

T———. New, but indistinct. A cast. Hythe. H. The same with a fossil of Shanklin, Isle of Wight. So.

Trochus. Species doubtful. Pl. XIV. f. 16. Near Court-at-Street. H. Also Boughton-Mount quarries, near Maidstone. F.

Venus angulata. (See *Cyprina.*)

V—— caperata? (See *Cytheræa.*)

V—— ovalis? Lowest beds of the middle group: quarry near the Ivy Cottage, Sandgate. S.

V——. Cast of a small species. Lowest group of stone: quarries above Hythe. H.

Vermetus polygonalis. Near Court-at-Street. H. Near Sandgate, and Seabrook. Min. Conch. Also from Bonchurch, and Ventnor Cove, Isle of Wight: but in the *upper* green-sand, or in gault. F.

Wood. Coniferous, silicified. Near Folkstone, and Wilsborough. Rolled fragments are frequent, at the junction of the gault with the top of the sands.

Interior of Kent.

(37.) I have dwelt the longer on the description of the coast near Folkstone, on account of the distinctness with which the strata are disclosed there, and of the geological celebrity of the place; which has the advantage, also, of being easily accessible to foreigners, from its proximity to France. The details above given will supersede the necessity of minute description in many of the following sections.

The strata succeeding the chalk offer but little variety between the coast and the vicinity of Godstone, in Surrey. The Upper green-sand is throughout comparatively obscure. The gault, which in general occupies but a small and narrow valley at the foot of the chalk escarpment, is extensively unveiled at the entrance of the river gorges, and in those cases its surface is varied by hills and other inequalities. The Lower green-sand agrees generally, both as to structure and composition, with that of Folkstone, but the proportion of calcareous matter decreases from Maidstone towards the west.

(38.) Extensive quarries have long been worked in the lowest part of the green-sand at Boughton, on the south of Maidstone, the geological relations of which are the same as at Hythe. The stone for the construction of Westminster Abbey is said to have been procured there. It is a variety of Kentish rag, like the Hythe stone, in nearly continuous beds, alternating with a soft sandrock, called by the workmen "hassock," and passing occasionally into chert *.

At the top of these quarries irregular fissures or cavities, approaching to a conical figure, called "vents" by the workmen, are frequent. These are filled with loose rubbly stone and sandy clay. In one of them the bones of hyænas were found, in 1827, by the late Mr. Braddick, of Boughton Mount, under circumstances like those in which similar remains occur in fissures in other parts of England. My specimens include several fragments of the long bones and jaws, with the canine and incisor teeth, some of which are much worn down by use; and these are accompanied by *Album Græcum* †.

Fragments of chalk-flints are found upon the surface near Boughton, about four miles and a half from the outcrop of the chalk: a fact which deserves attention, as such remains of the superior strata have been supposed either not to occur, or to be extremely rare, within the space between the North and South Downs.

(39.) The manner in which the rivers make their way to the sea, by an apparently unnatural course, across the ridges both of the chalk and the inferior strata, is one of the most interesting points in the general structure of Kent; and has been already dwelt upon by Mr. Conybeare ‡, Mr. Scrope §, and Mr. Martin ‖.

(40.) The great variation in width of the space occupied by the strata between

* This better stone is called here "Calkstone" (Kalkstein ?). Foreign workmen were often employed formerly in the British mines and stone works; and in some other instances,—as at the mines of Lead Hills in Scotland, they have left traces of their native languages in the technical terms.

† Since these pages have been at the press, the remains of an animal, which Mr. Mantell himself has ascertained to be distinctly an Iguanodon, hitherto found only in the freshwater beds of the Wealden, have been discovered by Mr. Brinstead, at Rockhall, near Maidstone, in a stratum of Kentish rag, abounding in the usual fossils of the Lower green-sand. They confirm the propriety of referring to the same animal the great bones and the teeth, previously discovered at Tilgate and other places in Sussex. See Jameson's Edinb. Journal, July 1834. (Vol. XVII. p. 200.) A full account of these and other new remains of this extraordinary reptile, will be laid before the Royal Society by Mr. Mantell.

‡ "Outlines," &c., pp. xxvii. and 145.

§ "On Volcanos," p. 213.

‖ "Memoir on Western Sussex," pp. 12—57.

the chalk and the Weald clay is another very prominent feature of this part of the country; and though it arises, in part, from the extensive denudation at the entrance of the gorges where the principal rivers traverse the chalk ridge, yet even if these were filled up, and the range of the downs between the coast and Dorking rendered uniform, the space occupied by the lower strata would be found to vary considerably*. The chief cause of this irregularity is the difference of the angles at which the strata rise in different places; the heights also which the sands attain, having a proportionate variation.

(41.) In the upper part of the Lower green-sand between Sevenoaks and Godstone, a ridge or saddle can be traced for several miles, in a direction nearly parallel to that of the central range of the Hastings sands, its course being from about 10° south of west to 10° north of east. The places where I have seen the structure of this ridge most distinctly, are on a line passing from Montreal Park, through Sundridge, to the grounds of Brasted Place, in the course of which several sections have been exposed. The strata consist of yellowish and somewhat ferruginous sand, and "hassock," including beds of a bluish stone, like that of the Boughton quarries and the vicinity of Folkstone: the fossils, also, are the same.

The ridge just mentioned is probably continued eastward; but my observations in that direction did not extend beyond a place called Cold Harbour, immediately on the west of Montreal Park, where the beds rise towards the south, at an angle of about 20°; the bend, also, or summit of the ridge being there exposed, on the verge of a small wood, but less distinctly than at Brasted Place, hereafter mentioned. Its continuity, however, is in several places interrupted by breaks or openings, from 50 to 100 paces in width, where a uniform surface at a much lower level is continued from north to south, across the direction; as if the ridge had been cut away in those places, or wide transverse fissures had been partially filled up and levelled over†. The first of these breaks is about sixty paces from west to east, and the summits of the heights

* On the coast line the distance from the chalk at Folkstone Hill to the outcrop of the lower green-sand at Aldington Corner, is about ten miles; but from Lenham to the outcrop is not more than two. A line parallel to the last, from Boxley, passing through Maidstone, is rather more than six miles long; but from Wrotham to the outcrop is less than four; at Tandridge, on the east of Godstone, less than one and a half; and at Reigate little more than one mile. On the west of Reigate the lower green-sand again runs out four miles, to Leith Hill, which is 993 feet above the sea. These details could not be expressed on the small map annexed to this paper: for better illustration the reader is referred to Mr. Greenough's Geological Map of England, and to the Ordnance Survey.

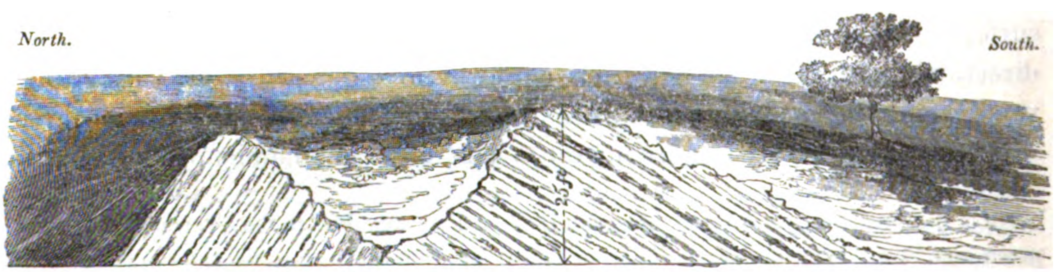
† A remarkable break of this description occurs between two portions of wood immediately on the north of the letter "*y*," of the word "*Dry-hill*" in the Ordnance map.

which it separates are about seventy feet above their base. The strata, which form the southern slope of the ridge, dip southwards at an angle of about 45°, and the apparent distance (or chord of the curve) from the beginning of the rise on either side is rather more than a furlong. The wood near Cold Harbour is full of old quarries, which seem to have been dug into the top of the saddle.

(42.) A very good view of these elevated strata is disclosed on the east of a lane which strikes off from the main road between Bessell's Green and Sundridge, passing Dry Hill Farm; quarries having been opened there in two detached points, marked A and B in the subjoined sketch. It is difficult to estimate the width of the ridge at this place from north to south, its terminations not being distinct, at either extremity, but it seems to be about 1200 paces.

<.. ....*about* 1200 *paces*...>

At the more northern of these quarries, A, the beds are distinctly, but slightly, curved; and the strike is not parallel to the general course of the ridge, but runs from about 16° east of north to 16° west of south; forming, with the direction of the ridge, an angle of about 64°. At the second quarry, B*, (of which a sketch on a larger scale is given below,) both sides of the saddle are visible within the distance of a few paces, the beds on the north rising at an angle of about 60°, while on the south they decline at an angle of about 45°.



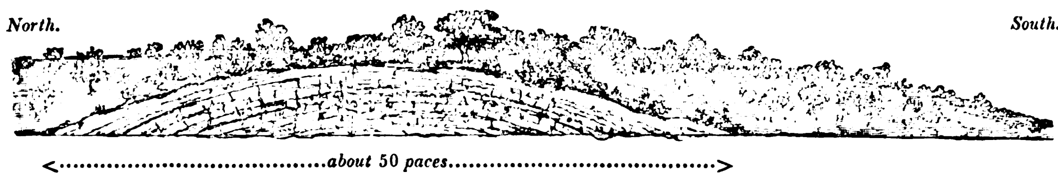
<........................... 22 *paces*.. ....>

In the southern portion of this section, which is about twenty-two paces in length, and twenty-five feet high, I counted twenty-two beds of concretional stone alternating with sand, and varying in thickness from eighteen inches to nine.

* This place is immediately on the east of a barn on the road-side, north of Dry Hill Farm, and about 270 paces distant from A, on a line bearing about 36° west of south.

A second break or open space, like those above mentioned, (p. 133.), occurs immediately on the west of Sundridge Church, which stands on the northern slope, very near the summit of the ridge; and a third break, with a flat of about 100 paces, separates the continuation of that height from another, occupied by a small wood belonging to Brasted Place, and called by the inhabitants the "New World": and here the top of the curve is visible in several places, from one of which this sketch was taken. The cracks in the principal bed here represented, (which is about nine-inches thick,) are wide and irregular; but the stone has every appearance of having been once continuous.

The bending of the strata is also very well disclosed in the grounds of Brasted Place itself, at the opposite side of the lane by which they are separated from the little wood of the "New World." The curve is there less rapid than in the wood; and the thickest bed of stone, marked A, is traversed by cracks from a quarter to half an inch in width, the separated portions being somewhat displaced, as if they had been forced out of continuity.



(43.) A continuation of the ridge above described may be traced westward from Brasted Place, for about four miles; and on the roadside ascending to the Chart near Moorhouse, about midway between Westerham and Lympsfield, beds are exposed, which dip rapidly to the north; obviously forming a portion of a saddle, like that of Dry Hill, and, to all appearance, a prolongation of it.*

From what I have seen in other parts of this country, I have little doubt that many of the ridges within the tract occupied by the lower green-sand may be ascribed to similar disturbances of the strata. A slight indication of something of this kind near Folkstone has been already referred to (32.). On the Ordnance map a prominent range is represented as running nearly north-west and south-east, from the village of Seal, through Seal Chart, to the

* Marks of disturbance along a line of direction different from that described in the text, are observable also about half a mile south of Dry Hill, near the Manor Farm House; where the beds on one side of the ravine dip towards a point about 20° south of east, while on the opposite side they are inclined to the west of north.

heights above Stone Street on the south of Ightham Common. This, if not very much exaggerated, is probably a derangement like those just mentioned. The greater ridge of the Hog's-back itself, on the west of Guildford in Surrey, of which the direction is nearly continuous with that of the ridge at Brasted, may be also connected with it; since the line of the Hog's-back, if prolonged eastward, would pass through the high range of sand hills between Shalford and Martha's Chapel, and thence almost directly through Park Hill, Cockham Hill, and Tilburstow Hill, which last-mentioned place is the seat of a similar disturbance. The distance from Tilburstow to the inclined strata at Moorhouse, is not much more than four miles, and the whole course of this elevated line is almost uniformly from east to west; the line from Moorhouse to Montreal, through Sundridge, deviating from that direction only a few degrees to the north. Mr. Martin has described similar cases of much greater prominence and interest in Western Sussex *.

(44.) The abrupt rise of the beds in many of these ridges, and the speedy return of the ground to its general inclination, imply the action of a force which, if direct, must have been very near the surface, and too much circumscribed to be reconcilable either with the effect of gaseous expansion or the impulse of mineral matter in a state of fluidity. The space between the north and south chalk downs seems, in fact, to have been elevated, not by the mere protrusion of one central ridge, but to have been broken up in several different places, so that large portions were thrust outwards, or bent into ridges, by a lateral push, as when a cloth is wrinkled on a table; a mode of accounting for the formation of such inequalities of the surface, which seems more probable than the action of any direct violence from beneath †.

* "Memoir, &c.," p. 76 et seq.

† There is indeed another hypothesis, which would account for the formation of prominences of small extent, by forces originating at very great depths. If we suppose a series of strata, comparatively soft and flexible, to be deposited over a tract composed of older rocks, with hills and ridges on its surface, and the whole to be then thrust outwards by a force beneath, the protuberances of the lower mass would compress and bend the strata above them into forms corresponding with their own;—just as in bound books the little inequalities of the cover, or any of the leaves, are impressed on the adjacent pages, and sometimes propagated through a large part of the volume. Nor is this case wholly imaginary. The masses of granite which are found, in many instances, to project above the disturbed strata adjacent to them, must have been elevated after they had cooled,—when their comparative solidity must have been very great:—and among the newer formations, the interval of time between the deposition of many of the groups, now in immediate contact, (as of the red marl and the oolites, near Bath,—the mountain limestone and greensands in the Lower Boulonnois,) must have been more than sufficient both for the condensation of the lower strata, and their subsequent erosion into prominences and valleys, even if the original surface had been uniform.

SURREY.

(45.) *Godstone.*—The upper green-sand assumes a new character near Godstone; and a step-like projection at the foot of the chalk appears there more distinctly than in the country to the east. As the productions of the little district between Godstone and Reigate are valuable in commerce, and its structure has been a subject of some doubt, I have given a separate map of it, in Plate VII. fig. 2.* The section, Plate X. a., No. 2., on the line from the chalk through Godstone, shows the position of the firestone beds in the upper green-sand; with the site of a remarkable elevation of the strata at Tilburstow Hill, an account of which has been already published by Mr. Mantell†: and No. 3., the section through Merstham, includes the site of the Fuller's-earth pits of Nutfield.

(46.) The firestone subordinate to the upper green-sand, in this part of the country, was, in 1827, extracted only between Godstone and the west of Reigate. The principal pits were situated on the west of the London road to the former place. The stone was obtained by an adit between five and six feet in height, and the succession of the beds affording it was thus:

Section of one of the Firestone Pits near Godstone.

	Feet.	In.
1. "*Hard roof.*" This, like the firestone beneath, is a uniform fine-grained conglomerate or sandstone, effervescing strongly with acids, and easily cut into any desired form. Throughout the stone are dispersed numerous minute scales of mica, and dark particles, scarcely perceptible without a lens. It forms a roof to the mines, of such firmness as to support itself to a width of 17 feet, extending indefinitely inwards.	1	3
2. "*Green bed*" of the workmen. (*Firestone.*) Stone of the same nature as the last, but harder and somewhat finer in grain, easily broken down into sand, effervescing. The beds 2. 3. and 4. though separated by seams of stratification, are of nearly uniform character.	1	9
3.	1	4
4.	0	10
5. A bed of bluish grey siliceous concretions, called "flints" by the workmen, passing into stone like that above mentioned. Fracture flat-conchoidal. Yielding with great difficulty to the knife; but effervescing slightly. The greyer stone near these concretions is much harder than elsewhere. The siliceous matter as it becomes more pure acquires greater hardness, with a splintery fracture and a glimmering lustre; and the micaceous particles, which are numerous in the softer varieties, are then scarcely apparent.	0 to 0	3 to 4
6. "*Green bed*;"—like 2. 3. and 4.‡	0	10

* In the small maps of this Plate the inequalities of the surface are not expressed: but the colours can easily be transferred to the Ordnance map.

† "Fossils of Tilgate," &c., p. 22.

‡ The more uniform and softer rock of these pits is used, principally, for lining fire-places

7. Bottom of the quarry. Stone unfit for working, from its containing much flinty matter.

All these strata dip at a very small angle to about 20° west of south. The rock is traversed by fissures, which divide it into somewhat rhomboidal masses; and smaller cracks are sometimes found within the blocks of stone.

(47.) The gault hereabouts occupies a tract which bears the name of "Black-land," and forms a slight depression below the band which affords the firestone.

(48.) The lower green-sand has distinct indications of a subdivision into three, like that of the vicinity of Folkstone (16.). On the line of section, No. 2. Plates VII. and X. ponds are frequent, in a situation corresponding to that of the greener middle group (24.); the surface being comparatively low, with vegetation of a somewhat different character. The stony beds of the lowest group then rise to form the escarpment of Tilburstow Hill*, which is nearly on a level with the chalk downs; and at the highest point, there is decisive evidence either of a sinking towards the chalk, or of elevation in an opposite direction; for at the top of the hill, the beds, which on the north of that place rise uniformly at an angle of not more than 10°, are suddenly thrown up to about 45°. The appearance of the section here is represented in the sketch subjoined:

South. North.

and furnaces, but is employed also for buildings under water. Great care is necessary, in building, to place the blocks so that the planes of stratification shall be horizontal. The equivalent of these beds in the upper green-sand of the continent, (the *Pläner kalkstein* of the Germans,) is employed for exactly the same purposes, at Aix-la-Chapelle and other places.

* This is the spelling of the Ordnance map: the word in the country is pronounced "*Tilbuster.*"

Inclined Strata, near the bottom of the Lower Green-sand, Tilburstow Hill.

	Feet.	In.
Soil and loam (marked *a a* in the cut).		
1. Soft nearly uniform sand; when dry of a bright buff colour	about 6	0
This has the appearance of having slid or subsided upon the next bed below. Immediately above 2. the sand is green.		
2. Fuller's-earth; very like that in the upper part of the pits at Nutfield, hereafter mentioned, and also like that which occurs in the lower green-sand at Brill in Buckinghamshire. This clay becomes soft and is diffused in water, but does not break down with the rapidity of common Fuller's-earth. The bed varies in thickness from 6 inches to 12: the masses of which it is composed have smooth surfaces and a saponaceous feel, with the aspect and lustre of bee's wax, probably produced by compression and motion on each other	0 to 1	6 to 0
3. A bed consisting of chert and soft sandrock ("Hassock"), intimately mixed, and passing into each other; about	3	6
This and the beds 4. 5. and 6. end abruptly above, as represented in the sketch.		
4. A course composed of almost continuous bands of brownish grey chert, from 3 to 6 inches thick, alternating with, and passing into, soft sandrock. This chert is like that on the northern surface of the hill, where it is much used for repairing the roads. By exposure it becomes divisible into slaty portions, approaching to a rhomboidal figure	6	6
5. Soft sandrock ("Hassock"), including green particles: the hue is various where exposed. In some places tinged with oxide of iron	about 3	6
6. Sand; green while it is moist, but when dry and exposed nearly white, containing layers which consist of stem-like or vermicular portions of white, translucent, quartzose sand, surrounded by sand of a green colour. This contrast of colour becomes indistinct in dry specimens, but is very conspicuous when they are moistened. The white vermicular portions have a border of darker green than the rest: they are generally about $\frac{1}{8}$th of an inch in diameter, somewhat curved, and in some cases have short lateral branches with round extremities. This remarkable structure is very characteristic of several parts of the lower green-sand, and is probably connected with the former presence of organized bodies	varying from 4 to 6	0 to 0
7. Coarse yellowish sandrock .... 8. Here ferruginous matter is more abundant, and the sand is concreted irregularly into nodular masses nearly continuous. 7 and 8 together are about 15 feet thick.	15	0
9. Ferruginous bands, like 8: a conglomerate of quartz grains, cemented by oxide of iron, with adhering sand, which in some places is white, and looks like mortar, but does not effervesce .... 10. Sand, with dark particles, and irregular tortuous seams of a ferruginous compound, like the carstone of Norfolk, consisting of fine rounded grains of quartz, cemented by hard, dark reddish brown, oxide of iron. This passes at the bottom into a less ferruginous sand, which is apparently continued down to the Weald clay. 9 and 10 together are about 15 feet thick.	15	0
Total thickness....about	60 feet.	

(49.) *Merstham.*—The aspect of the amphitheatre formed by the outcrop of the chalk and upper green-sand around this village is very characteristic: a prominent ridge of the latter stratum, passing from Blackditches to the south of Gatton, in a nearly circular curve, above which the chalk downs rise, with a similar curvature (see Plates VII. fig. 2., and X. a. No. 3.). Merstham occupies nearly the middle of the line which has been worked upon for firestone; the extreme points to which the quarries have extended of late years being near Godstone on the east, and Buckland Green on the west. The village stands on the confines of the upper green-sand and the gault*, a little to the south of an opening or gorge in the chalk, through which runs one of the principal roads from London to Brighton. The beds dip at a very small angle, towards the north; and those which include the firestone are visible to a thickness of about thirty feet, projecting like a step beyond the foot of the chalk escarpment. The works had been discontinued for some time before I visited the place; but the following list of the strata was given to me by the person who had superintended them †.

List of Beds at Merstham, Surrey.

	Feet.	In.	Feet.	In.
[*Lower beds of the Chalk.*]				
1. "*Chalk.*"				
2. "*Limestone.*" Grey marly chalk; about			150	0
3. "*Burry chalk:*" the "Craie Tufau" of the French. This will not burn to lime, but goes to dust in the kilns			50 to 60	0 0
[*Upper Green-sand.*]				
4. "*Quarry stone;*" (Firestone) subdivided thus:				
a. "*Roof,*" (sand 2 feet, soft stone 2 feet)? Total, about. This stratum is of great firmness and stability: the roof supporting itself perfectly in the drifts worked into the hill, which are 30 feet wide.	4	0	about 25	0
b. "*Firestone;*" including "*flints*" (chert), about 2 feet from the top: about	5	6		
c. "*Good hard building-stone.*"	2	0		
d. "*Burry stone;*" about	16	0		
[*Gault.*]				
5. "*Marl.*" Gault: the apparent thickness of which, in this part of the country, agrees with that on the coast.	about		150	0

All the beds become thinner towards the outcrop.

* A well at the Feathers-Inn is 150 feet in depth, with a boring of 60 feet at the bottom (in the whole 210 feet), all in "clay" and "marl." The boring, $2\frac{1}{4}$ inches in diameter, after going down to 60 feet, brought up such a quantity of water, that the well-sinker was drawn up in great haste, and the water rose to within 40 or 50 feet of the surface. Much sand, which had come up through the bore, was afterwards found in the bottom of the well.

† A more full account of the Firestone pits here, has been published by Mr. Webster, Geol. Trans., First Series, vol. v. p. 355.

(50.) The rise of the Lower green-sand is here very well defined; and the soil over the upper ferruginous beds of the formation is called "hazel-mould," in distinction from the "black-land" upon the gault. Immediately on the south of the ridge formed by this first member of the sands, a slight valley or depression, with a moist and more fertile surface, is occupied by cohesive sand of a dark greenish hue and softer texture, which corresponds to the middle group of Folkstone, above described, (16.) and (24.). The retentive quality of this latter stratum, which gives a somewhat marshy character to the tract in which it occurs, and the approach of its hue and texture to those of clay, have deceived even experienced geologists, and given rise to some mistakes respecting the lower strata of this neighbourhood. The section No. 3, I believe, expresses their true order and relations.

(51.) Fuller's-earth has been dug in this part of Surrey, beyond the memory of the oldest inhabitant. At present the extraction is confined to the neighbourhood of Nutfield. The beds come up near the top of the lowest member of the green-sand, and occupy a line on the north side of a ridge, which extends from the east of Nutfield nearly to Redstone Hill, on the west of Copyhold Farm. About two miles west of Nutfield, nearly upon the ridge, was a pit, by which the earth was extracted from a stratum six to seven feet thick; and at Colmonger's Farm another, of which the section was thus:

Fuller's-Earth Pit, near Nutfield.

	Feet.	In.
1. Greenish sand, occupying irregular cavities on the top of the clay, 2. 2. Very tough clay (impure Fuller's-earth) with the aspect of steatite. [See No. 2. of the Section at Tilburstow Hill, p. 139.]	about 3	0
3. Sandrock, abounding in green particles; about	4	0
4. A range of sandy nodules, of firmer consistence than 3.	1	0
5. Thin courses of bad Fuller's-earth	0 to 0	4 8
6. Continuous sandstone, forming the roof of the "earth-pits," and sustaining itself without support to a width of 11 yards	2	10
7. Ochreous clay	0	2
8. *Fuller's-earth*, of an uniform bluish colour* In this stratum, about 3 or 4 feet from the top, detached nodules are found, (from six inches to nine in diameter,) of sulphate of barytes, crystallized in oblique four-sided prisms, truncated at the edges and bevelled at the extremities, semi-transparent, and of a wine-yellow colour	16	0
9. White sand.		

The thickness of sand beneath,—between this stratum and the Weald clay, I did not ascertain.

The dip of the strata above detailed is about one in fifteen: (the angle, therefore, between 3° and 4°,) towards a point about 40° west of north.

* This was sold at the pits (September 1828) at 5*s.* per ton. The yellowish earth of another

(52.) *Reigate.*—The map and sections, Plate VII. fig. 2. and X a., Nos. 2. and 3., sufficiently indicate the general relations of the beds here, which have been already the subject of a paper in the Geological Transactions by Mr. Webster*; where a sketch is given of the history of the remarkable ancient quarries at this place. The firestone forms a terrace beyond the chalk, nearly level with the top of the remotest sand-ridge; and the gault runs out from the base of the terrace, at first horizontally, and then rises towards the tunnel, by which the road is conducted through the first ridge of the Lower green-sand†, here composed of cream-coloured and yellowish sandrock. From the town of Reigate the strata rise again towards Cockham Hill: so that there are here two ridges; first, that through which the tunnel is cut, and secondly, the southern ridge, formed of the lowest sand beds,—with what appears to be the middle, greener sand between. At Earlswood Common, about a mile to the east of the outcrop, the clay of the Wealds is found. The sudden fall from the chalk to the valley of Reigate and the abrupt rise thence to the outermost ridge of Red Hill, &c., is exceedingly striking. At Reigate Heath, on the west of the town, the vale which seems to be occupied by the middle sands is rushy and moist, bearing pools upon its surface: but the fall of the ground still farther west, where the continuation of the outer ridge of sands might be expected, is also a remarkable feature.

(53.) In proceeding westward, the rise of the sands at Buckland is likewise very rapid. Thence to Holmwood Common, on the south-west, no observations have been made, but the boundary between the green-sands and the Weald is less obviously marked; and there is a strong contrast between this space and the prominent ridges of Leith Hill; the lower tract, it will be observed, being that in which the streams converge to join the Mole before its passage through the gorge at Dorking.

(54.) It will be seen, even from the map (Plate IX.), that the outcrop of the Lower green-sand, from Reigate to the head of the valley of the Wealds, is not continuous; two, if not three, distinct tracts of this formation, bounded

pit was more in request; the price, however, the same. It is necessary for the purposes of the woollen manufacturer, that the Fuller's-earth should be free from any admixture of ochre or sand, which are found to cut the cloth.

* First Series, vol. v. p. 353, &c.

† The relations of a stratum of dark greenish sandy clay, about seven feet thick, immediately above the tunnel at Reigate, are at first sight doubtful. It might be taken for an advanced portion of the gault; but is, more probably, a subordinate bed within the first division of the Lower green-sand;—a detached portion, as it were, of the middle greener beds, which it resembles in mineral character. A similar bed occurs, in a corresponding situation at Pulborough, which Mr. Martin, with whom I examined it, has since ascertained to belong to the place here mentioned.

on the south by almost rectilinear escarpments, projecting successively beyond the narrow and comparatively regular line of the previous outcrop, on the east *. The breaks between these steps coincide with the gorges of the Mole and the Wey; a fact in favour of the hypothesis which ascribes the formation of these gorges to transverse fissures. 1.—The first of these tracts of sand lies between Leith Hill and the opening cut across the sands towards Guildford, by the south-eastern branch of the Wey †, in which the Surrey and Sussex canal has been dug. Its southern verge extends from Leith Hill, through Holdenbury Hill, to Bearland and Stroud-Green, with a mean breadth from the chalk of about $3\frac{1}{4}$ miles. 2.—The next step projects about 3 miles further south, with an average breadth of about 6 miles; and its escarpment is nearly parallel to the Hog's-back throughout the greater part of its length, from the Telegraph Hill, south of Hascombe, to Emily Farm, a little east of the centre of a line from Hindhead to Thursley. The anticlinal line, hereafter mentioned, along the top of Grayshot Down, may perhaps be the continuation of a ridge, or saddle, of which the beds rising towards Hascombe are the remaining northern portion, the southern slope having been carried away by denudation ‡. 3.—The sands on the north of the valley between Ludgershall and Harting-combe, may possibly be considered as a third step in these parallel outcrops, though much less regular than the two just mentioned: the lofty summit of Blackdown, at its eastern extremity, is standing out like a promontory, about two miles beyond the other parts of the escarpment on the south of Hindhead. It is impossible not to connect these appearances with the general action of the force by which the whole of this country has been upheaved; all the features coinciding with the hypothesis of its elevation on a line or lines parallel to the axis of the forest ridge.

(55.) *Dorking to Leith Hill, &c.*—The tract between Leith Hill and Guildford affords nothing particularly deserving of notice, except the great height (993 feet) to which the outcrop of the lower green-sand rises, at the point on which the tower is placed. The space included between the escarp-

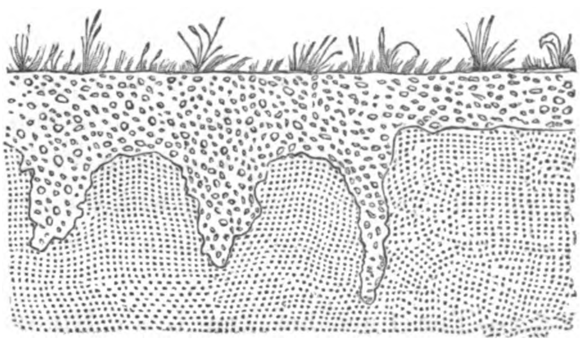
* To understand the structure of this country, the reader ought to have before him a map on a much larger scale than that in Plate IX., as Mr. Greenough's Map of England;—or the eighth sheet of the Ordnance Survey,—which, however, is by no means equal, in correct representation of the surface, to the more recent portions of that work.

† This stream has no name in the Ordnance map.

‡ Another anticlinal line, but in a direction oblique to that here mentioned, is indicated by the line of heights which runs from Milford, through Godalming, and thence by Unsted and Summersbury to Western Street, near Albury; the strata on the south-east of this line, near Godalming, dipping at a small angle to the south-east, obliquely from the range of the Chalk Downs.

ment and the downs from Dorking to Guildford is of nearly uniform character: but in approaching the latter place, the Lower green-sand rises with such rapidity, that Martha's Chapel equals or out-tops the chalk, though less than a mile distant from it horizontally. Slighter indications, also, of disturbance are evident throughout this tract. The lower marly chalk at Deerleap above Wotton is divided by smooth surfaces, produced by the sliding of large masses upon each other: and where the road rises from the mill towards Abinger Church, at a point which corresponds with a continuation of the ridge above mentioned, near Brastead and Sundridge, the beds are curved, so as clearly to indicate derangement.

(56.) The road west of Dorking, between Westgate Heath and the Rookery, is cut through the first beds of the Lower green-sand, the top of which is eroded into irregular cavities, resembling those which are found, throughout the south-east of England, on the surface of the chalk; and, like them, filled with reddish loam and fragments of chalk flints. This being one of many indications, on the margin of the great Wealden valley, that the agents, whatever they were, by which the chalk was excavated, acted in the same manner on the beds beneath it, and filled up the cavities with similar materials, at least as far down as the Lower green-sand.



The lower strata of the quarries near Cold Harbour, immediately under the tower at Leith Hill, are almost identical with those of Tilburstow, (p. 139); consisting of very green sand and soft sandrock, which alternate with chert, and include green matter, with white, vermicular or stem-like bodies, as at that place.

(57.) *Guildford, Godalming, Farnham, Hindhead.*—The tract on the south and west of Guildford, and thence to Hindhead, forms one of the most extensive surfaces of the Lower green-sand to be found in England; and the section from the heights on the north-west of Farnham to the Weald, (Plate X a., No. 4.) includes a succession of strata, from the Bagshot sands, one of the highest members of the English series, down to the Weald clay.

The quarries on the roadside between Guildford and Shalford, disclose a good section of the chalk, with numerous flints, dipping at an angle of about 5° or 6°, a little to the west of north; and on the opposite side of the Wey, beneath St. Catherine's Hill, the relative position of the lower strata is very well displayed.

(58.) *The Hog's-back.*—The remarkable ridge called the "Hog's-back," which runs from Guildford to a point about two miles from Farnham, has been produced evidently by an upthrow of the chalk, and the breaking off of the southern portion of the curve. The inclined position of the remaining side of the flexure is very well seen at the western extremity of a large chalk-pit between Guildford and Puttenham, where the strata dip towards the north, at an angle of about 30°. The upper beds are very white, with courses of the usual dark flint nodules; and a remarkable feature in this quarry, is the distinctness with which the chalk is divided into masses approaching to a rhomboidal figure, by seams oblique to the stratification; the angles of the portions thus bounded, standing out in the face of the cliff, like splinters in the shattered fracture of a crystal.

The Upper green-sand forms a slight projection along the foot of the Hog's-back; the Gault, a corresponding narrow depression along its whole length; and the Lower green-sand rises so rapidly beneath, that one or many inflections are necessary to account for its wide extent to the south. In approaching Farnham, the gault, near its contact with the sands, abounds in nodules containing a large proportion of phosphate of lime; resembling those of the vicinity of Folkstone (13.). The upper beds of the Lower green-sand rise, like the chalk, at a very high angle, and must have been bent suddenly in an opposite direction, since they are now continued, with a moderate inclination, several miles to the south. Along the north of Puttenham Common, the sand is reddish, and very like that of Red-cliff at Sandown Bay, in the Isle of Wight. A nearly continuous surface of the sands extends towards the south from Compton to Hurtmore, and North Brook Place, and is resumed on the south of the river, through Westbrook and Upper Eashing. It is again cut through by the stream, which the London road accompanies, on the south-west of Godalming; but recurs, in the heights south-east of the town, from Holloway-hill and Crown Pit to Munstead Heath, which seems to be nearly on a level with the top of the Hog's-back. On the west, the upper beds of sand form several prominences, among which Crooksbury-hill is the most conspicuous; their elevation having probably been the effect of protrusion. On the south-west of Crooksbury, the upper sands seem to expand, and to occupy a still wider horizontal space in that part of the denudation which corresponds to the less inclined beds about Farnham.

(59.) The general thickness of Lower green-sand here seems to be nearly the same with that of the coast, and may be taken as between 350 and 400 feet; though, from its superficial extent, a much greater thickness might be ascribed to it, if the disturbance and inflexion which it has undergone were not kept in view. There can be no doubt, both from the features of the surface, and the hue and texture of the strata, that the subdivision into three, which is conspicuous near Folkstone, and not much less distinct in Western Sussex, exists also in this tract. But the precise boundaries of these groups are by no means obvious, for there are not hereabouts those characteristic beds of stone, which are found near the coast; their place being supplied, in the uppermost group, by concretions of a coarse conglomerate, which in the country bears the name of "Bargate Stone *;" and, in the lowest group, by chert and indurated sandrock, like those of Leith and Tilburstow hills. This comparative scarcity of calcareous matter is one of the principal differences between the eastern and western tracts of this formation.

The more ferruginous concretions, (the "carstone" of Norfolk,) which are very abundant in the upper part of the Lower green-sand of this neighbourhood, are often so compact as to ring under the hammer, and are thence called "clinkers" by the quarrymen; sometimes forming plates or flakes, a quarter of an inch and upwards in thickness, and curved so as to resemble portions of concentric layers of petrified trees. This stone furnishes an excellent material for the roads, and gives a remarkable reddish hue to some of those which are macadamised in this country. Fragments of brown hematite also, like those of the Red-cliff near Culver in the Isle of Wight, are found at many places in this vicinity; as at Thursley, &c.

(60.) *Godalming.*—The heights about Godalming afford excellent sections, which may with some probability be assigned to the lowest part of the Green-sand formation. The order in general was thus :—

Holloway-Hill, Godalming.

	Feet.	In.
1. Green and variegated sand, abounding in large concretions of chert, and of calcareous conglomerate, ("Bargate-stone;") which is hard and sparry, and in some places passes into chert. It contains traces of shells and of alcyonic stems. False stratification is here remarkable; the concretions also following the oblique or false lines......	about 15	0
Some of the larger masses of this rock are precisely like the concretions on the shore near Folkstone (20.);—a very compact sparry variety of "Kentish-rag." In the upper sands of Polstead, near Puttenham, irregular concretions of this compound occur, imbedded in soft sandrock, and containing carbonate of lime in rhombs.		
2. Sand, of the same kind, without concretions; but including thin beds of a tough clay, like Fuller's-earth.†......	about 25	0
The dip here is towards the south of east, and all the summits are flat and uniform.		

* The origin of this term is somewhat doubtful. A place called "Burgh-gate," from whence it may have been derived, occurs in the Ordnance Map, on the south of the escarpment between Hambleton and Hascombe.

† The Fuller's-earth would refer these strata to the lowest division of the sands. Thin beds of that mineral, however, are found throughout this formation.

Among the looser sandy materials of Holloway-hill are spongy concretions, which show, when moist, the same vermicular structure as at Tilburstow-hill.

Blackheath, south-east of Guildford, seems to have been once a continuation of the sands near Godalming. Its top is nearly level with the chalk range, but lower than Martha's Chapel hill. On the south, the ground descends to Farley Heath, with a sort of escarpment like that of Crooksbury and Farnham commons, hereafter mentioned; and the road thence by Farley-green to Hound-house is in a richer sand, supporting pools in several places, and probably belonging to the middle group.

Crooksbury Common seems to consist of the upper members of the formation, impending, like an outcrop 150 to 200 feet thick, over the valley of the Wey, between Elstead and Tilford; and on the south of the stream the heights of sand are renewed. Farnham Common is analogous to that of Crooksbury, and apparently a continuation of the same plateau, deeply cut through by one of the principal streams of the Wey. On the south of these, is the lower tract of Frensham and Thursley commons, and thence the ground rises rapidly towards Hindhead, the ascent consisting of sand deeply trenched into channels. A conspicuous group of barren, somewhat conical hills, on the south of Frensham Common, called the "Devil's Jumps," is apparently the remaining portion of a stratum of sand reduced by abrasion to the present irregular form; and the pebbles and rolled masses on Thursley Common, immediately on the north of Hindhead, are sandrock, passing into chert, which seems to be unmixed with other matter, and to be the debris of the beds now removed.

(61.) *Hindhead.*—The crest of Hindhead is on the north-east of a depression called the "Devil's Punchbowl," round which the road is conducted. The highest part of the curve, or anticlinal bending, of the Lower greensand, seems to be just at a point where the new road, on a lower level than the old, has exposed a face of 10 to 25 feet in height. The flexure is very slight, but sufficiently perceptible, occurring in such a place, to be deserving of notice. The strata consist of soft sandrock, containing concretions, and nearly continuous beds of chert, passing into chalcedony, of various shades of yellow and brown; with occasional layers of bright yellowish sand, in which the lines of false stratification are conspicuous. All over Grayshot Down the subsoil is a soft, loose sand of the same description.

(62.) The whole of the tract here occupied by the sands, though not unpicturesque, is wild and barren in its aspect, destitute of wood, producing only ferns, heath, and furze. The surface is in fact, to this hour, nearly such as it may be conceived to have been when first uncovered by the departure of the sea; and its structure is just what may be imagined to result from the levelling effect of water under the influence of motion of no great violence. In crossing this desolate region by the main road from London to Portsmouth, it is difficult to believe that we are only forty miles distant from the capital, and midway to one of the chief naval establishments of the empire: but the nature of the soil effectually prevents improvement, and it is not improbable that this tract may remain for centuries unchanged, and still exemplify the power of geological causes in modifying the civil condition of countries, as well as their external features.

In the bottom of the "Punch Bowl," perhaps 200 feet beneath the road, a small stream arises, and the north flank of the highest ridge of Hindhead, which runs nearly west from the summit, is furrowed by nine or ten similar and nearly parallel trenches: the deepest of these is called Hackham Bottom, the stream from which is continued along the verge of Thursley Common to the Wey at Elstead. The ridge represented in the section No. 4. is that of Grayshot Down, as it appears from the lower ground on the north. It declines westward to Harem, and also to the south; so that there is here distinctly an anticlinal line, more than three miles north of the central valley of the Weald between Ludgershall and Harting-combe.

(63.) Although Hindhead is the most prominent point in this part of the country, it is not, strictly speaking, the escarpment of the Lower green-sand; for the strata, which rise very gradually on the west of the denudation, run out to the east beyond the highest summit, and caps of sand are preserved on some of the advanced ridges and in several detached points. For the same reason, Blackdown Hill, about four miles south of Hindhead, is no more than a massive cap of sand, resting with a very slight inclination upon the Weald clay: and all the deep ravines which separate the heights and ridges on the west and north-west of Blackdown, towards Lynchmere and Haslemere, have sand only at top; the clay rising here to not much less than six hundred feet above the sea. Blackdown forms the north-eastern promontory of what may be called the central valley of the denudation; the opposite and converging side of which is a similar escarpment of the Lower green-sand, extending from Harting-combe to Bexley-hill. The floor of the narrow intermediate space consists of the Weald clay, which, close to the junction, abounds in *Cypris Faba*; and where the valley opens into the wider expanse of the Wealds, the first range of the Wealden sand and sandrock, described by Mr. Martin, about 25 feet thick, and at a vertical distance of about 200 feet from the top of the clay, forms a sort of bar, or elevated ridge, across the entrance; occupying an extensive surface between Ludgershall upon the Lod, and Northhurst, and being thence continued, at a corresponding distance from the top of the clay, all round the denudation. The course of the Lower green-sands on the south and south-west of this valley having been pointed out by Mr. Murchison, it is unnecessary to pursue this description farther.

(64.) *Weald Clay.*—The lowest beds of the tract near Guildford have recently been exposed in a pit for the extraction of gravel at Pease-marsh, an extensive flat on both sides of the London road, between Arlington, south of Guildford, and Godalming. On examining the place, to which my attention was called by Mr. Murchison, I found beneath a thickness of four or five feet of flint gravel and sand, distinct strata of blue clay, nearly horizontal, though with an irregular surface, including flat nodular concretions of iron pyrites, also horizontally disposed. No fossils were visible; but from the situation and characters of the clay, it seemed most probably to be that of the Weald, brought up into this close proximity to the chalk, by the general elevation of all the strata. It is indeed probable that the Weald clay is very near the surface in many other places; but as the middle group of the sands is also retentive of water, and capable of sustaining ponds, the distinction can be ascertained only by attention to local circumstances. The difference of level is so small in the different portions of the Wey, from Pease-marsh, by Godalming, Pepperharrow, Elstead, and Tilford, that this clay may be the base of the stream throughout; but many of the ponds which occur at higher levels, in the tract between Dorking and West Sussex, may safely be referred to the middle group of the sands *.

(65.) *Tucksbury-hill*†, *&c.*—The summit of this hill, which forms the northern extremity of the section, Plate X. a. No. 4. is an outlier composed of siliceous and ferruginous sand, upon the surface of which are numerous angular fragments of pale yellowish flint. The ground descends from it on all sides, but with the greatest rapidity towards the valley of the Wey; and it affords an excellent view, both of the successive outcrop of the strata in the lower country, on the south-east, and (especially) of the tract on the north, occupied by the Bagshot sands ‡, to which the cap of the hill seems to belong; the flat-topped ranges and the lower barren tracts of that formation being seen from hence very distinctly. The summits of Romping-down and Chobham-ridge project above the surrounding country, with escarpments towards the east, nearly at right angles to the range of the Chalk Downs; but the general rise of the sands is towards the south, conformably to that of the chalk §. The succession of strata observable in

* Such are probably the ponds of Berry-hill, Lonesome, Wotton, and Abinger, near Dorking; of Thorncombe-street, Wormley-heath, Witley, and Lea-house, near Godalming; Frensham Great Pond; and many of the pieces of water in Woolmer Forest. Several of the ponds near Pulborough can with certainty be referred to the geological place mentioned in the text.

† This name of the hill is taken from the Memoir connected with Mr. Greenough's map. In the Ordnance map, one point on the summit is called *Farnham Beacon.*

‡ Warburton: in Geol. Trans., 2nd Series, vol. i. page 48.

§ I had proof of this rise, in passing along the main road from Guildford. At an early hour of the morning, in October, all the flat country on the north was occupied by a dense uniform fog, which filled the inequalities at the foot of the sand-heights on every side. Above this sea or lake of mist, which afforded a sort of fluid level, the tops only of the ridges were visible, like long dark islands, the southern extremities of which were uniformly higher than the northern; the intermediate line declining at a very small but perceptible angle.

descending from the elevation to the valley of the Wealds, is very instructive.

At the west end of the hill, beneath Warren's-corner, on the road to Basingstoke, Septaria are found in a stratum of the London clay, which occupies a considerable thickness on the slope of the hill, below the cap of sand. I was informed that "Pot-earth," of a different quality, occurs lower down, in Clarehouse-Park, in the situation of the Plastic clay; and I have seen the Chalk in the decline of the hill, between Lower Old Park and Halfway-house.

The Upper green-sand forms a slight prominence beneath this chalk, on the south of Dippenhall-house, between the words 'Dean's-farm' and 'Ridgway' on the Ordnance map, the strata dipping not much more than 5° to the north. The rock, which is there called 'Marl-stone,' does not precisely agree with any I have seen between this place and the coast, but is very like some of the strata in the corresponding place at East Knoyle, on the north of the Vale of Wardour. It is a subcalcareous sandstone, or variety of "fire-stone," very soft, uniform, of a yellowish-grey or cream-colour, scarcely effervescent, and remarkable for its lightness; and it includes concretions of a hard splintery limestone, approaching to chert, and of much greater density than the stone which surrounds them.

The Gault, on the line of the section, first comes up on the road descending from Ridgway to the river Wey, but is more distinctly seen at the extremity of Wrecklesham; and, in consequence of the more gradual rise of the strata, on the south-west of that village, it occupies a more expanded surface in Alice-Holt Wood, as described in Mr. Murchison's paper above referred to.

On the south of the main London road, where it is crossed by the road to Wrecklesham, is a bank with the Lower green-sand at the bottom, rising towards the village. The surface is waved remarkably; and the inequalities are filled up with gravel, consisting of broken flint pebbles, in large proportion, mixed with red loam, and in immediate contact with the yellowish sands below. The top of the gravel, is nearly level; but its depth to the sand varies from 1½ to 4 feet. This fact is analogous to the erosion of the sands near Dorking, mentioned above (56).

(66.) The mode in which the drainage of the north-western portion of the great valley of the Wealden is effected, and the different manner in which the streams escape, in this part of the country, from that of their egress through the North and South Downs, support the hypothesis of Mr. Scrope and Mr. Martin, that the gorges themselves were not produced by simple denudation, but at least prepared, by antecedent fissures cutting entirely across the Weald: while the appearances of the surface, above described, are so unlike those which would have been produced by rapid diluvial action, as to indicate either a long period of submersion, at no great depth, or very gradual drainage and long-continued decay.

The principal branch of the Wey, from its rise near Alton, to Farnham, is nearly straight, in a direction from south-west to north-east; but immediately below Farnham, instead of cutting across the chalk downs, it turns abruptly to the south-east, to join another branch; which likewise runs in a straight line nearly parallel to the former, from its source in the chalk near Selborne, through Kingsley, by Frensham, to Tilford Bridge, where the streams unite: and then taking a tortuous course, but in a general direction parallel to the Hog's-back, the river cuts deep through the platform of the sands, on the north and west of Godalming, receiving several streamlets by the way. But there, instead of continuing its direction, it turns suddenly to the north; and receiving another branch from beyond Cranley, far within the valley of the Wealds, cuts almost directly across both the green-sand and the chalk, and makes its way to the Thames at Weybridge. The mere closing-up of the defile at the mills on the north of Godalming, would convert the whole of Pease-marsh, Frensham, and Thursley commons into a lake:—and, on the other hand, a slight excavation towards the north, through Frensham to the river, would drain the great pond there.

The sudden change in the direction of the Wey, near Farnham, is the more remarkable, as the Blackwater, which rises on the northern slope of the chalk downs between Farnham and Aldershot, about two miles from the angle of the Wey near the west end of the Hog's-back, runs on the Bagshot sands, towards the north and west, by Frimley, Blackwater, &c., to join the Lodden, not far north of Strathfieldsay, in its course to the Thames near Shiplake. The line of the Wey, therefore, from Alton to Farnham, is nearly a continuation of that of the Blackwater*; the two streams being separated only by the prominence of the chalk between the Hog's-back and the foot of Tucksbury Hill†.

The gorge of the Wey is nearly opposite to that of the Arun, on the south of the Wealden, one branch of which runs almost directly north and south, from a point between Loxwood and Slinfold, to the sea at Little Hampton; and the structure of the two rivers is very much alike. The Arun rises in the centre of the Wealden tract, whence it runs directly to the sea; as does the Wey from Cranley: but it receives, near Pulborough, at right angles to the main stream, the copious branch (if it be not rather itself the principal stream,) called the Rother; which, having risen near the ponds of Wolmer Forest, very near the sources of the Wey, and followed the curves of the denudation for more than twenty miles, in the trough between the chalk escarpment and the Lower green-sand, is then carried suddenly out of that direction, and withdrawn from the valley of the Weald.

(67.) From whatever cause the transverse course of the streams may have originated, the relative composition of the strata was favourable to their retaining that direction, when once they had made their way across the chalk and Upper green-sand. For, as the lower beds of the chalk itself, and still more the Gault, are remarkably retentive, while the upper chalk is permeable by water,—the slope of all the strata being outwards, or from the central ridge of the valley, the whole of the waters imbibed by the chalk would be determined outwards, if any pervious channel were opened at its bottom. And if a fissure were cut through the whole series, without great vertical displacement, the retentive beds of the chalk-marl and clay, would immediately reunite, and close it below; while, the chasm in the chalk above remaining open, a permanent drainage outwards would be produced, and the break would be continually enlarged.

* The main stream of the Wey is that which runs direct from Wolmer to Shalford. See the map.

† It should, however, be kept in view, that the bed of the Blackwater hereabouts is several feet above that of the Wey.

(68.) The following is a list of some of the fossils obtained from the strata above the Weald clay, within the portions of Kent and Surrey mentioned in the preceding sections (37. to 67.):—

List of Fossils of the Gault and Green-sands, in the INTERIOR OF KENT, *and part of* SURREY.

Ammonites dentatus. Gault. Brick-field near Westerham. F.
A——— lautus. Gault. Same place. F.
A——— splendens. Gault. Bletchingley, Surrey. Mantell.
A——— tuberculatus. Gault. Brick-field near Westerham. F.
A——— ? A fragment of a very large Ammonite (or Hamite?), was found by one of my sons (W. I. F.), among the lowest beds of the green-sand on the south of Brasted in Kent; which, when complete, must have formed a spiral between two and three feet in diameter. The separate convolutions are about nine inches in breadth; and the flutings of the surface, which are simple, are about two inches across the broadest part, and in depth about an inch. The specimen belongs, not improbably, to one of the large species which occur in the Gault of Yorkshire, (see Phillips).
A———. Four species occur at Boughton quarries.*
Ampullaria canaliculata. Gault. Bletchingley, Surrey. Mantell.
Belemnites minimus. Gault. Bletchingley. Mantell.
B———. A large species. Boughton quarries. Also at Cold Harbour, near Montreal Park, Sevenoaks, Kent. F.
Cucullæa. (Species doubtful.) Lower green-sand. Boughton quarries. F.
Dentalium decussatum. Gault. Brick-field near Westerham. F.
Exogyra conica. Boughton. F.
E——— lævigata. Boughton quarries. F.
Fistulana. (Species doubtful.) Ditto. F.
Gervillia. (Species doubtful.) Boughton. F.
Gryphæa sinuata. Boughton. Also near Brasted; West Kent. F.
Inoceramus concentricus. Gault. Brick-field near Westerham. F.
I——— latus. In a fragment of yellow quartzose chert, loose on the surface, near Brasted, Kent. F.
Modiola parallela. Lower green-sand; Near Maidstone. M. C.
Mya. (Species doubtful.) Boughton quarries. F.
Nautilus elegans. Boughton. F.
Nucula pectinata. Gault. Brick-field near Westerham. F.
Pecten quinquecostatus. Lowest green-sand. Riverhill. G.
Pholadomya. (Species doubtful.) Boughton. F.

* All the specimens from Boughton were found in the Lower green-sand: the greater part in the soft grey calcareous rock, full of green particles, called "Hassock."

Plagiostoma. A small species. Lowest beds of the green-sand: Riverhill, near Sevenoaks. Mr. Goodhall.

Pleurotomaria striata*. Pl. XIV. f. 16. Boughton. F.

Plicatula pectinoides. Boughton. F.

Rostellaria carinata. Gault. Bletchingley. Mantell.

Serpula. Boughton. F.

Sphæra corrugata. Lowest green-sand. Trevereux, near Lympsfield, Surrey. F.

Terebratula Gibbsiana. Boughton. F.

T———— oblonga. Lower green-sand. Riverhill. G.

Thetis major? Boughton. F.

Trigonia alæformis. With two or more other species. Boughton. F.

Turbinolia Kœnigii. Gault. Bletchingley. Mantell.

Venus angulata? (Cyprina.) Large, flat. Boughton. F.

Wood, Dicotyledonous. Boughton; and near Brasted, West Kent. F.

Hyæna. Portions of the bones of the extremities of this animal, and fragments of the skull and teeth, both molar and canine, with pieces of Album Græcum, have been found imbedded in brownish sandy loam, at the top of the quarries of Boughton Mount. F.

Iguanodon. Distinct remains of this reptile, found by Mr. Binstead in the Lower green-sand at Rockhill, near Maidstone, have been examined and described by Mr. Mantell. See note on (38).

Hampshire and Western Sussex.

The south-western portion of the Wealden denudation has been so fully described by Mr. Murchison and Mr. Martin, that I shall refer to their publications already quoted, for an account of it; giving here only some additional facts with which I have been favoured by those two gentlemen: and for a similar reason I shall leave untouched the territory of Mr. Mantell in Western Sussex.

(69.) *Hampshire.*—Accumulations of broken chalk flints have been found very extensively, over the surface of the Lower green-sand, on the new road from Petersfield to Midhurst in West Sussex; at Sheet Hill; and several other places in this part of Hampshire. In the former situation, which is about three miles from the nearest chalk, the detritus covers an uneven surface of the sand, which appears to have been acted upon precisely in the same manner as that

* In the list of the fossils of the vicinity of Folkstone (p. 131.), this shell has been called a *Trochus*: but a very fine specimen obtained from Kent, and kindly mentioned to me by Mr. Charles Manning, has since convinced Mr. Sowerby that the true genus is Pleurotomaria. See the descriptions of the new species, in the Appendix.

of the chalk itself; the sand being eroded into irregular cavities, sometimes almost tubular, which are now occupied by chalk flints, a great part of them in small fragments, and all of a rusty yellow colour. Equally abundant accumulations of these are seen also on the hills of white sand (one of the upper members of the Lower green), at Stedham and Trotton commons, between six and seven miles east of Petersfield; but in this case the flints are not discoloured. This latter place is distant nearly three miles from the nearest point of the chalk, and between nine and ten miles east of that where the chalk escarpments are confluent. In the angle of the chalk west and north-west of Petersfield, particularly in the ascent to Alton by Stoner Hill, such heaps are yet more common. These facts coincide with the observations already mentioned, near Boughton, Dorking, and Wracklesham (38, 56, and 65); so that it would seem as if chalk flint gravel above the Lower green-sand was of general and frequent occurrence all around the denudation. Mr. Murchison, however, adds, that he has still no knowledge of any such debris beyond the limits of that formation, or within the Wealden properly so called.

(70.) The stiff and retentive marly beds, at the base of the Downs, sustaining the water which descends through the chalk, have produced a line of ponds along the bottom of the escarpment of the South Downs;—a result precisely analogous to the breaking-out of the springs above the marl, at Lydden Spout, upon the coast (8.), and all along the base of the Downs on the north.

(71.) One of the chief characteristics of the tract near Petersfield, consists in the great relative extent and prominence of the Upper green-sand; which runs out beyond the foot of the chalk escarpment, like a step or terrace, throughout the tract from Farnham, by Selborne and Petersfield, to the south of Petworth, and affords some of the best sections anywhere to be found, except perhaps in the Isle of Wight. Though in the parishes of Buriton, Harting, &c., there is an insensible passage from the grey chalk and chalk marl, into the Upper green-sand, still the *whole* of the terraces (there at least two miles broad) are exclusively composed of what is called in the country *Malm-rock**. The grey or lower chalk of this portion of the South Downs is charged with the *Inoceramus mytiloides, I. Cuvieri, I. Brongniarti*, and two species of small plicated Terebratula, and does not contain any of the characteristic malm-rock fossils enumerated in Mr. Murchison's memoir; nor does the malm-rock contain, so far as his observation goes, a single specimen of the genera Inoceramus and Terebratula, so abundant in the overlying

* The *Malm-land*, which is remarkable for the fine crops of corn produced upon it, is, properly, the soil over the lowest beds of marly chalk, which are carried out upon the tops of the projecting terraces; the term, "*Malm-rock*," being confined to the stony beds beneath.

chalk: a fact which is the more deserving of attention, as several other genera and species are found both in the Upper green-sand and the Lower chalk*.

(72.) *Vicinity of Pulborough.*—I am indebted to Mr. Martin for the section (Plate X a. No. 5.) across the Wealden district, from Duncton Beacon on the South Downs, through Petworth, to Cranley; and I have, from my own observations, continued it in the same direction to the North Downs. This section shows, what Mr. Martin's recent observations have fully confirmed, that the subdivisions of the sands below the chalk, in the north-west of Sussex, correspond with those above described, in the neighbourhood of Folkstone; and that a similar valley distinctly marks, in both cases, the place of the middle greener and retentive sands, (24.). I have had myself also an opportunity of seeing, with Mr. Martin, a section parallel to that of Plate X a., in which this structure is very clearly displayed, on a line about half a mile west of Pulborough, passing through the heights of Park-hill farm and Pethenden (with the valley of the middle sands between), to a detached summit within the Weald-clay, called Pickhurst Hill; (See Plate X b. fig. 2.). Fuller's-earth like that of Nutfield, appears at Fittleworth Church, near Pulborough.

Besides the mass of this intermediate group, a detached stratum, about 40 feet in thickness, of dark-coloured, greenish grey, retentive sand, including much pyritous matter, occurs above it, with some feet of ferruginous and yellowish sand between;—a subordinate bed, in fact, *within* the upper ferruginous mass of the sand: and this ought to be held in view, as in some cases it might be mistaken for the Gault. It is very conspicuous on the ascent of the London road, from the flats on the south, to the church at Pulborough; and can be traced thence, almost continuously, for some miles both to the east and west. No fossils have been found in this stratum, except some impressions of what may be the branches of fuci. A bed of dark hue, with the same characters, seems to occupy a corresponding place in the series near Reigate: See note † on (52.).

(73.) This country has been the scene of several upheavings and derangements of the strata, analogous to those above mentioned in West Kent (41. to 43.), but much more complex and extensive. Some of these have been described in Mr. Martin's work already referred to; and of others, more recently observed by that gentleman, I hope he will himself soon publish a description‡.

* See Mantell's "Tabular Arrangement of the Organic Remains of Sussex"—Geol. Trans. 2nd Series, vol. iii. p. 210. Terebratulæ are there mentioned among the genera common to both deposits.

‡ The forces by which such derangements may have been effected, appear to be still in action in this part of England. In the spring of the present year, 1834, distinct shocks of an earthquake were felt throughout a tract, of which Chichester seems to have been the principal point. At Pulborough, they were of such force as to ring the bells at the parsonage. An account of the phenomena, is, I believe, in preparation, by some members of the Philosophical Institution at Chichester.

(74.) The junction of the sands and clay, at Stopham brick-yard, on the west of Harwood's Green, near Pulborough, affords the only indications that have come to my knowledge, of any interruption or disturbance between the deposition of the upper part of the Weald clay, and of the incumbent Lower green-sand. The surface of the clay at the place in question is hollowed into irregular roundish cavities, at the bottom of which portions of green-sand were found, including several of the characteristic fossils of that formation; while the clay, immediately below, is equally characterized by the presence of Cypris. At the junction, the clay was mixed with sand; and specimens of *Panopæa plicata* were found even two or three feet within nearly pure clay, along with ferruginous concretions, containing fossils of the Wealden, impressions of Cyclas, Cypris, and remains of fishes: and this mixture was observable to the depth of several feet;—so that both the sand and clay must have been at the time of mixture in a state of softness; or the sand must have been introduced over a surface of argillaceous mud, before it had consolidated. When I had the pleasure of examining the place, with Mr. Martin, the circumstances were unfavourable to observation: and, as the junction of the two formations here, is on the slope of a hill, it might have been doubted whether the appearances could not be explained by the effects of subsidence producing intermixture, during very rainy weather, or under water, before any of the strata had emerged. Mr. Martin, however, who had seen the place when the phenomena were better exhibited, is of opinion that this explanation of them would not have sufficed. In this brick-yard, the loamy sand found near the junction is used *alone* for making the bricks; sand being required in the manufacture, only for sprinkling the moulds.

(75.) *List of Fossils from the Beds below the Chalk, in part of* HAMPSHIRE *and* WESTERN SUSSEX.

[*Upper Green-sand.*]

The following List of Fossils from the Upper green-sand in the vicinity of Petersfield, in addition to those mentioned in Mr. Murchison's paper on that district, (Geol. Trans. 2nd Series, vol. ii. p. 99.) I owe to the kindness of Mrs. Murchison, in whose collection the specimens are placed.

Ammonites catillus.
A——— splendens.
Arca carinata.
Avicula gryphæoides. (See Pl. XI. f. 3.)
Cucullæa. Much compressed.
Echino-spatangus. (Three new species.)
Fishes. Scales and vertebræ.
Gryphæa columba.
G——— vesiculosa.
G——— sinuata.
Nautilus elegans?? Much compressed.
Pecten asper.

Pecten Beaveri.
P—— nitidus.
P—— orbicularis.
P—— quinquecostatus. Besides one or two other species, indistinct.
Plicatula inflata.
Solarium granulatum. Mantell.
S—— or *Trochus.* Another species.
Thetis major.
Vegetable impressions. Like those of the upper chalk near Lewes. Mantell, t. 9. p. 157.

[*Lower Green-sand.*]

Ammonites dentatus. Stopham brick-yard, West of Pulborough, Sussex; in a mass of phosphate of lime. This, with the other fossils from the same place, was found by Mr. Martin covered by green-sand, in an excavation at the top of the Weald clay. Martin MSS.

A————. (Near to *Nutfieldiensis*, but a distinct species.) Lowest member of the sands near Pulborough: Martin.

A————. (Impressions of one or two other species.) Stopham brick-yard: Martin MSS. One of these is in a roundish mass of phosphate of lime, precisely like specimens found near Copt Point, Kent: the outer surface is whitish, and is eroded in small tortuous grooves, as if eaten by worms: the interior brown.

Auricula (new species). Martin, *ibid.*

Avicula? Martin, *ibid.*

Cardium? (New species; delicately striated.) Stopham brick-yard: Martin MSS.

Coprolite. Stopham brick-yard: Martin MSS.

Corbula gigantea. Bowyer's Common: Mrs. Murchison.

C—— striatula. Bowyer's Common, near Petersfield: Mrs. Murchison. Parham: Mantell, and Martin.

C—— (new). Near Pulborough: Martin, p. 32.

Crustacea. "At Bognor Common, in Fittleworth parish, there is a vein of friable "green-stone, rich in Pectens, Trigoniæ, and the remains of a crustaceous fossil "like a shrimp." Martin, p. 34, note.

Cucullæa decussata. Parham: Mantell, and Martin.

C——— glabra? Bowyer's Common: Mrs. Murchison.

C———. (Another species—or two?) Stopham brick-yard: Martin MSS.

Cyprina angulata. (*Venus*, Min. Con.) Stopham: Martin MSS.

Cytherea parva. (*Venus*, Min. Con.) Parham: Mantell. Bowyer's Common, and Lyss near Petersfield: Mrs. Murchison. Upper ferruginous member of the Lower green-sand, Pulborough Mount: Martin MSS.

Gervillia acuta. Parham: Mantell.

G——— aviculoides. Parham Park: In concreted masses of fine-grained ferruginous sand, with several other species mentioned below; all casts: Martin. Also Bowyer's Common: Mrs. Murchison.

G——— solenoides. Parham: Mantell.

G———. (Another species, probably new.) Upper ferruginous member of the sands: Martin.

Inoceramus gryphæoides. Lowest group of lower green-sand: Martin, p. 33.

Lima semisulcata. Plate XI. fig. 10. Pulborough: Martin.

Lucina? Bowyer's Common: Mrs. Murchison.

L——. (Perhaps two species.) Lowest member of the sands; near Pulborough: Martin.

Modiola æqualis. } Parham: Mantell.
M—— *bipartita.* }

M—— *imbricata.* Upper ferruginous sands: Mantell, and Martin.

M—— bella. Plate XI. fig. 9.

M——. (A new species.) Near Pulborough: Martin, p. 32.

Mya mandibula. Lowest member of the sands. Pulborough: Martin.

M— *plicata.* (See *Panopæa plicata*).

M—. (Two species not figured.) Martin, p. 33. Lowest group of lower green-sand.

Mytilus edentulus? Martin, p. 32.

M—— *lanceolatus.* Parham: Mantell.

Natica. Parham: Parkinson; Organic Remains, vol. 3. Pl. 6. fig. 2. Lyss near Petersfield: Mrs. Murchison.

Nautilus. Near Pulborough: Martin, p. 31.

Nucula impressa. Parham: Mantell. Lowest member of the sands; Pulborough: Martin.

N—— *antiquata.* Upper ferruginous member of the Lower green-sand; Pulborough Mount: Martin.

Orbicula. (Not figured.) In sand rock: lowest member of the sands; Pulborough and Stopham: Martin.

Panopæa plicata. Lower member of the sands; Parham Park, and Stopham brick-yard: Martin MSS.

Patella. Parham: Mantell.

Pecten obliquus. Parham: Mantell, and Martin.

P—— *orbicularis.* Pulborough: Martin. Parham: Mantell.

P—— *quadricostatus.* Parham: Mantell.

P——. (A new species.) Martin.

Pholadomya. Lowest member of the sand near Pulborough: Martin, p. 32. and MSS.

Pinna tetragona. In sand-rock; lowest member of the sands: Martin.

P——. (A cast.) Stopham brick-yard: Martin.

Rostellaria calcarata. Parham: Mantell.

R——— *Parkinsonii.* Parham: Mantell. Upper member of the sands; Pulborough Mount: Martin.

R———. (Very like *Pes Pelicani.*) Parham: Mantell.

Tellina æqualis. } Parham: Mantell, and Martin.
T—— *inæqualis.* }

T——? (A species not figured.) Lowest member of the sands, near Pulborough: Martin.

Terebratula lata. } Parham: Mantell.
T——— *ovata.* }

Terebratula nuciformis. Upper member of the sands; Pulborough Mount: Martin.
T——— *depressa.* Upper ferruginous member of the Lower green-sand; Pulborough Mount: Martin MSS.
T———. (Another species—uncertain.) Same place: Martin.
Thetis major. Lowest member of the sands; Pulborough: Martin.
T—— *minor.* Bowyer's Common, and Lyss, near Petersfield: Mrs. Murchison. Parham: Mantell. Upper member of the sands; Pulborough Mount: Martin.
T—— (new). Stopham brick-yard. Martin MSS.
Trigonia alæformis.
T——— *clavellata?* } Bowyer's Common: Mrs. Murchison. Parham: Mantell. Stopham: Martin.
T——— *dedalæa.* Parham: Mantell.
T——— *spinosa.* Pulborough: Martin, p. 33.
Turbo rotundatus. Parham: Martin MSS.
T——. (Another species.) Near Pulborough: Martin, p. 31.
Turritella granulata. Parham, and Pulborough: Martin MSS.
T———. (Another species.) Near Pulborough: Martin MSS.
Venus angulata. See *Cyprina.*
V—— *Faba.*
V—— *ovalis.* } Parham: Mantell.
V—— *parva.* See *Cytherea parva.*
V——. (Casts of two other species.) Stopham: Martin MSS.
Vermicularia concava. Parham-park, Parkmount-lane near Pulborough, Chiltington-common. Martin, pp. 33 and 34.

The Wealden.

(76.) In adopting this general denomination, proposed by Mr. Martin, for the formations below the green-sand, in the Wealds of Kent, Surrey, and Sussex, I have extended its acceptation to the Purbeck strata also, which do not occur within those counties; because the whole group abounds in fossils of the same character. And though the Purbeck strata consist principally of limestone, which has many indications of lacustrine origin, they include, like the upper members of the Wealden, distinct alternations of marine fossils with those of freshwater:—one very thick bed especially, which consists almost entirely of oysters,* showing that the sea must have had access to the waters from which they were deposited. Mr. Martin has ascertained that the Wealden strata above the Purbeck, consist, throughout, of alternations of sand, sand-rock, and grit, with clay and marl; so that the separation of the Weald-clay from the Hastings sands, is in a great measure arbitrary. But as in the only tracts where this group has yet been observed, the sands rise above the valley of the clay, into a very prominent ridge, which forms a striking fea-

* Webster: Geol. Trans., 2nd Series, Vol. II., p. 40.

ture of the surface, this subdivision is to a certain extent natural, and may be retained with advantage.

(77.) *Valley of the Wealds.*—The beds of sand, sand-rock, and limestone subordinate to the Weald clay, have been traced by Mr. Martin throughout the tract represented in his map of Western Sussex, and I refer to his memoir for an account of them: their place is indicated in the Section, Pl. X. a. fig. 5. I have myself observed beds of the same description,—no doubt continuous with those described by Mr. Martin, though I have not traced their continuity, on the opposite side of the Wealden and of the forest ridge, about Ewhurst, and on the east of that village*. And in the course of the valley eastward, through Surrey and Kent, distinct and almost continuous ridges, apparently produced by the greater durability and prominence of similar strata, are observable from the escarpment of the sands, and are in part expressed in the Ordnance Maps.

Two, if not three lines of these subordinate strata cross the road which descends from the escarpment of the sands through Ewhurst. 1. The first is at the foot of a height, which runs from the south of Coneyhurst Farm, through Woodland; the beds consisting of limestone, (Sussex marble) full of large Paludinæ and Cypris. A group, possibly a continuation of this, occurs in Mr. Turner's grounds, north of Forest Green, at Atherley, about two miles east of Woodland, below Leith-hill Place; but there the stone is greenish micaceous grit, in three contiguous courses, each about 12 inches thick, containing very large Paludinæ, Uniones, and stemlike concretions, where the stone adjoins the whitish sand, on which it rests. Above Henhouse Farm also, about a mile and a half east of Atherley, a range of high ground indicates the presence of firm bands of stone; and grit is found there, which includes similar Uniones, and a few Paludinæ. 2. A second band, composed of ironshot sand, over variegated reddish brown clay, crosses the road, at the church of Ewhurst, passing thence eastward through Lyefield Farm. The stone-pits of Forest Green seem to be on this line, but they consist of beds of grit including Uniones and Cypris, above yellowish sand, reddish clay, and concretional sandstone, with casts of Uniones. 3. At Bowles's Farm, on the east of Cranley, is a bed of very compact sand-stone, apparently lower in the series than those above mentioned: and the roads hereabouts are repaired with grit from Newhouse, between Cranley and Ewhurst. Stone is also found nearly on the same line eastward, at Redford and Standling; and again on the south of Capel (on the road from Dorking, about a furlong north of the 30th mile-stone), is a prominent ridge, with a course of sand, in beds from 2 to 6 inches thick, in light-coloured clay.

The height last mentioned, near Capel, may probably be the continuation of a ridge which, on the Ordnance Map, begins about 3¼ miles to the east of that place, passing from Stand-hill, through Norwood and Horse-hill; and which (being resumed on the east of the Mole), forms a range nearly parallel to the escarpment of the Lower green-sand,—by Lady-farm, about two miles south of Earlswood-common on the road from Reigate to Brighton, Outwood-common, Lostland, south of Gayhouse-farm, and thence, through Hook-stile, to the stream south of Comfort's-Place farm, and Moat farm. On the east of the place last mentioned, the ridges between the Lower green-

* See the eastern part of the Section, fig. 5.

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forms a range nearly
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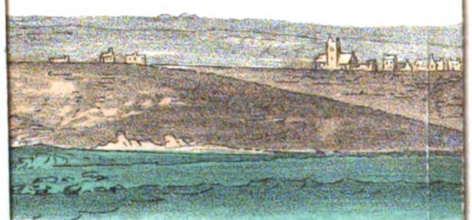
Sketch of Part of the

Quarries 50 feet

Shanklin Isle of Wight *Artillery B*

Sandg



feet *Spring breaks out*

Chalk

sand and the Hastings sand, are not so well defined; but on the south of Boughton, a series of heights extends from Marden to the east of Staplehurst.

(78.) *Coast of Kent.* There is, strictly speaking, no section of the Weald clay and the upper part of the Hasting sands on the coast of Kent; the line of heights which, at some very remote period, may have been sea-cliffs washed by the English Channel, being now covered with vegetation, and separated from the sea by the wide tract of Romney Marshes. Having, myself, some years ago, observed indications of sand and stone, in the Weald valley near the coast where it is difficult to find good sections exposed, my friend the Rev. G. E. Smith was good enough, at my request, to examine that part of the country; and from his notes I learn that the greater part of the series there must consist of sand and sandy clay,—the blue fissile clay, which occurs in the upper part of it, not recurring, or not having been detected, farther down.

The first rise of the clay from beneath the green-sands, is represented in the view Plate VIII.; and the general section of the coast between Folkstone and Beachy Head, (Plate X. a. No. 6.) includes the strata on the west of Hythe. The shore beneath that town, which is sometimes laid bare, when the sea carries away the shingles, during the prevalence of easterly winds, consists of soft bluish clay, which has the characters of river mud, and differs much from the uniform slaty clay of the Wealds. But the latter has been cut through in sinking wells above the main street of Hythe, which, in some instances, have gone to the depth of 75 feet entirely in clay. In one of these wells, the succession of beds was thus;—beginning at a point about 60 feet beneath the bottom of the Lower green-sand.

Upper Part of the Weald-Clay at Hythe.

		Ft.	In.
1.	Soil	2	6
2.	Reddish tough clay* .... 6 to	7	0
3.	Greenish sandy clay, in thin bands, alternately of dark and lighter hues.. 5 to	6	0
4.	Blue, uniform, slaty clay, containing Cypris about a foot from the top .. about	5	0
5.	A band, composed of argillaceous iron ore, abounding in *Paludina elongata*, and Cypris		?
		18	0
6.	Blue clay continued. Here a boring was made to a depth of about 20 feet: all in bluish clay	20	0
	Total	38	0

Blue clay with Cypris occurs also, according to the Rev. G. E. Smith, immediately below the green-sand, at Aldington Corner; but nothing like it, he informs me, in the succeeding parts of the section towards the south. A bed of limestone, with Paludinæ ("Sussex marble") occurs at Hurst†, beneath Court-at-Street, and seems to be continued in the clay which passes from that place round the base of Aldington Knoll; and a similar stone is found, in a corresponding situation in the cypriferous clay, at Daniell's Water on the south-west, Stanford Bridge, on the

* In descending from the sands at Linton, south of Boughton, and in many other places, the top of the Wealden is seen to consist of very red clay.

† The term *Hurst* is of such frequent occurrence in the names of places in Kent, Surrey, and Sussex, that the Ordnance Maps alone afford a List of about 120 such names. Having sent this List to the Rev. Joseph Hunter, late of Bath, that gentleman has favoured me with some obser-

west of Ashford, and near Bethersden, about 22 miles south of Stanford Bridge. A continuous range of slightly elevated ground, extending from Lovelace near Bethersden towards Shadoxhurst (in a direction parallel to that of the other ridges of this country, and to the range of the chalk escarpment), may also indicate the existence of some stratum of greater firmness than the clay.

Mr. Smith mentions two subordinate courses of sand, with sand-rock, sandy clay and loam, as occurring in the lower tract, or valley of the Weald, between Aldington Corner and the cliffs of sand and grit on the north of Rye. (1.) The first of these runs from near Bilsington, through Orleston; with which line a range in the interior seems, from the map, to be continuous, for about four miles more towards the north-west,—through Woodchurch Beacon and Redbrook Street. It seems to be parallel to the ridge above mentioned between Bethersden and Shadoxhurst; and sections of the strata are disclosed at Bilsington Priory; on the roads from Bilsington Cross to High-house; from Ruckinge to Ham Street, and from Ham Street to Orleston; and perhaps near Warehorn Leaton. (2.) The second course, which consists of red clay with sand and sand-rock, begins at Brookarm, on the verge of the marshes, and passes through Bench-hill. On the south of this last-mentioned range, sand and sandy clay appear to abound: concretional beds of hard

vations of so much interest, that, but for the immediate object of these pages, I should willingly have inserted them in full.

" The word," Mr. Hunter states, " does not occur in Lye's Saxon Dictionary; but I observe " that the modern Lexicographers speak of a Saxon word, hẏrſt, as synonymous with *sylva*; and " *hursta*, it seems, occurs in low Latin, for 'wood'. Wachter explains *Horst*, Germ., 'locus " 'nemorosus et pascuus'; and refers it to ὀρος, mons. Kilian has *Horscht*, Teut. 'virgultum; " 'sylva humiles tantùm frutices proferens.'

" In England, *Hurst* appears to signify a small wood; but, in Scotland, a barren height or " eminence, and sometimes a shallow in a river. I do not find the word," Mr. Hunter continues, " in any of the provincial glossaries; and yet I think it is not quite out of use, in its uncompounded " state, to denote a Wood, generally; but I much doubt whether any specific difference can be dis- " covered between the sense of this word and that of many other words, in a language which is " particularly rich in terms which designate woods, or woody places: *grove, thicket, copse,* " *brake,* &c.

" If *Drayton's* authority (*Polyolbion*, viii. 2.) were not thought sufficient to prove that in " England the word was formerly used to signify a Wood, the combinations in which it occurs in the " names of innumerable places, dispersed all over the southern part of the island (i. e. south of the " Tweed), would be sufficient to prove it. There is *Oak-hurst*, *Ake-hurst* (a varied form of *Oke-* " *hurst*); *Elm-hurst*, everywhere; *Ew-hurst*, *Hasel-hurst*, *Ash-hurst*, *Ashen-hurst*, *Maple-hurst*, " *Nut-hurst*, *Beam-hurst* (Staffordshire), *Brere-hurst*, *Box-hurst*; besides many *Hursts* without " any prefix,—of which *Hurst-Monceaux* is one; *Monceaux* being an addition made after the Con- " quest, from the name of some Norman Lord.

" So many instances in which the names of trees are united with this word, would, I think, of " themselves be sufficient to prove that it was really in use in England, in the sense of 'wood'; and " it may be added, that it lies deep in the language,—the wòods so designated being older than " the towns which have risen near them, and those towns of Saxon foundation.

"Again, there are other instances in which the adjunct is congruous with this idea of *Hurst*; such " as *Hawk-hurst*, *Crow-hurst*, *Broad-hurst*, *Buck-hurst*, *Brocklehurst* (Brock-hole-hurst),—the wood " where the badger (brock) made his holes. So also *Brock-hurst*, *Park-hurst*, *Coney-hurst*, &c. &c.

" It must, however, be admitted, that there are many names of places, into the composition of " which the word *Hurst* enters, of which it is extremely difficult to trace the origin; and when " those for which we can account are taken out of the list, it is hard to form even a conjecture con- " cerning those which remain. In this respect, however, the compounds of *Hurst* are but in the " same predicament with the prefixes to *-ton*, *-ham*, *-field*, *-by*, and many of the local terminals; " and probably they are, in many instances, the names of early Saxon proprietors, detorted " from their original forms. Some, however, more skilful etymologist, or one better acquainted " with the language of our ancestors of the 6th and 7th centuries, when probably these names first " became fixed, might explain:—*Shadocks-hurst*, *Cog-hurst*, *Bub-hurst*, *Tile-hurst*, *Sissing-hurst*, " *Capen-hurst*, *Dicken-hurst*, &c. &c."

grit, with Paludinæ and Cypris, occurring in the sands about Stone and Knock-house; and still more conspicuously in the range of heights further south, which extends from Boons-hill to the cliffs below Playden, not far from Rye.

(79.) *Hastings Sands.*—Mr. Webster has described and given a drawing of the cliffs on the east of Hastings, in a preceding volume of these Transactions*; and a general section of the coast between the chalk downs of Kent and Sussex will be found in the annexed Plate, X. a. No. 6.† I shall not, therefore, here detail the stratification of this portion of the Wealden, especially as lists of the strata will be given hereafter, in describing the coast of the Isle of Wight and of Dorsetshire; but shall confine myself to an account of the cliffs, on the west of those represented in Mr. Webster's Sectional View,—which were uncovered to a great extent during the progress of the buildings and improvements recently carried on between Hastings and St. Leonard's‡.

(80.) *Shore on the West of Hastings.*—The anticlinal line of the ridge consisting of the Hastings-sands runs inland, from the shore towards a point about 60° west of north; beginning on the east of Hastings, about Lee Ness Point, and passing through Battle, and thence along a series of ridges, to its greatest height at Crowborough Beacon, on the south-west of Tonbridge Wells. The strike, on the west of Hastings, is not parallel to the anticlinal ridge, but oblique to it at an angle of about 44°, the strata running nearly from east to west, and dipping generally towards the south. The direction of the coast line for a short distance, at St. Leonard's, coincides with the strike, but from Hastings to the entrance of that place, makes an angle with it of about 10°,—the line of the shore running from about 14° north of east, towards the south of west; and on the west of St. Leonard's, the coast turns a little towards the north of west, and again makes a small angle with the strike. In going along the shore, therefore, from Hastings towards Bulverhithe, the strata first appear to be inclined

* Geological Transactions, 2nd Series, Vol. II. p. 31, &c. For additional information on the Wealden tracts in general, the reader is referred to Mr. Mantell's publications; Mr. Lyell's "Principles of Geology," (3rd edition), Vol. IV. chap. 21 and 23, pp.165—191, 219, &c.; and to "A Sketch of the Geology of Hastings," 12mo, 1832, by the author of the present paper.

† This general section is on the same scale of relative height and horizontal distance, as all the others in Plate X. a.; but as a correct estimate of the elevation is, in this case, important to theory, the heights are given in true proportion, on the line immediately below, as has been done by Mr. Lyell, in one of his chapters on the structure of the Wealden.

‡ The Sections following in the text, from (80.) to (90.), formed the substance of a Notice read before the Geological Society, in November, 1833 (Proceedings, vol. ii. p. 1.); and are here introduced by the permission of the President and Council.

to the south of west; then to become horizontal; and beyond St. Leonard's, to rise a little from the sea,—the same beds recurring there in a reversed order. The Section, Plate X. b, fig. 2, which is on a much larger scale than Plate X. a, No. 5, represents the cliffs here referred to, and will illustrate the structure above described.

(81.) The top of the great stratum of white and nearly pure sand, which forms the cliff under the castle at Hastings, comes down to the shore at the White Rock, and disappears under the sea on the west of it. A stratum which has many of the same characters, and seems to be a continuation of that of Hastings, rises at the bottom of the cliff, about 350 paces west of the church at St. Leonard's; all the beds in the intermediate space being consequently higher in the series. There is still some obscurity as to their relations, from the effects of disturbance; and some points are concealed: but the following list gives an approach to the order of their succession, descending,—with an estimate of the relative thickness of the groups, and the places in which they are found.

Supposed Groups of Strata on the Shore between Hastings and Galley Hill.

No.		Estimated Thickness. Feet.	Feet.
I.	Sand, and sand-rock, in large proportion; with clay, in alternate courses		150
	a. Heights above and within the entrance of St. Leonard's, from Hastings ...	50	
	b. From the archway at entrance of St. Leonard's to Warriors' Gate......	50	
	c. Space corresponding to the vacancy at Warriors' Gate (thickness estimated from the horizontal distance)	50	
II.	Sand-rock, clay, and Fuller's-earth.........................about		75
	a. Heights between Warriors' Gate and the White Rock; nearly thus, in detail:		

1. Slaty clay	8 feet.	7. Dark sand-rock, with lignite..	2
2. Sand and sand-rock..	20	8. Alternations of sand-rock, sand, and sandy clay, about	25
3. Fuller's-earth	2		
4. Sand-rock	4		75?
5. Fuller's-earth	2	9. Light blue clay, continued downwards into (III.)....	?
6. Sand-rock	12		

III. Sand-rock, alternating with grit, slaty clay, and clay iron-ore, and including one or more layers of *Endogenites erosa*, with numerous other fossils.... between 50 and 60

a. Ledge under the White Rock.

b. Strata in the cliff behind the new Brewery on the east of the White Rock. *Endogenites erosa* in great numbers.

The connexion of *a.* and *b.* with the light blue clay, (II 9.) was not disclosed: but the whole group seems to be the same with III. *c.*

c. Ledge of rocks under the "Marina" at St. Leonard's.

d. Beds around St. Leonard's church, and in the cliff on the west of it.

At these places the grit and conglomerate include remains like those of Tilgate Forest.

IV. White sand, and soft sand-rock, including thin flakes of light grey clay, and some portions of lignite .... upwards of	80
a. Cliff under the castle, Hastings.	
b. Shore below, and on the east of the White Rock.	
c. Bottom of the cliff, near the Sussex Hotel, west of St. Leonard's.	
V. Brownish sandy clay, with much lignite, immediately beneath IV.	35
a. Under the Castle-cliff, behind Pelham-place, Hastings.	
VI. Yellowish and ferruginous sand, and sand-rock, including nodules of pyrites, and grains of reddish (pisolitic) oxide of iron	?
a. Shore, about low-water mark, beneath the town of Hastings.	
b. Shore between St. Leonard's and the Martello Tower, No. 39.	
VII. Variegated clay and sand, of various shades of red inclining to purple, and light greenish grey....................................	?
a. Heights west of Bopeep.	
b. Shore from Bulverhithe to Galley Hill.	
c. Similar beds, with granular oxide of iron, are found on the east of Hastings, in the bay of the Lover's Seat, &c.	

(82.) The following details respecting the strata just enumerated may be worth preserving, as the surface of the cliffs will probably soon be concealed.

I. *a.*—The highest members of this series are partially exposed on the north of the back street, near the eastern buildings of the Marina and the archway at the entrance of St. Leonard's; from whence down to the shore is a series of strata, which are horizontal on the line of the strike, but rise in reality towards the north, at an angle between 12° and 15°. The uppermost beds consist of soft grey sand-rock, with some intermixture of clay, and form a total thickness of about 66 feet above the road. The lower members are visible in the back street, and on the west of the houses are seen to rise towards the west. The horizontal portion occupies about 150 paces from west to east, and after that space, in consequence of a change in the direction of the shore towards Hastings, a rise towards the east begins to be apparent. The strata which connect this group with the beds of clay around the church hereafter mentioned (III. *d.*), have been carried away or are concealed.

I. *b.*—The group next below is partially seen on the shore between St. Leonard's and the White Rock. Between the archway and the vacancy in the range of heights, which is called *Warriors' Gate*, is a low cliff about 250 paces in length, and about 30 feet high, which has been cut away to admit of the erection of houses. It consists of sand-rock, alternating with clay or marl; the beds of which rise and disappear in succession, corresponding altogether to a total thickness of about 50 feet.

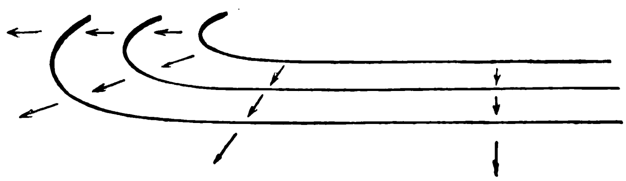
I. *c.*—The opening at *Warriors' Gate* occupies a horizontal space of about 300 paces, and within it, on the north, is a bank of sand-rock like the strata last described. On the east of this opening, a low range of grass-covered cliffs, from 40 to about 60 feet in height, extends without interruption to the beginning of the road over the projecting masses at the White Rock*; and two

* The storms during the high tides of 1833 and 1834, had so shattered the mass which bore the name of the White Rock, that very few of the interesting appearances represented and described by Mr. Webster now remain, the face of the rocks which afforded them having been either concealed or carried away. The destruction had been such in April 1834, that the town of Hastings, formerly concealed by the prominence of the shore, was then visible from the entrance of St. Leonard's.

remarkable beds of greenish Fuller's-earth, in general about two feet thick, but in some places much thicker, separated by about four feet of sand-rock, rise upon the road-side, and are continued steadily in the face of the cliff, nearly to the White Rock, being, near that place, more than 30 feet above the bluish clay (II. 9.) at the bottom. The base of the cliffs here is about 20 feet above a floor of rocks which is bare at low water, and consists of yellowish, firmly concreted sand, or sand-rock, abounding in granular (pisolitic) reddish oxide of iron*. This granulated rock forms, hereabouts, a ledge beneath high-water mark, dipping to the west of south, at an angle of about 11°, with a strike towards a point about 6° or 7° south of east.

II.—About 120 paces west of White Rock, where the road formerly began to rise over that prominence, the cliff behind the new houses, about 40 feet high, consists of a large proportion of sand and sand-rock, with alternations of clay; and in some places contains so much lignite, in the form of indistinct fragments of stems and portions of branches, as to have a dark brown or blackish hue. A bed of light bluish clay (II. 9.) forms the lowest part of this cliff, and seems to be continued downwards; it probably corresponds to the beginning of the series of beds of clay &c., (III. *c.*) near the church of St. Leonard's.

On the shore at low water, about 150 paces west of the place last mentioned, is a group of beds which are curved, so that their dip is divergent, those on the east dipping towards the south, at



an angle of about 10°; they consist of sand-rock, and may possibly be continuous with the sloping bed at the White Rock, shown in the section, and inferior to the bluish clay of II. 9. Other appearances indicate that this has been the scene of some derangement, so that the relations of the beds, above described, to those under the White Rock and on the west of it, are still doubtful: the whole series, however, is nearly conformable, and almost continuous with the rest of the strata towards St. Leonard's.

On the east and south of the nook, in which is the light bluish clay, II. 9. a bed of brownish sand-rock about 10 feet thick, immediately adjoins the road, dipping to the south of west, at a much more rapid inclination (about 18°) than that of the adjacent strata. This bed, nevertheless, may be a continuation of those which form the curve represented above; and its present position may have been the result either of subsidence, which has caused it to fall away from the apparently continuous mass of strata within it on the north, or of some more extensive derangement of the coast at this place.

III. *a.*—*White Rock Ledge.*—The great ledge visible upon the shore at low water, to the solidity of which the prominence of the White Rock (so long as it remained) was to be ascribed, rises beneath the sea, about 200 paces to the east of the rock, and seems to be continued for a considerable distance in that direction. A series of conformable strata of sand-rock, concretional grit, and slaty clay, here occupies the whole space between high- and low-water mark, for more than 100

* This stratum I did not see in these cliffs: but granular oxide of iron abounds in those on the east of Hastings, and seems to be very generally diffused in a lower part of the series. The grains which I have here called Pisolitic, seem to have existed originally in the form of iron pyrites;—of which substance globules of various sizes from that of pistol bullets downwards, are still found on the sand-rock at St. Leonard's. The origin of the ore of iron to which the name of Pisolitic has been applied, is ascribed by Haidinger to the decomposition of pyrites.—Translation of Mohs' Mineralogy, vol. ii. p. 412.

paces; with a strike to about 20° east of south, and dip to the west of south: and this remarkable group contains in some places pisolitic grains of reddish oxide of iron, disseminated in yellow sand-rock, like that which is found in the strata beneath.

III. *b.*—The beds in the upper part of the cliff behind the Brewery are a continuation of part of the group upon the shore (III. *a.*), and, like it, contain great numbers of the singular fossil which has been called *Endogenites erosa.* They are probably the same with those of III. *c.* which rise on the shore under the Marina at St. Leonard's, of which an extensive section was exposed in excavating the site of the church; and both groups are interesting, for their apparent identity with the Tilgate strata, which have furnished to Mr. Mantell an almost inexhaustible store of extraordinary fossil remains.

Beds of the Group (III. b.) in the Cliff on the North-east of the White Rock.

	Ft.	In.	Ft.	In.
1. Earthy brown sand-rock, about..........			2	0
2. A group, about 10 feet in average thickness, composed as below.				
a. Sand in thin courses, alternating with clay, which includes Cyclades. The sand passes into grit, and in some instances also abounds in *Cyclas media* in the state of pulverulent carbonate of lime. From the different hue of the sand and clay, the cross fracture is perceptibly striped in very thin layers; and in the darker beds the surfaces of the clay are often dotted with white specks, the sections of very small cylindrical cavities, now filled with very fine sand or clay, which seem to have passed through several of the adjacent folia, vertically or obliquely	2	0		
β. Thin courses of subcalcareous grit, alternating with bands of clay. The grit is in small concretional masses, often not more than half an inch in thickness, which thin off to an edge. On the surfaces adjoining the clay are very numerous Cyclades	4	0		
γ. Flat, nodular masses of argillaceous iron ore, containing Cypris. In the fallen debris are fragments, apparently from this place, which contain also clusters of *Paludina elongata* in great numbers	3	0		
δ. Soft argillaceous sand-rock, alternating with thin layers of darker clay, and including some portions of iron ore.......... about	1	6		
ε. Alternate layers of grey sandy clay, and yellowish ferruginous sand-rock, passing into grit, and including the remains of *Endogenites erosa.* This and the succeeding stratum very much resemble (*b.*) above	1	6		
ζ. Light greenish grey sand, passing into grit, and alternating with clay, as in (*b.*). This bed contains *Paludina fluviorum,* and *Cyclas media,* in great numbers..........	2	0	14	0
3. Yellowish sand-rock, with ferruginous stains, passing in some places into grit..			3	0
4. Slaty clay, alternating with yellowish and brown sand, and including remains of leaves and stems, in the state of lignite, generally about $\frac{1}{10}$th of an inch in thickness. The lignite is divided into rhomboidal portions, separated by thin partitions of clay, which, when the coaly matter is removed by decomposition, have a deceptive resemblance to organic structure. This group passes insensibly into (5.)..........	?			

	Ft. In.	Ft. In.
5. Uniform sand, with alternations like those described above, (2. *b.* and 2. *e.*). Continued nearly to the bottom of the cliff, where the rock is a fine uniform white sand-rock, like that of the great cliff at Hastings.		
The distance from the bottom of 5. to the base of the cliff, is about		45 0
The total height of the cliff being........ about		65 0

The foregoing divisions are evidently arbitrary. In a general view, this section may be said to consist of rather more than 50 feet of thinly stratified sand and clay, with grit in concretions; including, at the upper part, a stratum of darker colour, about 12 feet thick, near the middle of which the remains of Endogenites are found.

(83.) The rock composed of alternating layers of sand, and darker sandy clay, No. 2. *a.* of the preceding list, constitutes a large proportion both of the Weald clay and the Hastings sands; and a similar alternation of sand and clay of different hues and consistency, extends upwards beyond the limits of the Wealden, into the Lower green-sand. When the masses of the rock are dry, the structure is less conspicuous, but it becomes beautifully apparent when they are moistened. The delicacy and distinctness of the folia which are then seen in the cross fracture of the beds, are very remarkable; the separate leaves being frequently as thin as paper, yet perfectly distinguishable, from their different alternating shades of greenish grey; and commonly continued with great regularity for considerable spaces; a structure clearly indicating very tranquil deposition, such as might be expected in a fluid suspending solid matter divided to extreme minuteness, yet subject to frequent changes at nearly equal intervals; which may well be conceived to have taken place in the waters of a lake or estuary, at different seasons, or during different conditions of the waters,—if it be going too far in theory to suppose the minuter laminæ to have been the produce of successive tides.

(84.) The continuity of the ledges of rock under the Marina at St. Leonard's, with those of the shore under the White Rock, is rendered more probable by the occurrence of the *Endogenites erosa* in both*. The principal ledge at the former place is very conspicuous on the shore at low water, and is one of the most remarkable geological features on the west of Hastings†. The following are the beds of which it is composed:

* I did not myself see this fossil at St. Leonard's; but Mr. Woodbine Parish, jun., informed me that the specimen represented in fig. 8, Plate XIX., was obtained at the foot of the cliff around the church.

† These prominent ledges are precisely analogous to those which occur in the Hastings sands on the south coast of the Isle of Wight, where several reefs of rocks run out almost directly into the sea, and have obtained separate names from the inhabitants. On the Sussex coast they are less conspicuous, from the more rapid dip towards the sea, and the obliquity of the strike to the line of the coast; but many more such ledges do exist, between the flat near Pevensey and Cliff-end, about midway between Hastings and Winchelsea :—see hereafter, (95.)

Beds of the Group (III. c.) composing the Ledge on the Shore beneath St. Leonard's.

		Ft.	In.
1.	Hard, subcalcareous, greenish grit, full of fossils; chiefly Cyclades, with Paludinæ, and some large Uniones	1 6 to 2	0
	A thick and nearly continuous stratum, very like the stone of *Hollington* about $2\frac{1}{2}$ miles north-west from Hastings; its structure, however, like that of the White rock, is distinctly concretional. The top of the concretions, when exposed and washed by the sea, exhibits beautifully the minute stratification of the original sand; and the globular masses on the underside project into the sand (2.) below. The stone is traversed nearly at right angles by veins of calcareous spar, and includes portions of trees, converted into lignite. It is associated also with patches of a looser conglomerate, consisting chiefly of rounded grains of whitish, nearly opake, quartz, including the teeth, scales, and bones of fishes, and of a species of Trionyx ?. The strike of this stratum is about 10° south of east, and the dip towards the west of south, at an angle of about 11°.		
2.	Yellowish sand-rock, abounding in impressions of Cyclades, and also resembling part of *Hollington* group	4	0
3.	A band of slaty argillaceous iron ore	0	3
4.	Slaty clay, with numerous shells, chiefly Cyclades and Cypris	0	9
5.	Continuous band of iron ore; like 3, above	0	2
	Total about	8	0
6.	Slaty clay with Cyclades and Cypris		

III. *d.*—The group last mentioned must be continuous with that in the height to the westward, although the connexion is at present concealed; for a line from the point where the grit rises from the shore, would reach the base of the vertical cliff near the church*,—where slaty clay, with grit and sandrock, occupy a thickness, according to the quarrymen, of more than 70 feet. The same strata then rise gradually westward, and disappear about 700 paces west of the church. Several quarries, concealed from below by a terrace-like projection, have been opened for the extraction of the grit near the top of these western heights: and a hard sparry conglomerate, immediately beneath the more uniform stone, has afforded many of the Tilgate fossils; a large collection of which, presented to the Geological Society by Mr. Woodbine Parish, includes specimens of bones and *teeth* of the Iguanodon, scales and other remains of Lepisosteus, and shells of the genera Paludina and Cyclas in profuse abundance. The cliff here may be about 90 feet in height, and its base about 25 feet above low-water mark.

List of Beds composing the Group (III. d.) at the Church, St. Leonard's.

		Ft.	In.	Ft.	In.
1.	Soft sand-rock at the top of the hill (visible)			6	0
2.	Greenish grey sand			2	0

* The dip, however, of the strata in this cliff, is not to the south, like that of the ledge under the Marina, but northwards; so that it is not impossible that there may be here some local derangement, though I saw no indications of it on the shore. I had, however, an opportunity, in an early stage of the improvements at St. Leonard's, of seeing what may have been a fault, in the rising ground on the west of the Assembly Rooms, which was then opened in preparing the foundations of some houses. The surface thus exposed was nearly at right angles to the coast, and consisted of sand-rock, over greenish clay or Fuller's earth, in regular strata, dipping north, about 20° east: while immediately without, and separated by a distinct vertical line or crack, was a mass of clay;—which, however, may have been brought into that situation by subsidence, as the place is close to the shore.

	Ft.	In.	Ft.	In.
3. Reddish, and purple sandy clay; thickness not ascertained..........				?
4. Blue and grey slaty clay, about..................................			20	0
5. Greenish Fuller's-earth..	2	0		
6. Dark shale	2	0		
7. Band of iron-stone	0	4	17	0
8. A band of clay iron-stone and slaty clay	2	0	to	
9. Slaty clay approaching to clay iron-stone........................	0	6	20	0
10. Firmer slaty clay including small flat nodules of iron-stone with numerous large Cyclades..	10	0		
11. Hard grit, about..			1	6
12. Soft sand-rock, in 3 or 4 courses			2	6
13. Firm sandy clay, with Cyclades; firmer and more sandy at bottom....			3	6
14. Yellow and reddish sand (or very soft sand-rock), in very thin alternating courses..			1	0
15. Soft sand-rock, resembling the last but of lighter colour. This seems to go down to the base of the church. Visible, about..............			9	0
16. A bed of firm sand-rock (immediately on the east of the church), about			2	0
17. Thin beds of slaty clay; with interposed layers, or thin masses, nearly continuous, of clay iron-stone, including layers of Cyclades. Visible about			6	0
Total thickness (visible)............			70	0

The strata in the roadside on the east of the church dip towards the east of south, at an angle of about 10° to the horizon; but behind the church the dip is 3 in 40 (or about 4°), towards the *north.*

The following is an approximate list of the strata in the cliff on the west of the Sussex Hotel, between the bottom of the group last mentioned (III. *d.*), and the White sand-rock IV.; corresponding therefore to the strata on the east of the White Rock, beneath the group III. *a.*, which contains the Endogenites. The measures exceed the truth, but the proportions are probably correct.

	Ft.	In.
1. Brown sand-rock ....about	40	0
2. Sand-rock with clay, including Cyclades, about	6	0
3. Beds of darker hue, apparently consisting of clay and sand	10	0
4. Dark yellowish brown sand-rock	6	0
	70	0
5. Very white sand-rock, or slightly coherent sand, occupies about 30 feet at the bottom of the cliff, and is continued downwards. The femur of an Iguanodon was found in this stratum	30	0
Total about........	100	0

IV.—In the space between the base of the cliff at the Brewery and the Castle-hill, all the beds have been carried away. But the great white sand bed IV. *a.* & *b.* is itself visible at high-water mark immediately below the middle point of the White Rock; and thence to the place where the road to Hollington is cut through this stratum. From the Castle-hill, where it is at least 80 feet thick, it is continued with perfect uniformity of character to the top of Fairlight Down*.

* The massive beds of scarcely concreted sand around Tonbridge Wells,—on the Race-ground, at Rusthall-common, and in the heights of Frant and Eridge-park, appear to be a continuation of

IV. *c.*—The white sand-rock above supposed to be a continuation of that on the Castle cliff, probably rises on the shore under St. Leonard's church, but is not visible in the cliff, till it reaches a spot on the east of the Sussex Hotel, where caves have been cut in the mass of almost uniform sand, not to be distinguished from that of Hastings. It would be very desirable to ascertain by experiment whether marine salt exists in this deposit.

V.—Immediately below the sand-rock (IV.), at the western extremity of the Castle rock, is a thickness of about 35 feet, of dark brownish, tough, sandy clay, including lignite in considerable quantity, some of the continuous pieces being several feet in length. This group goes down to the level of the road or street; and thence to low water mark, a space about 20 feet in thickness is concealed. But under the Parade on the east of Pelham-place, a floor of grey sand-rock, is exposed at low water, the strike of which seems to be nearly from east to west. It includes crusts and patches of brown oxide of iron; and is traversed by two sets of cracks, one running nearly north and south, the other from the north of east to south of west, which divide the surface into nearly rhomboidal portions, with angles of 72° and 108°.

VII.—*Cliffs on the West of St. Leonard's.*—The line of the coast at St. Leonard's coincides with the strike for about 200 paces west of the arch at the entrance to that place; and the strata at the water level appear to be horizontal; but about 400 paces west of the Sussex Hotel, the heights turn inland towards the north of west; so that the strata in the retiring portion of the cliff are lower in the series than those upon the shore. They agree with those which are visible at low water beneath the town of Hastings, and with the lower strata in the cliffs around the shallow bay, or cove, at the Lover's Seat.

VII. *a.*—The cliff west of the Church is continued for some distance at an uniform height of about 100 feet. It becomes lower in approaching Bopeep; and at a point where it turns inland, between 200 and 300 paces east of the Martello Tower No. 39, is a floor of sand-rock, at low-water mark, full of grains of oxide of iron, like that of the coast to the eastward; the strike being towards the east about 25° south; and the dip east of north, at an angle of about 11°. The upper part of the cliff at this place, which is about 40 feet high, is composed of brown sand-rock, in beds from 2 inches to 6 in thickness. A grass-covered height, of less elevation, occurs immediately on the west of Bopeep, and the rock exposed there to a thickness of about 10 feet, consists of reddish sandy marl (VII. *a.*), not distinguishable from the Red marl of Devonshire. A low flat hill about 300 paces west of the Tower No. 40, consists for about 20 feet at the top, of sand alternating with clay, in beds dipping very gently to east of north.

VII. *b.*—At the east end of the cliff at Bulverhithe, on which stands the Tower No. 43, the beds dip regularly about east 30° north, at an angle of about 1°. Thence, along the shore, to the Tower upon Galley-hill (No. 44.), strata of reddish sandy clay or marl, variegated with light tea-green, are very well disclosed, declining, towards the east, at an angle between 2° and 3°: and above these coloured marls, is brownish sand-rock, about 50 feet thick.

this stratum of Hastings. On the north of those great beds, and above them, is a group composed of thin, alternate beds of sand-rock and slaty clay, in many respects resembling that of the Brewery near the White Rock. These upper beds are quarried at Huntley's Farm, about a mile west of the northern entrance of Tonbridge Wells; where they abound in Cyclades, Paludinæ, and *Cypris Valdensis* (*C. Faba* of Min. Conchology), and include the remains of several plants, among which are *Sphænopteris Mantellii*, and a new species of fern, represented in the wood-cut at p. 181. The relations of the strata at this place, and in the tract on the north of it, towards the valley of the Weald, are well deserving of attentive examination: I am indebted to the Rev. Mr. Pope of Tonbridge Wells, for having pointed them out to me, and for a collection of specimens obtained there by himself.

On the west of Galley-hill, the strata in the banks, which scarcely can be called cliffs, are inclined slightly to the west of south; and the flat shore, near Cowden Point, consists of beds of clay and sandy clay, varying in colour from dark to bright blue, declining very gently towards the south-west, and extending outwards to some distance under the sea, with a strike towards a point about 16° south of east. Under the Martello Tower, No. 51, about four miles west from Galley-hill, is sand-rock, with ferruginous seams, and thin alternating beds of clay, slightly inclined to the west; from their situation not improbably one of the groups subordinate to the Weald-clay mentioned by Mr. Martin.

(85.) *Endogenites erosa.*—In cutting down the cliff on the east of the White Rock, immediately within the site of the new Brewery, large surfaces of the several strata were successively laid bare; and I was so fortunate as to visit the place when one of them was exposed, which contained a great number of the singular fossil bodies to which the name *Endogenites erosa* has been given, and to see some of them in their original position before they were disturbed. The workmen assured me that the fossils had been still more numerous in a portion of the same strata cut away not long before.

The place in the series, of the strata which include these fossils, has been already mentioned (p. 164–8.). I observed but one line in the face of the cliff which seemed to afford them, about 6 feet from the top of the group III. *b.* (81.) and (82.), which was about 10 feet in total thickness. The workmen told me, however, that some were afterwards found at a short distance below, where the strata were still nearly the same. I did not find any specimens of the fossil upon the shore; but fragments are frequently washed up by the sea in the neighbourhood of this place; and I saw a very large specimen in the face of the bank, on the side of the road over Cuckoo Hill, which joins that from Hollington to Hastings. Mr. Woodbine Parish obtained one, (Plate XIX. fig. 8.), which was dug out in his presence near the Church at St. Leonard's. Their occurrence at Tilgate Forest, where they were discovered by Mr. Mantell, has been mentioned in the Geological Transactions and in his own publications*; and Mr. Martin mentions the Endogenites, as having been found near Mulsey, in Western Sussex, in the first course of sand with reddish clay, subordinate to the Weald-clay, and above the Sussex marble†. There can be little doubt that when the corresponding beds in other parts of the Wealden district have been examined, they will be more extensively discovered.

The rapid change of character in the beds of this formation appears from the fact, that the great concretions of grit, several feet in length, and 2 or 3 feet in thickness, which are found upon the shore to the westward, do not occur in this cliff, though not more than 200 paces distant; their place being apparently supplied, in the strata above those which include the Endogenites, by nodular masses of hardened sand-rock. The bed III. *b.* 2. *ε.* (p. 167.) which includes these fossils, passes both above and below into the adjacent strata, but has in general a darker hue. The fossils were closely enveloped in a mass of slightly coherent sandy clay; and I was enabled, with care, to preserve some specimens, (one of which is represented in Plate XIX. fig. 4. *a.* and *b.*) with part of the surrounding rock still adhering, as a proof that the coating of coal by which the nucleus was invested had never been of greater thickness, and that the whole of it was retained.

(85.) All the specimens of this singular fossil which I saw, lay with their

* Geol. Trans., 2nd Series, vol. i., p. 423;—and Mantell's Fossils of Tilgate, p. 54.
† "Memoir" &c. p. 41, note ‡.

longer diameter and their flatter surfaces in the horizontal position. Their appearance when first uncovered by the removal of the rock above, was that of elongated and flattened elliptical bodies, tapering at both extremities; as represented in fig. 1. of the subjoined wood-cut. They consist of two distinct portions; a stony nucleus, of a dark brownish grey colour, with a very slight tinge of purple; and a crust or case, in the state of lignite, which has externally a nearly uniform surface, and varies in thickness, in different specimens, and in different parts of the same specimen, from about $\frac{1}{10}$ to $\frac{1}{2}$ an inch. This crust becomes thicker near the extremities of the nucleus, and, in many instances, extends considerably beyond it, in a sort of appendage at both ends; but in other specimens of smaller size these appendages do not appear to have existed. The annexed wood-cut explains the structure of one of the largest specimens, and shows the relative proportion of the parts; and the figures in Plate XIX. show some of the principal varieties of form which the fossil has hitherto presented.

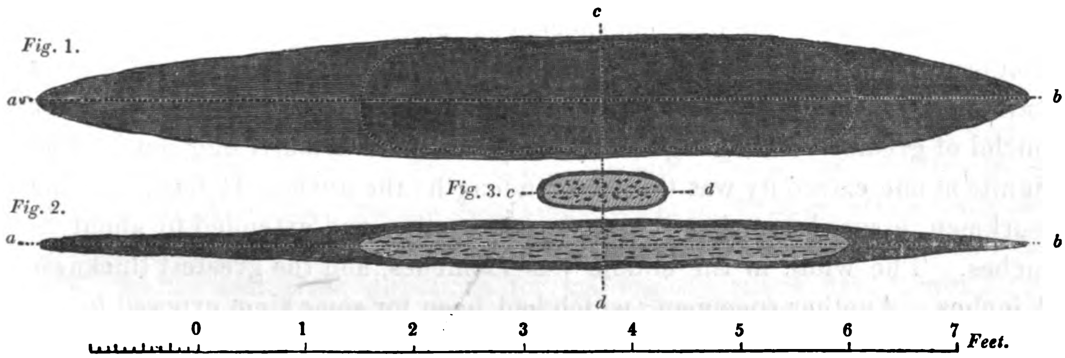


Fig. 1 of the wood-cut on this page represents the external appearance of the entire fossil, as seen from above; the situation of the nucleus being indicated by an obscure dotted line. Fig. 2 is a longitudinal and vertical section, on the axis or line *a*, *b*; and fig. 3, a transverse vertical section, on the line *c*, *d*; showing the proportion of the coating to the nucleus.

The figures in Plate XIX., which are on a scale of one sixth, in diameter, of the natural dimensions, are intended to represent some of the forms of the complete fossil, and of the nucleus when divested of its coating of coal. They are, however, from necessity so much reduced, as to convey but a very imperfect impression of the bulky objects which they represent.

Fig. 1 represents the greater part of a very large nucleus, of which only one of the extremities seems to be wanting. The remaining extremity is of irregular shape, as if it had been broken; and the specimen is much compressed in the middle. Fig. 2 is a nucleus apparently complete, tapering towards one extremity, nearly as may be supposed to have been the case in the part which is wanting in Fig. 1. Fig. 3, *a* and *b*, are horizontal and side views of a much smaller specimen, still retaining its coaly covering, with part of the smooth surface, hereafter mentioned. Fig. 4 is a larger specimen, with some of the sandy clay in which it was imbedded still adhering, the laminæ of which are curved as if they had adapted themselves to its form. The specimen retains the greater part of its covering of coal, which has a smooth outer surface, of a light brown or drab colour: and at the lower part, a portion of the coal has been drawn away from the nucleus, apparently by the contraction of the investing matter to which it strongly adheres. One end of the specimen, where a portion has been accidentally broken off at *b*, shows the proportionate thickness of the coating to the nucleus within. Fig. 5 is a smaller nucleus, nearly complete, very short in proportion to its width. Figs. 6 and 7 are sections of specimens broken across, and exhibiting the flat surface of the fracture in the nucleus, with the proportion of the coaly covering, and the porous structure of the nucleus. Fig. 8 is the nucleus of a large specimen found by Mr. Woodbine Parish, in the strata near St. Leonard's Church. It is remarkable for the compressed appearance of one extremity, and seems to have been originally longer in that direction. It still retains a portion of the investing coal, and of the smooth outer surface of that coating, but the greater part has been removed or disturbed. Fig. 9 is taken from a specimen from Tilgate Forest, presented to the British Museum by Mr. Mantell, which is remarkable for its length, its nearly cylindrical figure, and the acute tapering of the extremity. The superficial furrows also, in this specimen, are deeper and much larger than in the greater number of the nuclei found near Hastings*; but in this respect it is approached by Figs. 1 and 2. Fig. 10 represents rather more than one half of a complete nucleus, of the natural size: the upper surface of *a*, of which fig. *b* is a separate representation, showing the appearance of a fracture on the line of the longer axis.

(86.) The size of the different specimens varies considerably. The largest that I saw in its place, and from which the foregoing wood-cut was taken, must have been in the whole full nine feet long; but there were portions of other nuclei of greater size, among the fallen specimens previously dug out. The lignite at one extremity was three feet in length; the nucleus 4½ feet; and the workmen assured me that the coal at the other end extended to about 18 inches. The width in the middle was 12 inches, and the greatest thickness 4 inches. Another specimen, which had been for some time exposed to decomposition, was about 7½ feet long; the nucleus about 5½ feet, with about 12 inches of lignite remaining at each extremity; and from these dimensions there seem to have been gradations down to a few inches in length. The nucleus of the smallest specimen that I obtained, which is represented, of its natural size, in Plate XIX., fig. 10, is not more than 3 inches long, and about 2 inches wide; yet the external figure is complete, and the internal tubes are not smaller than most of those in the largest masses.

(87.) The original form of this vegetable was probably cylindrical; and that shape is still retained in a large specimen of a nucleus from Tilgate Forest, now in the British Museum; Plate XIX., fig. 9: but in the majority of the specimens the figure has evidently been compressed, and the section is now an oval variously modified; figs. 6, 7, 10. In those represented in

* Since this sheet has been at the press, I find, on examining several other specimens in Mr. Mantell's museum, that the uncompressed figure and greater size of the external tube-like furrows, are general characters of this fossil at Tilgate Forest.

figs. 2 and 9, the extremity is more acute than in the greater number of the specimens. In a few instances (as in fig. 8, and less obviously in figs. 2, and 1,) the nucleus seems to have been suddenly reduced in thickness near the broader end; but no specimen of this form was observed *in situ*. None of the specimens exhibited the tapering figure, somewhat like that of a ninepin, represented in the engraving in the Geological Transactions*; but many of the broken and worn fragments washed up on the shore near the White Rock had acquired some approach to that form. There was not, in any of the specimens, the slightest indication of lateral branches from the main body; but they all lay as if they had been distributed without connexion in the stratum in which they were found.

(88.) The coaly covering did not, in any instance, show traces of organic structure; it burned with a slight flame when thrown upon hot coals, and in the flame of a candle became white, and was reduced in bulk without losing its form. In some of the fresh specimens it was coated with a thin crust, of a light brownish or drab colour, with a very slight glistening lustre; apparently consisting of compressed clay. This is represented especially in figs. 4, *a* and *b*, and partially shown in figs. 3 and 8.

(89.) The internal structure of this fossil has been partially described and represented in the Geological Transactions†, by the Secretaries and a Committee of the Members. I am enabled to add some further particulars to what is there stated, through the kindness of my friends Mr. Brown and Mr. Stokes: the former having lent me the specimen represented in Plate XX., fig. 3., and given directions for making the slices, figs. 1. and 2.; to which Mr. Stokes was so good as to add a very thin slice, represented in figs. 4. and 4. *a*. The vermicular cavities or tubes, of which a longitudinal section is represented in fig. 1., and a transverse section in fig. 2. and 4., are all coated within with transparent quartz crystals, the summits of which are discernible with a lens; and in some cases the cavity of these tubes was partially occupied by exceedingly minute crystals of quartz, either detached in the state of sand, or intermixed with a flocculent coaly matter. The transverse sections of these tubular cavities exhibit a similar change of form, from circular to elliptic, to that shown by the entire plant. In the greater number of cases no trace of truly organic conformation could be detected with the microscope in these sections; but in two specimens a distinct indication of the original vegetable structure was to be seen. These are represented in Plate XX., figs. 3. and 4. The former figure, drawn from the extremity of a solid and opake

* Second Series, vol. i. Plate 48.

† Second Series, vol. i. Plates 46 and 47: and Mantell, Tilgate Fossils, Plates 2 and 3.

mass, a little decomposed, shows, within a cavity, a somewhat circular band, exhibiting organic structure, which is probably tubular*; and the same kind of structure is indicated in the other figures, 4. and 4. *a*, which are taken from a transparent slice belonging to Mr. Stokes; the latter being a more highly magnified portion of fig. 4.

(90.) *Fossils of the Wealden.*—The catalogue of the organic remains of Sussex, published by Mr. Mantell in the last volume of these Transactions, and which he has stated to have been intended to accompany these pages†, renders it unnecessary to insert here the fossils of that portion of the Wealden. The following list, therefore, will contain such species only as have been found in the tracts described in the preceding pages of this paper, or as do not occur in Mr. Mantell's catalogue: and I have been enabled to add several species to those of my own collection, through the kindness of Lord Greenock, Mr. Hills, Mr. Martin, and especially of Mr. Mantell.

List of Fossils of the Wealden, in KENT, SURREY, HANTS, *and* WESTERN SUSSEX‡.

Bulla Mantelliana. Pl. XXII. f. 3. With *Unio antiquus*, within a cavity in the grit of Tilgate Forest: M.

Corbula alata. Pl. XXI. f. 5. Pounceford near Burwash, Sussex: M.

Cyclas angulata. Pl. XXI. f. 12. Weald clay: M.

C—— major. Pl. XXI. f. 13. Weald clay, in nodules of clay iron ore, with *Cypris Valdensis* and *Paludina elongata*, Hythe (Kent): F. With Cypris, fish-bones, and pyrites, in iron ore; upper part of the Weald clay, near Pulborough: Martin. Henhurst, near Ockley, Surrey; in Weald clay. With *Paludina fluviorum* in thin bands of very hard ferruginous calcareous grit, passing into ferruginous sand; near the top of the Weald clay on the west of Leith-hill, Surrey: F.

Also called

Cyclas media. (*Cyrena media*, Ann. of Phil. Vol. VIII. p. 376. *Cyclas media*, Min. Con. Tab. 525. f. 2.) Pl. XXI. f. 10. So generally diffused throughout the Wealden strata that the specification of localities is hardly required. The following are some of the circumstances under which this shell has been found. In coarse grit near the top of the Weald clay, at Atherley, south of Tanhurst, Surrey. In very compact uniform grit, with thin carbonaceous vegetable impressions,—shell calcareous: also in very fine-grained micaceous sand-rock, with

* In this figure, from the greater difficulty of representing the opake object, the partitions between the dark spots which denote the cavities of the tubes, are much too wide: the real proportion of the cavity to the partition is more correctly expressed in fig. 4. *a*.

† "A Tabular Arrangement of the Organic Remains of the County of Sussex." Geological Transactions, 2d Series, vol. iii. p. 215.

‡ In this list the letter M. denotes that the specimen is in Mr. Mantell's collection; F. in that of the author.

Cypris; impressions only, without traces of the shell: Hollington, near Hastings. In nodules of clay iron ore: Cliffs west of St. Leonard's. In shale, called "Shab," alternating with beds of limestone called "Greys," (a stone almost entirely composed of thin shells): Limestone pits north-west of Battle: F. With *Paludina fluviorum*, in bluish compact and sparry limestone, ("Sussex marble"); Daniel's Water, Kent. In sand-rock near Tunbridge Wells: M. At the top of the Weald clay, mixed with bivalves of the Lower green-sand; Stopham brick-yard near Pulborough: Martin.

Cyclas media. (Young.) Plate XXI. f. 9. Hastings sand, Hollington, in hard grit; shell converted into carbonate of lime: F. Etchingham near Robertsbridge, Sussex: M.

C—— ——. (A gibbose variety.) Plate XXI. f. 11. Penhurst pits, in a bed of limestone, about 3 inches thick called "Top-greys": F.

C——. A wider species than *media*. Hastings sand, Hollington: F.

C—— *membranacea*. (*Cyrena membranacea*, Ann. of Phil. 1824. VIII. p. 376.) Cliff west of St. Leonard's, in sandy shale, with Cypris: F. Weald clay, Shipley, near East Grinstead, Sussex, with a spiral univalve (Potamides?): M. Limestone pits near Battle: F. Penhurst, Ashburnham, and Pounceford: M.

C—— subquadrata. Plate XXI. f. 8. Hastings sand, East Cliff, Hastings, in soft, fine, sandy clay, not effervescent: also cliff west of St. Leonard's: F.

C——. One or two other species, probably new, occur in the Weald clay, at Atherley, Surrey: F.

Cypris granulosa. Pl. XXI. f. 4. In ferruginous sand, Tilgate Forest: M.

C—— tuberculata. Pl. XXI. f. 2. Frequently black. With *Cypris Valdensis* and *Paludina elongata*, in nodules of clay iron ore, near the top of the Weald clay: found by Lord Greenock, at Hythe

C—— Valdensis. Pl. XXI. f. 1. (*C. Faba*, Ann. of Phil. 1824, VIII. p. 376.; Min. Con. Tab. 485.) This fossil occurs in such numbers in every part of the Wealden group, that it may be considered as characteristic of the formation; and being found in all the places where these strata have been hitherto observed, the specification of localities would be superfluous. Its profuse abundance may perhaps be accounted for by the fact, that the animal which inhabits the valves or crusts, sheds them periodically*. The Cypris to which the specific name of "Faba," was given by M. Desmarest†, occurs in strata probably superior to the chalk; and though the characters of the valves nearly approach to those of the Wealden Cypris, M. Deshayes is of opinion that it probably constitutes another species‡. On these grounds, I have thought it expedient to adopt a new specific name for the fossil represented in Pl. XXI. f. 1.; and that of *Valdensis* (of, or belonging to the *Wealden*) is intended to indicate both its geological or stratigraphical position, and the local situation of the tract in which it has hitherto been found in the

* Lyell "Principles," &c., 3rd edition, vol. iv. p. 98.

† Brongniart and Desmarest, "Crustacées Fossiles," p. 141, Pl. XI., fig. 8.

‡ "Coquilles Characteristiques," p. 255, Pl. 10. figs. 4. and 5.

greatest abundance. A description of the several species of this genus represented in the annexed plates will be found hereafter, in the Appendix.

Melanopsis ? attenuata. Pl. XXII. f. 5. (*Melania attenuata*, Ann. of Phil. 1824, VIII. p. 376.) In the Hastings sands, Hollington: F. Pounceford: M.

M———— ? tricarinata. Pl. XXII. f. 4. (*Melania tricarinata*, Ann. of Phil. ibid.) Pounceford near Burwash, Sussex: M.

Mytilus Lyellii. Pl. XXI. f. 18. Beds below, or at the bottom of the Hastings sands, near Battle: F. In slaty clay, near Pounceford: Messrs. Lyell and Mantell.

Neritina Fittonii. (Mantell; South-East of England, p. 248.) Pl. XXII. f. 7. Casts in the grit of Tilgate Forest: M.

Ostrea ? (a thin-shelled species). Sand-rock of the Hastings sands, west of St. Leonard's: F.

Paludina carinifera. (Min. Con.) Hastings-sands, west of St. Leonard's; below the White Rock, Hastings; and at Hollington: F. In Septaria, at Resting-oak Hill, near Lewes: M.

P——— elongata. (Min. Con.) This fossil is very generally diffused in the Wealden strata. It occurs in nodules of clay iron ore, near the top of the Weald clay, at Hythe: F. In hard blue grit, with *Cypris Valdensis* and *C. granulosa ?* In the grit of Tilgate Forest: M. Near Ockley, in Surrey: F.

P——— fluviorum. (*P. vivipara*, Min. Con.) One of the most abundant univalves of the Wealden. On compact calcareous beds in the Weald clay; Bethersden and Daniel's Water, Kent. At Henhurst, Surrey; in ferruginous sandstone. In concretions of grit in the Weald clay, very large. At Forest-green, and near Ewhurst, Surrey; near Ockley, Surrey, with *Cypris Valdensis*, in beds of "Forest marble." South of Den-park, Sussex: F.

P——— Sussexiensis. Pl. XXII. f. 6. Resting-oak Hill, near Lewes, Sussex: M.

P——— two or more other species, probably new, occur at Tilgate: Mantell.

Potamides ? With *Cyclas media*, in shale, alternating with limestone; pits north-west of Battle: F. In Weald-clay, East Grinstead: M.

Psammobia ? Tellinoides. Pl. XXI. f. 6. With Cyclas in limestone; Pounceford near Burwash, Sussex: M.

Tornatella Popii. Pl. XXII. f. 8. Lenthington (pronounced Langton) Green, near Tonbridge Wells, in dark brown ferruginous sand-rock, with Unio, Cypris, and Cyclas: Rev. Mr. Pope; and M.

Unio aduncus. Min. Con. Bolney, near Pulborough: Martin. Near Cuckfield, Sussex: M.

U— antiquus. Min. Con. Weald clay, near Pulborough: Martin. Tilgate Forest, very frequent: M.

U— compressus. Min. Con. Weald clay, near Pulborough: Martin. Tilgate Forest: M.

U— cordiformis. Min. Con. Tilgate: M.

U— subtruncatus. Pl. XXI. f. 15. With *Cypris Valdensis*, *Cyclas media*, and *Tor-*

natella Popii? in dark brown ferruginous stone, Lenthington-green, near Tonbridge Wells. Also at Tilgate Forest: M.

Unio Gualterii. Pl. XXI. f. 16. Discovered by Mr. Walter Mantell in the dark brown ferruginous sandstone of Lenthington-green, near Tonbridge Wells: M.

U— Mantellii. Pl. XXI. f. 14. In calcareous grit, passing into ferruginous sand, near the top of the Weald clay; Atherley and Henhurst, Surrey: F. Tilgate: M.

U— Martinii. Pl. XXI. f. 17. Upper part of the Weald clay, near Henhurst, Surrey: Martin, and F.

U— *porrectus**. Min. Con. Weald clay, near Henhurst and Atherley, Surrey: F. Large specimens, with *Paludina fluviorum* and *Cyclas media*, occur in the cliffs west of St. Leonard's, in firm bluish grit: F. In sandstone, Tilgate Forest: M.

Reptiles. The reptiles of the Weald clay and Hastings sands in Sussex, nearly all of which have been discovered by Mr. Mantell, have been so fully treated of in his various publications, that I shall refer to those works for an account of them, and here only enumerate their names, with some of the chief places of their occurrence. The remains, however, of oviparous quadrupeds seem to be dispersed throughout the whole of this formation, though hitherto found principally in the Weald clay and the upper part of the sands beneath it: it is from this latter situation, in the grit and sand-rock of Tilgate Forest, that the greater number of Mr. Mantell's specimens were obtained.

Trionyx Bakewelli. (Mantell, S.E. of England, p. 255.) Tilgate Forest.

Emys, (species unknown.) Same place.

Chelonia. Ditto.

Saurians,—of at least six genera.

Crocodile. Remains of two, if not of four, species. (Ibid. p. 265.)

The teeth, scales, and some of the bones, are mentioned by Mr. Mantell, as occurring at Tilgate. A vertebra, which was considered by the Baron Cuvier, as belonging to this genus, was found in the strata of shale and limestone at the bottom of the Hastings sands, near Brightling, Sussex: F.

Phytosaurus cylindricodon. The teeth: Tilgate Forest. (Mantell, S.E. of England, p. 292.)

Plesiosaurus. Vertebræ, teeth, and other remains: Tilgate. (Ibid. p. 281.)

Megalosaurus Bucklandii. The teeth, (supposed) ribs, and vertebræ. Tilgate Forest. (Ibid. p. 260.)

Hylæosaurus. (First described by Mr. Mantell, in a paper read before the Geological Society (Proceedings, &c. Vol. I. p. 410.), and since published in his Geology of the S. E. of England; p. 289, &c. Plate V.) The remains were found in Tilgate Forest.

Iguanodon. (Mantell, Philos. Trans. 1825, p. 179.) The remains of this mon-

* Several indistinct specimens of this genus, including probably some new species besides those above mentioned, have been found at Henfield and Atherley, in Surrey, by the Author; and near Pulborough, by Mr. Martin.

strous reptile have hitherto been found chiefly in the upper part of the Hastings sands at Tilgate Forest: but very large bones, belonging, as it now appears, to the same animal, have been obtained much higher up in the Wealden series, at Loxwood, and Headfold wood, in Western Sussex*: and very recently, even beyond the limits of the Wealden group, among the lower strata of the Green-sand, near Maidstone, (as already intimated, p. 132; note †): they occur also as far down as in the Great Sand-bed of the cliffs on the coast near Hastings, where that stratum reappears on the shore west of St. Leonard's. I am requested by Mr. Mantell to state, that the mass of remains from Maidstone confirms the appropriation to this reptile, which he had previously made, of other bones of great size found detached, and in different places; and that, among other new points in the osteology of this extraordinary creature, the Maidstone specimen has enabled him to ascertain that certain phalangeal bones which approach to the mammalian character,—with flattened claw-like extremities, resembling those of land-tortoises,—belong to the *hind* feet of the Iguanodon; while the fore feet of the creature appear to have been long and slender, like those of the recent Iguana.

In addition to the Saurian remains which can be referred to distinct genera, there are also in Mr. Mantell's collection, detached bones, probably belonging to new or nondescript reptiles.

Birds. Fragments of some long bones found at Tilgate, and at first supposed to have belonged to Pterodactyles, appear to be really those of a bird, probably a species of Ardea. (Mantell, S. E. of England, p. 283.)

Fishes. The fishes of the Wealden, especially of the two upper members, have hitherto been imperfectly collected; and it still remains to be determined to what species of this tribe many of the remains which frequently occur in the Weald clay are to be referred. All the specimens from this formation in the collections of the Geological Society, of Mr. Mantell, and Mr. Martin, have been recently examined by Mr. Agassiz, with a view to his work on Fossil Ichthyology, now in progress; and the following are some of the genera to which he has referred them.

Pycnodus microdon. Teeth. (Represented in Mantell's Tilgate: Pl. XVIII. f. 26, and 27.)

Hybodus grossicomis. Teeth. (Ibid. Pl. V. f. 14, and XV. f. 2.)

———. Two other species, not yet figured.

———. The dorsal defences referred by Mantell to a Silurus, (Ibid. Pl. X. f. 4, and f. 6.), Mr. Agassiz considers as belonging to an Hybodus.

Lepisosteus. (*Lepidotus*, Agassiz.) The remains of one or more species of this genus have long been known, as diffused throughout the Wealden; in every part of which detached scales and fragments of the scale-covered surface are very commonly found. The Teeth are represented in Mantell's Tilgate fossils, Pl. X. f. 2.; the scales, in Pl. X. figs. 3, 4, 15, and 16; and from an examination

* Murchison: Geol. Trans. 2nd Series, vol. ii. pp. 104, 105.

of these, and of some very fine specimens of the head and fore part of the fish, belonging to Mr. Martin, Mr. Agassiz has been led to divide the genus into two species, distinguished by the forms of the teeth.

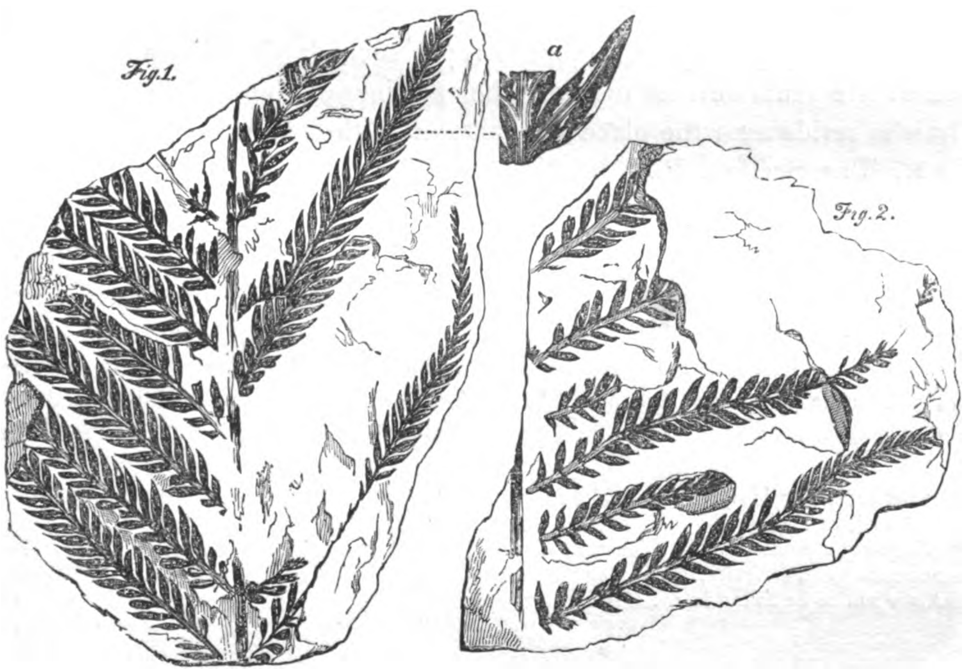
Coprolite,—(or, more correctly, masses of phosphate of lime approaching to the form, and possessing many of the chemical characters of Coprolite,) has been found by Mr. Martin in cavities on the surface of the Weald-clay, at Stopham brick-yard, near Pulborough, but so mixed with fossils of the Lower green-sand that the whole may probably have belonged to that formation. The recent discovery of the Iguanodon, near Maidstone, forms an additional link of connexion between those two formations; and coincides with other evidence which indicates the probable continuity of their deposition.

REMAINS OF PLANTS.

A *Cone* of an unknown species, (Pl. XXII. f. 10.), remarkable for the double prominence, or ridge, in most of the scales; (see Appendix No. 1.): in a mass of hard, greenish grit. From a quarry on the estate of Henry Shirley, Esq., at Pippingford in Ashdown Forest, very near the highest point of the ridge of the Hastings sands.

Endogenites erosa. (Plates XIX. and XX.) Described in the preceding sections (85.) to (89.). Tilgate Forest: M. Coast west of Hastings: F. In the first course of sand in the Weald-clay, near Mulsey's Farm, about 2½ miles north-east of Pulborough, on the main road to London: Martin.

Sphenopteris gracilis: represented in the subjoined wood-cut. See the descriptive note in the Appendix A, p. 349. From beds of sandrock and slaty clay, in the quarries at Huntley's Farm near Tunbridge Wells, above the great bed of White sandrock: Rev. W. L. Pope.



The Isle of Wight.

(91.) The general relations of the strata on the southern coast of the Isle of Wight, have been described by Mr. Webster* with so much ability, that little was left to succeeding observers but the task of filling up details, and of supplying some facts respecting the lower members of the series, which did not fall within the immediate scope of his inquiries. Having already published a general account of these lower strata in another place†, I shall here give some farther observations on what is commonly called "the back," or south side, of the island.

(92.) As the chalk passes entirely across the Isle of Wight, nearly from west to east, in a narrow ridge composed of vertical strata, and again invests a portion of the southern promontory of the island, with a cap of almost horizontal beds, at present detached from the central ridge and extending nearly to the sea,—the result is, that two very distinct sections of the vertical chalk and inclined strata beneath it are disclosed upon the shore, at the extremities of the central range; and again, two other sections, in which the same strata are prolonged from beneath the horizontal chalk, on each side of the promontory that projects towards the south, so as to meet the continuation of those which rise from the middle of the island, and with them form very flat curves. The coast thus exhibits a series of sections of almost unequalled richness and variety: and though the general characters of the strata are well known, there is still quite enough to be learned in this most interesting geological region, to repay such detailed researches as have been of late years devoted to some other portions of England, but which those only who reside near the place can carry on with complete success.

(93.) The Section, Pl. X. a. No. 7. (which is on the scale of the Ordnance Survey), shows the general order of the strata on the southern coast of the island, and, with the aid of a good map‡, will enable the reader to follow the ensuing detail. In the lower of the two lines, the heights are on the same scale as the horizontal distances.

Chalk.—The relations of the lowest beds of the chalk are best seen, on the west, at Compton Bay; and on the east, in the cliffs under Bembridge Down; both sections exhibiting admirably the passage from the white chalk to the Upper green-sand. Large portions of the chalk are pre-

* "Letters to Sir Harry Englefield," &c. 4to. 1816.

† "Annals of Philosophy," Nov. 1824, p. 367, et seq.

‡ The map annexed to Mr. Webster's letters, in Sir H. Englefield's volume, (Plate 48.) though less accurate geometrically, gives many names, and much information useful to the Geologist, which are not to be found in the Ordnance Survey.

served also at the top of the higher Downs, on the south of the island, resting on a plateau of the Upper green-sand; and the lower beds of the chalk are in many places visible in descending from these heights, as from Niton to the undercliff, and above Old Park, on the south-west of Wolverton. The gradation of hue and texture, from the whitest chalk,—through various shades of grey, and various degrees of softness, to the state of bluish marl, resembles precisely what is observable in the same part of the series at Beachy-head, on the shore near Folkstone, and on the opposite coast of France, under the cliffs of Blanc Nez.

The central ridge, or anticlinal line of the chalk, it will be remarked, is neither continuous nor rectilinear; but is divided, about the middle of the island, between Carisbrook and Shorwell, by a tract of irregular ground, intervening between two nearly parallel branches of the chalk range about three miles apart. The first, or southernmost, of these branches runs directly from the Needles to Brixton-down; the more northern from Arreton-down to Bembridge-down and Culver. The course of the principal streams of the island also, is transverse to that of the central chalk range: the river Medina, which nearly bisects the island from north to south, rising high upon the sands, about Stroud Green on the south of Kingston, and running almost directly northward to the estuary at Cowes. The other principal stream, the Eastern Yar, springs beneath the southern chalk, about Whitwell, not far from Niton; and after a tortuous course, instead of joining the sea in Sandown Bay, it cuts through the ridges of the green-sands and the chalk, between Yaverland and Brading. The egress of the streams, therefore, is here analogous to that already described in Kent and Sussex: and this effect may not improbably be ascribed, in both cases, to fissures, by which the lines of drainage were in the first instance determined.

Upper Green-sand.—This formation is but partially disclosed along the base of the central ridge of chalk; but is distinctly seen in the sections at Compton Bay, and on the south of Bembridge Down, and in several places along the escarpment of the undercliff*; the course of which, it is to be observed, is not exactly parallel to the anticlinal ridge, but oblique to it, running towards a point about 17 south of west. The total thickness here, in some places approaches to 100 feet, and on an average is not much less than 70 feet: its step-like projection beyond the chalk, as in Western Sussex, is conspicuous in several places, especially beneath St. Catherine's Down. One of the most accessible sections is in the ground rising above the ravine at Luccombe, where the road from Shanklin to Bonchurch crosses the strata obliquely. About the middle of Old Park is a continuous section of beds, apparently undisturbed and more than ¾ of a mile in length, rising very gradually towards the south, or west of south; and consisting above, for between 30 and 40 feet, of subcalcareous sand and stone, alternating with chert in concretions, and below of similar sand, with spongiform masses, like those of the upper part of the sections near Folkstone (21. and 22.). But one of the best sections, perhaps, of the upper green-sand, is visible above the road from Niton, towards Blackgang-Chine, over the Sand-rock spring. The brow of the cliff at that place is about 591 feet above the sea†; and the beds composing the vertical cliff at top, which is itself more than 100 feet high, may be thus divided:

Alternations of soft subcalcareous stone, with concretional chert. . .	30 to 40 feet.
Yellowish grey sand and stone, with some chert.	60 — 80
Alternations of yellowish grey and bluish stone, and sand	15 — 20

* As above Western Lines; above St. Lawrence, where the road comes down from the interior, and thence westward; between Rans and Marables. At the place last mentioned the precipice is about 60 feet high, with gault beneath, and is traversed obliquely by a footpath up the whole face.
† Englefield and Webster, p. 238.

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Gault.—This stratum consists, in the Isle of Wight, of dark, bluish grey, harsh, sandy clay, interspersed with minute particles of mica: but I did not discover, anywhere, the beds of light bluish, plastic clay, like that of Folkstone, which abounds in the characteristic fossils, and which, I believe, forms the lower part of the formation. The clay here, which seems not to exceed 70 feet in thickness, contains very few fossils, and these, from their imperfect preservation, are difficult to obtain. The tract, however, which this stratum occupies has been very little explored. One of the best sections of the gault which I saw, was at East-End, between Luccombe and Bonchurch, where the clay contains nodules, and branching crystalline rods of pyrites, some thin shells in fragments, and minute crystals of sulphate of lime, perhaps produced by decomposition. The top of the sands beneath this stratum, here slopes both towards the west, and outwards, towards the sea; so that on the melting away of the gault, everything favours the subsidence and ruin of the upper part of the cliffs.

Lower Green-sand.—This stratum, which forms the principal portion of Mr. Webster's 'Ferruginous Sands,' occupies a great part of the surface on the south of the Isle of Wight, and is everywhere conformable to the chalk; a ridge of highly inclined strata of sand parallel to that of the central chalk, crossing the island, from the shore on the south of Bembridge Down to the foot of Afton Down*. The sands are then reflected southwards, and form the lower ground in the interior, from Mottestone, through Brixton, Shorwell, Kingston, Godshill, and Newchurch, to the coast. Throughout the greater part of the shore at the 'back of the island,' this stratum is either below the level of the sea, or concealed by the debris of the undercliff; but where it rises,—westward from Rocken-End, and eastward from Bonchurch Cove, it exhibits the most distinct and fully developed sections.

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(94.) *The Wealden.*—The Purbeck strata do not make their appearance in the Isle of Wight; and the two remaining members of the Wealden pass into each other by insensible gradation, the Weald clay constituting but a small proportion of the whole. A valley or depression, however, corresponding to the site of the clay, is still a well marked natural feature: the escarpment of the green-sands projecting over it on the one hand; while on the other, the

* Grit, not in itself distinguishable from that of Hastings, and containing Paludinæ, occurs on the north-east coast of the Isle of Wight, near Cowes. See Mr. Webster's "Letters," &c. p. 321;—and "Annals of Philosophy," 1824, vol. viii. p. 379.

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served also at the top of the higher Downs, on the south of the island, resting on a plateau of the Upper green-sand; and the lower beds of the chalk are in many places visible in descending from these heights, as from Niton to the undercliff, and above Old Park, on the south-west of Wolverton. The gradation of hue and texture, from the whitest chalk,—through various shades of grey, and various degrees of softness, to the state of bluish marl, resembles precisely what is observable in the same part of the series at Beachy-head, on the shore near Folkstone, and on the opposite coast of France, under the cliffs of Blanc Nez.

The central ridge, or anticlinal line of the chalk, it will be remarked, is neither continuous nor rectilinear; but is divided, about the middle of the island, between Carisbrook and Shorwell, by a tract of irregular ground, intervening between two nearly parallel branches of the chalk range about three miles apart. The first, or southernmost, of these branches runs directly from the Needles to Brixton-down; the more northern from Arreton-down to Bembridge-down and Culver-cliff. The course of the principal streams of the island is transverse to that of the central chalk range: the river Medina, which nearly bisects the island from north to south, rising high upon the sands, about Stroud Green on the south of Kingston, and running almost directly northward to the estuary at Cowes. The other principal stream, the Eastern Yar, springs beneath the southern chalk, about Whitwell, not far from Niton; and after a tortuous course, instead of joining the sea in Sandown Bay, it cuts through the ridges of the green-sands and the chalk, between Yaverland and Brading. The egress of the streams, therefore, is here analogous to that already described in Kent and Sussex: and this effect may not improbably be ascribed, in both cases, to fissures, by which the lines of drainage were in the first instance determined.

Upper Green-sand.—This formation is but partially disclosed along the base of the central ridge of chalk; but is distinctly seen in the sections at Compton-bay, and on the south of Bembridge-down, and in several places along the escarpment of the undercliff*; the course of which, it is to be observed, is not exactly parallel to the anticlinal ridge, but oblique to it, running towards a point about 17° south of west. The total thickness here, in some places approaches to 100 feet, and on an average is not much less than 70 feet: its step-like projection beyond the chalk, as in Western Sussex, is conspicuous in several places, especially beneath St. Catherine's Down. One of the most accessible sections is in the ground rising above the ravine at Luccombe, where the road from Shanklin to Bonchurch crosses the strata obliquely. About the middle of Old Park is a continuous section of beds, apparently undisturbed and more than ¾ of a mile in length, rising very gradually towards the south, or west of south, and consisting above, for between 30 and 40 feet, of subcalcareous sand and stone, alternating with chert in concretions,—and below of similar sand, with spongiform masses, like those of the upper part of the sections near Folkstone; (21.) and (22.). But one of the best sections, perhaps, of the Upper green-sand, is visible above the road from Niton, towards Blackgang-Chine, over the Sand-rock spring. The brow of the cliff at that place is about 591 feet above the sea†; and the beds composing the vertical face at top, which is itself more than 100 feet high, may be thus divided:

Alternations of soft subcalcareous stone, with concretional chert. . .	30 to 40 feet.
Yellowish grey sand and stone, with some chert.	60 — 80
Alternations of yellowish grey and bluish stone, and sand.	15 — 20

* As above Western Lines; above St. Lawrence, where the road comes down from the interior, and thence westward; between Rans and Marables. At the place last mentioned the precipice is about 60 feet high, with gault beneath, and is traversed obliquely by a footpath up the whole face.

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The affinity in mineralogical composition,—indeed in most of the characters except the species of the fossils which they contain, between the strata in this portion of the series in the Isle of Wight, and those above the chalk on the north of the island, is exceedingly striking; though the groups are separated by the entire mass of the green-sands and the chalk. In both we find reddish and variegated sandy marls, of various and similar shades of tea-green, purplish, and grey; in both, also, beds of sand and of grit*; and in both series, too, is an alternation of beds containing marine fossils, especially Oysters, with strata which abound in Paludina, Cypris, and other productions of fresh water. The inferences from these facts are now so obvious, that nothing, it would seem, but the strongest prepossessions in geological theory could so long have kept them out of sight†; and the proof they furnish of the repeated submersion and re-elevation of the land, is irresistible.

(95.) On the other hand, there is a very obvious resemblance, in mineralogical character, between a great proportion of the deposits, both above and below the chalk in the Isle of Wight, and the reddish and variegated marly sands of the new red sandstone (red marl), of England. Nothing can better prove the insufficiency of mineralogical characters, as a ground of identification in geology, than this close resemblance in the productions of periods so distant; while it demonstrates also the permanence and uniformity, both of the substances out of which the strata have been composed, and of the operations which produced their aggregation‡.

Weald Clay.—This stratum is visible on the coast, in one of the sections at Sandown Bay, and in both of those on the west of Rocken-End, forming a narrow band of comparatively low and flat ground,—encircling, and, as it were, insulating the Hastings sands, which rise from beneath it into heights of small elevation. In Sandown Bay, the most eastern portion of the clay, which

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† Soon after my examination of this part of the Isle of Wight, I had the pleasure of a visit there from M. Constant Prevost; and the following passage in one of his letters, written on his return from an excursion to the west of the island, coincides precisely with what is mentioned in the text:—" La succession des couches rappelle tout-à-fait celle de même nature, que sur une échelle " moins grande recouvre la craie, ou mieux est posterieure à la craie, à Alum Bay: c'est la même " disposition générale, le même assemblage de couleurs, les alternatives de sable et d'argile avec " lignite, les mêmes septaires, &c.; tout est analogue dans les deux series, à l'exception des " fossiles. On peut retrouver une analogie aussi forte entre les argilo-sables (Hastings sands) " inferieurs à la craie, et la grande formation du nouveau gres rouge; les argiles verte, jaune, et " rouge, les gres blancs et bigarrés, les conglomerats," &c.

‡ The abundance of the variegated reddish and greenish sandy clays in the upper members of the Wealden group, both here and in Sussex, is such,—and their proportion to the whole so great, that the name of the deposit might very well have been taken from them; and if the term Red-marl be retained as a general denomination, these and the new red sandstone might with some advantage be called the *Upper* and *Lower* (or first and second) *red marl*; which would indicate both their mineralogical resemblance, and their relative position in the series.

succeeds the sands of Red-cliff, is much obscured by intermixture with the ruins of several different strata fallen from above; but it abounds in the characteristic fossils. The corresponding portion of the Weald clay, on the west of the Hastings sands, between the fort at Sandown and Shanklin Chine, forms a flat shore, which is visible only at low tides. Beyond Atherfield-point, in like manner, the clay rises from beneath the Lower green-sand, and exhibits beautiful sections in the Chines immediately on the north-west of that prominence: thence it passes inland, through the lower grounds of Sutton, Thorncross, Yafford, Marsh-Green, Mottestone, Brook-House, and Compton-Grange, and meets the coast on the south of the Lower green-sand ridge, at Compton-Grange Chine; where a similar section to that of the west of Atherfield (or rather to that on the east of Sandown Bay), is exposed: but thereabouts the strata seem to have been disturbed,—whether by mere subsidence or the presence of a fault, I did not ascertain.

Hastings sand.—The general position and relations of that portion of these sands which is visible on the coast of the island (for the sections do not go down to the lowest strata), will be obvious from what has been already stated, with the aid of the section, Plate X. a. No. 7. In Sandown Bay the sands form but a small insulated spot, of an irregular figure, surrounded by the Weald clay: but on the south-west coast the superior strata of the formation are much better developed; occupying an oblong tract, approaching to the shape of half an oval, from the west of Cowleaze Chine to Compton-Grange Chine.

It will be seen from the Ordnance Map, that two small but remarkable prominences called Atherfield Rocks, and Brook Point, project beyond the general line of the shore, between Rocken-End and Freshwater Bay: so that the coast is divided into three shallow recesses, called Chale Bay, Brixton Bay, and Compton Bay; the last being, in fact, only the eastern portion of Freshwater Bay. Atherfield Rocks, and the heights on the south-east of them, belong to the Lower green-sand, of which they are the outcrop. Brook Point (or perhaps the more obtuse prominence of the shore between that place and Southmore,) is apparently the central and lowermost portion of the Hastings sands; the culminating point being much nearer to the chalk in the centre of the island, than to that on the south, in consequence of the more rapid rise of the strata in the central range. A considerable prominence, however (which, in actual elevation, is the highest point of the Hastings sands), occurs at Barnes's-high.

The rocky ledges which shoot out from the land in several places along this part of the shore, form some of its most striking features; and make this coast exceedingly dangerous to shipping. They all consist of the subcalcareous grit, which occurs throughout the Hastings sands, in concretions more or less continuous and frequently of great bulk. Similar ledges appear also, but are less prominent, in the section at Sandown Bay; and, as has been already mentioned (84.), on the coast near Hastings.

(96.) *Sectional Lists of the Strata.*—The preceding passages will enable the reader to connect the subjoined lists of the strata, in which I have availed myself of the notes annexed to three beautifully executed sectional drawings of part of this coast, by Sir John Herschel*. I shall here follow the shore

* I should gladly have inserted Sir John Herschel's sectional drawings, and my own, in place of the reduced general section, Plate X. a. No. 7.; but this could not have been done without such reduction as to exclude the greater part of their contents, and such exaggeration of the heights, in proportion to the horizontal distances, as wholly to destroy their resemblance to the natural appearance of the cliffs.

In the following list I have adopted throughout Sir John Herschel's measurement; and from the difficulty of estimating the vertical thickness of the strata, in consequence of the varying from east to west: giving, 1st, A section from beneath Bembridge Down to the middle of Sandown Bay; 2ndly, The opposite side of the curve, from Bonchurch Cove, eastward, towards the same point; 3rdly, The succession of beds beyond Rocken-End, north-westward, to the geological centre, or lowest point, on the south-west range of the coast; and 4thly, The series from the chalk under Afton Down to Brook Point. This will involve some apparent repetition, as the strata in all the sections are essentially the same; but it will perhaps be the best mode of assisting the inquiries of those who wish to become acquainted with this district.

(97.) *Sectional List of the Strata from the south-west of* Bembridge Down *to the middle of* Sandown Bay.

The Section begins at the bottom of the flinty chalk. Beds very thick and massy. The flints small and disseminated.

Paces.		*Paces occupied by each division.*
0—510.	*Lower White Chalk, without Flints.*	
0—255.	This part of the beach is occupied by ruined masses from above. The base of the cliff, where accessible, seems to consist of knobs of white chalk, bedded in a greyer mass. The stratum is defined by a layer of distant, insulated flints, which separates it from the flinty chalk above. Dip about 65°. Strike, about 6° north of west; which is very nearly the direction of the coast	255
255—510.	The finest and thickest beds of pure white chalk. Dull; not very white chalk; easily scratched by the nail. Beds, 3 or 4 feet thick; separated by layers, 5 or 6 inches thick, of chalk like the rest, but interlaced with a kind of network of very grey matter. Dip, 60° north. Strike, 74° west, almost coincident with the trend of the shore	255
350.	Inocerami, much crushed. At 450 paces, the same, but less frequent. At 500, dip, 60° north; strike, 69° west of north	
510—783.	*Marly and Grey Chalk.*	
511.	Outcrop of a seam of greyer chalk	273
526.	In the grey chalk a layer of yellow harder knobs	
540.	A bed of very uniform grey chalk, 6 to 8 feet in thickness exposed	
600.	A thick bed of grey chalk, as at 540; and the same rubbly yellowish layer as at 526	
650.	Grey chalk; thick uniform beds, 3 or 4 feet	
700.	Grey and white chalk, in alternating layers. This alternation extends about 20 feet up the cliff, which shelves back	
750.	At a breaking away of the talus, the outcrop of the grey chalk is superbly seen. Alternating, dark grey, almost blue, layers, and white, like a striped riband. Corals occupy the lower 5 feet. [The same appearances are very remarkable at the foot of Blanc Nez, on the French coast near Calais.]	

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obliquity of the section to their planes, I have stated the horizontal spaces occupied by the strata at the base of the cliff, which give at least a comparative view of their proportions. I find, from the mean of several comparisons, that my own paces (which are somewhat shorter than Sir J. Herschel's), are about 43 (strictly 42·77) = 100 feet: and in my section the Upper green-sand occupies 196 paces on the shore; the Gault 94; Lower green-sand 840; the Wealden, to the culminating point of the Hastings sand, about 2000;—of which space the Weald-clay may be 600, and the Hastings sand about 1400, from their first rise to the middle or top of the saddle.

Paces occupied by each division.

783—900. *Upper Green-sand* 117

[The rise of this stratum is here very distinct in the section on the shore; and its course inland is marked in the original Ordnance Map (scale, 6 inches to a foot,) by a distinct ridge parallel to that of the chalk, passing from the shore close to the little village of Yaverland, on the north.] ....

783. Here the green-sand crops out, in a bed 20 feet thick, of very dark grey, sandy, calcareous layers, with concretions of harsh lime-stone ....20 feet.

787. Fine specimens of coral..

800. A thick bed of green-sand, with *Siphoniæ*. In 3 feet the fossils change, the corals disappear, and the *Siphoniæ* come in. In this bed is a layer, 1 foot thick, of very black chert.

850. A darker set of layers, 1 foot, rises among the green-sand beds ....

900—1020. *Gault.*—A blue-grey marly mass, almost like the lowest beds of the chalk, but more mud, or silt-like. Harsh to the touch 120

[I could obtain no specimens of the fossils, which were few and broken. The slope above this stratum is covered with grass.—F.]

1020—1767. *Lower Green-sand* 747

1020. Reddish brown sand rises; small rolled gravel, and quartzy pebbles. Trend of the shore, 16° 30′ south of west. Dip, 70° north. Strike, 74° west. Thickness, 30 or 40 feet.

1061. Yellowish grey mud; outcrop (presumed) concealed by rubbish; over blue mud, passing into grey, and much mixed ....

1100. Vivid yellow sand, 6 feet. Light grey mud, 8 feet. Blue mud, 15 feet 29

1140. A great bed of dull brown sand. 1st subdivision, = 15 feet. 2nd, = 20—25 feet. 3rd, = 30 feet; brown and green-sand, and quartz pebbles, and bits of iron-stone. The lowest 3 feet very green-sand 65

1200. Deep brown sand, full of bits of oxide of iron, of a strong resinous lustre and high polish. The upper 3 feet rather less brown. [Like that which abounds in the Lower green-sand of Western Sussex and Surrey; (59.)] 58

1250. The cliff becomes mural.

1258. Presumed outcrop of pale yellow sand. Mere sand; no cohesion: has a few broken shells ....Thickness, 40 feet. 40

1323. Red sand, but not so dark as at 1200. A vivid stripe of orange and yellow. Thickness, 20 feet.

1341. A continuation of the last, separated by a rather honeycombed line. Apparent dip = 23° ....Thickness, 50 feet. 100

1406. A mere continuation of the last, separated by a dotted line, but same material. [The sand-rock hereabouts is divided, by fissures, into masses approaching to rhomboids.] Thickness, 30 feet.

1470. Outcrop of a very thick bed of dark grey mud or silt, contrasting strongly with the red sand which overlies it. Apparently the equivalent of the middle, more cohesive, greener, and less stony member of the Lower green-sand, like that of Folkstone (24—28.)? The darker sand here gives a green streak, when scraped or struck with the hammer.]

1600. The cliff loses its mural character, and falls back into an amphitheatre, full of the rubbish of the bed above ....

1676. A very red (almost blood-red) seam, a foot thick, visible in the rubbish of the beds above ....

1710, &c. *Wealden.*

[A fresh range of low sectional cliff commences on the beach at 1710; the amphitheatre of the higher cliff retiring far back,—perhaps from the rise of the *Weald-clay*; the decay of which, and its efflux in the form of mud, seems to have produced the ruin and fall of the upper strata.]

Paces occupied by each division.

1767—2150. Black slaty clay, with layers of sandy stone 2 inches thick, formed of agglutinated leaves, like sheets of paper.

[Apparently the same alternation as that which abounds on the confines of the Lower green-sand and Wealden group, described (83.), p. 168.]

1850. The amphitheatre of the retired cliff has again come round to the beach..........

1880. Layers of small flat oysters, agglutinated by calcareous matter, very like one of the beds between Atherfield and Shepherd's Chine. [See hereafter, 5580, p.197.] ....

1900. The apparent dip of the strata is now much less, = 10° ....

2000. The stratum here is like mashed slate; but earthy and incoherent, with stony layers occasionally ....

2100. Very clayey: the stony layers, when broken, appear to be very white indurated clay; but their old cracks, dark blackish brown.................................

2132. Like slates; as thin as paper, but friable ....

2150. Sand. Upper 2 feet stony. Red layers of stone and rubble mixed. Apparent rise of the strata 2° or 3°; but they dip back 10°. [*Quæ.* Commencement of the *Hastings sands*?] .... } 370

2400. A very pale sandstone. Outcrop concealed ....

2520. Mixed red and brown-yellow clay: no fossils. The strata still rise from the east. Trend of the beach, 19° south of west; and so, forward to the Fort, and back to the cliffs.

2700. Grey and red clay. No fossils.

2894. Red clay. Strata still rising at an angle of about 12° from the east.

3000. Shore too low to show the strata distinctly.

3240. A layer of tough gritty sandstone; horizontal, or rising a very little to the south-west.

3300. Another layer of tough gritty sandstone, on the beach.

3330. *Culminating point of the saddle.* Strata almost exactly horizontal. The red clay is seen resting on the stony layer of 3240 and 3300.

3400. The strata now begin to dip 1° *towards the west.*

3506. The first wooden barrier to stay the shingles on the beach near Sandown Fort.

3535. Red clay, resting on stony layers strangely contorted. The same clay also underlies them. These contorted layers extend 50 paces.

3617. Third wooden barrier. Here the grass comes down to the beach, and an embankment begins at high-water mark.

3700, the fifth wooden barrier.	3782, the seventh barrier.	3862, the ninth barrier.
3741, the sixth.	3821, the eighth.	Here begin zigzag weirs.

4050. In a line with the eastern edge of the south-east point, or bastion, of Sandown Fort.

(98.) The junction of the Lower green-sand with the Wealden strata is one of the most interesting points in the sections upon this coast, from the importance of determining whether the transition from the freshwater to the marine strata was gradual or abrupt. As far as my own observations have gone, the change, in all the sections of the Isle of Wight, is unaccompanied by any marks of disturbance, or any variation in the characters of the strata themselves, and can in fact be learned only from the total change of the fossils: a few feet in thickness, of beds conformable with those both above them and below, dividing the strata which abound in Cypris and Paludinæ, from the lowest members of the green-sand formation, which contains shells of many different marine genera in great numbers;—Trigonia, Gervillia, large Gryphites, especially *G. sinuata,* with others decidedly marine. The bed which contains these fossils is apparently the equivalent of the lowest stone beds of the coast near Hythe, and is detached from the ferruginous stone at the top of the Lower green-sand, by a mass of soft, dark, sandy clay, which seems to correspond to the middle group of Kent.

The strata on the west of Red-cliff are so much obscured by the washing away and ruin of the clay beneath the green-sands, that no continuous section is observable here. An obvious depression, however, corresponds to the site of the Weald-clay; and both the clay and the sands which rise from beneath it include their characteristic fossils in great abundance and perfection, and contain the same large proportion of reddish and variegated marly and sandy clays, with occasional beds of subcalcareous grit, as on the Sussex coast. The following details may be added to what is stated in the preceding list.

The upper part of the clay abounds remarkably in *Cypris Valdensis*; and contains some nearly continuous bands of clay iron ore, in elongated flattened nodules, two to nine inches in thickness, including clusters of *Paludina elongata.* The beds above this clay form as it were the transition into the green-sand formation, consisting, for some feet, of alternate layers of greenish and grey sand and sandy clay of different shades, like those described above, (83.). A vertical portion of the cliff at the top of the clay, which was exposed to a thickness of between 30 and 40 feet, consisted of the following substances:

				Feet.	
Greenish-grey sand and clay in alternate bands..............				10	0
Clay and sand with iron ore				2	0
A band or course of iron ore, with Cypris..................	0	8			
Greenish-grey sand, alternately of dark and lighter hues......					
Bluish slaty clay, abounding in Cypris....................					
Clay iron ore..................................about	0	8			
Slaty and sandy clay..................................					
				20	0
A bed of dull, solid, earthy calcareous stone................				0	9
Greenish-grey sandy clay................................	7	0	to	8	0
Sand-rock, in some places very ferruginous.................					
Total, about........				40	0

About 770 paces from the bottom of the Lower green-sand, a bed of sand-rock, from 12 to 14 feet thick, makes its appearance: perhaps one of the courses of sand, subordinate to the Wealden, indicated in Western Sussex by Mr. Martin.

In this upper part of the Wealden is at least one thin bed of limestone, consisting principally of the shells of a species of oyster (or Gryphæa?), of which I could not find any distinct specimens. It is invested with a thin crust of fibrous, somewhat earthy, carbonate of lime, having the appearance of what has been called "Cone in cone." In one loose specimen of this limestone, I found a fragment of an Ammonite, evidently derived from some more ancient stratum, washed down and lodged in the mud of which the whole of this formation is composed. The fragment is too small to indicate the species, but the genus is perfectly clear.

I did not find among the strata any one containing *Paludina vivipara*; but on the beach were several loose blocks containing that fossil, with *Cypris Valdensis*, and not distinguishable from the stone of Bethersden in Kent,—the "Sussex Marble."

About 1800 paces from the Lower green-sand, a large block of sand-rock on the shore had the waved surface, or ripple mark, which is common throughout the upper part of the Hastings sands: and here the alternations of greenish grey sand and sandy clay, so frequently mentioned above, are again very conspicuous.

About 1950, was a mass of indurated clay iron ore attached to a nodular portion of hard siliceous grit, containing moulds of large Paludina, filled with sparry sulphate of barytes: a fact which accords with the supposed continuity of deposition of the Weald-clay and the Lower green-sand; sulphate of barytes being found, it will be remembered, in the fuller's-earth of Nutfield, at the bottom of the latter formation*.

About 2040, are strong beds of sand-rock including concretions of hard grit; and thence westward the entire cliff is composed of reddish clay and sand. From this part of the series, which seems to correspond to the strata near Brook Point, on the south-west coast of the island, it is probable that the remains of the Iguanodon have been derived, of which Dr. Buckland has given an account in a paper read before the Geological Society†: and near the same place beds arise of purplish red and variegated clay, alternating with fuller's-earth of a clear bluish green colour, mixed with cohesive sand.

(99.) *Strata from* BONCHURCH COVE *to the middle of* SANDOWN BAY.

The direction of the coast on the south of Sandown Bay, from the Fort to the south of Dunnose‡, is about 15° west of south. But on rounding that promontory the direction changes, and the general trend of the coast thence to Rocken End, is towards a point between 15° and 17° south of west, which seems to be generally the strike in the southern portion of the island; the dip being south 17° east.

The summit of the Downs here consists of *Chalk*, with the *Upper green-sand* beneath; and the subsidence of the *Gault* has produced very extensive ruin, especially at East End and thence to Luccombe; the debris there affording numerous fossils, among which were the following:—*Ammonites Rhotomagensis*, *A. Seliguinus*, *A. varians*, *Gryphæa vesiculosa*, *Inoceramus tenuis*, *Mya mandibula*, *Ostrea spinosa*, *Pecten orbicularis*, Serpulæ, *Vermetus Polygonalis*.

The *Lower green-sand* rises a little on the west of the streamlet at Bonchurch-Cove, and the following subdivisions, though in a great measure arbitrary, will give a general notion of its composition.

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* Sulphate of barytes has been found also in the Upper green-sand at Worbarrow Bay, Dorsetshire.

† Proceedings, vol. i. p. 159: and Geol. Trans. 2nd Series, vol. iii. p. 421.

‡ The names of the headlands in the Ordnance Map of this part of the coast, are different from those of the Admiralty chart and of Mr. Webster's map of the island. In the former, the height between Luccombe and Shanklin Chines is called Dunnose; and the greater promontory between Luccombe and Bonchurch-Cove, (which in the other maps, above mentioned, is named Dunnose,) is called *Chine-head*. I have adopted the position assigned to *Dunnose* in the Admiralty chart. The top of *Shanklin Down*, (which is not very different from the general level of the Chalk Downs hereabouts) is according to the Ordnance Survey, 792 feet above the sea.

A. *Bonchurch Cove to a fissure north of Littlestairs Point.*

a. The top of the first group of sand, about 30 feet thick, may be traced north-eastward, and thence north, to its outcrop in the shoulder of the cliff, above a point called Horseledge, immediately on the east of Derranew. It is composed chiefly of brownish sand; but in some places reddish and yellow. It may be remarked in general of these strata, that the colour seems to depend on the accident of exposure to moisture; the recent surfaces disclosed by the falling away of the cliffs, being frequently ferruginous yellow, or even whitish; whilst in other parts of the same beds the hues are brown and dark greenish grey: the difference arising apparently from the state of the iron, which the sand contains.

b. The next group, also about 30 feet thick, is composed of dark brownish sand and sandy clay, but is bright yellow in some of its higher points. It rises at a short distance east of Bonchurch Cove, occupies the shore thence to Steel Bay, and forms the principal portion of the cliffs at Luccombe Chine, whence it is continued northward to the summit of Knock-Cliff, on the south of Shanklin Chine.

c. The bed or group which rises about midway between Steel Bay and Luccombe Chine extends on the shore to about an equal distance north of the Chine, and goes out beneath the summit of Knock-cliff. It is about 30 feet thick, generally of a dark grey and brownish hue.

d. At a place called Derranew, north of Luccombe Chine, a bed rises, of much darker hue, and more approaching to clay than the preceding. It occupies about a third of Knock-cliff, near the lower part, where it spreads into a terrace; forms the upper part of Shanklin Chine, and caps the cliff as far as the south side of Small-hope Chine, a detached portion appearing on the top of the cliff at Little-stairs Point. From this stratum masses have fallen, like those of Parham in Western Sussex, consisting of highly ferruginous sand-rock, with numerous impressions of shells (Gervillia — Natica — Rostellaria—Terebratula —Thetis—Trigonia—Turbo—Venus ?). These are found in nodules loose upon the beach south of the Chine, and *in situ,* within the Chine itself, at the upper part; and the debris of these upper strata, at the foot of the cliffs between Shanklin and Small-hope Chines, afford several varieties of concretional sparry stone, abounding in green particles, like the blocks on the shore near Folkstone (20.), containing the remains of an Astacus, Corals, and Spatangi, with shells of the genera Ostrea, Serpula, Sphæra, and Trigonia.

e. A bed or group, not very prominently distinguished from the last, rises immediately on the south of Knock-cliff. It is in general of a dark greenish, mud-like hue, contains a great proportion of silicate of iron, and seems to correspond to part of the middle group between Sandgate and Folkstone. This occupies about a third of Shanklin Chine, and forms the upper portion of Small-hope Chine, whence it declines a little to the chasm at Little-stairs Point, by which it seems to be cut off abruptly.

f. Appears above the sea on the south of Shanklin Chine; forming, as it rises, a terrace covered with the debris of the upper strata, as far as Small-hope Chine, where its top is about 22 feet above sea; and then declines to the fissure near Little-stairs Point. It consists of an intensely deep green, almost black sand, (no doubt a part of the middle group of Folkstone), and in many places contains very fine specimens of *Gryphæa sinuata.*

Immediately on the north of Little-stairs Point, about 800 paces north of Small-hope Chine (and about 1600 from Shanklin Chine) is a remarkable break or fissure: and here Sir John Herschel found reason to suppose that a fault exists, the strata on the north of the chasm not corresponding with those on the south of it. The occurrence of such faults is highly probable, from the proximity of this place to the great displacement in the central ridge of the island*.

Hence to the end of this cliff, in Sandown Bay, the beds rise more rapidly than in the preceding part of the section, from Bonchurch; and the order, in Sir John Herschel's sketch, beginning at the fissure, is as follows:

B. *From the fissure to the middle of* Sandown Bay.

Paces.

0—580. The cliff, about 100 feet high, which forms the north side of the fissure, consists of three portions.

1. Bright yellow sand, which goes out at 400, perhaps a continuation of *e*, last page?:
2. Deep muddy green, almost black sand or silt, (perhaps a continuation of *f*?) going out at top about 580. The beds 1 & 2, together, occupy about a fourth of the cliff, at the upper part.
3. A thick stratum of sand of various hues, cut off by the fissure on the south, but occupying the shore thence to about 600: the bottom rising rapidly, and going out near 1400 at the top of the cliff, which is there about 110 feet high. This stratum is subdivided thus:—

a. Sand, dark red and dull brown, with a greenish tinge; entirely cut off by the fissure, not coming down to the shore.

b. A thicker bed of sand; at the bottom dull greenish and dark grey,—but, as it rises, of a vivid yellow, in some places tinged with red. Dip, about 3° at the bottom, about 2° at top. Contains *Gryphæa sinuata* in great numbers.

c. Vivid yellow sand, harder than *a* and *b*; rising on the shore at 420, and extending thence to 580. Dip, 3°.

580—1100. A great bed of sand, dull dark grey on the shore, but at the upper part lighter, and near its disappearance bright yellow. This bed is much subdivided as it ascends; the lowest subdivision consists of transversely disposed layers (*false stratification*), on which those above rest unconformably, indicating either an inclined beach or some peculiarity of deposition. Goes out at top at 1750.

1100—1268. Sand; grey at the bottom of the cliff, bright yellow at top. Goes out about 1780.

1268—2000. A very thick bed or group, consisting of sand, and very sandy clay or silt. Goes out at top, about 2150.

1268—1630. A very dark sand or silt, of a deep dirty green, or almost black colour.

1500. Dark arenaceous clay, with yellow and green efflorescence. Dip, 5°—10°.

[The cliff, from 1780, northwards, declines rapidly in height.]

2000. Sand, luteous yellow, without cohesion.

2000—2160. A clayey sand, or rather arenaceous clay,—dirty brown silt; yellow at the upper part: about 20 feet thick. The bottom goes out, at the top of the declining cliff, about 2270.

2160—2300. Yellow sand.

2300. Dull yellowish sand, with thin blackish layers. Apparent dip, about 25°.

2350. Bright yellow sand.

2400. The coast bank is of sand, 15 or 20 feet high. The cliff ends here, and the flat begins. A low sand-hill commences about 2436. (*Quæ.* loose blown sand?)

* My own section, however, ascribes the more rapid rise of the beds on the north of the prominence at Little-stairs Point, to the change in the direction of the shore; which brings the face of the cliff more nearly into the line of the greatest inclination, and makes the dip appear to be greater than before.

Paces.

2700. The King's Head Inn, at Sandown, by Sir John Herschel's measurement, is 2700 paces from the gap or fissure at Little-stairs point.

The coast, from the end of the cliff above mentioned, to a point about 400 paces north of the Fort, is a dead flat, occupied by the Weald-clay, which is visible at low tides on the shore beneath the Inn, and thence southward.

At 364 paces north of the Inn, beds of ferruginous (Hastings) sand first make their appearance, rising from beneath the clay, which dips to the south-west at an angle of about 5°: this being the descending side (on the south-west) of the curve, of which the summit is at 3330 of the preceding list, (97.).

(100.) *Strata on the South-west Coast of the* Isle of Wight, *from* Blackgang Chine *to* Brook Chine.

At the west end of the back of the island, the Lower green-sand makes its appearance beneath the Gault, a little to the east of Puckaster Cove, where the sands are ferruginous. I have no sections from that point to Blackgang Chine, a space much obscured by ruins fallen from above: but thence westward, the sections, from about the middle of the Lower green-sand to the lowest beds of the Hastings series which appear above the sea, are probably the most complete and the best developed that anywhere exist in England. In the following list, the numbers, as far as Cowleaze Chine, are taken from Sir John Herschel's sections, and the descriptions from his notes, with additions from my own.

A. *Blackgang to Cowleaze Chine.*

In the broken ground above Blackgang Chine, whitish sand-rock is visible immediately beneath the Gault, above the Sand-rock spring*, which breaks out about 150 feet above the sea, and apparently about 50 feet below the top of the green-sand, from whitish sand, containing much lignite in small fragments, with a considerable depth beneath of dark and ferruginous sands mixed with clay. There can be little doubt that these upper beds which form the shore between Puckaster Cove and Blackgang Chine, belong to the uppermost group of this formation. (See above (16.) et seq.) The same beds form also the heights about the village of Chale, and seem to extend from that place from Walpen to Kingston, as already mentioned, (93.) p. 184.

The strata immediately over Blackgang Chine, rise upon the shore at a considerable distance to the east†. They consist of the following substances:

* A full account of this spring, by the late Dr. Marcet, has been published in a former volume of these Transactions, (1st Series, Vol. I. p. 213, &c.). It is remarkable for the extraordinary quantity of saline matter which the water holds in solution;—no less than 107 grains in 16 ounces; of which 41·4 are sulphate of iron; 31·6 sulphate of alumina. The saline matter in one of the strongest mineral waters previously known, at Horley Green, near Halifax in Yorkshire, is only 40 grains in the same quantity of water. The water of the streamlet at Blackgang Chine itself is pretty strongly impregnated with sulphate of iron.

† The gravel on the beach along this part of the coast consists, in a great measure, of small rounded fragments of chalk flint; which, from their incessant agitation under the surge, are worn, and almost polished, to such smoothness and mobility, as to render it extremely laborious to walk there.

[*Lower green-sand.*]

1, 2. Loosely coherent sand and sand-rock.
3. Dark sand or silt, like loose black mud.
4. Sand-rock like 1 and 2, in homogeneous blocks.
5. Black mud-like sand.
6. A great bed of sand, loosely coherent, like 1, 2, and 4, in blocks about 6 feet thick.
7. Loose black mud or silt, much like 5.
8. Mere loose sand, without cohesion.
9. Black earthy sand, rising on the shore about 900 paces east of the Chine, and forming the bed over which the streamlet falls.

In the following detail of the strata, the distances are measured, in both directions, from the middle of the Chine, as being one of the most remarkable points of the shore.

Paces.		*Thickness in Feet.*
850 to 560,—east of the Chine.	Yellow agglutinated sand above, passing below into a dark muddy silt. It has no green earth in it. This bed forms the upper stony-looking layer over which the water falls at the Chine. The bottom goes out at 350 paces west of the Chine; 15—20 feet thick.	20
0.	Middle of *Blackgang Chine.*	
560 east, to 240 west of the Chine.	Sand, full of green earth. The second or middle stony-looking bed of the fall, which has there a convex surface.......................... Bottom goes out at 590 west of the Chine	20
240 east, to 400 west of the Chine.	Very dark or almost black sand, forming the base of the cauldron of Blackgang; coloured red externally by the action of water and air on the ferruginous matter which it contains..................Goes out at 1040 west of the Chine.	15
400 west of the Chine, to 520.	Black slaty clay or mud, like mashed slates, without solidity of aggregation; decomposes into muddy earth................Goes out at 1130 west.	?
500.	Hereabouts are very remarkable stems of Siphoniæ. [This part of the shore, about 500 paces north-west of the Chine, is called *Cliff-End.*]	
520 to 614.	Green-sand closely intermixed with ferruginous layers and much pyrites, which give it compactness and solidity..........................Goes out at 1420 west.	5
614—768.	Three feet at top, forming a transition from the last stratum, by alternation with the following. Below, 10 feet consist of deep green, almost black, and very uniform sand; without fossils.. Goes out at 1520.	13
768—812.	Rugged ferruginous sand, of a brown colour ....Goes out at 1580.	7
812—1090.	1. Mixed green and yellow sand, very dark, including *Gryphæa sinuata*, in very hard tough lumps..Thickness, 4 feet. 2. A second bed, at the bottom of which is a layer of *Gryphæa sinuata*.........1 foot. 3. Mixed brown and green sand, including detached specimens of *Gryph. sinuata*..7 feet. The bottom of this group goes out at 1800.	12
1090—1360.	Very green sand, softer than the last. Cliff mural. Lines of false stratification at the top............This bed goes out on the east side of Walpen Chine about 1910.	
1360—1590.	Brown green-sand, much like the last, but different in cohesion .... Goes out at top in the east side of Whale Chine, at 2480.	
About 1431,	a copious spring has, in its fall, coloured the whole face of the cliff with a broad red streak. The whole seems to be greenish grey sand, and clay; very dark and moist. The cliff continually scales off in great flakes, which are washed away, so as not to form much talus. Red drip frequent....................................	
1590—1800.	Sand, with layers of great flattened and oval concretions of very tough calciferous stone, 2 feet in diameter. [*Quæ.* like the Cowstones of the Devonshire coast*].. Goes out at 2660.	12

* See De la Beche, Geol. Trans., 2nd Series, vol. ii. p. 113.

Paces. *Thickness in Feet.*

1800—2200. Very dark sand, which, from 2100 to 2400, forms a mural cliff, standing back behind the rubbish of the next stratum below, and its own. At 2200 it is cut into a ravine (not marked in the Ordnance Map) called *Ladder Chine*: there is, however, very little of a stream from it. This stratum forms the beach-line of *Walpen Chine.* Goes out at 3010.

1950. The middle point of *Walpen Chine.*

2200—2900. Loose dark mud. It contains, especially at 2400, the large Gryphæa, but smaller than the gigantic specimens of the beds next below. The ruins of the stratum form a terrace-like projection, increasing in height gradually from 2200. Goes out at 3800.

2570. The middle point of *Whale Chine.*

2900—2948. A group of sand, the bottom of which goes out at 3710. ....

3070. A bed of fine large Gryphites, over 2 feet of sand, hardened so as to throw out the springs, which have stained its exterior a vivid red................Thickness, 4 feet.

3100. Very large Gryphites, in the same hard, green brown sand. They occur in knobs, and are concreted firmly together. [Clusters also of Serpulæ and Terebratulæ.] ....

3146. A layer of fine Terebratulæ, strongly agglutinated in the darker green sand........

3152. Gigantic Gryphites below the layer of Terebratulæ, at 3146..................

3170—3400. Brown sand; upper part more compact than lower. The bottom goes out at 4610.

3400—3560. Sandy silt....................................Goes out at 3410. 10

[This part of the shore, which is called *Atherfield High-cliff*, strongly resembles that between Shanklin Chine and the middle of Sandown Bay.]

3560—3700. Dark mud.......................................Goes out at 4610. 10

3700. Hard tough sandstone, passing into the next division below, which is softer. The separation is marked by great concretionary masses, in balls or kidneys, some of them 6 or 7 feet long, and 4 to 18 inches thick, including *Gryphæa sinuata* and Perna, with small Ammonites in pyrites. Similar concretions occur also at the top of this bed, and at the bottom of the next ....This division goes out at 6070. 18

4010. Passes insensibly into the mud next below: near the junction a small Ammonite.... Goes out about 6080. ?

4010—4725. A loose, incoherent, blue-grey, muddy clay. It is in a state of great ruin, and has overwhelmed the beach with a vast talus of its mud, which bases the sand-cliff at *Atherfield*, and forms a slope, on which are fishing-huts, boat capstans, and a path up to the Preventive Station, which cannot be seen from the beach. The place where this bed goes out at top is indistinct, but it seems to form the upper part of the south-east side of *Shepherd's Chine*, about 6100 ....

[This clay appears to be the equivalent of the fuller's-earth of Surrey. It is about 15 to 30 feet thick and contains very numerous fossils: Ammonites, Echini, Terebratulæ and Corals; with crystals of sulphate of lime, perhaps produced by decomposition.]

4725—4775. Brown and green sand-stone, 2 feet thick, and well defined ....

[Apparently the equivalent of the lowest beds of stone very near to the bottom of the Lower green-sand at Hythe; and here abounding in marine fossils, among which are the following genera: Ammonites, Avicula, corals, Corbula, Cucullæa, Exogyra, Gervillia, Gryphæa (especially *G. sinuata*), *Nautilus elegans*, Ostrea, Panopæa, Pecten, Pinna, Plagiostoma, Serpula, Thetis, Trigonia, Vermetus, with others of the Lower green-sand. Nothing can be more striking than the sudden contrast between such an assemblage and the fossils of the clay immediately below.] ....

The continuation of this fossiliferous stratum is still visible, high up in the ruined face of the cliff and above the clay, as far as 5700 paces ....

Paces. [*Weald Clay.*] Thickness in Feet.

4775—5700. A mass of incoherent, muddy-brown, grey, and blue clay immediately succeeds to the last bed, and goes out in the east side of Shepherd's Chine about 6100. It has covered the beach with an immense ruin of mud, which contains the substances under mentioned. The ledge called *Atherfield Rocks*, which is visible at low water, about 10 feet below the bed of sand-rock with Gryphites, consists of blue slaty clay, including *Cypris Valdensis* in myriads, with thin portions of pyrites......

Between 4800 and 5000 is *Atherfield Point*; and here the course of the beach alters.

5040. At this point the stratification of the clay is distinctly discernible on the beach. It is deep blue black, and shivery ....

5440. Here occurs a thin seam of pyrites in large flat cakes, with rounded outlines, in great abundance. They seem to form a bed, but are individually discrete, like the flints in chalk*. The rise of this seam is not visible ....

5500. Large, well-formed, transparent crystals of selenite, 2 or 3 inches long, lozenge-shaped, not lenticular..

5580. Thin stony layers of very tough limestone, half an inch thick, which seems to consist of agglutinated small oysters, the flat shells of which are chiefly visible......

About 5700, immediately on the west of Atherfield Point, is a deep and rugged recess, called *Tiepit.*

5700—6220. A thick bed (50, 60, or 70 feet) of black shaly mud, including occasional layers of tough, hard, shelly limestone, consisting, seemingly of agglutinated bivalves (Cyclades)†. The concave surfaces of the shells lie uppermost, and form the whole surface of the layers. The lower surface of these layers of stone is curiously corrugated, (or studded) with short, crossing protuberances, apparently the edges of projecting shells. The layers are one or two inches thick. There are also in this bed tough, stony, non-effervescent layers; but the general material is a blue or black clay, which breaks into thin layers, like mashed slates. [This bed constitutes the bottom and a great portion of the lower part of *Shepherd's Chine*: it rises to the top of the cliff, far to the west, about 500 or 600 paces west of *Cowleaze Chine.*]............ 50—70

6220. About this point is the middle of *Shepherd's Chine*‡.

6220—6440. The whole is yellow sand, but little coherent; the upper part more compact, including large pyritous balls excessively hard and tough; the lower soft and shivery. This bed occupies on the shore about half the space from Shepherd's to Cowleaze Chine. The top goes out about 900, the bottom at 1200 paces west of Cowleaze. It crosses *Cowleaze Chine* at the upper part, and thence westward rises steadily at the upper part of the cliff ....

6440—6615. Upper 7 feet shaly mud, in thin flakes; lower 3 feet black, not adhesive mud, which breaks into layers. No fossils. The whole 10 feet thick 10

6615, to about 20 north-west of Cowleaze Chine. A stratum consisting of two layers: upper 3 feet sand; the lower 3 feet a black shaly clay, passing into the stony stratum next below. Goes out about 1500 paces north-west of the Chine 6

6650. Is about the middle of *Cowleaze Chine.*

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* Flat, cake-like, nodules of pyrites occur in what I have supposed to be the upper part of the Weald-clay, at Peasemarsh, near Guildford in Surrey. See above (64.).

† Some of these beds of limestone break into rhomboidal pieces, the angles of which projecting in the face of the cliff, produce serrated lines remarkably contrasted with the uniform surface of the clay.

‡ It is through this chine that a streamlet, which once made its way to the shore at *Cowleaze Chine*, now reaches the sea; and the manner in which the alteration was produced, shows the facility of changes on a coast composed of materials like these sands and clays. The streamlet in the Ordnance Map is seen to rise near the village of Kingston, probably at the junction of the ferruginous upper member of the Lower green-sand with the middle retentive group (25.). It was very tortuous near the shore, and formerly came close to the edge of the cliff near its present outlet, but made its way to the beach at Cowleaze; till, the soft and narrow barrier at top having been cut through, the water soon deepened the chasm, and formed a new chine, leaving its previous bed, with Cowleaze Chine itself, deserted and dry.

[As the *Weald-Clay* and its passage into the sands beneath are better displayed here than in any other place with which I am acquainted, I shall subjoin a more detailed enumeration of the beds, collected from the successive portions of the ruinous cliff, which, when I examined the place, were well exposed on the shore at *Ticpit*, thence to *Shepherd's Chine*, and within that Chine itself and *Cowleaze Chine*. This list is still no more than an approximation; but time and labour only are required to carry the enumeration to any extent of detail: it begins almost immediately beneath the remarkable bed above mentioned as abounding in fossils (4725—4775), which may be considered as the lowest member of the Lower green-sand.]

	Ft.	In.
A group of beds, full of crystals of sulphate of lime, perhaps produced by exposure:—detail thus: *a.* Clay, with much pyrites .... *b.* Greenish and blue slaty clay . *c.* Clay and sand, in thin alternate course, including minute bones of fishes	12	0
Dark bluish grey slaty clay, with thin courses of very fine light greenish sandy clay	8	0
A bed of limestone, with thin oyster-shells (or Gryphites?) indistinct ..	0	3
Shale, as above, abounding in *Cypris Valdensis*, and including a bed of pyrites with *Paludina elongata*....	1	3
A course of limestone, with Cyclades at the bottom..................	0	3
Thin, paper-like courses of sand, alternating with slaty clay .... Bluish grey shale, with small bones of fishes and some crystals of sulphate of lime	4	0
Sandy clay of a lighter hue	0	2
Bluish grey shale, with Cypris and fish bones.........................	1	6
Greenish grey shale; the folia penetrated by cylindrical and vertical portions (like stems) of lighter grey sand	1	6
Flat nodular portions of very poor clay iron-ore	0	2
Greenish, very sandy, clay	2	0
Greenish grey sand and clay in thin courses, alternating with dark, tough, slaty clay, containing clusters or patches of *Cyclas media* with *Cypris Valdensis*	10	0
Lighter coloured slaty clay, containing Cypris; alternating with grey and whitish, somewhat sandy clay	10	0

	Ft.	In.
Similar beds, including pyritous wood and pyrites, with a band of siliceous limestone, curiously embossed at the bottom with Cyclades converted into carbonate of lime (see 5700; p. 197).	7	0
Similar beds	8	0
Shale with *Cypris Valdensis*........	4	0
Sandy clay, including a bed 6 inches thick, of great firmness..........	15	6
White sand-rock	1	6
Sandy clay and shale	8	0
Ditto, of lighter colour............	1	0
Beds of sand and clay, including nodules of iron-ore	4	0
Greenish white sand in stripes	2—4	0
Apparently light greenish sand and brownish sandy clay	12	0
Greenish grit, containing numerous empty moulds of Cyclades	3	0
Yellowish sand-rock, with lines of false stratification .... [A line of darker hue occurs in the group. *Quæ*. Remains of bones?]	20	0
[The preceding group of grit and sand-rock, which is not improbably the equivalent of one of Mr. Martin's beds subordinate to the Weald-clay, first appears on the shore about the opening of Shepherd's Chine; and rising thence gradually westward, occupies about 20 feet in the side of *Cowleaze Chine*, near the middle.]		
Beds of greenish grey sandy clay, of two shades of colour, alternating with specks of mica. A range of nodules of iron-ore is within a few inches of the top, containing Paludinæ and Cyclades.	15	0?

Total thickness about 140 feet.

I sought here, but without success, for remains of the large Saurians like those of Loxwood and Tilgate forest. Nor were there visible upon the shore any continuous masses of subcalcareous grit.]

B. *Cowleaze to Barnes's Chine; about* 2150 *paces.*

The strata on the west of Cowleaze Chine afford little variety and no very prominent features. The Chine cuts through the bed, or group of sand-rock above mentioned;—which goes out on the north-west of a prominence called Barnes's Hill (or Barnes's High), and probably is the cause of its durability and elevation.

0—75. At the foot of the cliff, where Cowleaze Chine opens upon the shore, a seam of hard yellowish grey sand-rock arises, which is slightly effervescent: it goes out at the top of the cliff about 1800 north-west of Cowleaze Chine. If it were necessary to assign any strict boundary to the formation, this might be considered as the beginning of the *Hastings Sands.*

75—900. A mass of reddish and variegated tenacious sandy clay next comes in, much interspersed with pyrites and containing wood-coal. It rises about 75 paces from the Chine, and occupies more than 800 paces on the shore, the top going out about 1800, and the bottom about 2000, very near to Barnes's Chine. The proportion of red and greenish variegated clay, like those of this great bed, to the sand-rock, is henceforward so great in the cliffs, that the name of *sands* is misapplied to this part of the formation. The general resemblance of the strata to the variegated marls of the new red sandstone, (*keuper* of the Germans,) has been already mentioned.

900—1050. A group of sand-rock, including in several parts of its course large nodular masses of hard grey grit, next occupies about 150 paces on the shore. It is about 15 feet in vertical thickness.

1050—1800. This space on the shore seems to be totally occupied by dark reddish, marly and sandy clay, variegated with greenish and grey, which form a large portion of the upper and middle portions of Barnes's Chine.

1800 to about 1950. A bed of sand-rock, called by the inhabitants "*Barnes's Sand-rock*", rises about 1800. It is cut through by the lower part of Barnes's Chine, and goes out far to the north-west of it.

1950. Dark reddish and variegated clay again comes in, and is continued towards the north-west.

2150, from *Cowleaze*, is the middle point of *Barnes's Chine.*

C. *Barnes's Chine to Grange Chine;* 2300 *paces.*

The cliff throughout this space also is very little varied. The bed of sand-rock above mentioned (1800 to 1950) rises steadily in the middle and upper part of it, crossing *Chip's Chine*, and going out at top near *Ship-ledge*, hereafter mentioned.

The dark red and variegated clay, 1950, occupies the shore on both sides of *Barnes's Chine*, and extends far to the north-west. The coast here is throughout a range of low, nearly uniform cliffs, of a dull reddish hue.

500, north-west of Barnes, is the place of *Chip's Chine.*

1000. The place of *Ship-ledge*; a group of sand-rock beds, which runs out far into the sea, and is rendered more solid by concretions of subcalcareous grit.

2300. The place of *Grange Chine.*

D. *Grange Chine to Brook Chine;* 5600 *paces.*

635—660. A bed of sand-rock rises at 635 from Grange Chine, and at 800 is very near the top of the cliff.

790, is nearly the place of a chasm in the cliff, perhaps *Jackman's Chine*?

1500. The middle point of *Chilton Chine.* Hence to *Bull-rock-ledge*, reddish and variegated marly sand and clay appear to form the shore.

1900—2000. A bed or group of sand-rock, beneath reddish and variegated marly clay and sand, here occupies the shore for about 100 paces, forming before it rises one of the principal ledges of the coast, which stretches far into the sea, and is called *Bull-rock-ledge.* This bed in its progress westwards is a remarkable feature in the cliff. It is from 15 to 20 feet thick, and rises gradually to the north-west; attaining its greatest height above the sea near a gap or chasm at *Southmore,* and then declining very slowly, till it comes down to the shore between 1000 and 900 from Brook Chine. It seems therefore to form a curve; which, however, is only apparent, resulting from the general rise of all the strata from the interior towards the sea, combined with the curvilinear prominence of the coast between Chilton and Brook Chines. The true relation of the beds here is explained in the transverse section, Plate X. b. fig. 4.

This sand-rock bed, in its progress through the extensive space just mentioned, is of nearly uniform character, the chief difference arising from the frequent concretion of the sand into subcalcareous grit. In several places, the fallen blocks contain cylindrical stems of Siphonia, with shells, occasionally, of the genera Cyclas, Paludina, and Unio; and the grey sand-rock includes small patches or specks of greenish clay.

The cliff beneath the apparent curve formed by the sand-rock bed, consists throughout of dark reddish and variegated marl, or sandy clay, which seems to form all the lower portion of the prominence at Southmore; the greatest height which it attains being about 30 feet above the sea.

In approaching *Brook Chine,* from the spot where the sand-rock bed above mentioned sinks below the shore, the cliff is low and partially covered with grass, but seems to consist of reddish and variegated clays.

A bed of firm grey sand-rock rises at a small angle from the south-east, about 300 paces from *Brook Chine,* which it crosses, and forming a very slight but really existing curve, goes down about 320 paces beyond it, on the north-west; the highest point being near the middle of the Chine. All below this curved sand-rock bed consists of dull red and greenish variegated clays: these are seen especially in the north-west side of the cove, or bay, which leads to Brook Chine; and the floor beneath high-water mark is composed of them.

(101.) *Strata on the South-West Coast of the Isle of Wight, from the Shore under Afton Down to Brook Chine.*

The line of the coast immediately under Afton Down cuts the strata very obliquely. The *Upper green-sand* does not offer any important difference from that of the section under Bembridge Down on the east of Sandown Bay. The following measurement commences with the rise of the *Gault,* which is distinctly marked, this stratum occupying a valley or depression between the upper and lower green-sands.

0—170 is the width of the oblique section of the *Gault.*

170—725. *Lower green-sand:*—affording nothing so different from the other sections in this island already described as to require detail.

512. The middle point of *Compton Chine.*

725—1076. The *Weald clay* (which appears on the beach below the cliff about 710), first rises distinctly above the beach at 725; and thence for a considerable space the shore is occupied by mud and fallen ruins, the remainder of the original cliff being thrown back. Blue clay, however, is visible, apparently in situ, at several points along the shore, and fragments of a thin bed of limestone full of Cyclades, are frequent.

1066. At this point a few regular beds of limestone, six to nine inches in thickness, composed in a great measure of Cyclades, and alternating with shale abounding in Cypris, are dug out of the cliff to be burnt for lime.

1076. Here beds of reddish clay or marly sand, (like those which occur below the Weald Clay on the coast from Atherfield to Brook Chine,) make their appearance, and occupy the shore to about 1850, where *blue* clay and shale are found again*.

1100. Shore much obscured by the fallen ruins of the strata.

1200. In the *remoter* cliff, beds of dark bluish shale are seen, above the reddish clay.

1200—1224. Very red clay on the shore.

1276. A bed of reddish and variegated sandy clay rises, evidently in situ; and thence to 1500, all the nearer and lower part of the cliff is composed of it, in ruins. Above, in the more distant cliff, is the blue clay of the Wealds.

1450. Reddish and variegated clay appear in situ on the shore.

1500. A bed of sand-rock of a yellowish grey colour rises. Immediately over it, at 1530, is dark mottled clay, with much pyrites and coal.

[1600—1850. An under cliff on the immediate shore.]

1630. A group of beds of sand-rock rises, about 10 feet thick.

1710. Thin beds of sand, with lignite, on the shore in the under cliff. In the remoter cliff is a small chasm or chine at the top only†.

1886. Bluish beds of slaty clay again rise on the shore, in which *Cypris Valdensis* occurs abundantly. Strata hence to the next Chine much contorted.

1980. A small opening or chasm, called "*Twenty-acres Chine*," on the east of which the cliff is about 40 feet high. At the upper part, immediately below the diluvium, are beds of bluish shale in situ.

[At the top, all along the cliff, from about 1850 to Brook Chine, is a coating of diluvial loam and gravel of a very red colour, and 10 or 15 feet thick.

All the strata in the cliffs hereabouts, from 2000 onwards, rise towards the south-east. They are visible also very distinctly on the shore beneath high-water mark. Compare these with the strata on the west of Hastings (80.) to (84.).]

2073. A strong band of *sand-rock*, 4 feet thick; thin shale 2 feet below.

2090. A bed of iron ore, about six inches thick, with Paludinæ.

2100. Sand-rock 6 feet thick; false stratification remarkable.

2140. Stony bands, in shale, with *Paludina elongata*.

2173—2185. A strong band of firm sand-rock, about 4 feet thick rises; nodules of grit at the lower part, immediately above the dark red clay.

2190. Dark reddish clay, apparently continued to 2400.

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* The weather was so bad during my examination of this part of the coast, that it was out of my power to ascertain the cause of this recurrence of the Weald-Clay, after the appearance of the sands and variegated marl. It may be no more than the effect of subsidence; and the second mass of clay, the beds of which are contorted, may have fallen from the heights above; the remoter undisturbed cliffs consisting apparently of sand at the bottom, and at the top of blue clay and shale. But, on the other hand, the existence of one or more faults might be expected in this part of the island; for it is not probable that the great mass of strata, which are nearly vertical in the central range, should return so soon to the slight inclination in an opposite direction, which they exhibit on the south, without the formation of cracks. The question is locally interesting, but does not affect the general order and proportion of the formations.

† This remote cliff was not examined, for the reason given in the last note.

2370. *Biddlecombe's Chine*; cliff on the east of it, about 25 feet high.

2400—2410. A strong sand-bed rises to the middle of *Compton-Grange Chine*, on the north-west side.

2410—2552. All reddish and variegated clay; diluvium still at top.

2462 Middle of " *Compton-Grange Chine*."

[On the shore, at the mouth of this Chine, are large masses of angular, grey and yellowish, flint fragments, cemented by ferruginous matter. The coast from hence to Brook Point runs out uniformly in the same direction.]

2552. A strong band of reddish sand-rock; goes out at 2615.

2582—2658. Reddish and greenish clay and sand.

2658. A bed of sand-rock rises; under it is reddish matter, but concealed on the shore.

2694—2700. A bed of *sand-rock* rises, about 4 feet thick, with reddish stains and spots, like those of the new red sand-stone.

2700—2822. Dark red and variegated marly clay seems to occupy all this space.

2843—2855. A bed of fine-grained sand-rock, which forms a ledge in the sea, (the first from Compton-Grange Chine) rises about 2843, and goes out under the diluvium at the top of the cliff, about 3000, very near to *Brook Point*. It may possibly be the same with that which re-appears on the other side of the point, and crosses the upper part of Brook Chine.

2855—2952. Variegated, wine-red and greenish, cohesive sand, not effervescent, occupies this space on the shore, and forms the upper part of the Point and nearly the whole of the cliff below the diluvium thence to near Brook Chine.

2952—3030. A group, consisting of sand and sand-rock, with concretions of subcalcareous grit. This forms the base of the Point; and the upper beds of the group seem to go down, beneath the variegated sand of the last-mentioned stratum, between the Point and Brook Chine. The boat-men informed me that some of the ledges of sand and sand-rock run out several miles into the sea from this part of the coast. The lower part of this group includes, in great numbers, large trunks of petrified coniferous wood*, frequently of a dark brown colour, penetrated by carbonate of lime and effervescing abundantly with acids; the cracks by which they are traversed being filled with the same substance. At very low tides, compact variegated sand, like that which abounds on other parts of this coast, appears below the sand-rock of the Point, and seems to be the lowest visible stratum of the island.

The extremity of *Brook Point* is about 3060 paces from the rise of the Gault under Afton Down, measuring along the shore; thence to the Chine the shore turns inwards a little towards the east, and the distance is about 830 paces; of which about 250 are occupied by the sand-rock of the Point, beneath the variegated clay. About 320 paces from the Chine a bed of firm sand-rock rises, and crossing the upper part of it, forms a slight curve: it is, in fact, a continuation of that already mentioned, which rises about 300 paces on the south-west of the Chine.

3890. The middle of *Brook Chine* is about 3890 paces, reckoning round the Point, from the top of the Gault under AftonDown.

(102.) *Fossils of the Beds below the Chalk in the* Isle of Wight.

[*Upper Green-sand.*]

Ammonites cinctus. East End. In grey marly chalk, with few green particles.

A——— *Mantellii*. Western Lines. Some of the specimens compressed into ovals.

* See Webster's Isle of Wight, p. 153—4.

Ammonites Mantellii? A variety without tubercles. Western Lines. Sandrock near Niton.
A——— Seliguinus. East End.
A——— varians. East End. Bonchurch. Grey chalk marl. Western Lines.
Belemnites. Western Lines.
Cardium. Western Lines.
Cucullæa glabra. Western Lines.
C——— decussata? Western Lines.
Exogyra undata. Western Lines.
Gryphæa canaliculata. Western Lines?
G——— vesiculosa. East End and Western Lines.
Nautilus compressus. Western Lines?
Pecten orbicularis. East End: some specimens very large.
P—— quadricostatus. East End. Western Lines.
Plagiostoma Hoperi? Western Lines.
Plicatula inflata. Western Lines.
Siphonia Websterii. Parkinson, Int. Org. Rem. Western Lines. Figured by Mr. Webster, Geological Transactions, 1st Series, vol. ii. pl. 27—30.
Solarium conoideum. Pl. XI. f. 14. Western Lines.
S——— ornatum. Pl. XI. f. 13. Western Lines.
Spatangus. Near the Sandrock Spring.
Terebratula depressa? Western Lines.
T——— pisum. Western Lines.
T——— (new). Western Lines.
Trochus. Western Lines. St. Boniface. Upper Green-sand, or Chalk Marl.
Turrilites tuberculatus. Near Bonchurch.
Venus? Western Lines.
Vermetus umbonatus. (*Vermicularia umbonata,* Min. Con.) Western Lines. Large specimens?
V——— polygonatus. Bonchurch and Ventnor Cove.

[*Gault.*]

Ammonites Seliguinus (syn. *A. Beudantii.*) East End.
Gryphæa. East End.
Mya mandibula. East End.
Pecten orbicularis. Compton Bay: In harsh gritty Gault.
P—— quinquecostatus. Compton Bay.

Fishes. Obscure impressions of. East End.

Plants. *Fucoides Targionii.* (Ad. Brongniart, "Végétaux Fossiles," Pl. IV. fig. 6.; and Mantell, "S. E. of England," p. 166.) East End.

[*Lower Green-sand.*]

Ammonites furcatus. Pl. XIV. fig. 17. Atherfield.

Astacus. East of Shanklin.

Astrea. East of Shanklin Chine, and Atherfield Point: in fuller's earth.

Corbula striatula. West of Shanklin Chine, in ferruginous nodules, with many other fossils. Near Atherfield.

Exogyra conica? Atherfield Point.

Gastrochæna. In Coral, near Atherfield Point.

Gervillia aviculoides. West of Shanklin Chine. Atherfield Point.

G——— solenoides. Same place: in ferruginous nodules.

Gryphæa vesiculosa? Sandown Bay: in a mass of yellowish sand, with polished fragments of brown iron ore.

G——— sinuata. East of Shanklin Chine: in ferruginous sand, with dark particles and fragments of iron ore. Frequent on the east of Atherfield Point. Near Niton: very large.

Inoceramus concentricus. Near Atherfield: in fuller's earth: in sandy stone, with vegetable impressions (*Fucoides Targionii?*).

Lingula. Barnes's Chine. Isle of Wight?

Modiola depressa? Near Atherfield: in fuller's earth.

Mya plicata. (See *Panopœa.*)

Natica. In ferruginous nodules, West of Shanklin Chine.

Nautilus radiatus?. Near Atherfield. This and other specimens from Kent very much resemble *N. radiatus*, from Malton, Yorkshire. It is very distinct from *N. elegans*.

Ostrea carinata. East of Shanklin. Atherfield Point: in green sand and in the fuller's earth.

O—— macroptera. Near Atherfield.

Panopœa plicata. Atherfield Point. East of Shanklin: with Serpula.

P——— (new). Atherfield.

Pecten obliquus. Atherfield Point, with *Terebratula Sella.*

Perna quadrata? Fallen masses on the shore east of Shanklin Chine.

Pinna tetragona? Atherfield Point: in fuller's earth.

P—— (new species?). Near Atherfield: in green sand, like the middle bed of Sandgate, Kent.

Plagiostoma elongatum. Atherfield Point: in fuller's earth.

Rostellaria calcarata. Shanklin, top of the cliff, west of Chine: in ferruginous nodules, with many other fossils.

Rostellaria Parkinsonii. Shanklin: in ferruginous nodules. Same situation.

Serpula antiquata? Atherfield Point: fuller's earth.

S——. Another species, with *Ostrea.* Atherfield. Cowleaze Chine.

Spatangus. East of Shanklin. Atherfield. Cowleaze Chine? fuller's earth.

Sphæra corrugata. Shanklin, (large specimens.) Sandown Bay.

Siphonia. Near Atherfield Point: in green sand.

Terebratula biplicata. Chale Bay.
T——— Gibbsiana. Atherfield Point.
T——— latissima. Near Atherfield.
T——— nuciformis. East of Shanklin.
T——— Sella. Sandown Bay. Atherfield Point: in greensand, and in fuller's earth. With *Pecten obliquus*; Chale Bay.
T——— parvirostris. Pl. XIV. f. 13. Debris on the shore east of Shanklin.
Thetis major. Atherfield Hill. Blocks loose on the shore.
T—— minor. In ferruginous nodules, west of Shanklin Chine.
Trigonia alæformis. East of Shanklin; of unusually large size: and in ferruginous nodules, west of the Chine. Atherfield Point; large, in sand very like the middle Sandgate bed.
Turbo conicus. West of Shanklin Chine: in ferruginous nodules.
T—— rotundatus? Shanklin.
Turrilites? Near Atherfield.
Vermetus concavus. With *Terebratula Sella*: Atherfield; and east of Shanklin.

[*Wealden.*]

Ammonites. A fragment imbedded in a portion of Sussex marble, with Cyclas, Ostrea, and *Paludina elongata*. This Ammonite probably formed part of a foreign mass accidentally brought into the Weald clay, during the progress of its deposition.
Cyclas major. Atherfield Rock, in Sussex marble and Weald clay: also forming singular prominences on thin layers of stone; see p. 197 line 24, and p. 198. Cowleaze Chine. In ironstone, west of Shepherd's Chine. Barnes's Chine, very large. Compton Bay.
C—— media. Sandown Bay. Atherfield Rock, about 2 inches thick, in a bed almost composed of these shells, incrusted with fibrous carbonate of lime. West of Shepherd's Chine: in coarse ferruginous sandrock, probably one of the subordinate beds of the Weald clay: in pyrites. Cowleaze Chine. Barnes's Chine.
C—— membranacea. Sandown Bay: large, preserving its iridescence. Near Atherfield. Shepherd's Chine. Barnes's Chine.
C——. (A thick and gibbose species.) Sandown Bay in ironstone.
Cypris Valdensis. Pl. XXI. fig. 1. Occurs throughout the Wealden. At Sandown Bay; Atherfield; Shepherd's Chine; Cowleaze Chine; Barnes's Chine; Under Barnes's High; Brook Point; Compton Bay.
Cypris tuberculata. Pl. XXI. fig. 2. Near Atherfield and Cowleaze Chine.
Modiola (new). Sandown Bay.
Ostrea. A bed of limestone nearly composed of oyster shells occurs in the Weald-clay at Sandown Bay; near Barnes's Chine; and on the west of Compton-Grange Chine.
Paludina acuminata. Near Atherfield. Near Barnes's Chine (young).
P——— elongata. Occurs throughout the Wealden. Sandown Bay: in ironstone. Atherfield Rock: in clay. Tiepit, near Atherfield. Cowleaze Chine: in no-

dular masses of ironstone. West of Shepherd's Chine. Near Barne's Chine: in stem-like masses of pyrites. Under Barnes's High. West of Compton Chine.

Paludina fluviorum. Sandown Bay, with Ostrea, Cyclas, and *Paludina elongata*: in a course of stone, about 2 inches thick: also with *Cypris Faba*, in similar stone.

Potamides? In clay, Sandown Bay.

Remains of Fishes. Scales of one or more species of Lepisosteus, (Lepidotus of Agassiz,) apparently the same with those which are frequent in the Wealden of Kent and Sussex, are found in the Weald-clay at Sandown Bay: as are also the teeth, vertebræ, and other bones of some small species of fishes, at Sandown Bay; near Atherfield Point; and at Cowleaze Chine.

Large concretional masses with small tubular erosions on the surface, much resembling those of Sandgate in Kent (13.), containing a large proportion of phosphate of lime, and affording during solution the smell of *Coprolite*, have been found at Atherfield.

Reptiles. The toe-bone of a very large *Iguanodon*, found under the cliffs of the Wealden strata on the shore of Sandown Bay,—and fragments of other bones, probably of the same animal, found near Brook Point?, have been described by Dr. Buckland, Geol. Trans. 2nd Series, vol. iii. p. 421.

Portions of the teeth of another Saurian, probably a *Crocodile*, have also been found at Sandown Bay.

Plants. Impressions of the leaves of a species of Fern: in the Wealden sand-rock: at Sandown Bay, and on the east of Barnes's Chine.

Dorsetshire.

(103.) *Isle of Purbeck.*—The principal additions which I have to make, to what Mr. Webster has published on the Isle of Purbeck*, are the distinction of the ferruginous sands below the chalk, which contain marine fossils, from the representative of the Hastings sands; and the indication of a stratum between the Portland stone and the Kimmeridge clay, which I propose to distinguish by the name of the *Portland sand.*

The section, Pl. X. a. No. 8. represents the coast on the east of the Isle of Purbeck, from the chalk at Ballard Down to Durlstone Head; and No. 9. a section near the middle of the peninsula, from the Chalk to the shore of Kimmeridge-bay, of part of which Plate X. b. fig. 6. is an enlarged illustration. In the coast section on the east of Purbeck the whole series from the chalk down to the Portland stone is disclosed†: the Upper green-sand, Gault,

* Letters to Sir H. Englefield; and Geol. Trans. 2nd Series, vol. ii. p. 37—41.

† A beautiful view of this section of the Isle of Purbeck is visible with a telescope, from the heights on the west of the Isle of Wight; and reciprocally, the transverse section of the latter

Lower green-sand, and Weald clay, in strata highly inclined, occurring in a nook or recess called Punfield, at the southern foot of Ballard Hill; and the Hastings sands, occupying the whole of the long range of cliffs thence to the town of Swanage; the section of which is so distinct, that with sufficient labour all the details can be made out. The strata correspond, however, precisely with what I have mentioned in the preceding accounts of the Isle of Wight and of the coast near Hastings*, and, as at those places, consist of sand and sand-rock, including concretions of calcareous grit, and alternating with a very large proportion of reddish and greenish cohesive sandy clay. Detached portions of lignite are frequent also throughout the series here. Fragments of the trunks of silicified coniferous trees have been found in dark brown masses; and detached bones of the Iguanodon sometimes occur loose on the shore beneath the cliffs near the town of Swanage†.

The Hastings sands can be traced entirely across the peninsula to Worbarrow Bay, in a range of heights passing through Godlingston, south of Westwood, Steeple, North Egleston, and Tineham: but the subdivisions between the sands and the chalk become indistinct on the west of Punfield; a slight difference only in the hue of the vegetation on the surface indicating in some places the presence of the Weald clay. The junction of the sands with the Purbeck strata is concealed, at Swanage, under the level tract which separates the sand cliffs from the hill above the town: and the only place among the numerous sections westward, in which the connexion between the Hastings and the Purbeck strata is visible, is on the south side of Worbarrow Bay. At the time of my examination, the appearances there were not distinct, but I shall here insert what I observed, as these beds are supposed to represent the strata on the north-west of Battle, which have been considered as the lowest in Sussex.

island forms a very striking object from the hill above the town of Swanage. Views thus seen from a sufficient distance have all the abstract clearness of a geological outline; while the minutest features are preserved without any departure from the true proportion of height to horizontal distance.

* For this reason I have thought it unnecessary to insert here the list of these strata to which I have referred above, (79.). The spaces which the several formations occupy, measured along the foot of the cliff, are thus: Upper green-sand, about 250 paces; Gault, 200; Lower green-sand, 240?; Weald-clay, 46?; Hastings sands, 3,500;—Total distance from the chalk to the bottom of the sands, about 4,250 paces. A flat of about 200 paces intervenes between the sand cliffs and the rise of the Purbeck strata. Compare these spaces with those at Man-of-war Cove, hereafter (110.).

† See Dr. Buckland's paper, Geol. Trans. 2nd Series, vol. iii. p. 421.

*Beds on the confines of the Hastings sand and the Purbeck strata, at Worbarrow Bay**.

	Paces.
Grey sand, occupying on the shore	8
Yellowish sand	5
A space concealed at top; where visible the beds consist of grey clay, bituminous or carboniferous, which includes at the bottom concretions of quartzose grit, and contains Cyclades	9
A group including beds of stone composed of small Paludinæ, in a cement containing much green matter:—the "marble" and "marble-rag" of the Swanage quarry-men	16
Brown and grey clay, alternating with bluish grit, and thin beds of stone .... About	25
Clay and limestone, including the "Leaning vein" of the quarries on the east of Purbeck. [*Quæ.* the "Lane-end Vein" of Mr. Webster?]	?

Here the ground rises into the prominence called Worbarrow Knob; and the back on top of a very extensive mass of stone is waved, like the ripple-mark on the sea-shore. In the little cove between the "knob" and Gad Cliff, a thickness of about 50 feet consists of clay, alternating with beds of limestone very much contorted.

(104.) *Purbeck strata.*—The ridge of the Purbeck and Portland strata runs nearly from east to west, entirely across the peninsula; but the dip is not uniform, and the strata form a curve, or a portion of a dome-like prominence, of which the highest part is between Acton, St. Alban's Head, and the heights above Kimmeridge, and thence to Tineham Hat; the culminating point being about Swyre Head, which seems to be about 700 feet above the sea,—nearly on a level with the chalk down at the western extremity of Purbeck Hill, and perhaps 100 feet higher than the summit of Ballard Down†.

The whole of the Purbeck series is exposed in the ruinous cliffs of Durlstone Bay, where the strata have been enumerated in detail by Mr. Webster‡. At the upper part they consist of compact limestone, alternating with clay, and abounding in freshwater shells, especially of the genus Cyclas: but including also a thick bed called "cinder" by the quarry-men, which is almost entirely composed of oyster-shells. At the lower part, the formation consists principally of fissile limestone, the junction of which with the Portland strata exhibits some very remarkable appearances.

All the stone which is quarried at present, occurs in the upper part of the series; and from Mr. Webster's list it appears that in a thickness of about 125 feet, 55 consist of beds of useful stone; 12 feet of the "cinder" composed of oyster-shells; and the remaining 58 of slaty clay, and thin beds of unprofitable stone. I was informed that about 150 feet more, of what the work-

* This is the spelling of the Ordnance Map, and the word is so pronounced in the country. It is sometimes printed *War*-borrow, and by Mr. Webster, *Worth*-barrow.

† The top of the Down between Acton and Bottom, (about the place of the final *s* in "*Downshay's Farm*", in the Ordnance Map), is much higher than St. Alban's Head, and not much below Swyre Head. It seems to be nearly level with Encombe Head (Hound's-Tout), and the east end of Ballard Down.

‡ Geol. Trans. 2nd Series, vol. ii. pp. 38, 39.

men call "rubbish" and "slate", intervene between the lowest of the courses (or "veins") of good stone, and the top of the Portland formation; so that the total thickness of the Purbeck formation here is about 275 feet.

	Ft.	In.	Ft.	In.
Workable stone, and "rubbish"	99	0		
"Cinder"	12	0	124	8
Workable stone, and "rubbish"	13	8		
"Rubbish" and "slate"			150	0
Total			274	8

The high ground between Peverell Point and Durlstone Head is divided by a depression or ravine, on the north of which, in addition to the flexures and contortions seen in all the sections, and well represented in Mr. Webster's plates, the strata are traversed by fissures, produced by upheaving, or subsidence, or both. The effect of these disturbances can be traced by means of the "cinder" bed; disjointed portions of which are still visible, inclined at different angles, in three or four successive falls, the first throwing down that bed more than 100 feet, and others 40, 15, and 3 feet. The fissures which separate the disjointed masses are widest at the top, and are filled with fragments of the dislocated strata. The place where these derangements occur is called "the Gulley": on the south of it the strata are much less disturbed, and the "cinder" can be traced almost continuously in its proper situation, till it disappears near the face of the hill, not far from Durlstone Head.

The groups at the top of the formation called the "Marble" and the "Marble rag", consist for the greater part of small Paludinæ, cemented by carbonate of lime with a very large proportion of green matter. These beds are exposed on the shore at Peverell Point*, and were quarried many years ago at Langton, from which place it is said the pillars in the interior of Salisbury Cathedral were obtained. Another stratum, also containing a large quantity of green matter, but of a conglomerated or coarse sandy texture, is found at the top of the formation in some of the sections westward,—as near Worbarrow Knob, and on the east of Lulworth Cove. It includes a large and thick species of Unio; the shell, as Mr. Webster has remarked, being so abundant as to constitute a very large proportion of the whole mass.

A characteristic of the upper part of the Purbeck series, both on the coast and in the interior, is the occurrence of seams of fibrous carbonate of lime, frequently more than two inches thick, and either detached within the beds of clay, or adhering to the limestone beds, like the thinner crusts attached to the limestone of the Weald clay.

The bivalves, principally Cyclades, of which a great part of the Purbeck stone is composed, are not less numerous, and commonly much more distinct, in the slaty clay of the "rubbish" between them; which cannot be distinguished from the clay with Cyclades ("Shab") of the limestone pits on the north-west of Battle in Sussex. The "Slate", a coarsely fissile limestone at the lowest

* A very remarkable appearance, which I am at a loss to explain, was observed by Mr. Babbage and myself in 1824, on the back, or top of the Purbeck strata, at that time exposed on the shore between the town of Swanage and Peverell Point. The surface there, which dipped at an angle of 7° or 8° towards the north, was depressed in some places into nearly circular pits or cavities, from 4 to 7 feet in diameter, and about a foot deep in the middle,—as if the beds had been forced in by a violent blow; the depressed surface being divided by irregular but nearly concentric cracks, which were filled with white sparry carbonate of lime. Three of these depressions were visible; two of them about 6 feet apart, one of which was $7\frac{1}{2}$ feet, the other about $4\frac{1}{2}$ in diameter at the outer edge. A third, about 10 paces to the west of these, was of smaller dimensions.

part of the Purbeck series, was formerly much quarried for roofing, in the hill above Tillywhim, and near the south coast of the peninsula: and there, as well as in the corresponding beds of Portland and the north of Weymouth, I have found in it casts in calcareous spar of one or more species of Cypris.

(105.) *Portland Stone.*—This formation first appears upon the coast beneath the Purbeck strata at Durlstone Head, and rises slowly in the rocky cliffs on the west of Tillywhim to a point about midway between Winspit and St. Alban's Head, where it is succeeded by the Portland sand. The stony strata there retire as they rise from the shore, and occupy the margin of an irregular space thence to Gad Cliff, where they return to the coast and sink under the sea: so that between the extreme points of Durlstone Head and Gad Cliff (or rather Worbarrow Knob, a rocky hummock on the west of that place), a real curvature combined with the general inclination of the strata towards the north, which is in some places very rapid, has caused an extensive disclosure of the lower beds, excellent sections of which are visible on the west of St. Alban's Head. The component strata of the Portland stone in Purbeck, agree with those of the Isle of Portland, which have been described by Mr. Webster.

(106.) *Portland Sand.*—I propose to give this name to a group of strata which holds the place of that mentioned by Mr. Conybeare as occurring beneath the equivalent of the Portland stone at Shotover Hill in Oxfordshire, and in Bucks; and which in the interior contains a large proportion of sand, including green particles, ascertained by Dr. Turner to be of the same composition with those of the green sands beneath the chalk*. I have found a similar group abounding in green matter, and containing, as at Shotover, very large concretions of grit, in a corresponding place in the lower Boulonnois†, where a great part of the formation consists of sand. But on the Dorsetshire coast, and I believe, in the Vale of Wardour also, the beds are generally of a dark grey colour, more coherent, less sandy, and the calcareous matter which they contain, is more uniformly diffused‡. The group is certainly of sufficient importance to require a separate name, and that of *Portland sand,* while it expresses the more usual character, indicates also its intimate connexion with the Portland stone. On the other hand, it graduates into the Kimmeridge clay beneath; and its position seems to be

* See above, (10.) note §. † Geol. Soc. Proceedings, vol. i. pp. 9 and 27.

‡ On the west of Upway, however, near the coast of Dorsetshire, nearly half the substance of this stratum is made up of grains of green earth; and along the whole line of the formation in that quarter, the prevailing character is that of siliceous sand and green earth.—See Dr. Buckland's and Mr. De la Beche's Memoir, in the preceding part of this volume: p. 20, and note.

analogous to that of the sand and subcalcareous grit which occur between the Oxford oolite and Oxford clay,—the inferior oolite and the lias clay: ?? The whole mass of strata deposited in the first instance, having been in all these cases, sand and mud; the upper part of which abounding more in calcareous matter, was subsequently converted into stone, and the lower more or less concreted into nodular masses of calciferous grit, in proportion to the quantity of carbonate of lime diffused through it.

In the Isle of Purbeck, the *Portland sand* first rises above the sea about midway between Winspit and the point of St. Alban's Head, and is disclosed by denudation on the north of that remarkable promontory, in a ravine called Pier Bottom, near which place the Kimmeridge clay appears to rise on the shore. A good section of the sand is visible at Emmet's Hill, a ridge capped with Portland stone, between Pier Bottom and Chapman's Pool; and the group may be traced thence, beneath a capping of stone, all round the inflections of the high ground from Bottom Farm, by the prominences called Encombe Point (or Hound's Tout), and Swyre Head, through Kimmeridge, to Gad Cliff, where it declines along with the stone and sinks again under the sea. Its relative place and its effect in modifying the surface, are well seen in the amphitheatre of high ground which nearly encircles Kimmeridge Bay; of part of which Pl. X. a. No. 9, and X. b. fig. 6, are illustrations: the summits all around consisting of Portland stone, and the rapid grass-covered slope beneath of this sand, resting upon a tract comparatively flat and uniform, which is occupied by the clay of Kimmeridge. The sand again makes its appearance on the coast west of Purbeck, in a small portion distinguishable by its bluish grey colour, beneath the rocky cliffs called Horsewalls, which form the most prominent part of the shore between Lulworth and Durdle Cove. In the complex and disturbed tract on the north and west of Whitenore, the Portland sand is found wherever the superior strata rise high enough to disclose it; and in the Isle of Portland it everywhere accompanies the stone, and has the same characters as on the coast of Purbeck.

The following is a List of the strata at *Emmet's Hill*, immediately on the north of St. Alban's Head:—Pl. X. b. figs. 5 and 6.

	Feet.
1. *Portland stone*, with layers of flint near the bottom, forming a shattered and inaccessible precipice at the top of the cliff ....30 to 40 feet	——
2. *Portland sand.* Soft stone, or marly coherent sand, with a rugged external surface of a yellowish grey or brownish colour; but in the recent fracture, of a dark bluish or greenish grey. It includes concretions of firmer consistence. In a bed of stone of the same description at the cross-roads above Kimmeridge Farm, which seems to belong to the same place in the series, *Trigonia clavellata*, *Ammonites giganteus*, and other fossils are found	25 to 30
3. Bluish grey, inclining to green, sandy clay and marl, including ranges of concretions approaching to stone: the whole effervescing with acids. The more stony portions acquire by exposure a yellowish brown tinge, and are in some places coated with a crust of white pulverulent carbonate of lime. A bed of this group dug for building near Bottom Farm, consists of bluish grey sandy stone, but slightly effervescent, and is streaked or mottled with portions of a darker hue. In some other places the strata are divided by fissures into nearly vertical flakes, two and three feet in thickness, and include occasionally nodules of much more compact texture..	about 60

	Feet.
4. A rugged platform at the foot of the cliff above described, is covered with debris, and partially clothed with shrubs and vegetation. The beds appear to be:— *a.* Soft, dark bluish grey, effervescent sand-rock, or indurated marl, including a band of firmer consistence, which contains casts of *Panopæa depressa* and other bivalves. *b.* Brownish marly sand-rock, softer than *a.* *c.* A firmer stratum, including, about 20 feet from the bottom, large subglobular, but nearly continuous concretions of greater firmness, which also contain casts of *Panopæa depressa* and other fossils. [These concretional masses, not improbably represent the great nodules of Shotover Hill in Oxfordshire.]	40 to 50
Total estimated thickness of the sand........................	120 to 140

Springs break out at the bottom of this group, where the Kimmeridge clay might be expected. The total height from the top of the cliff may be between 250 and 280 feet.

(107.) *Kimmeridge clay.*—The clay which has obtained its name from the farm and bay of Kimmeridge, rises from beneath the beds last mentioned,—on the east, near the point or southern prominence of St. Alban's Head, and on the west, immediately under the lofty precipices of Gad Cliff. It occupies, apparently, the whole of the low undulating tract which intervenes between these extreme points; and is capped, about the middle, by the projecting mass of Portland stone and sand which forms the summit of Swyre Head. The bituminous strata which characterize this formation are seen with greater distinctness on the shore of Kimmeridge Bay, as the coarse sand, grit, and limestone found between them and the Oxford oolite on the north-east of Weymouth, do not come up to the surface in the peninsula of Purbeck. The little promontory of Hen Cliff may be considered as the centre of an almost semi-circular space, which is continued in a narrow slip or platform, along the shore to Pier Bottom: Plate X. b. fig. 6.

The strata on the shore at Kimmeridge Bay form a low dome-shaped prominence, the culminating point of which is at some distance from the ridge of the Isle of Purbeck. At Broadbench, where they are very well displayed, they rise with a very slight inclination from the south; and rise also from beneath Gad Cliff on the west; but at Hen Cliff the dip is towards the south-east, conformably to the general disposition of the strata beneath St. Alban's, and thence to Durlstone Head; while it is obvious that under the main ridge of the peninsula they must dip to the north, along with Portland and Purbeck strata. The rise of the beds from the sea, where the shore is cut into by the circular erosion at Kimmeridge, has produced an apparent curve in the cliffs around the bay; so that the strata seem to rise from the sea near Broadbench, and to decline again as the line of the coast returns toward the south in approaching Hen Cliff. The natural sections hereabouts are very distinct; and a considerable surface also of some of the strata is exposed upon the shore, consisting apparently of the lowest beds in the Isle of Purbeck. The coast at Kimmeridge Bay is probably not less than 400 feet below the bottom of the Portland stone; and if 100 feet of that interval be assigned to the Portland sand, it will follow that about 300 feet of the bituminous Kimmeridge clay are disclosed on the coast of Purbeck; which probably, is not far from the total thickness of the formation.

The beds here consist in general of bituminous fissile clay in a large proportion, alternating with thin courses of brown subcalcareous stone, or bituminous limestone. The clay in some cases contains so much bituminous matter, as to be used for fuel under the name of "coal*"; in others it contains a large proportion of carbonate of lime, alternating with the laminæ of the clay. To these more calcareous and whiter beds the name of "White Lias" is given in the neighbourhood.

The connexion of the Kimmeridge clay with the Portland sand and stone is visible, though the section is in some points inaccessible, at a place between Gad Cliff and the commencement of the lower cliffs of the bay, where the following was the order:—

1. Dark sandy marl (Portland sand) about 100 feet. A specimen taken here about 100 feet below the Portland stone, consists of light grey, soft, calcareous matter, including minute green particles in very large proportion; the whole very much resembling some portions of the Upper, and of the middle strata of the Lower green-sand.

2. A series of beds about 30 feet in thickness, composed of shale, in part so bituminous as to serve the purposes of fuel; in other places passing into a very bituminous soft fissile limestone ("White lias") of a light brown or grey colour, which on decomposing becomes almost white. The dark surfaces of the fissile beds are spotted with numerous light grey specks, probably the remains of organized bodies.

Another form in which calcareous stone alternates with the bituminous shale above mentioned, is that of a dark brown stone,—sometimes of the consistence of indurated marl, effervescing freely, sometimes acquiring a flat conchoidal fracture and greater hardness, and but slightly effervescent.

The strata around Kimmeridge Bay, which seem to belong to a lower part of the series than the second group above mentioned, include a remarkable bed of brown, bituminous, and somewhat gritty limestone, about two feet thick, which is divisible into rhomboidal fragments. This is succeeded by a considerable thickness of shale, less bituminous than the "coal"; which includes with other fossils, great numbers of *Ammonites biplex* much compressed, and alternates with thin beds of the limestone. At Hen Cliff three or four such beds occur in the shale. One of the same character is conspicuous in the arch or curve of the cliff at Kimmeridge Bay, and another about 30 feet below, seems to be the lowest stratum of the Isle of Purbeck.

The Kimmeridge clay, sinks into the sea at Gad Cliff, and does not again appear till after an interval of seven or eight miles, where a very good section is visible in Ringstead Bay on the west of Whitenore. The beds which occupy the shore thence to Weymouth Bay form the transition from this clay into the Oxford oolite; and as a full account of them will be given by Dr. Buckland and Mr. De la Beche†, I shall only mention here that the

* It burns with a bright flame, emitting a very disagreeable smell, and leaves a grey, light, and spongy cinder.

† The country around Weymouth had been previously illustrated by a paper of Professor Sedgwick, in the Annals of Philosophy for 1826, vol. xi. p. 339, &c.; where its resemblance to the cliffs near Scarborough was pointed out, and the relations of the beds between the Portland strata and the Oxford oolite, in different places, explained. The Memoir of Dr. Buckland

whole of this series, including both the bituminous strata of Kimmeridge, and the more complex group beneath, is fully developed in the Lower Boulonnois, of which I have given an account in another paper read before this Society*; and that the coast of Yorkshire near Scarborough is composed of similar strata†.

(108.) On a general view from the heights in Purbeck or Portland, of the great bay or excavation of the coast, of which the Isle of Purbeck forms the east wing, and that of Portland the western promontory, it is natural to suppose that the strata in both places are the remaining portions of a wide plane, which at one time passed continuously through both places, and formed the reflected portion of that which rises from beneath the chalk and runs in a nearly uniform direction from Ballard Hill to the heights near Lulworth Cove. This ridge, if continued, would pass through Weymouth: but the chalk is suddenly interrupted at Whitenore Cliff, and its main outcrop on the west of that place, being directed towards a point about 15° or 16° north of west, makes an angle of about 20° with its previous range through the Isle of Purbeck. On a close examination, this change is found to be attended with some very remarkable circumstances; the coast on the north and west of Whitenore having been the scene of great disturbance, by which a very complex series of faults has been produced. The general disposition of the strata, however, is still that of a saddle; the northern side of which dips to the east of north, while the beds in the Isle of Portland, (the only remaining portion of the slope on the south side,) decline towards a point about 48° east of south‡. The upper beds of Portland are therefore but a part of the mantle-shaped covering which once enveloped the lower strata both in Portland and in the intermediate space from thence to Kimmeridge Bay, where indications of the mantle-shaped arrangement are still visible; the strata on the east of the bay sinking into the sea between Tillywhim and Durlstone Head, very much in the same manner as they do at the Bill of

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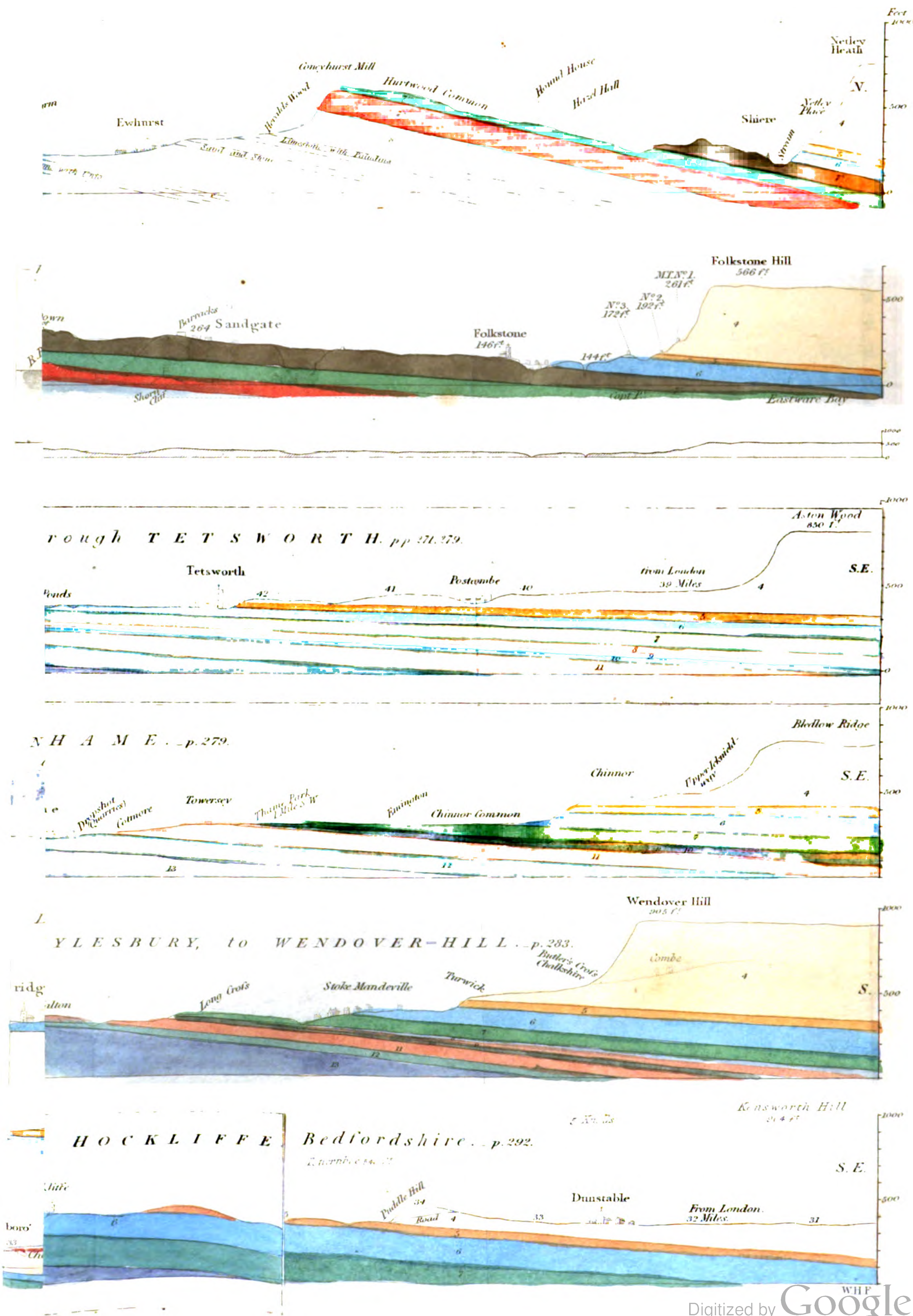
and Mr. De la Beche, so often referred to in the text, has been printed in the beginning of the present volume of the Geological Transactions.

* Proceedings, vol. i. p. 6.

† Sedgwick; Ann. of Phil. 1826. J. Phillips; Geology of Yorkshire, 4to, 1829.

‡ The *strike* in Portland is well determined by the position of the two points on the opposite side of the island, where the beds beneath the stone rise from the sea. These are,—on the west coast, a spot almost due west of the words "Hr. Light" in the Ordnance Map; and, on the east coast, the place where the shore is cut by a line passing through the letter c in "Church-hope," and the bottom of the letter E in the word "ISLE". The line joining these opposite points, makes an angle of about 48° with the meridian; the dip being consequently directed to about 48° east of south. See the Map, Plate VIII.


Ewhurst
Coneyhurst Mill
Hurtwood Common
Hazel Hall
Shiere
Netley Place
Netley Heath
N.
Folkstone Hill
566 ft
Sandgate
Folkstone
Eastware Bay
rough TETSWORTH. pp. 271. 279.
Tetsworth
Postcombe
from London
39 Miles
Aston Wood
850 F.
S.E.
N H A M E . p. 279.
Towersey
Chinnor Common
Chinnor
Bledlow Ridge
S.E.
YLESBURY, to WENDOVER-HILL. p. 283.
Long Cross
Stoke Mandeville
Wendover Hill
Combe
S.
HOCKLIFFE
Bedfordshire. p. 292.
Puddle Hill
Dunstable
From London
32 Miles.
S.E.

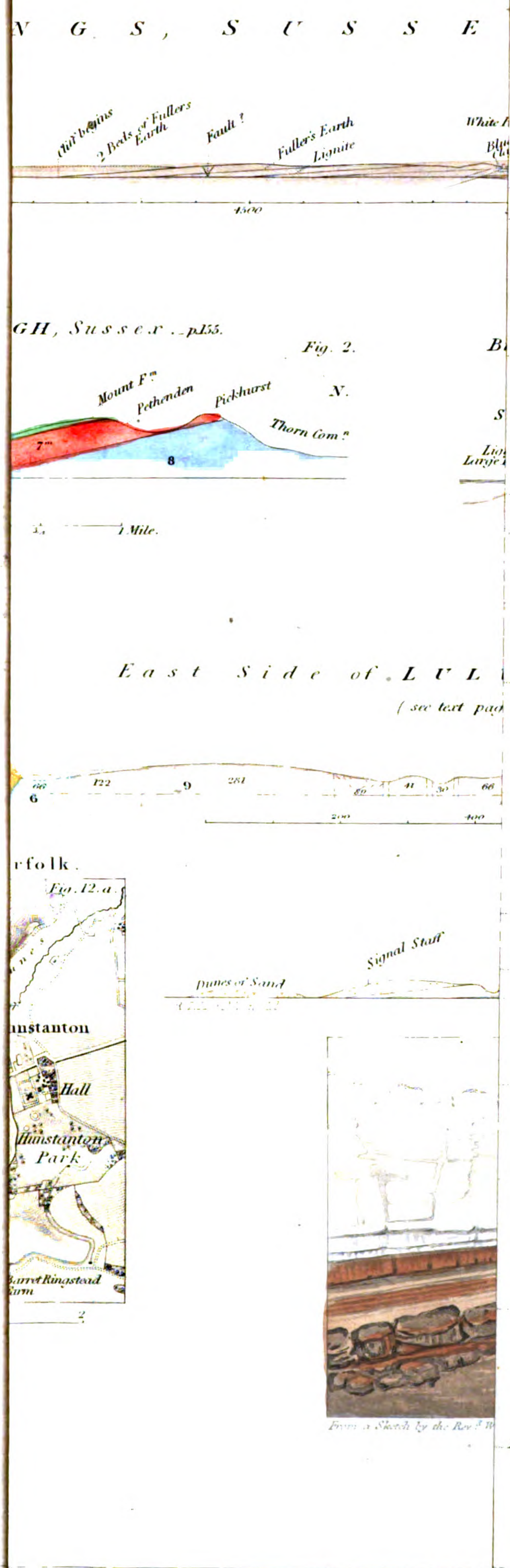
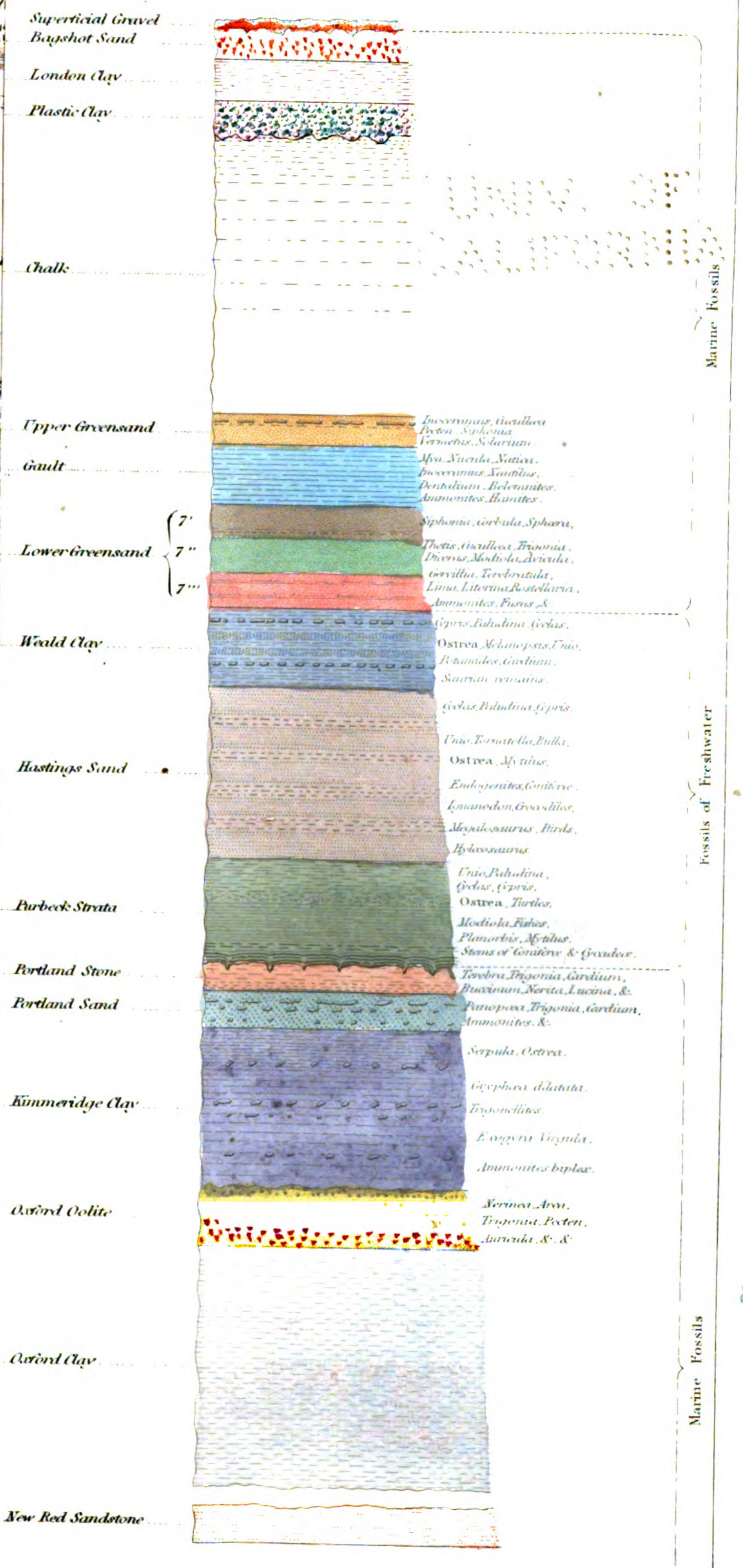


Fig. 13.

ABSTRACT SECTION of the Series of Strata represented in this Plate and in Plate X.a.



W.H.F.

Portland. The structure in this case is, in fact, analogous to that of the Isle of Wight; except that the top of the curve has in that place been carried away, and that what remains of the upper strata on the south of the island is much less inclined.

(109.) *Coast west of Purbeck.*—The sections west of the Isle of Purbeck, as far as Whitenore on the coast of Dorsetshire, have been generally described and represented by Mr. Webster with his usual clearness *, but have not yet been examined in detail. The Purbeck strata especially are disclosed there under a great variety of aspects, no fewer than nine sections of the beds between the chalk and Portland stone being visible, on the shore of the small bays by which the coast is indented, within the short space of five miles †. One of the most remarkable circumstances in the structure of this part of the coast, is the rapid convergence of the strata in proceeding westward from the Isle of Wight; the total distance from the top of the green-sand to the beginning of the Portland stone, which, between Ballard Downs and Durlstone Head is about two miles and a half, being reduced to about 150 paces at Durdle Cove. The sectional sketches Pl. X. a. Nos. 8. to 10′, which are drawn to the same scale, exhibit the proportion of this reduction; and Pl. X. b. figs. 7. and 8., show on a much larger scale, the detail of the beds in the east side of Lulworth Cove, and on the east of the isthmus connecting the ridge of Portland stone with the chalk, at Man-of-War and Durdle Coves; beyond which some detached vertical masses, standing out in the sea like walls, and successively coming nearer to the main cliff, are the last indications of the beds below the chalk upon this part of the coast.

In these western sections of the groups immediately below the chalk it is impossible to recognise all the subdivisions of the coast of Kent, and the adjoining counties; the separation between the upper and lower green-sands having in a great measure disappeared, and the latter being greatly reduced in thickness, or wholly united with the upper sands. In the Wealden, likewise, the clay can scarcely be separated from the strata representing the Hastings-sands, which occupy a considerable space; and here, as in the Isle of Wight, the proportion of red and variegated sandy clay to the ferruginous sands is very great, one distinct group of such clay being observ-

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* Letters, &c., pp. 185-6, 193-7.

† These sections are: 1. *Worbarrow Bay.* 2. *Mewp Cove*, not named in the Ordnance Map. 3. *Bacon Hall*, a nook on the west of Mewp. 4. and 5. *Lulworth Cove*, east and west sides; Pl. X. a. No. 10.; and X. b. fig. 7. 6. *Stare Cove.* 7. West of *Horse-walls.* 8. *Man-of-War Cove*; Pl. X. a. No. 10′., and Pl. X. b. fig. 8. 9. *Durdle Cove.* The coast hereabouts being difficult of access, and the adjacent country thinly inhabited, I believe that the best stations for a geologist who wishes to examine it with ease, would be Swanage, for the eastern part of the Isle of Purbeck; and East Lulworth, for the coast westward. A good boat should be taken in calm weather, at Lulworth Cove or at Worbarrow, to view the cliffs from the sea.

able at the top and another at the bottom of the sands. The curves and contortions of the limestone beds in the Purbeck strata, where they alternate with clay, are strongly contrasted with the parallelism and regularity of the more uniform parts of the series, both in the sands above, and the Purbeck and Portland formations below; the difference being probably ascribable (as Mr. Conybeare, I believe, has remarked,) to the effect of lateral pressure, upon a mass consisting of folia which differ so much in their power of resisting flexure and compression, as the limestone and the clay.

Lulworth Cove.—The relative space occupied by the different groups below the chalk, on the east side of this Cove, is as follows: (See Pl. X.a. No. 10.; and X.b. fig. 7.)

		Feet.	Ft. In.
1.	*Upper Green-sand*, including large concretions of chert		76 0
2.	*Blue Clay* (*Gault*), occupying a depression, in part covered with grass		66 0
3.	*Wealden*. Clay and sand:—		
a.	Reddish sand and clay	122	
b.	Sand of various shades, yellowish and brown: about the middle are beds of coarse conglomerate, consisting of fragments of translucent quartz and of blackish flint [A coating of diluvial gravel extends from the chalk to about the middle of this space, where the cliff is about 40 feet high.]	281	
c.	Reddish sand and clay. [The cliff is here 10 or 12 feet lower.]	80	
d.	Dark-brown sand, including fragments of lignite and of fossil wood. [Large Unios and a small Paludina (*elongata*?) are found near this place.]	4	
e.	Grey and whitish sand … 15 0 Greenish clay and sand. [Cliff about 30 feet high.] … 26 0	41	
f.	A band of red clay and of dark-brownish matter	?	
g.	Yellowish sand		
h.	Dark carbonaceous sand		
i.	Variegated sand and clay, greenish and reddish. [A depression here in the outline of the cliff. At the lower part beds of compact grey lime- and clay. Surface in part concealed and covered with grass.]	66	
	Total, about....		600 0
4.	*Purbeck strata*: estimated at 150 yards; cliff about 80 feet high. [Distinct ledges of coarse sand-rock, including much green matter and a thick species of Unio, are quarried near the top of the formation. On the shore were fragments of beds of fibrous carbonate of lime, 7 to 8 inches thick]		450 0
5.	*Portland-stone* (estimated at 80 yards)		240 0

The *Upper Green-sand* is very distinct in this section. The place of the *Gault* is indicated by a slight depression, which is continued in the grassy hills on the east of the Cove. The *Lower Green-sand* may, possibly, be included in the general mass of sand, 3. *a.*; but the *Weald clay* is not distinguishable. Below the mass of yellowish and ferruginous sands, 3. *b.*, is a considerable extent of variegated clays, comprising beds much charged with carbonaceous matter; the whole clearly referrible to the *Hastings sands.* The transition thence to the *Purbeck strata* is not distinctly seen; but some of the beds, 3. *i.*, of grey uniform limestone, alternating with clay, near the junction, resemble those of the "lime-works" on the north-west of Battle, which are supposed to be the lowest members of the Hastings series. The top of the *Purbeck* on the east of the Cove contains very numerous Unios in coarse green sand-rock: and on the west side a bed of greenish slaty stone, in the upper part of the series, consists of oolitic particles, and contains Cypris. Near the junction of the Purbeck with the *Portland stone,* the site of the "Dirt-bed", which in the Isle of Portland contains silicified trees and Cycadeæ, is very distinctly seen.

Man-of-War Cove, Pl. X. a. No. 10′.; and X. b. fig. 8.—In the isthmus here, which connects with the main land a wide peninsular mass of Portland stone rising towards the south, many of the beds are inclined backwards, and lean towards the chalk hills. A coating of reddish gravel, from 3 to 6 feet thick, extends to some distance from the chalk along the top of the isthmus, and is shown by the dotted line in fig. 8. The following are the strata at this place:

	Paces.
1. *Chalk.*	
2. *Green-sand*	35
3. *Wealden-clay and Sands.*	
a. Dark clay, much mixed with sand; and including a mass of ferruginous sand-rock, 4 to 6 feet thick: seems to represent the *Weald clay*	7
b. Light grey, and white sand	7
c. Red clay, nearly vertical; but inclining a little towards the chalk	10
d. Grey, and brownish sand, including at top a conspicuous bed, of dark hue, which contains much lignite in large pieces. [The breadth of the isthmus here, at the bottom, is about 150 paces from west to east; at top about 40 paces.]	40
e. Dark red and variegated clay. A considerable depression here in the outline of the cliff	10
Total, about	74
4. *Purbeck strata.* Upper calcareous beds much distorted. About the middle a bed of oysters is conspicuous, which, as it rises, is divided like a Y, and one of the portions reflected back towards the chalk. Estimated thickness (probably less than the true)	30
5. *Portland stone* (estimated)	80—90

(110.) *Isle of Portland* *.—The coast of Dorsetshire, from the promontory of Whitenore to Lyme Regis, forms the subject of a memoir by Dr. Buckland and Mr. De la Beche, which is printed at the commencement of the present volume: I shall not, therefore, give any general description of it; but having been favoured with a perusal of that valuable paper, I find it necessary to mention some details respecting the appearances observable near the junction of the Purbeck and the Portland formations, with a view to a comparison of this part of the series in the interior, with that of the coast in England, and in the Boulonnois.

Mr. Webster, in his account of the strata above the Portland stone†, has described a remarkable bed, called by the quarry-men the "Dirt" or "Black "dirt", which he found to contain portions of the trunks of silicified trees; one of which he himself saw standing upright, and divided at the lower part, "so as to give the idea of roots". He states that these trunks were not found in any other part of the series; but not having seen any fossils in the beds above the Portland stone, he expresses himself with caution as to the place of the boundary between the Purbeck strata and the oolitic group beneath

* The substance of this and the following sections, to (116.) inclusive, was read before the Geological Society on the 13th of May, 1835; and is inserted here by permission of the President and Council.

† Geol. Trans., 2nd Series, vol. ii. p. 39, &c.; read Nov. 1824.

it; intimating, however, that it will probably be found at the top of the chert or flint in the upper part of the oolite. Some years afterwards Dr. Buckland described specimens of a new family of fossil plants from the "Dirt-bed" above mentioned; to which, at the suggestion of Mr. Brown, he gave the name of Cycadeoideæ *, but which M. Adolphe Brongniart, adopting a different system of nomenclature, soon after formed into a genus which he called Mantellia †. Dr. Buckland was subsequently led to infer that the "Dirt-bed" was actually the soil in which both the silicified trees and the Cycadeoideæ had grown: and in a paper read before the Society in 1830 ‡, now published in this volume, he and Mr. De la Beche have stated several facts respecting that remarkable bed; adding in a note § that Professor Henslow had ascertained the existence of two other beds of dirt (or of clay with carbonaceous matter) below it; one of them about seven feet beneath, the other about two feet still lower down.

On visiting the Isle of Portland last summer, with a knowledge of these facts, I found that the clay, or "dirt", below the *Cap*, (the upper apparently of the two additional clays described by Professor Henslow,) itself contains Cycadeæ, in an upright position, and to all appearance in the places where they had grown; and I obtained also some new evidence respecting the character of the beds immediately above.

(111.) The following are a sketch and enumeration of the strata exposed at the time of my examination, in the quarries about the middle of the island, and westward of that point; which I was enabled to revise during a second visit to Portland, when I had the satisfaction of being accompanied by Mr. Brown.

The whole mass of the strata which now form the Isle of Portland must have been subjected to great disturbance long before the surface acquired its present configuration; by which the vertical rifts, from a few inches to some feet wide, were formed, which are now observable in the face of the quarries, passing indiscriminately through both the Purbeck and Portland strata, and having in many instances produced displacement in the separated portions: and this at such distances from the present coast of the island, as to prove that no recent disturbance or subsidence of the sea-cliffs has had any share in producing them. Yet it is remarkable that the surface over these disjointed beds is now perfectly uniform; the inequalities occasioned by the sinking and fracture of the slaty Purbeck strata near the top having been completely filled up to a level by rubble and vegetable soil. In one place a fissure between two and three feet wide cuts down, almost vertically, through about thirty feet of stony strata,

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* Geol. Trans., 2nd Series, vol. ii. p. 395; read June, 1828.

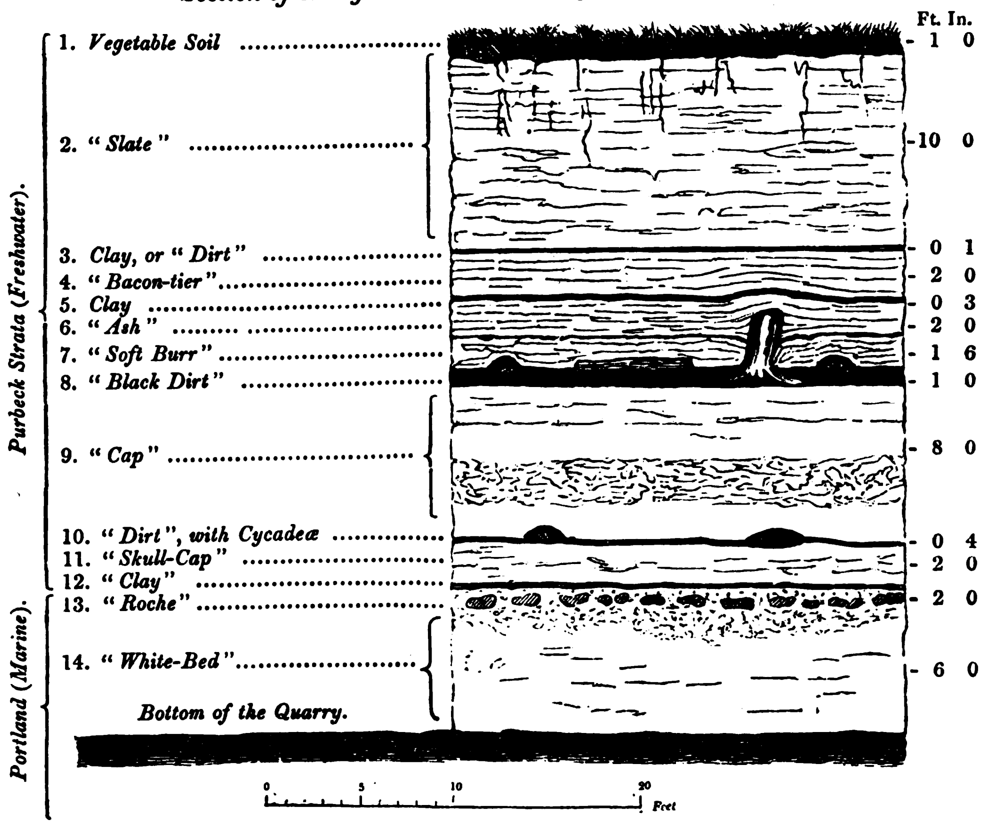
† *Prodrome d'une Histoire des Végétaux Fossiles*, 1828, pp. 92 and 96.

‡ Proceedings of the Geol. Soc., vol. i. p. 217. *et seq.*

§ Page 16. of the present volume.

and still retains its width at the bottom. The thin slaty beds of the Purbeck are in this instance disturbed and bent, downwards and towards the fissures, to some feet on both sides; but the soil above is perfectly level; and in some other cases, where two or more cracks are near each other, the intermediate masses are still more contorted and displaced. It will be shown hereafter that appearances of the same kind are observable in the Portland-stone quarries in Wiltshire, Oxfordshire, and Bucks.

Section of one of the Portland Quarries. 1834.



2. The "*Slate*" of the preceding section is nothing more than the coarsely fissile limestone which pervades the whole of the Purbeck formation, but at the lower part less frequently alternates with clay. Its thickness varies in different parts of the Isle of Portland, from about fifteen to less than six feet. In some places it includes small veins of rhombic carbonate of lime in minute crystals; but has commonly the general aspect and flat conchoidal fracture of freshwater limestone. On a close examination these beds are found to contain the remains of one or more species of Cypris*; and I saw a few traces of small Modiolæ, like those which abound in the corresponding strata in the Vale of Wardour and Buckinghamshire. The Cypris, in fact, is found in all the beds above the oolite (13. of the Sketch above); so that no doubt remains respecting the boundary between the Purbeck and the Portland formation below. Nothing can

* As, with few exceptions, casts only of the interior of the crusts are obtained here, it is difficult to determine the species of these fossils. Mr. Sowerby is disposed to refer most of them to a new species, *C. tuberculata*, Pl. XXI. fig. 4.; and a few perhaps to the *C. Valdensis*, Pl. XXI. fig. 1.; both of which abound in the corresponding part of the Purbeck formation in the interior.

be more remarkable than the immediate contact of these two groups; the upper consisting of freshwater limestone with few fossils; the lower distinctly oolitic, with fossils in great number and variety, and all of them marine*.

3. Besides the "*Black* Dirt" (No. 8.), or, as it is usually called by the quarry-men, "*the* Dirt", two or more thin courses of clay occur above the *Cap*: one (No. 3.), about two inches thick, between the *Bacon-ledge* and the *Slate*; another (No. 5.), about an inch in thickness, dividing the former from the *Ash*. The number, however, of these thin beds of clay varies in the different quarries; and, in general, it may be said that such alternations with the limestone are not unfrequent. They all bear the name of "Dirt", and are more or less mixed with fragments of stone and with carbonaceous matter; but contain commonly much more clay than either of the two beds hereafter mentioned, which include the remains of plants.

4. The *Bacon-tier* consists of calcareous slate alternating in some places with thin beds of sand. It is from 2 feet to 2½ feet in thickness.

6. *The Ash* is a soft fissile limestone, like the last-mentioned bed, from which it is easily separated in working. In general it is from eighteen inches to two feet thick, and is closely connected with the *Soft Burr*, 7. When the incumbent beds are removed, it generally exhibits an uneven surface, with numerous bosses or prominences, enveloping the broken tops of the trunks, which stand upright in the dirt-bed below, as described by Dr. Buckland and Mr. De la Beche. Oblong depressions also are frequently observed on the surface of the *Ash*, called by the quarry-men "graves", the origin of which it is not easy to explain.

7. The *Burr of the Ash*, or *Soft Burr*, is between two and three feet thick. It has obviously been deposited around the lower part of the petrified trunks, and is always separated from them by a small space, at present occupied by the carbonaceous matter produced by the decomposition of part of the tree: and this is the case also where the *Ash* envelopes the top of the broken stumps. The junction of these two beds, around the trunks, is often attended with some very interesting appearances, for an account of which I refer to a note by Professor Henslow in the preceding part of this volume†.

8. The "*Dirt*", or "*Black Dirt*", in Portland is separated from the stone, both above and below, by well-defined surfaces; while some of the other beds of clay, or dirt, pass by gradation into, or adhere closely to, the stone which adjoins them. It is from twelve to eighteen inches thick, and differs from all the other beds alternating with the slaty limestone, in containing large worn fragments of stone‡, from three to nine inches in diameter, in such numbers that the whole deserves the name of coarse gravel. With these are mixed coarse carbonaceous matter and minuter fragments of stone; but seldom, in the Isle of Portland, any continuous or cohesive clay:—the carbonaceous matter arising, no doubt, from the remains of vegetables, and being most abundant immediately around the trunks and Cycadeæ, which this bed includes, or supports.

At Upway, on the north of Weymouth, the representative of the "Black Dirt" likewise contains petrified trees: but the pieces of stone which it includes are few and much smaller, and it approaches more nearly to the usual form of vegetable mould, or of clay. On the north-east of Weymouth its place can be distinctly recognised in the cliffs between Lulworth Cove and Wor-

* Compare what is here stated, with the account of the junction of the marine beds with the top of the Wealden, at Atherfield in the Isle of Wight (*supra*, p. 196, last lines).

† Pages 16. and 17.

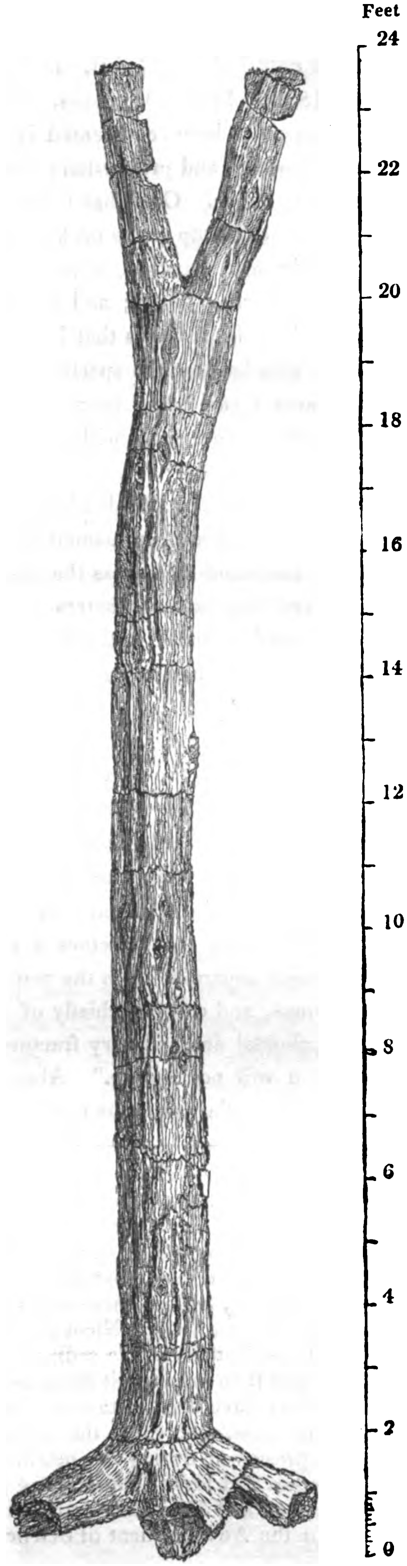
‡ In these fragments I could find no fossils; Mr. Webster considers them as belonging to the lower beds of the Portland stone.

barrow Bay; and in the Isle of Purbeck, beneath Worbarrow Knob. In the loftier cliffs at Gad Cliff it is not accessible; but among the fallen ruins on the shore were some portions of silicified trunks. Between Tillywhim and Durlstone Head a cavity can be perceived in some places, in the part of the cliff where this bed might be expected.

Petrified Trees.—The portion of the trees left standing above the dirt-bed in Portland, is frequently more than three feet in height: and one instance was mentioned to me in which six feet of a trunk stood thus in the upright position. I did not see any case in which the roots penetrated into the Cap below; but observed several fissures in the top of that bed, some of them coated with a crust of stalactitic carbonate of lime. In one instance a prolonged branch of the root had evidently been bent out of its course by meeting the Cap, and was continued horizontally along its surface for several inches: the quarrymen said that such cases were not uncommon, and that the roots sometimes ran along the top to a much greater distance, but never penetrated the Cap itself.

Some very fine specimens of the silicified trunks had been found not long before I saw them; one of which had been judiciously restored, by joining the fragments and placing the whole erect against the wall of a house. The total height from one extremity to the other was above 20½ feet; the diameter of the stem where the roots went off, about 11½ inches. The trunk was nearly straight and undivided for about 17 feet, and the branches slight in comparison with the main stem.

A still finer specimen, found, I believe, near the same place, in Dungeness Quarry, and at the same time with that just described, has been brought to London for sale; and I am enabled, through the favour of Mr. Freeman, in one of whose warehouses the specimen was deposited, to insert a representation of it, from a drawing made by Mr. Sowerby, after careful admeasurement, as it lay horizontally, the fragments which had been separated appearing to fit exactly. The total length, from the extremity of the roots to that of the branches, was about 23½ feet, and to the bifurcation nearly 20 feet. The roots and undivided portion of the stem to the first crack, occupied about 2 feet. The situation of the other cracks, of which there are fourteen or fifteen, is expressed in the figure. The trunk is compressed throughout; the branch on the right, especially, having been much flattened near its extremity.



At 2 feet from the extremity of the root, the greatest diameter is 18¾ inches, the transverse diameter only 12½; at 4 feet, the diameters are 16½ and 11¼ inches; at 11 feet, 14¾ and 11½; and at 18 feet, 15 and 9½ inches. The right branch at its extremity, 11 and 4½ inches.

The specimen here represented is much like that which is preserved in the Isle of Portland, in general aspect and proportion; but many of the stumps which I saw standing in the quarries were much larger. One that I measured,—of which 5 feet stood upright from the lowest point of the roots to the top of the broken trunk,—was 2 feet in one of its diameters, and 6 feet 9 inches in circumference. Another, 5 feet 10 inches in total height, was about 2 feet 10 inches in diameter, and 9 feet 4 inches round; and I was assured that others had been found of much greater thickness. All the larger trees that I saw were in the quarries on the north-west of the church; one of which afforded also the specimen represented in the wood-cut, with several large Cycadeæ. In many places I saw large branches lying prostrate, and partially immersed in the Dirt;—one of them, above 3 feet long, within 2 feet of another portion, about 10 feet in length, and in the same direction with it*.

From the evidence afforded by thin transparent slices, both of the transverse and longitudinal sections, which have been examined under the microscope† by Mr. Brown, the fossil trunks of Portland are found to possess the characters uniformly belonging to coniferous wood: but it must be observed that these characters are not absolutely confined to Coniferæ.

The *Cycadeæ* found in the "Black Dirt" are generally from 9 inches to a foot in diameter, and about 9 or 10 inches high. I myself saw but one specimen, which had been recently taken from its place, in this bed; and it was stated by the quarry-men that on the west of the main road from Chiselton to the church, they have been found, or noticed, only in the Dirt above the Cap; while on the east of the road, as I shall presently mention, they are certainly found below that bed. In the eastern quarries, indeed, the workmen, who had not seen them elsewhere, asserted that the Cycadeæ were never found above the Cap; but this I found afterwards to be incorrect. In both situations, they are much less common than the coniferous trunks.

9. The "*Cap*" is the thickest of all the strata above the Portland stone; the average thickness being about 8 feet, the extremes 6 and 9 feet; of which, in some cases, about 18 inches at the top are easily separable from the rest. When recently exposed, the whole of the remaining mass is continuous, and consists chiefly of uniform limestone of a light brownish or drab colour, with a flat conchoidal and splintery fracture; but it cannot be used for building, as, in the workman's phrase, "it will not *square*." About the middle and towards the lower part it is spongy, or cavernous, including tortuous cavities surrounded with botryoidal carbonate of lime; and it has

* It would be desirable to ascertain the direction in which the prostrate stems lie, with respect to the meridian, and to the roots and portions of the trunk remaining upright, in order to determine whether they were overthrown by an uniform current of wind or water.

† One of the longitudinal slices examined by Mr. Brown was broken from the extremity of the left branch of the tree represented in the annexed wood-cut.

The process by which these slices are prepared for the microscope has recently been carried to great perfection by Mr. Nicol of Edinburgh. It consists in attaching a thin polished slice of the fossil, separated by the ordinary method, to a piece of plate glass, by means of a uniform cement; and then grinding it down as far as possible on the lapidary's wheel. In this way transparent slices have been obtained, which exhibit the internal structure of fossil wood with beautiful distinctness, and show the extreme delicacy with which the original vegetable structure has been preserved during the petrifactive process. Two papers by Mr. Nicol on the structure of the recent and fossil Coniferæ are published in the Edinburgh Philosophical Journal, vol. xvi. 1834, pp. 137 and 310; and a third in the Report of the Fourth Meeting of the British Association for the Advancement of Science, 1834, p. 160.

altogether a very strong resemblance to the *Travertine* of Italy. The top is sometimes penetrated by conical and nearly vertical cavities, encrusted with a yellowish stalagmitic coating. In the Isle of Portland it is compact and continuous at the bottom; but in other places the lower part, and in some cases the whole, is resolved by decomposition into slaty strata.

At Upway, on the north of Weymouth, the lower portion of the Cap consists of a series of thin beds of limestone alternating with very thin courses of clay. In Portland, even where most compact, it contains a few casts of a small species of Cypris; and these seem to be more frequent (perhaps because more easily detected) in the more fissile representatives of the bed at Upway and Bacon-hall. In one or two instances I found in it obscure traces of small univalves like those of Garsington and Combe Wood near Wheatley in Oxfordshire.

In a nook or recess, called by the boatmen *Bacon-hall**, upon the coast about a mile east of Lulworth Cove, the section of this part of the series was as follows:

a. "*Black Dirt*" of Portland.

b. *Cap*, consisting of:

i. Slaty limestone, divided by dark lines of stratification; which at the lower part become more distinct, and at last take the form of ii.

ii. Dark grey indurated slaty clay; one bed of which is nearly 2 inches thick.—Beneath it is

iii. A thin flake of soft whitish limestone.

c. *Dirt.* An indurated bed, of a light brown colour, 4 to 5 inches thick; composed of argillaceous (and carbonaceous) matter, and including small fragments of stone.

d. (*Skull-cap?*) Limestone, somewhat botryoidal; the more compact portions having a flat conchoidal fracture; 2 to 6 inches thick.

e. *Portland stone*, abounding in the characteristic fossils, and including, about 6 feet from the top, a band of flint, in detached masses, about 4 inches thick.

10. "*Dirt*" *below the Cap.* Immediately below the Cap in the Portland quarries, and consequently separated from the "Black Dirt" by a thickness of about 8 feet, is another bed, also called "Dirt" by the quarry-men, from 2 to 6 inches thick, but more uniform in its texture than the former, resembling coarse silt or indurated loam, and containing in some places small fragments of stone, but never such large masses as the "Black Dirt". This lower bed deserves especial notice, from its affording specimens of Cycadeæ, in an upright position, and partially immersed in it, as if they had grown there. Of these I myself saw two in their original place at a quarry called "the Wheat-croft", on the east of the "Traveller's-rest"; one of them about six inches high, surrounded with the Cap, into the lower part of which it projected above the Dirt for about half its thickness, so that it was necessary to cut away the stone to take it out; and from the existence of many other specimens in the debris of the same quarry, which the workmen assured me had all come out of this bed, I believe them to be of frequent occurrence. Among the latter was one of unusual size, larger indeed in its horizontal dimensions than any other specimen I have seen, either from this bed or the Dirt above the Cap†. This, from its flatter form, may possibly

* Notwithstanding the apparent firmness of this rocky coast, great changes are constantly in progress there. An old boatman who conducted me, without having been asked a question, expressed in very strong terms his surprise at the alterations produced, to his own knowledge, within the last thirty years.

† The specimen is now in the museum of the Geological Society. It is of an irregular figure approaching to an oval, and measures 20 inches by 19 in its horizontal diameters, the vertical thickness varying from $6\frac{1}{2}$ to 9 inches. Another less perfect specimen which I saw in the same quarry, was about 9 inches thick, and its diameters not less than 34 and 30 inches. Of the Cycadeæ from the Upper Dirt-bed very few exceed 10 inches, in height and horizontal diameter. The largest I have seen is nearly 10 inches high, and about 12 in diameter near the bottom.

belong to the species *nidiformis* of Adolphe Brongniart (*Cycadeoidea megalophylla* of Dr. Buckland): but it deserves inquiry whether the specimens in the lower bed agree in all respects with either of those found in the upper one.

In the Isle of Portland, no trees have hitherto been found in this lower dirt; which, from its smaller thickness, might seem to have been less adapted to their production than the upper one. But if I can rely upon a single observation, part of a prostrated trunk exists in the Dirt below the Cap, in a section exposed on the west of the road leading from Upton (on the main land of Dorsetshire) to Poxwell. I came to this conclusion from observing that the inclined stratum of limestone over the bed including this specimen was distinctly botryoidal, and of great thickness,—two characters which accord with those of the Cap; while the stone below it contained Portland fossils. But I saw no Cycadeæ in the bed at this place.

11. "*Skull-Cap.*" The thickness of this bed in Portland varies from one to three feet, and it frequently swells out suddenly from 15 or 18 inches to double that thickness, and returns as rapidly to its previous dimensions. It is less uniform than the Cap, and sometimes has an obscurely conglomerated appearance, but, like that bed, consists of freshwater limestone, and is in some places botryoidal. It includes also, as Mr. Webster has stated, small cavities coated with minute rhomboidal crystals of carbonate of lime, like those found in the slaty beds above.

12. At the lower part, the "Skull-Cap" is closely attached to, or passes into, a seam of argillaceous matter, sometimes not more than half an inch, and seldom more than $2\frac{1}{2}$ inches thick, by which it is separated from the Portland stone. This seam appears never to be wanting in these quarries, and is much more uniform than the Dirt immediately above the Skull-Cap, which is very unequal in thickness: in some instances it is incorporated with, or adheres very closely to, the top of the Portland stone *.

13. and 14. The top of the *Portland series* consists of very fine-grained oolite, resembling the roe of fishes, and of a very light brownish hue. With the oolitic particles, other rounded fragments, less regularly shaped, are mixed and united by a calcareous cement, so that the whole compound is very like the recent conglomerates which abound on the shores of New Holland, of many of the Indian Islands, and of Bermuda; especially resembling the newly-formed masses of the last-mentioned islands, described by Lieut. Nelson in a paper lately read before this Society †. This oolitic portion is seldom more than four inches thick, and passes at the lower part into dark grey flint, in irregular concretions, which form an interrupted range near the top of the bed, and include the same petrifactions (but silicified), with those which abound in the limestone immediately around and below them. The stone below the flints, to a distance of from two to four feet from the top, is called "*Roche*" by the quarry-men, and is essentially continuous with the lower part of the bed; but it contains so many casts of shells (of which, indeed, it is almost entirely composed), as to be useless for the purposes of building, and is therefore always separated in the quarry. The remainder of this stratum, about 8 feet thick, is known in the island as the "White-bed", and is that which is now, almost exclusively, quarried for the market under the name of Portland stone. This and the lower strata of the formation, which are not worked at present, have been already described by Mr. Webster.

Among the fossils of the White-bed in Portland, are a Corbis?, *Cytheræa parva*, Lithodomus, *Pecten lamellosus*, *Perna quadrata*, Plicatula, *Terebra Portlandica*, *Trigonia gibbosa*, *T. incurva*.

* The existence of Cycadeæ within three feet of the Portland beds being certain, it deserves inquiry whether they may not occur also in this lower and thinner Dirt-bed immediately above the stone.

† Proceedings, vol. ii. p. 81.

At Upway, this bed, or one of those immediately below it, is beautifully white, like chalk, and contains nodules of dark grey flint, frequently hollow and lined with quartz crystals, which it would be impossible, without attending to their fossils, and their geological position, to distinguish from those of the chalk. One of the characteristics of the best Portland stone, both of this and other beds, is that the blocks ring very distinctly under the hammer, giving out a clear and agreeable note.

(112.) It appears, therefore, that on the Dorsetshire coast the Portland strata are everywhere succeeded by a series of beds of freshwater limestone, alternating with beds of clay, or of a compound called "dirt", which contains carbonaceous matter and fragments of stone; and that two at least of these "dirt" beds, the first about three feet, the second about twelve feet above the top of the Portland series, include the remains of plants, which grew in the places where they are found; nor is it wholly improbable that similar remains may hereafter be discovered in some of the other and thinner beds of "dirt".

A point which Mr. Brown considers as well deserving of remark is, that the only remains of vegetables hitherto found in these strata, under the circumstances above described, belong to two nearly related families, Coniferæ and Cycadeæ, which have lately been regarded as forming a distinct class, characterized not only by the greater simplicity of the parts of fructification, but also by some peculiarities of internal structure, and thence have been considered as intermediate between Phanogamous, and Cryptogamous or Acotyledonous plants.

Another striking fact connected with the remains included in the "dirt beds" is, that they are composed almost entirely of silex, though surrounded either by limestone or by the mixed components of the dirt itself. The cavities in the petrified trunks are lined with minute crystals of quartz; and Dr. Prout, who has been so kind as to examine specimens of the coniferous wood taken from the confines of the Purbeck and Portland formations, in Portland, and other places to which I shall refer hereafter,—finds them all to consist almost wholly of siliceous matter, with very slight traces only of carbonate of lime and of iron; some of the darker parts of a specimen, from the Vale of Wardour containing also bituminous matter. The Cycadeæ likewise are described by Dr. Buckland as being almost entirely siliceous, "varying from "coarse granular chert to imperfect chalcedony"*.

(113.) The great abundance of small, worn, fragments of shells and stone at the top of the Portland formation, is what might have been expected on the surface of an island of small height, just protruded from the sea,

* Geol. Trans., 2nd Series, vol. ii. p. 398.

perhaps so gradually as to have been near the surface for some time before its emersion. The next step, in the series of revolutions which produced these strata, must have been the diffusion of fresh water over the new land, from which the "Skull-cap" was deposited; and this was followed by a drying up or retirement of the water, so as to disclose and convert into dry land the lower of the two beds of clay, or dirt, which now contain the Cycadeæ. I am not sufficiently acquainted with the habits of the recent plants of this family, to form any opinion as to the length of time necessary for their acquiring the size of the specimens now found petrified, nor to judge how far the rapidity of their growth would be modified by climate: but all the known species are said to be of slow growth; and being found at Japan, as far north of the equator as 40°, and at the Cape of Good Hope and Port Jackson, in the southern hemisphere, about latitude 34°, they cannot be considered as strictly tropical productions.

A *second* submersion of the surface in fresh water must have followed the production of the Cycadeæ in this lower bed, from which the "Cap" was accumulated, to a thickness of between seven and ten feet, and the "Black Dirt" deposited above it; and a *third*, and apparently more durable submersion, still in fresh water, must afterwards have taken place, by which the "slate" and a great part of the Purbeck strata were produced. In this last case the water seems to have been at first unmixed, but to have become after a time accessible to the sea; since not only does the Purbeck formation contain a thick bed of oyster-shells, but thence upwards, throughout the Wealden, oysters are found, in strata which in several instances alternate with others abounding in freshwater shells.

(114.) Mr. Lyell has pointed out the resemblance between the geological events which produced the strata of Portland Island, and those which are known to have occurred at the mouth of the Indus, from the effect of successive earthquakes connected with volcanic eruption*; and it is clear that all the changes above supposed to have taken place,—depression and elevation of the land, through comparatively small depths and at different periods, with alternate though irregular submersions both in salt and fresh water,—have been produced in that region, not only within the period of tradition, but many of them so recently as in 1819. Among other facts, it is stated, that for some years after the earthquake of Cutch, which happened in that year, "the withered Tamarisks and other shrubs protruded their tops above the "waves, in parts of the lagoons formed by subsidence, on the site of the

* Principles of Geology, 4th edition, vol. ii. p. 237–242.

"village of Sindree and its environs. Every geologist," Mr. Lyell justly remarks, "will at once perceive, that forests sunk by such subterranean "movements may become imbedded in subaqueous deposits both fluviatile "and marine, and the trees may still remain erect; or sometimes the roots "and part of the trunks may continue in their original position, while the "currents may have broken off or levelled with the ground their upper "stems and branches*."

(115.) It is very desirable that the examination of the Portland quarries should be repeated from time to time: for as the valuable stone lies deep in the series, and it is necessary, for the purpose of obtaining it, to remove the whole of the incumbent matter, the features described in this paper are constantly undergoing a process of destruction; while, on the other hand, new facts are continually brought into view, which are lost if not observed at the moment. The greater part of the phænomena described by my predecessors had thus disappeared when I visited the island, and a few hours might have removed the fossils which I observed in the bed below the Cap. Geologists may assure themselves that the trouble of a journey to Portland will be most amply rewarded; since few places, it is probable, in the world, exhibit with such distinctness and in so small a space, phænomena of more extraordinary interest, or of greater importance to theory.

(116.) The strata, abruptly cut off by the sea on the west coast of Portland, are found no more in that direction in England†; nor do they occur on the opposite coast of France immediately on the south, which consists of the primary masses of Guernsey, Auvigny, and the main land about Cherbourg. On the east of the last-mentioned promontory, where they might be expected to appear among the beds beneath the chalk between the mouth of the Seine and Bayeux, their presence, I believe, has not been distinctly ascertained. And on the north of the Seine they must be far below the level of the English Channel, at least as far as Etaples, where the rocks upon the shore consist of chalk with flints *in situ*. The Portland beds, with a thin covering of the lowest Purbeck strata, rise from beneath the chalk and green-sand on the south of Equihen in the Lower Boulonnois, and are found all along the cliffs thence to the north of Cape Gris-nez, where they again give place to the superior strata. They have not yet been discovered, so far as I am informed, further to the north in Europe.

* Principles of Geology, 4th edition, vol. iv. p. 274.

† The most western point where the Portland strata have been found in England, is on the main land near Portisham, twenty miles west of Lulworth Cove. See p. 15. of this volume.

(117.) *List of Fossils from the Beds below the Chalk, on part of the Coast of* DORSETSHIRE.

[*Upper Green-sand.*]

Cirrus depressus. Worbarrow Bay.
Exogyra conica. Face of the Hill top, W. of Osmington Mill.
E——— lævigata. Worbarrow Bay.
Gryphæa vesiculosa. Swanage Bay, under Ballard Hill. Hill top, W. of Osmington Mill, with stems of Siphonia.
Ostrea, new. Between Ham Cliff and Osmington Mill.
Pecten asper. Swanage Bay. Hill top, W. of Osmington Mill.
P—— orbicularis. Swanage Bay. W. of Osmington Mill.
P—— quadricostatus. Swanage Bay. Worbarrow Bay.
P—— quinquecostatus. Swanage Bay.
P—— ————. A very convex variety (young ?). Worbarrow Bay.
Serpula antiquata. Swanage Bay
Siphonia. Stems. Worbarrow Bay. Hill top, W. of Osmington Mill.
Terebratula pectita. Swanage Bay.
Vermetus concavus. Swanage Bay. Osmington Mill.

[*Gault.*]

Mya mandibula. Punfield*, Swanage Bay.

[*Weald Clay.*]

Cyclas media. Punfield. In thin beds of bluish limestone, encrusted with fibrous carbonate of lime ("cone in cone").
C—— membranacea. Punfield.
Cypris tuberculata. Pl. XXI. f. 2. Punfield.
C—— Valdensis. (*C. Faba*, Min. Con.) Pl. XXI. f. 1. Punfield.
Exogyra? Punfield. In brown clay.
Melanopsis? attenuata. Pl. XXII. f. 5. Punfield. In blue clay.
M——— ? tricarinata. Pl. XXII. f. 4. Punfield. In blue clay.
Ostrea. A plicated species. Punfield. In a bed of stone subordinate to the Weald clay, the greater part composed of shells; with a striated bivalve (a Cardium ?).
O——. A smooth species. Punfield. In greenish sandy stone, coated with fibrous carbonate of lime.
Paludina acuminata. Punfield.
P——— elongata. Punfield. With *Cyclas media*, in greenish grey sandy clay.
Unio. Punfield. In thin, slaty, dark bluish clay.

SAURIAN REPTILES. Fragments of bone of a Saurian; and the teeth apparently of a Crocodile. Punfield.
WOOD. Coniferous, silicified, in fragments. Punfield.

* *Punfield* is a small nook or recess on the north of Swanage Bay, between the ridge of Ballard Down and the sand-cliffs.

[*Hastings Sand.*]

Cyclas media. Sand-cliff between Swanage and Punfield. In nodules of clay-iron-ore, with Paludinæ; also in hard subcalcareous grit.

Paludina elongata. Same place and situation.

Unio. One or more species occur in the concretions of grit within the sand-beds, between Punfield and the town of Swanage.

Saurian Reptiles. Large bones of the Iguanodon have been found loose on the shore at the foot of the sand-cliffs near Swanage, by the Rev. T. O. Bartlett; (see Dr. Buckland's Notice, already referred to*;) but their precise place in the cliffs is still to be ascertained.

Wood. Large portions of the stems of silicified coniferous trees have been found on the shore under the sand-cliffs in Swanage Bay, by the Rev. T. O. Bartlett. The stone into which they are converted is of a very dark brown colour, receives a fine polish, and does not effervesce with acids.

[*Purbeck Strata.*]

Corbula alata. Pl. XXI. f. 5. Numerous in slaty limestone, at Upway, on the north of Weymouth, with *Cyclas media.* Durlstone Bay: Isle of Purbeck.

Cyclas media. Pl. XXI. f. 10. This fossil occurs throughout the series of Purbeck strata, and is one of the most abundant fossils of the formation, some of the beds being almost entirely composed of it. Upper beds of the series, at Peverell Point, and Durlstone Bay. At Upway, west of the road, 50 feet above the "Cap".

C—— angulata. Pl. XXI. f. 12. In "Quarry vein", one of the strata worked for stone, near Swanage. In hard stone resembling the lower chalk, when indurated; Durlstone Bay. Of large size, in slaty stone, at Upway, N. of Weymouth.

Cypris. Casts, in transparent carbonate of lime, of the interior of one or more small species of this genus, occur in great abundance in the beds of slaty limestone, which frequently includes rhombic crystals of carbonate of lime, at the bottom of the strata above the "Dirt bed", as well as in the "Cap" over the Portland stone: but it is difficult to determine the species, as the external surface is commonly wanting. In a few instances an exterior spine or prominence, like that of *Cypris spinigera*, Pl. XXI. f. 3., is perceptible; and in others the protuberance at the end of the valves, represented in the figures of *C. Valdensis*, Pl. XXI. f. 1., was observed. It is not, however, improbable that some of the casts may belong to species different from both of these. Isle of Purbeck, and coast thence to the west of Lulworth Cove. Quarries at Upway, north of Weymouth. Isle of Portland: in the "slate".

Exogyra bulla. Pl. XXII. f. 1. Durlstone Bay.

Ostrea distorta. Pl. XXII. f. 2. Durlstone Bay. The bed called "Cinder", about the middle of the strata which are worked for stone, consists almost entirely of this and other species of oyster.

* Proceedings of Geol. Soc., vol. i. p.159.; and Geol. Trans. Second Series, vol. iii. p. 421. *et seq.*

Ostrea. A new species? Durlstone Bay. West side of Lulworth Cove, in bluish sandy stone. Durdle Cove, in a bed like the "Cinder".

Paludina carinifera. W. of Lulworth Cove, with *Unio compressus*, and a pearly oyster, in the uppermost of the Purbeck beds, some of which are almost entirely composed of shells of Paludinæ. Also, with bones of fishes, in very blue compact and sparry limestone.

P——— elongata. Peverell Point. Abundant in the uppermost beds of the Purbeck stone, with much green matter. Durlstone Bay, with *Cyclas media.*

P——— Sussexiensis. Pl. XX. f. 6. Peverell Point; in splintery limestone, with disseminated calcareous spar. Durlstone Bay.

Unio compressus. Durlstone Bay; in oolitic stone, with *Cypris.*

U— new species? At the upper part of the series; in beds composed of carbonate of lime, apparently derived from the presence of these shells, with a large proportion of green matter (silicate of iron). East side of Lulworth Cove. Worbarrow Bay. [The occurrence of bivalves in this place is mentioned by Mr. Webster, Geol. Trans., 2nd Series, vol. ii. pp. 39, 40.]

Reptiles.—*Turtles.* Fragments of the shell and bones of Turtles are not unfrequent, and even entire skeletons are sometimes found in the Purbeck strata.

Saurians. Fragments of bone, and teeth.

Fishes. Palatal bones: Durlstone Bay. The scaly remains, also, of different species, are frequent in the slaty strata of the Purbeck stone.

Plants. Near the junction of the lower slaty beds of the Purbeck with the Portland stone, large trunks and branches of coniferous wood are found in great abundance in the "Black Dirt" above the "Cap", in the Isle of Portland, and on the coast east of Lulworth Cove; and in the dirt below the "Cap"? between Upton and Poxwell.

A Cone, represented in Plate XXII. f. 9., and stated to be "from Purbeck", is in the Museum of the Geological Society. It has some slight resemblance to the cone of a Dammara of the Moluccas.

Cycadeoidea (*Mantellia* of Adolphe Brongniart, "Prodrome", &c.). Remains of at least two species of Cycadeæ occur in the Isle of Portland, along with the trunks of coniferous trees, in the "Black Dirt" above the "Cap"; and those of at least one species, also in the dirt or clay, between that bed and the "Skull-Cap".

[*Portland Stone.*]

Ammonites biplex. Isle of Portland.

A——— new. Isle of Portland.

Cerithium? excavatum (*Turritella excavata*, Min. Con.). West of the Isle of Portland.

Cytherea parva (*Venus*, Min. Con.). West of Portland, in the flint of the "Roche".

Lithodomus. New. Upper part of the "White Bed", Portland.

L———. Another species? Same situation.

Monodonta. New. Lowest beds of the Portland stone. Near Blacknore, Isle of Portland.

Pecten lamellosus. Lowest beds of the stone. Same situation.

Plicatula? Casts of the interior, numerous in the "Roche" immediately over the "White bed". Portland.

Terebra Portlandica. Pl. XXIII. f. 6. Very numerous in the "Roche": also in the "White bed". Portland.

Trigonia incurva. Pl. XXII. f. 14. (Miss Benett*: Pl. XVIII. fig. 2.) In the "White bed". Portland.

T——— gibbosa. Frequent in the "Roche". Portland, and elsewhere on the coast.

T——— ———. A variety, approaching to *incurva*, but less oblique. Portland.

Venus parva. (See *Cytherea.*)

[*Portland Sand.*]

Ammonites giganteus. Cross-roads above Kimmeridge Farm, on the north-east. Isle of Purbeck.

A———. New species. In concretions of splintery indurated marl, or soft limestone. Lowest beds of the Portland sand. Emmet's Hill: Isle of Purbeck.

Cucullæa. (A small species.) Portland.

Exogyra nana. West side of Portland Island, on an Ostrea.

Ostrea lævigata. East side of Portland.

Panopœa depressa. (*Mya depressa*, Min. Con.) In concretions of dark bluish grey indurated marl. Lower part of the sand. Emmet's Hill: Isle of Purbeck.

Pecten. A new species? Upper part of the sands. Blacknore, Portland.

Serpula tricristata. Pl. XXIII. f. 8. East side of Portland. *Quæ.* in Kimmeridge clay?

S—— variabilis. Pl. XXIII. f. 7. East side of Portland. *Quæ.* in Kimmeridge clay?

Trigonia clavellata †. Cross-roads above Kimmeridge Farm on the north-east. Isle of Purbeck.

FISHES. *Scales* of fishes are found in strata apparently belonging to this formation, under Gad Cliff, in the Isle of Purbeck.

Rays of dorsal fins (see the abstract of a paper by M. Agassiz, Proceedings of the Geological Society, vol. ii. p. 101.) occur in nodules either of this formation or of the Kimmeridge clay, on the east coast of Portland.

[*Kimmeridge Clay.*]

Ammonites biplex. Numerous in the bituminous shale of Kimmeridge Bay, with transparent sulphate of baryta: sometimes along with an Ostrea.

* "A Catalogue of the Organic Remains of the County of Wilts;" 4to, with 18 plates. Warminster, 1831.

† Besides the shells mentioned above, two or three other bivalves, of which the genera are indistinct, have been found in the Portland sand, at Emmet's Hill and other places, in the Isle of Purbeck.

Ammonites mutabilis. Young.

Astarte cuneata? In firm brown shale. Kimmeridge Bay.

Panopœa depressa. Kimmeridge Bay?

Ostrea deltoidea. East of Portland. *Quæ.* in Portland sand?

Fishes. *Teeth.*

Rays of dorsal fins.

[*Weymouth Strata and Oxford Oolite**.]

Ammonites circularis. Pl. XI. f. 20. In reddish sandy beds above the pisolite. Abbotsford.

Astarte cuneata. In ferruginous sandy stone. Near Weymouth †.

Belemnites fusiformis. North of Weymouth.

Clypeus clunicularis. (Smith, "Strata Identified"—Coral Rag, fig. 6.) Weymouth; in oolitic sand.

Exogyra nana. In whitish oolitic stone, between Ham Cliff and Osmington. North of Weymouth.

Gervillia aviculoides. In the coarse grit between Ham Cliff and Osmington Mill.

Melania Hedingtonensis. In oolitic sand, near Weymouth. In reddish sand-rock, above the pisolitic clay, near Abbotsford.

Modiola bipartita. In hard reddish clay. Osmington.

Ostrea. A thick-shelled species, near Abbotsford, in oolitic sand, at the top of the oolite.

O——. Species? Between Ham Cliff and Osmington Mill.

Nerinea Goodhallii. Pl. XXIII. f. 12. Cliff east of Osmington Mill; in coarse rag. Mr. Goodhall.

Pecten annulatus. In sandy beds, near Osmington?

Pullastra? In marly pisolite at the top of the Oxford oolite, near Backwater, going from Wycke Church; Weymouth.

Terebratula inconstans. Near to Osmington, in blue clay. Boat Cove.

T————. New? Oval: reddish beds above the pisolite. Abbotsford.

Trigonia clavellata. Abundant on the shore between Ham Cliff and Boat Cove. In ferruginous sandstone near Weymouth, with *Astarte cuneata.*

T——— *costata.* Osmington.

Trochus Sedgwickii (olim *T. reticulatus*). From the reddish beds above the pisolite. Near Abbotsford. Upper part of the Coral rag, and lower of the Kimmeridge clay. Near Weymouth.

* As the sands and clays of the Weymouth group pass insensibly into the Oxford oolite, it is difficult, and perhaps unnecessary, to distinguish them by a definite boundary. The fossils appear to be the same.

† Most of the specimens here referred to, from the neighbourhood of Weymouth, are in Mr. Goodhall's collection.

DEVONSHIRE.

(118.) The coast on the west of Portland as far as Sidmouth has been described by Dr. Buckland and Mr. De la Beche* in these Transactions; where also the former has published a map of the coast between Teignmouth and Portland, with views from Sidmouth to Bere Head, and from Lyme Regis to the vicinity of Weymouth and Portland †. The coast of Devonshire, therefore, requires no additional illustration; and for the local extent and distribution of the strata in the interior of that county, it is now in my power to refer to the beautiful Geological Map recently completed by Mr. De la Beche ‡, and to be followed by an explanatory memoir and sections.

As the beds between the chalk and the bottom of the lower green-sand on the west of Purbeck appear to have coalesced, and are no longer marked by the previous subdivisions, the green-sand of Devonshire may be regarded as the equivalent of the whole series. The lower green-sand seems especially to have been reduced in bulk, in its progress westward. The gault has wholly disappeared; but some of its characteristic fossils are found in the sand and grit of the cliffs on the west of Lyme. At the bottom of the sands the boundary is everywhere distinct: and the plateau which shoots out to the west of Dorsetshire is found successively in apposition with the lower oolite, the lias, and new red sandstone; while its remotest portion rests on grauwacke slate. Throughout the greatest part of the tracts thus occupied, the green-sand forms a flat-topped, uniform cap, investing the hills, as far west as Sidmouth on the coast, and the Blackdown range on the north of that place, nearly to Wellington; and finally, it constitutes an extensive outlier, from the north-west of Teignmouth to Penhill, about six miles south-west of Exeter, which caps the heights of Great and Little Haldon, and is detached from the more continuous tract above mentioned by an interval of more than twelve miles, occupied by the new red sandstone.

Several insulated portions of chalk, however, still remain above the eastern portion of the green-sand platform, especially upon the coast between Sidmouth and Lyme, and along the line from Beaminster through Chard and White Stanton. The transition from the chalk to the sands is well seen at some of the junctions, especially on the south-west of Axmouth, where the strata

* See their joint memoir at the commencement of the present volume; Geol. Trans., 2nd Series, vol. i. p. 40, &c.: and a separate paper by Mr. De la Beche, vol. ii. p. 109, &c.

† Ibid., vol. i. p. 95, &c.

‡ "Ordnance Geological Map of Devon, and of portions of Cornwall and Somerset, by H. T. "De la Beche, Esq.," in eight coloured sheets.

rise a little towards the north from the point of *Bere Head*, so that sections of the subjacent beds are exposed in the cliffs on both sides of that promontory. The beds immediately below the chalk are best seen on the shore towards Branscombe, and have been described by Mr. De la Beche, who has also mentioned the quarries near that place, from which stone corresponding in situation to the firestone of Surrey is extracted *.

The section at *Whitecliff*, on the east of Bere Head and of the village of Bere, is thus:

	Feet.
1. *Chalk*: white at top, yellowish below; very sandy, containing throughout numerous small nodules of flints, both in bands and irregularly disseminated,—more numerous at top. Vermetus is a frequent fossil here .... [At the bottom is a course of very sandy chalk, including concretions or lumps of greater firmness, produced apparently by the unequal diffusion of the siliceous matter.] Total, 60 or 70 feet.	60
2. Yellowish grit, with green stripes	10 to 12
3. A conglomerate of lumpy concretions, and apparently of *fragments* also, of hard matter; with green particles between the lumps. Petrifactions numerous .... About	5
4. Beds of *chert*; both continuous and in irregular concretions, alternating with bands of siliceous grit; from 3 or 4 feet down to a few inches in thickness .... Total, about 40 or	50
5. Bluish green and grey sand, with bands of more solid texture, increasing gradually in number towards the bottom .... About 30 to	40
6. Bluish moist sand, in some places almost black, abounding in petrifactions, and becoming darker in colour downwards, the hue apparently depending on the degree of moisture. This bed contains Gryphites, traces of large Ammonites, Vermetus, and numerous stems of Siphonia .... About 50 or 60 feet. [This darkly coloured sand contains at the lower part large nodules, consisting of greenish grit, in courses from 3 to 6 feet apart. The stratum is in immediate contact with the red marl. Springs come out at the junction.]	60
7. *Red marl.* At the top containing gypsum in nests; throughout including spots and patches of a light greenish grey, and alternating with beds, of irregular thickness, of the same hue. ("Bunter sandstein"?)	

I have inserted the preceding list from notes taken during the summer of 1825, as its coincidence with that since published by De la Beche, shows the correctness of both. It will be evident, upon comparing these lists with each other, and with that of the sands near Lyme, that the group which here succeeds the chalk is the equivalent of the Upper green-sand; the local variations in this formation on the Devonshire coast not being greater than those of the range which extends from Folkstone into Surrey; in the course of which the Upper green-sand is in some places almost wholly wanting, while in others it acquires great thickness, and often contains beds almost suddenly developed, no trace of which is to be found in the intermediate spaces. The *grizzle* of Sutton quarry, and the *Beer-stone*, are varieties of the siliciferous stone on the confines of the chalk and Upper green-sand, which under various denominations, "Fire-stone", "Totternhoe-stone", &c., occurs very generally in that part of the series, and is everywhere in request for building. The total absence of blue clay is remarkable in the section at Bere. The place where it might have been expected is immediately beneath the cherty groups of Mr. De la Beche's figures 1 and 2 †; and if the gault were added to those sections, estimating

* In a large pit or quarry at the bottom of the chalk, near Sutton and Widworthy, a stone, called *Grizzle* by the quarry-men, is dug in the situation of the firestone. The beds are altogether about 5 feet in thickness. It contains green particles, and does not burn to lime. Among its fossils is *Catillus Cuvieri*.

† Geol. Trans., 2nd Series, vol. ii. pl. 16.

its thickness only at 100 feet, the total thickness of the whole of the green-sand group would not be more than 300 feet: the actual thickness of the sands being nearly 200 feet at Lyme Regis; and at *Whitecliff*, according to my own measurement (it is not stated by Mr. De la Beche), about 160. The beds below this cherty group represent Mr. De la Beche's "*Fox mould*" (No. 6. of the above list); and are apparently the equivalent of the upper and more ferruginous group of the lower green-sand: the lower, moist, and dark-coloured sands, with the "cowstones" at the bottom, being probably the equivalent of the middle, dark, cohesive sand of Sandgate (24.), Shanklin (192.), and Black-gang Chine (195.);—the "cowstones" representing the calcareous group of Hythe, &c. This occurrence of nodules dispersed in sand is frequent wherever calcareous strata are near their termination; as in the cases of the Portland stone, the lower oolite, &c.

I have stated these resemblances that the whole case may be before the reader: but in the vale of Wardour,—where the distinct occurrence of a bed of blue clay with the characteristic fossils of the gault, leaves no doubt as to the place where the sands are divided,—the inferior beds of the Upper green-sand acquire a character very like that of the Lower in other places; and the latter is either wholly wanting, or very imperfectly represented.

(119.) *Blackdown Hills.*—In approaching the hills of green-sand, their aspect on every side is the same, precisely resembling that of the long flat-topped ranges of this formation, and of the Bagshot sands, in Kent, Surrey, and Hampshire. The surface is barren, and the chief products, at present, seem to be furze and heath; though in former times, it is reported, extensive woods were here. I ascended first from Wellington on the north of the Blackdown Hills, and found red marl for more than two thirds of the height, so nearly resembling some of the sandy and variegated clays of the Wealden, especially of the Hastings sands, that but for the presence of sulphate of lime in crystalline nests, it would be difficult to distinguish them; while the greenish varieties of the marl also very much resemble some of the beds above the chalk in the Isle of Wight. From Beacon Hill, on the south-west of Wellington, the uniform level of the summits is very striking, the eye being carried over the whole range without interruption, and the ravines quite lost sight of. The absence of the remains of chalk from the debris on the top of these hills is remarkable: I searched long, but did not see a single fragment of flint, all those which I could find being chert, easily distinguishable from chalk flints. In the yellowish sand near the surface, at the Barnscombe side of the hill, brown iron ore is found, in polished fragments of very high lustre, resembling those of the lower green-sand at Sandown Bay in the Isle of Wight (1200; p. 188.), of Surrey (59.), and Western Sussex.

Although the strata forming these hills are in a general view continuous, the whole country is divided by fissures, attended in some cases with considerable dislocation; for an account of which I refer to Mr. De la Beche's Map of Devonshire, and his essays on Theoretical Geology *.

* "Researches in Theoretical Geology," 1834, p. 185, &c.

Three nearly parallel lines of fault, running about north and south, are especially remarkable in Mr. De la Beche's Map; one on the east of the county, passes from about a mile north of Combe Beacon, through the hill which bears that name, along the valley of Wambrook, and the streamlet west of Chardstock, across the Axe, to a point about two miles east of Axminster; the total extent to which it has been traced being about ten miles. A second fault extends from Balay Down on the north of Challenge, through Membury, to the bed of the Yart south of Yetlands; the lias being thrown up into immediate apposition with the green-sand through a great part of its course, as is also the case in the preceding fault near Wambrook. A third and shorter fissure, about three miles in extent, reaches from the north of Wilmington to Stockers, about two miles south of Widworthy, crossing the main London and Exeter road, and skirting the eastern slope of an outlying hill of chalk on the south of that village.

(120.) The hills which have furnished the greater number of the Black-down fossils form the western range of the group between Honiton and Wellington, about six miles to the south of Beacon Hill above mentioned. Their escarpment, between Punchey Down on the north, and Upcot Pen on the south, is distinguishable at a great distance by the white line produced by the refuse thrown down from the openings of the sithe-stone pits; the heaps thus formed constituting an almost continuous horizontal stripe in the face of the hill.

The whole thickness of the sandy strata above the red marl in this part of the country, seems to be about 100 feet. The contrast between the barrenness of the upper sands, and the comparative fertility of the marl beneath, is everywhere very conspicuous; and it would seem from the unequal ascent of the hedge-rows and cultivated ground that the surface of the marl is very uneven.

The strata which afford the whetstones are about 80 feet below the top of the hill, to which they are parallel. The mines (or "pits" as they are called) are driven in direct lines into the hill, almost horizontally, and in some cases to considerable distances. The stony masses from which the sithe-stones are cut, are concretions of very irregular figure, imbedded in looser sand, nearly resembling those which occur in the upper division of the Lower green-sand near Sandgate (21.): and though very irregular in shape, marks of the stratification of the sand can be traced on their outside. The masses of which the sithe-stones are made, vary from 6 to about 18 inches in diameter, and the beds which afford them would form a total thickness of about 7 feet, of which about 4 are fit for that purpose; the looser stone at the top and bottom being employed for building.

The following is a sectional list of the beds in one of the principal sithe-stone pits at Punchey Down, which, I was informed, was a fair representative of the whole:

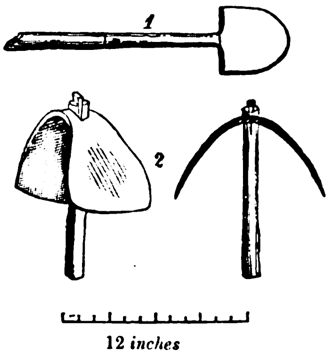
	Ft. In.		Ft. In.
1. Reddish sand rock, extending upwards to the top of the hill.			
2. "*Fine vein*". Concretions of firmer consistence; the best for sithe-stones. [Shells are found in all the strata here, but abound remarkably in this one, and in the "*rock*" beneath it]	0 2	to	1 0
3. "*Top sand rock*"; sand with irregular concretions; of no use	3 0	to	4 0

	Ft.	In.		Ft.	In.
4. "*Gutters*"; concretions of stone in 4 or 5 courses, in the sand. This bed is that most commonly used for sithe-stones	3	0	to	5	0
5. "*Burrows*"; stone and sand of the same kind, but used only for building ..	2	0	to	3	0
6. "*Bottom stone*"; a range of concretions, affording excellent sithe-stones.... [These concretions sometimes extend downwards, even to 5 feet, in the sand.]	0	2	to	0	6
7. "*Rock sand*"; chiefly sand, with fewer concretions; of no use				4	0
8. "*Soft vein*"; concretions which afford excellent sithe-stones	0	2	to	0	6

The strata below are not known to the workmen. The total thickness, therefore, of the strata which furnish the material for sithe-stones, including the rejected sand and rubbish, is from 12 to 18 feet; the whole of which is removed in cutting the drifts or galleries.

Sithe-stones.—As the manufacture of these stones occupies a great number of the inhabitants of the country, and is of some commercial importance, a large proportion of the whole quantity used in England being supplied from the Blackdown pits*, I shall here describe the method of preparing them.

The sithe-stone men take from the owners of the soil the privilege of digging for stones, leaving 40 yards on each side between the drifts (or "pits" as they are called). There is no limitation as to depth, and the drifts are commonly pushed to about 500 yards inwards, greater distances not repaying the labour of bringing out the sand. When first taken out, the stone is greenish and moist, and can be cut or chopped with ease. The tools employed are a sort of axe or adze with a short handle (fig. 2.), called a "basing-hammer", which is ground to a sharp edge. These are made at the adjacent village of Kentisbere. The other tools are "picks", without any peculiarity of structure, and "hollowing-shovels" (fig. 1.), for digging the masses of stone out of the sand.



For the purpose of cutting the stones, a vertical post of wood, or "anvil", is so fixed in the ground as to stand between the knees of the workman, who sits upon a sort of bench built of stone, with some strong pieces of old leather attached as a defence to his left knee. He first, with the edge of his "basing-hammer", splits from the blocks, upon his knee, long portions approaching to the shape of the sithe-stones†; and then cuts or chops them down, nearly to the required size, upon the anvil and his knee,—just as a carpenter cuts timber with an adze. After being thus rudely shaped, the stones are "hewn" to the proper dimensions with a larger "hammer", and then rubbed down with water by women, on a large stone of the same kind; and when dried they are fit for sale.

The stones when finished vary from about ten to twelve inches in length; some have the shape of a portion of an almond, with the ends and sides cut square, and about 2 inches by 1½ in thickness; others are almost cylindrical, but smaller at each end, with the sides a little curved; the diameter in the middle about 2 inches.

* Sithe-stones are also manufactured in great numbers in Derbyshire from the sandstone of the coal formation. (Farey's Derbyshire: 8vo, 1815; p. 437-8.)

† The masses of stone, I believe, split best in the direction of the lines of stratification of the sand.

A good workman can cut out of the blocks about seven dozen of the stones per day *. They are sold by the makers chiefly to one merchant at Honiton, who supplies the retail dealers. The prices (in 1825) varied from 2*s.* per dozen, for the finest stones, 11 to 12 inches long, down to 8*d.* a dozen for the coarsest, 10 inches in length.

(121.) Between the sand and the red marl beneath it, I did not observe any perceptible valley, nor any indications of an intermediate bed of clay.

In a lane at Standhill, between Wellington and Bryants, about half a mile from the latter place, the strata were thus; belonging to what is, here, the upper part of the new red sandstone.

		Ft.	In.
1.	Dusky red clay, or marl, adhering to the tongue	2	0
2.	Light greenish clay, with glittering particles (mica) ... about	1	0
3.	A band of greenish sandy clay, in part concreted and sparry, irregular in thickness	0	9
4.	Greenish clay, like No. 2. ... about	2	0
5.	Reddish clay, like No. 1., in part concealed at the bottom		

These beds are scarcely distinguishable from those at the top of the Hastings strata, at the back of the Isle of Wight.

At Kentisbere, about 1½ mile west of the escarpment of the hills which contain the stone pits, the strata of red marl appeared to dip to the south-east. They consist of coarse gravel and conglomerate of a dull red hue, under firm, red, marly sand: and here there is a distinct alternation of yellow sand with the red marl, the former appearing below the marl in thick stony beds at least 50 feet thick. A rough section at this place is given in Plate X. a. No. 12.

(122.) *Fossils.*—The great numbers and variety of the Blackdown fossils may be ascribed in part to the extent of the quarries, which have been dug for sithe-stones during a long series of years; but the beds themselves must be more than commonly fertile in these productions, since the entire thickness of those from which almost all the specimens have been obtained, does not exceed twenty feet. Their beautiful preservation arises, in some measure, from the loose sandy character of the matrix in which they are imbedded, and from which they are easily detached: but the composition of the fossils themselves has also contributed to this effect; for, with very few exceptions, the shells are converted into chalcedony, and the

* Mr. Meade, of Chatley near Bath, has favoured me with the perusal of a letter from the Rev. Mr. Steinhauer, dated in 1813, in which, after an account of the whetstone pits at Blackdown, it is stated that the preparation of the sithe-stones is so injurious to the health of the workmen, that in the little village of Punchey Down, which is inhabited exclusively by the stone-cutters, the writer saw but one elderly person, and was informed that few reached the age of forty. The complexion and figure of the greater number he describes as striking and interesting in a high degree; but it was the hectic aspect, and itself a proof of disease. When I visited the place about twelve years afterwards, I did not meet with anything that called my attention to the health of the quarry-men: but the facts described by Mr. Steinhauer are analogous to those which prove the frequency of consumption among the grinders of needles, and the workmen at some other trades, where minute particles of solid matter are diffused in the air, and taken into the lungs.

whole of their calcareous matter has disappeared*. This is the more remarkable, as in many other places, indeed generally, the fossils of the green-sands consist of carbonate of lime; the absence of which, however, is prevalent throughout the sand of the Blackdown Hills, which seldom effervesces with acids; and to this circumstance, probably, the excellence of the concretions which they contain, as a material for whetstones, is to be attributed.

A very extensive collection of fossils from the Blackdown pits was formed by the late Mr. Miller, of the Bristol Institution; and is now in the museum of that establishment. The Managers were so good, at my request, as to allow the whole of this valuable collection to be sent to London, where it was examined by Mr. Sowerby, by whom the subjoined list, and the annexed plates, have been prepared: and I have great pleasure in expressing my obligation for this mark of their confidence and favour.

(123.) *List of Fossils from the Sands of* BLACKDOWN, *and of some other places in* DEVONSHIRE†.

Ammonites auritus. M.
A— denarius. A thin crust of hydrophanous chalcedony, over spongy siliceous stone. M., Min.Con., F.
A— dentatus. M.
A—falcatus. M.
A— Goodhallii. Blackdown. M., F., Min. Con. Near Lyme. D.
A— Hippocastanum. Dowlands cliff, near Lyme. Min. Con.
A— lautus. M.
A— splendens. Pinhay, in hard green sparry stone. F.
A— triserialis. Pl. XVIII. f. 27. Mr. Sowerby's museum.
A— tuberculatus. M.
Ammonites varians. A gibbose variety. M. Pinhay. F.
A— varicosus. M., F.
A— Another species, probably new. M.
Amphidesma tenuistriatum. M. Pl. XVI. f. 7.
Arca rotundata. M. Pl. XVII. f. 8.
Astacus, Portions of. Pinhay. Miss Anning. Near Lyme. D.
Astarte concinna. Pl. XVI. f. 15. M. Mr. Sowerby's museum: D.
A— cuneata. F.
A— formosa. M. Pl. XVI. f. 16.
A— impolita. M. Pl. XVI. f. 18.
A— lineata. F.

* See Conybeare; "Outlines," &c., p. 128.

† All the Fossils in this list are from the Whetstone Pits at *Blackdown*, except those to which a different locality is assigned: and all the specimens from the Blackdown pits, where a different composition is not mentioned, are casts in chalcedony.

The letter M. denotes that the specimen is from the collection of the late Mr. Miller, now in the museum of the Institution at Bristol: Min. Con. refers to Mineral Conchology: D. to a paper of De la Beche, on the chalk and sands in the vicinity of Lyme Regis and Bere; Geol. Trans. 2nd Series, vol. ii. p. 109 et seq.: F. to the Author's Collection.

Astarte striata. M. Min. Con.
A— multistriata. M. Pl. XVI. f. 17.
Auricula? incrassata. M., F. Min. Con.
A—? Two species, not figured. F.
Avicula anomala. M. Pl. XVII. f. 18.
Cardium Hillanum. F., M., and Min. Con.
C— proboscideum. M. Min. Con.
Corbula truncata. M. Pl. XVI. f. 8.
C— elegans. F., M., Min. Con.
C— gigantea. M., Min. Con.
C— lævigata. Min. Con.
C—. Two other species, probably new. M.
Cucullæa carinata. M. In red jasper-like stone. Min. Con.
C— costellata. M., F. Min. Con. Collumpton, Devon: near Lyme. D.
C— decussata. Pinhay or Bere? F., Min. Con.
C— fibrosa. M., F. The sand-rock of this specimen is very like that of Risborough, near Hythe. In red jasper-like stone or chalcedony. Min. Con.
C—glabra. Pinhay. In firm sparry grit. M., Min. Con. Near Lyme. D.
C— formosa. M. Pl. XVII. f 7.
Cyprina angulata. (*Venus angulata.* Min. Con.) The shell about one third filled with chalcedony, as with a liquid. In some specimens the shell, the place of which is now occupied by chalcedony, had been bored through, as represented in the Plate: in others the shell is covered by a thin outer crust of chalcedony, opake and hydrophanous; and the cavity is nearly full of very fine siliceous sand, over which in some places is a thin crust of flat botryoidal translucent chalcedony. M. Teignmouth. Min. Con.
C—cuneata. M. Pl. XVI. f. 19. Drawn from a specimen in Mr. Goodhall's collection.
Cyprina rostrata. M. Pl. XVII. f. 1.
Cytherea caperata. (*Venus.* Min. Con.) M., F. Variation in the depth of striæ. Min. Con. Blackdown, and near Lyme.
C— lineolata. (*Venus.* Min. Con.) M., Min. Con. Berehead. F.
C—parva. (*Venus.* Min. Con.) M., Min. Con. Pinhay? F.
C— plana. (*Venus.* Min. Con.) M., Min. Con. Pinhay? F.
C— subrotunda. M. Pl. XVII. f. 2.
Dentalium cylindricum. Near Exmouth. Min. Con.
D— ellipticum. F.
D— medium Pl. XVIII. f. 4. M., Min. Con.
Echinus, portion of an. Bere: In white calcareous sandstone. F.
Exogyra conica. (*Chama*, Min. Con.) M., F. Ware, west of Lyme Regis. Pinhay. Bere. F.
E— conica: var. Ridge high and sharp. Berehead. F.
E— halyotoidea? (*Chama*, Min. Con.) Blackdown. F.
E— lævigata. (*Chama*, Min. Con.) Lowest part of the green-sand at Berehead: In soft agglutinated sand, abounding in green particles. F.
E— undata. (*Chama*, Min. Con.) M. and Min. Con.
Fusus clathratus. M. Pl. XVIII. f. 19.
F— quadratus. (*Murex*, Min. Con.) M. Pl. XVIII. f. 17.
F— rusticus. M. Pl. XVIII. f. 18.
F— rigidus. M. Pl. XVIII. f. 16.
F— another species? M.
Gervillia aviculoides. M. Lyme. Min. Con., F.
G— solenoides. Min. Con.
Gryphæa canaliculata. (*Chama*, Min. Con.) M. Outer surface calcareous and effervescent, chalcedony within. F.

Gryphæa canaliculata: a broad variety. In yellowish effervescent sand, with green particles. F.
G— vesiculosa. Berehead ? M.
Hamites spinulosus. M.
Inoceramus concentricus. M. In iridescent chalcedony: Pinhay. In green hard stone. Min. Con., F. Near Lyme. D.
I— gryphæoides. M. Near Lyme Regis: In concretional masses of hard greenish grit, including very small scales of mica, and some minute black specks, under Dowland's Cliff. Miss Anning; and F.
I— sulcatus. Berehead. M.
Isocardia ? F.
Lima semisulcata. (*Plagiostoma semisulcatum*. Nelson.) M. Pl. XI. f. 10.
L—? subovalis. M. Pl. XVII. f. 21.
Littorina pungens. M. Pl. XVIII. f. 5.
L— gracilis. M. Pl. XVIII. f. 12.
Lucina ? orbicularis. M. Pl. XVI. f. 13.
L— Pisum. M. Pl. XVI. f. 14.
Lutraria striata. Pinhay near Lyme. Min. Con.
Mactra angulata. M. Pl. XVI. f. 9.
Modiola reversa. M. Pl. XVII. f. 13.
Murex Calcar. M., F. In iridescent chalcedony. Min. Con.
M— quadratus. (See *Fusus*.)
Mya læviuscula. M. Pl. XVI. f. 6.
M— mandibula. Pinhay Cliff. In firm green micaceous sparry grit. F.
M— plicata. (See *Panopæa*.)
Mytilus inæquivalvis. M. Pl. XVII. f. 16.
M— lanceolatus. Min. Con.
M— prælongus. Pl. XVII. f. 15.
M— tridens. M. Pl. XVII. f. 14.
Nassa costellata. M. ? Pl. XVIII. f. 26.
N— lineata. M. Pl. XVIII. f. 25.
Natica (Parkinson, Geol. Trans.). F.
N— ? carinata. M. Pl. XVIII. f. 8.
Natica granosa. M. Pl. XVIII. f. 7.
N— canaliculata. (*Ampullaria*, Geol. Suss.) M. Pl. XVIII. f. 6.
Nautilus elegans. M. Also in the sand near Lyme Regis. D.
Nucula angulata. M., F., Min. Con.
N— antiquata. M., F., Min. Con.
N— apiculata. F. Pl. XVII. f. 10.
N— impressa. M., F., Min. Con.
N— lineata. M. Pl. XVII. f. 9.
N— obtusa. M. Pl. XVII. f. 11.
N— pectinata. Pinhay. In hard greenish stone. F.
Ostrea carinata. M. Near Lyme Regis. D.
O— macroptera. Berehead. F.
Panopæa ovalis. M. Pl. XVI. f. 5.
P— plicata. (*Mya*, Min. Con.) M. Pinhay. F.
Pecten Stutchburiensis. M. Pl. XVIII. f. 1.
P— asper. M.
P— compositus. M. Pl. XVII. f. 20.
P— Millerii. M. Pl. XVII. f. 19.
P— orbicularis. M. Pinhay. F.
P— quadricostatus. M. A cast in grey chalcedonous chert. F. Haldon Hill, Devon. Min. Con.
P— quinquecostatus. Pinhay. F.
P—, (new.) Bere. F.
Pectunculus umbonatus. Blackdown. F. Haldon, Devon. Min. Con.
P— sublævis. Min. Con.
Perna rostrata. M. Pl. XVII. f. 17.
Petricola canaliculata. M. Pl. XVI. f. 11.
P— nuciformis. M. Pl. XVI. f. 10.
Phasianella pusilla. M. Pl. XVIII. f. 13.
P— formosa. M. Pl. XVIII. f. 14.
P— striata. M. Pl. XVIII. f. 15.
Pholas prisca. M. In silicified wood. The shell is chalcedony.
Pinna tetragona. M., Min. Con.
Podopsis striatus. M., F. Effervesces.
Pollicipes lævis. M. Pl. XVI. f. 1. (See also Pl. XI. f. 5.)

Psammobia? gracilis. M. Pl. XVI. fig. 12.
Pyrula Brightii. F. Pl. XVIII f. 21.
P— depressa. M. Pl. XVIII. f. 20.
Rostellaria calcarata. M., Min. Con.
R— macrostoma. M. Pl. XVIII. f. 23.
R— Parkinsonii. M., Min. Con., F., Pl. XVIII. f. 24.
R— retusa. M. Pl. XVIII. f. 22.
R— Another new species. F.
Scalaria pulchra. M. Pl. XVIII. f. 11.
Serpula ampullacea? M.
S— antiquata. M. Pinhay. Calcareous.
S—carinella. M. Min. Con.
S— filiformis. M. Pl. XVI. f. 2.
S— plexus? M. Effervescent.
S— tuba. M. Pl. XVI. f. 3.
S— vermes. Pl. XVI. F. f. 4.
Siphonia pyriformis (Goldfuss). Pl. XV. *a.*
Solarium conoideum. (*Cirrus plicatus,* M. C.) M.
Spatangus Bufo. (Goldfuss, Pl. XLVII. f. 7.) M.
S— Portion of another species, probably new. M.
Tellina inæqualis. Pinhay; M. Blackdown; Min. Con.
T— striatula. M. Pinhay; F. Blackdown; Min. Con.
Terebratula biplicata. M., F. Calcareous.
T— dilatata. M. Pl. XVIII. f. 2.
T— dimidiata. Haldon, Devon.; Min. Con.
T— latissima. (*T. lata,* Min. Con.) M.
T— megastrema. M. Pl. XVIII. f. 3.
T— Pisum. M., Min. Con.
T— striatula. M.
T— Lyra. M.
Thetis major. Blackdown. M. Berehead; Min. Con., F.
Thetis minor. Large. A cast in firm sparry grit. Pinhay, or Bere. F. Blackdown, and near Lyme. Min. Con.
T— (new.) Pinhay. A cast. F.
Tornatella? affinis. M. Pl. XVIII. f. 9.
Trigonia affinis. M., Min. Con. Blue mammillated chalcedony.
T— alæformis. Blackdown. M.:—Ridges very sharp. F. Near Lyme. D.
T— dædalea. M., Min. Con.
T— eccentrica. M. Hembury Fort, Devon. Min. Con.
T— pennata. Teignmouth. Min. Con.
T— quadrata. M. Pl. XVII. f. 12.
T— spectabilis. M., Min. Con.
T— spinosa. M., Min. Con. Near Lyme. D.
Turbo conicus. M., Min. Con.
T— moniliferus. M., Min. Con.
T— rotundatus. M., Min. Con.
Turrilites costatus. M. Not chalcedony.
Turritella costata. M., Min. Con.
T— granulata. M., Min. Con., F.
Venus angulata (see *Cyprina.*)
V— caperata (see *Cytherea.*)
V— Faba. F., Min. Con.
V—? immersa. M. Pl. XVII. f. 6.
V—? sublævis. M. Pl. XVII. f. 5.
V— lineolata (see *Cytherea.*)
V—? ovalis. M., Min. Con., F.
V— parva } (see *Cytherea.*)
V— plana }
V—? truncata. M. Pl. XVII. f. 3.
V—? submersa. Pinhay. F. Pl. XVII. f. 4.
V—. (Two other species; probably new.)
Vermetus concavus. Pl. XVIII. f. 10. Pinhay. Berehead. M.
V— polygonalis. Calcareous. Bere. F.
V— radiatus. (*Planorbis radiatus.* Min. Con.) M.

In addition to the species mentioned in this list, there are several others in Mr. Miller's collection, apparently new; but being too indistinct for figuring, they have been omitted.

(124.) *Blackdown to Shaftesbury.*—The great range of the chalk escarpment in the interior of England, which stretches, like the shore of a sea or lake, from Crewkerne in Dorsetshire to the north-east of Dunstable in Bedfordshire, is perfectly analogous in structure and appearance to the downs of Surrey and Sussex. It is interrupted by three or four indentations or gulfs;—one of great width, opening towards the west, between Crewkerne and the heights about Stour-head in South Wiltshire; another expanding to the north-west and terminating in the defile where the Thames cuts through the chalk, in its course to the south-east from Buckinghamshire and Oxfordshire. The vales of Pewsy and of Warminster are intermediate bays of the same general structure but of smaller dimensions; and all these valleys are apparently the result of denudation, aided by previous disturbance of the strata,—which has carried away the chalk, and laid bare to various depths the strata beneath it*.

The Green-sand hills range nearly from west to east for about ten miles on the south of Wellington and Taunton, and are then broken through irregularly, retiring towards the south to join the north-western extremity of the Dorsetshire chalk, of which some large outliers exist in the vicinity of Chard and Crewkerne. The chalk escarpment is thence continued in a direction parallel to the northern range of the Blackdown hills, to an opening on the north of Blandford, through which the Stour makes its way to the sea at Christchurch;—the tributary branches of that river, before it cuts through the chalk, winding extensively over the country around Sturminster, from whence the waters of the whole bay are conducted to the south-eastern coast. From the opening of the valley of the Stour the escarpment turns nearly north towards Shaftesbury, between which place, or rather between the prominence of the Upper green-sand on the north of it, and Mere, is the opening of the vale of Wardour. The beds immediately below the chalk from Crewkerne to Shaftesbury, have not yet been examined in detail, but the general distribution of the strata is represented in Mr. Greenough's Map.

South Wiltshire.

(125.) *Vale of Wardour.*—This tract may be considered as an eastern prolongation of the first of the great gulfs above mentioned, which being suddenly reduced in width between Shaftesbury and Mere, is continued east-

* The principles of structure in these tracts, are ably discussed in Dr. Buckland's well-known paper "On the Formation of Valleys, by Elevation of the Strata that inclose them," (Geol. Trans., 2nd Series, vol. ii. p. 119, &c.,)—where the vales of Wardour, Warminster, and Pewsy are expressly mentioned in illustration of the author's views.

ward as a valley surmounted on both sides by hills. It will be seen from the Map, Plate IX., that the anticlinal line by which this lower tract is traversed coincides in direction with that of the great Wealden denudation of Hants, Surrey, and Sussex; and is parallel also to the line of upthrow on the coast of Dorsetshire and the Isle of Wight, and to other shorter lines of elevation, the connexion of which is not at present visible, on the north of the Weald,—through Burgh-Clerc, Ham, Shalbourne, and Burbage, to the Vale of Pewsy. One of the anticlinal lines of the lower strata, beneath the new red sandstone, from Frome to the Steep Holm in the Bristol Channel also runs nearly from east to west; whilst, on the contrary, another line of fault by which the lower beds are intersected, beginning near Portishead-point on the west of Bristol, runs *northward*, across the Severn, through Newnham, and thence to the north-west of Gloucester *.

(126.) The Vale of Wardour has the general form of a triangle, the base of which extends from the chalk hills on the south of Shaftesbury to those of Mere, the apex being a little to the west of Harnham Hill on the south-east of Salisbury: for it is deserving of observation, that the stream of the Nadder escapes from this valley, not directly through the angle at its geological summit, but through the north side; in a manner perfectly analogous to that of the egress of the streams from the Wealden denudation in Kent and Sussex.

The heights which bound the vale consist at top of chalk, the inclination of which, like that of the strata beneath it, on the north of the anticlinal line, is in many cases more than 20°; while on the south, it is seldom more than 3° or 4°, apparently deviating but little from the general disposition of the strata in the South-east of England; and this anticlinal line itself is throughout much nearer to the north than to the south side of the vale. The strata from the chalk down to the gault inclusive seem to be continued all through, and to be nearly uniform in thickness; but the surface between the chalk hills is very irregular, and is divided by a ridge or bar formed by the escarpment of the Portland strata, on the east of which the ground is hilly, but on the west comparatively flat and low :—the appearances being altogether such as would arise from the deposition of the green-sands and chalk, over a tract partially occupied by the Purbeck and Portland forma-

* The anticlinal lines near Bristol, on the Map, Plate IX., are taken from Messrs. Buckland and Conybeare's paper on that district. For a full account of their relations to those in the South-east of England, the reader is referred to a paper since published by the Rev. W. Conybeare (London and Edinburgh Phil. Mag. for 1832, vol. i. p. 122, &c.), who states that one of the great lines of fault, by which the transition strata of the Quantock Hills in Somersetshire (beyond the range of the Map, Plate IX.,) are traversed, runs also nearly east and west.

tions, so as to overlie the latter, and beyond them come into immediate contact with the subjacent clays.

The small map, Plate VII. fig. 3, gives a plan of this valley on a larger scale than that of Plate IX., and the Sections AB to GH, Pl. X. a., No. 13., further illustrate its structure:—the strata being the *Chalk,—Upper green-sand,*—traces of the *Lower green-sand,* and of the upper members of the *Wealden*; beneath which the *Purbeck* and *Portland* formations are more fully disclosed.

(127.) *Chalk.*—The beds at Harnham Hill, immediately on the south of Salisbury, are inclined to the north; and about a mile to the west of that hill a curved ridge, or horseshoe, formed of the upper chalk, seems to be the first divarication of the strata which bound the Vale of Wardour*. It therefore deserves inquiry whether the continuation of the fissure produced by an upheaving on the east of this point, may not be discoverable in the space between Salisbury and the head of the Wealden denudation. The southern limb of the chalk forms a continuous and lofty ridge from Harnham, through Compton Hill and Chiselbury, to White Sheet Hill, around the base of which the Upper green-sand occupies the whole space from Berwick St. John's to Shaftesbury, the escarpment of the latter formation, which is the immediate boundary of the vale, being continued all along the foot of the chalk range, and rising from beneath it towards the north.

On the summit of the ridge at Chiselbury, the chalk includes black flints in spongiform nodules: the Down slopes northward at an angle of upwards of 26°; and at its foot there is a depression or trough. The lower and marly chalk form a ridge at Hoopside, about 200 feet above the stream at its base, and perhaps 100 below the summit of the highest range, which as the name indicates is curved, and nearly parallel to the curve of the upper chalk at the Race-course. The hill in Wilton Park belongs to the upper chalk, which there crosses the stream of the Nadder, passing through North Burcombe and thence towards the north of west, to form the higher downs, on the north of the valley, at some distance from the ridge of the sands. The lower chalk and chalk marl constitute an intermediate tract, in several places outtopped by the sand ridge. In the height above South Burcombe, is chalk with veins and nodules of flint; and nearly on a level with the river, north-west of Hoopside, the Upper green-sand comes in.

The succession from the flinty chalk to the Upper green-sand, on the north of the valley, is well seen in the road from Hindon to Fonthill Gifford. The ridge on which the archway stands, at the entrance to Fonthill Park, being chalk with large flint nodules, exposed in a pit immediately without the plantations, dipping north about 12°, and separated by a depression from the ridge of the Upper green-sand, which is here very low.

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* The Map, Plate VII. fig. 3, unfortunately, was engraved before I had observed the structure described in the text, so that the points here referred to are not included in it: but the features are well represented in the Ordnance Map; the aid of which, indeed, is almost necessary throughout these pages, to understand what is stated respecting the structure of the country.

(128.) *Upper Green-sand.*—The effect of the unequal inclination of the two sides of the valley is remarkably shown by the great difference in the extent of the spaces occupied by this formation. On the south, the upper beds are concealed at the foot of the chalk hills; but the lower strata shoot out into plateaus, which form the tops of the hills all the way to Shaftesbury; but on the north the whole series of the Upper green-sand rises abruptly and forms a very narrow ridge of unequal height. The Map and Sections, Plates VII. fig. 3. and X. a., No. 13., sufficiently explain this structure.

Some of the best sections of the transition from the chalk into the Upper green-sand are visible near Barford St. Martin and thence to Baverstock. In the lane over Baverstock Hill (called in the country Cloudles) the series consists of alternate beds of chalk and sand with green particles, succeeded by a thick bed of green-sand abounding remarkably in *Gryphæa vesiculosa*, which can be traced almost entirely round the valley. The ridge of these sands over Dinton House is full 200 feet above the bottom of the depression between it and the lowest chalk.

The greatest superficial extent of this formation occurs in the vicinity of Shaftesbury, where the upper part seems to have been better preserved than in the continuation of it eastward. The sections vary from 50 to 60 feet in thickness; of which about a third at top contains beds of chert like those of the Isle of Wight: but the lower beds only are found in the plateaus which project beyond the chalk.

Several good sections of the upper strata are visible in the lanes about Shaftesbury;—at Ludwell, Hernsham Street, in the ascent from Brookwater, and thence to the foot of White Sheet Hill, where some of the quarries include chert and veins of chalcedony.

From Castleditches,—an ancient fort or encampment on the summit of a remarkable prominence, the sand which composes the top declines uniformly towards the foot of the chalk range, but extends with an even surface, westward to Shaftesbury, and eastward to Barford Heath. The beds have many points of general resemblance to the sands of Blackdown;—with this important difference, that a very distinct stratum of bluish clay (Gault), which is wanting at Blackdown, is here found, everywhere, below the sand.

The relations of these strata are well shown in a large quarry at the top of the hill east of the valley of Fovant and of the Pembroke Arms, where the following was the order:—

Fovant Quarry.

	Ft.	In.
Soil and Grass.		
1. Greenish sand, alternating with gray, including stone which passes into chert, in irregular concretional bands and masses:—very like the sands of Blackdown .... 14 to	16	0
2. Sand of a much darker hue, below passing into stone .... about	5	6
3. Stone called "Greenstone", in firm beds, which are quarried for building; upper surface irregular; contains *Gryphæa vesiculosa*, Pectens, and shark's teeth .... about	9	0
This stone is valuable from its not being affected by frost. It can therefore be dug at any season, and stands well in water, as the foundations of bridges, and in exposed situations, as in copings, &c.		
4. Stone; but not good	1	6
5. Sand; depth unknown.		

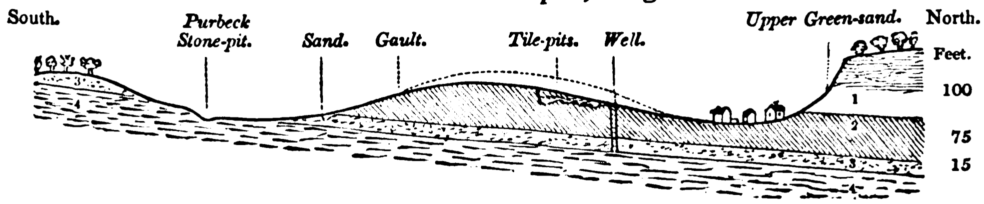
On the north of the valley, the Upper green-sand appears likewise to consist of two portions;

that which immediately succeeds the chalk, the equivalent of the fire-stone of Surrey, and the Malm-rock of Western Sussex, abounding in chert. To the lower portion the term Green-sand is strictly applicable, as it is composed of sand, and abounds in green particles.

About two miles west of Ridge the sands suddenly expand and occupy a large space from the north of Fonthill Abbey to Stop Beacon, where the surface is strewed with fragments of chert, the remains, probably, of the higher beds which have disappeared. But further west, between the Abbey and East Knoyle through Middlemore, the ridge again is narrow and highly inclined; but so much reduced in height, that the chalk of Hindon can be seen over it from the flat country at the mouth of the vale. The sands again expand a little on the west of East Knoyle; but at Upton their dip is not much less than 40°; so that the horizontal section occupies but a few paces, and on the north the chalk is seen at a lower level, connected by insensible gradation with the sands.

(129.) *Gault.*—The clay beneath the Upper green-sand seems to be co-extensive with that formation. It forms on the south of the Vale of Wardour a rapid slope; on the north, a depression, immediately below the sand; and is identified in several places with the gault of the eastern counties by the characteristic fossils. At Lower Donhead, under Lidhurst, it contains Ammonites with coproid masses of phosphate of lime; and at Ridge, where one of the most distinct sections is exposed, many other fossils have been found, the clay having been long used for tile-making. The beds all dip to the north, between 6° and 7°; and a well has been sunk through the clay, and a thin bed of sand beneath it, down to the Purbeck strata; the order being thus:—

Section at the Tile-pits, Ridge.



		Ft.	In.
1. *Upper Green-sand*, at the upper part of the hill, consisting of—			
a. Green-sand.			
b. Green sand-stone, full of *Gryphæa vesiculosa* at the upper part......8 to	10 ft.		
c. Greenish sand..more than	30		
d. A bed called by the workmen "malm-rock"; sand with stems of Siphonia and impressions of Ammonites ....about	60		
		100	0
2. *Gault*, including near the top a bed of pyrites, shot through with veins of calcareous spar, of which some large crystals are found here. The rest is clay* containing Ammonites, and other characteristic fossils, with Septaria and ovoid concretional masses of phosphate of lime		75	0

* About 3 feet of clay, which occurs on the north-west of Ladydown, may belong either to this stratum, or to one of the beds subordinate to the Purbeck formation.

3. Sand; (perhaps the representative of the Lower green-sand) said to be like that of the hill top. Masses of a calcareous conglomerate in the upper part	15	0

4. Fissile stone; some of the upper beds of the Purbeck series:—

a. Slaty limestone, abounding in Cypris and Cyclas, with smooth Paludinæ, and another acute spiral univalve.

b. Fine-grained oolite in uniform globular particles, like the roe of fishes.

(130.) *Lower Green-sand.*—This formation is nowhere prominent in the Vale of Wardour, and scarcely observable throughout the greater part of it. The ferruginous sands below the gault in the eastern portion of the valley may not improbably be referable to some of the Wealden sands; but on the road descending from the Pembroke Arms to Catherine Ford, a bed of greenish sand occurs below the gault, which seems to be superior to the Wealden strata; and if this be continuous with a bed of sand which appears at Penthurst and Fovant, it must belong to the marine beds; as I found at the former place a Pecten and the stem of a Siphonia. Ochreous sand, with some blue clay, to a total thickness of five or six feet, occurs likewise above the Purbeck strata at Totterdale (*Totteridge* of the Ordnance Map),—a height on the south of Tisbury, to which I shall hereafter have occasion to refer. On the north side of the valley, sand of the same doubtful character occurs immediately below the gault; but a bright ochreous clay, in a corresponding place between Apsell and Chicksgrove, is in my notes referred distinctly to the Lower green-sand; and a part of the sands from Fonthill Abbey to Stop Beacon, may also belong to the same formation. On the whole, however, the difference between the bulk of the Lower green-sand here, from that which it exhibits in Kent, Sussex, and the Isle of Wight, is very remarkable, and accords with the rapid thinning out of the formation westwards, on the coast of Dorsetshire and Devon.

(131.) *Wealden.*—The indications of the upper members of this group in the Vale of Wardour are likewise indistinct, nor did I find here any of their fossils; but where the strata rise slowly from beneath the gault on the east, under Fovant Wood, and thence by Catherine Ford and the sloping ground towards Dinton and Teffont Magna, (Pl. VII. fig. 3; and Pl. X. a., No. 13.,) are traces, probably, of the Weald clay and Hastings sands; the pond at Dinton Parsonage, especially, resting on a bed which answers well to the site of the Weald clay. These indications deserve notice, as they furnish the only instance with which I am yet acquainted, of the occurrence of the upper members of the Wealden in the interior of England. The place where these strata may be looked for with the greatest chance of success, is on the descent from the plateau of the Upper green-sand to Catherine

Ford; and their existence is rendered more probable, by the distinctness with which the connected strata of the Purbeck group are developed; the whole series apparently thinning out towards the west.

(132.) *Purbeck Formation.*—The Purbeck beds rise from beneath the sand and clay at Dallard's Farm, near the eastern angle of the Vale of Wardour; and from that point they can be traced,—on the south of the Nadder, at least as far as Totterdale, south of Tisbury; and on the north, to Ashley Wood, west of Ladydown, or perhaps to Stop Street, a hamlet above the village of Fonthill Giffard; occupying also the greatest part of the intermediate heights between these extreme points. The strata throughout agree with those of the coast; their fossils, with the exception principally of oysters, belonging to freshwater genera; and at the lower part near their junction with the Portland stone, they likewise include beds of clay alternating with limestone; one of which at least contains the trunks of silicified trees. The abundance of marine shells in the Portland beds immediately below, is here as remarkable as in the Isle of Portland.

The Map and Sections, Pl. VII. fig. 3., and Pl. X. a., fig. 13. A B &c., show the general relations of the Purbeck series. The principal quarries open, in the upper part of this formation, when I examined the country, were at Dallard's Farm above mentioned; at Dashlet on the south of the Nadder, about midway between Catherine Ford and Chicksgrove; and on the opposite bank of the river, at Teffont Evias and near Legh-barn. The junction of the Purbeck and Portland strata was best seen in a quarry at Wockley, on the south-east of Tisbury, the counterpart of a much larger one, worked some years ago at Chicksgrove (or Chilmark) Mill, but now obscured by decomposition from long exposure.

At *Dallard's Farm*, the beds first seen, on the west of the upper green-sand and gault, were thus:—

	Ft. In.	Ft. In.
1. Soil and Grass.		
2. Yellowish brown ferruginous loam, or clay		1 6
3. Slaty stone and clay, including seams of fibrous carbonate of lime:		
a. Slaty limestone, containing *Ostrea distorta*, Pl. XXII. fig. 2.	0 6	
b. Fissile whitish calciferous clay, called "Spangle" by the quarrymen, including great numbers of a small Modiola	0 6	
c. Whitish uniform limestone, including *Corbula alata*, Pl. XXI. fig. 5., like that near the coast at Upway	0 9	
d. Fissile clay	1 0	
e. Clay; somewhat like *d*, but more approaching to stone	0 6	
f. Fissile clay, like "Spangle", with Modiolæ, like those of *b*.	1 0	4 6

	Ft. In.	Ft. In.
4. Slaty limestone in firm beds, alternating with blue fissile clay:		
a. Rough and irregular above .... 6 in. to	0 9	
b. Stone; firm and durable, abounding in Cyclades;—within the valves of which are deposited beautiful casts of a small species of Cypris. See Pl. XXI. fig. 7 *b.*	1 3	2 0
5. Alternations of very blue fissile clay, with thick slaty stone, containing *Ostrea distorta*		1 6
6. Stone; continued downwards .... visible		2 0

These lower beds are of different tints of blue and gray; the gray by exposure becoming white, and the blue portions graduating into a hard, somewhat splintery stone, which in some specimens might be taken for limestone of the carboniferous series; some of the slaty strata alternating with clay (3 above), consist of worn, rounded, fragments of shell and of stone, and are very like some of the upper beds of Bermuda. The outer surface of the more uniform limestones is here much eroded by the weather; and when the masses are split, the natural partings are frequently found to be furrowed or eroded with tortuous irregular channels, from half an inch downward in diameter.

The pits along the south bank of the river, where the Purbeck series emerges from beneath the heights of sand, afford several good sections;—very much alike, and fairly represented by the following detail of one at *Dashlet*. (See the Map, Pl. VII. fig. 3.)

Section of the Stone-pits at Dashlet.

1. Brown, loam-like clay, including, or passing into 2.		1 0
2. Concretional, but nearly continuous masses of soft stone, with layers of Cyclades and Cypris, and oolitic particles .... about		0 6
The oolitic particles, when decomposed, leave empty cavities in the firmer cement, which might be mistaken for casts of Cypris.		
3. Fissile stone, in irregular beds, almost entirely composed of Cyclades and Cypris		1 3
4. A group of clay and limestone:		1 3 to 1 6
a. Thin slaty, calciferous clay, including *b.*	0 3	
b. Delicately fibrous carbonate of lime, with impressions of *Cyclas media* on the surfaces adjoining the clay; the beaks unusually sharp	0 2	
c. Clay	0 1	
d. Flattened roundish masses of uniform white and gray stone, imbedded in the clay of *c.* and *d.*; vertical cracks within, as in Septaria	0 4	
e. Brownish clay .... 1 in. to	0 2	
f. Fibrous carbonate of lime	0 1	
g. Fissile clay, calciferous below .... 1 in. to	0 6	
5. Compact limestone, in some places bluish, containing very large Cyclades (*C. major*); a large flat bivalve (Unio?); small bones and palates of fishes; and fragments of *Ostrea distorta*, Pl. XXII. fig. 2		1 4 to 1 6

The slaty limestone in the pits hereabouts affords the same beautiful casts of Cypris as are found at Dallard's, frequently inclosed within the valves of Cyclades, of which, in fact, the beds are almost entirely composed. In other cases the surfaces of the strata are covered with impressions of a small Modiola. The clay is often divisible into fragments, which are polished, as if by friction under strong pressure.

Some of the beds of uniform whitish limestone, to which the workmen give the name of "Lias", very much resemble the stone of Monte Bolca; and where most compact, are so like the stone used in lithography, that their application to that purpose seems to be well deserving of trial. The exposed edges of the thicker folia are eroded deeply into spongiform cavities. In some of the pits, the limestone, alternating with clay, has the appearance of united concretions or lumps; but within the stone is uniform, the aspect that of freshwater limestone, and the fracture splintery or very flat conchoidal, resembling a rock found in a corresponding place at Garsington near Oxford, which is there called "Malm". The masses split into irregular flakes at right angles to the surfaces, not more than a twentieth to an eighth of an inch thick. Both the clays and limestones in this part of the Purbeck series have sometimes a bluish colour; and both inclose large specimens of *Ostrea distorta*.

On the north side of the valley, as the Purbeck strata rise more rapidly, the sections are not so much expanded; but about Teffont Evias slaty limestone, alternating with clay and fibrous carbonate of lime, is seen not far from the gault, dipping about north 15° west, at an inclination between 2° and 4°. A thick coating of these strata invests the heights thence to Ladydown, (see the section, Pl. X. a., fig. 13. A B.); but about midway to that place, it is cut through by a natural ravine, which runs from Chilmark to the Nadder at Penthurst Bridge, and not improbably may have originated in a dislocation. The Portland beds which form the lower part of the ravine have been extensively quarried on both sides.

At Ladydown, near the highest ground occupied by the Purbeck formation, quarries have long been worked to great extent, chiefly for the sake of the fissile cycladiferous stone, like that of the Isle of Purbeck, which here bears the name of "Tilestone". Among these beds is a group which abounds in the remains of fishes.

On the south of the Nadder, near Benston, a prominence, like a step at a lower level, extends beyond the sands and clay which form the upper part of the hills, and is continued to Wockley and the west of Anstey Water, capping the height occupied by Totterdale Farm, where the Purbeck beds run out. In the lower part of this projection, a large quarry was for many years worked at Chicksgrove Mill, and another more recently at Wockley; the bottom of the former is nearly level with the river; the top about 50 feet above it, and about 30 feet lower than the top of the prominence above mentioned. The total thickness of the Purbeck strata indicated by these data does not exceed 60 feet.

A few beds occur in the upper part of the section at Chicksgrove, which do not remain at Wockley ; but the rest are so nearly the same at the two places as not to require a separate detail.

List of the Beds at Chicksgrove Mill, and Wockley Quarries.

	Ft.	In.	Ft.	In.
Chicksgrove.—				
Grass and soil ....about	0	9		
1. Loam; including fragments of stone, like the "*lias*" of the pits above mentioned ....about	1	3		
2. Bluish clay, passing into 3. .... 3 in. to 6 in.	0	5		
3. Yellowish brown, tough clay, very uneven at the bottom; filling up the irregularities of 4....................................3 in. to 9 in.	0	6		
4. A bed of coarse, somewhat gritty limestone, very irregular in thickness, but nearly continuous; in many places having the aspect of magnesian limestone, and containing nests of carbonate of lime in rhombic crystals.....1 ft. to 3 ft.	2	0	5	0

	Ft.	In.	Ft.	In.
5. A bed, likewise very irregular, consisting of—				
a. Brownish clay, at the upper part.				
b. Cavernous concretions or crusts of carbonate of lime, in the form of irregular flakes; which in some places have a deceptive appearance of organic structure. This bed accommodates itself to the inequalities in the surface, both of 4 above and of 5 below it; and seems to be a mass of loose loamy clay, shot through by stalagmitic carbonate of lime........				
6. A bed much decomposed, and very unequal in thickness: apparently consisting of soft, calciferous clay, with some portions of firmer limestone				
All the preceding beds seem to be above those of the Wockley Quarry.				
7. (Apparently the same with 2. and 3. of Wockley.) Irregular portions of limestone, very indistinct from decomposition; sometimes wholly wanting; sometimes in the form of thin slaty beds waving over the inequalities of the clay (8.) below ... . 1 ft. to 1 ft. 6 in.	1	3		
	——			
The whole thickness from 4ft. to 7ft. inclusive is ....about			6	0
8. Tough clay, (seems to be the same with 4. of Wockley).				
Wockley.—				
Grassy surface.				
1. Ferruginous loam and sand, filling the irregularities in the top of 2..... 6 in. to			1	0
2. Compact limestone, much decomposed, but in the fresher pieces mottled, grey and bluish. At the bottom this bed is divisible into flakes or thin strata, curved, or waving; very like the lower part of the "slate" of Portland, and the fissile beds above the Portland stone at Bacon Hall, (p. 223.) (*Quæ.* the "Soft Burr," or "Bacon-ledge"). .... 1 ft. 6 in. to 2 ft.			1	9
3. Decomposed whitish, fissile limestone; passing at the lowest part into 4., and very nearly resembling the "Cap" at Bacon Hall .... about			2	6
4. (8. of Chicksgrove Quarry.) Tough dark clay, in some places very like Fuller's-earth: seems to represent one of the "dirt beds" of Portland and the coast near Lulworth, but is more uniform, and does not contain fragments of stone				
5. (9. of Chicksgrove.) Fissile stone and clay.				
a. Hard stone..	0	5		
b. Thin slaty stone, in some places sandy, abounding in casts of Cypris, and in *Cyclas elongata*, Pl. XXI. fig. 9. This bed very much resembles the decomposing "Cap" of Upway (p. 223.) and may perhaps correspond to the "*Ash*" of Portland (p. 220.)	1	3		
The beds of this part of the section, at Chicksgrove, include also a minute spiral univalve. They are intersected by veins of stalactitic carbonate of lime, like those in the "Cap", &c., of Portland.				
c. Fissile calcareous matter, in beds of unequal thickness, curved at the lower part over the masses of *d.*; precisely like the bottom of the "Cap" at Bacon Hall, (p. 223.)	0	10		
d. Irregular concretional masses of black flint, rugged without when detached; not in themselves distinguishable from chalk flints	——		2	6
6. (10. of the Chicksgrove section.) Fissile, somewhat gritty limestone; at top enveloping the flinty masses 5. *d.*; below adhering to 7. This bed at the upper part contains casts of Cypris in great numbers. The proprietor of Chicksgrove Quarry told me that fishes, like those of Ladydown, were found in this part of the series, both there and at Wockley; but the specimens which I could obtain were much smaller than those of that place..................				

Bed		Ft.	In.	Ft.	In.
7. (11. of Chicksgrove.) Uniform, soft, very white limestone, here called "chalk"; but abounding at the upper part in Portland fossils: *Pecten lamellosus, Cardium dissimile, Trigonia gibbosa, Ostrea expansa.* This bed is not fit for building, and is burnt into lime: it seems, nevertheless, to represent the "white-bed" of Portland, though without oolitic structure					
8. (12., &c., of Chicksgrove.) From 7. to the bottom of the quarry, a depth of about 25 feet, in 8 or 9 beds, is called "Freestone": the detail as follows:—					
a. Whitish stone, called "chalk", of uneven, subconchoidal fracture; containing great numbers of *Pecten lamellosus* and Cytherea		2	0		
b. Cream-coloured, somewhat sandy stone, also with *Pecten lamellosus*		2	6		
c. Similar stone; *Trigonia gibbosa*, Cytherea, *Pecten lamellosus.* Sometimes this bed includes 5 to 8 inches of sand ....2 ft. to		3	6		
d. Concretional stone and sand.					
i. Stone	0 0 to 1 8				
ii. Sand, separating and surrounding the concretions of i.	4 0 to 2 6				
about		4	0		
e. Stone and sand:—					
i. Concretional stone	1 0 to 3 0				
ii. Sand around the concretions.....................	2 6 to 0 6	3	6		
f. Stone		4	0		
g. Ditto		3	6		
h. Ditto		2	0		
				25	0

These lower beds (which afford the best stone) contain *Ammonites giganteus* of great size: they are more like the form of the Portland stone which occurs in the Isle of Purbeck than that of Portland Isle itself.

Bottom of the Quarry.

At a new quarry near Chicksgrove Mill, the dip was east 25° south, at an angle of 2° or 3°.

(133.) *Junction of the Purbeck and Portland formations.*—It is obvious that the preceding strata, down to 7, represent the lower part of the Purbeck series, which in the Island of Portland includes the petrified trees and Cycadeæ; and the section here is valuable, as it exhibits some variation in the form of those lacustrine deposits. One of the principal points of difference between the sections at the two places is, that the freshwater strata here rest, immediately, upon a bed containing marine fossils, without the intervention of any clay or dirt. Another difference is, that no flinty masses are found here, at the top of the Portland formation, like those immediately above the white bed in the Isle of Portland; but, on the contrary, a range of irregular masses of black flint occurs distinctly within the *freshwater series*, and is separated from the Portland stone (No. 7. of the preceding list) by a bed of freshwater limestone (No. 6.), including casts of Cypris. As the flint, in this latter case, does not contain fossils, its presence immediately above the junction, while it is wanting in the usual place below, might at first sight mislead: but the occurrence of flinty masses is by no means unfrequent in other parts of the Purbeck group; and in the quarries north of the Nadder, opposite to

Dashlet above mentioned, where some of the beds partially composed of dark-coloured flint, are full of Cyclades and other freshwater fossils.

(134.) *Petrified Trees.*—I saw no traces of trees or Cycadeæ either at Chicksgrove or Wockley, nor could I learn that any specimens had been found there; but I had the satisfaction of finding, on the road from Totterdale towards Walmead*, at a point nearly on a level with the top of the quarry at Wockley, several fragments of a silicified coniferous trunk, with cavities encrusted with quartz crystals, as in Portland and the Boulonnois†, which had obviously come from a stone-pit just then filled up, on the road-side: and soon afterwards, the workman who had dug them out informed me, without being asked a question, that all the fragments were portions of one large mass, "thicker than a man's thigh," which, he said, stood upright among the strata, "*like a gatepost*,—and did not lie flat like the beds "of stone. He had quarried," he said, "many a piece near this place, "as much as a man could heave up, and all standing upright." This testimony leaves no doubt that trunks in the erect position have been found here, —precisely in the geological place where they might have been expected; and it is highly probable that further examination will lead to their discovery *in situ*.

A bed or beds, of clay, near the junction of the two formations, in which silicified trees may be expected, comes to the surface at several points along the river, between Ham Cross and Ashley Wood on the west of the Ladydown Quarries. In one place on this line, at a streamlet which crosses the road from Chicksgrove to Ham Cross, a bed or beds of clay, apparently belonging to the upper part of the Chicksgrove section, comes down to the level of the road, and well deserves to be examined; and on the descent from Totterdale, above mentioned, towards Anstey Water, is another spot where fossil trunks might be sought for with great probability of success.

(135.) *Portland Strata.*—The general disposition of the Portland beds in the Vale of Wardour will be understood from the map and sections, Pl. VII. fig. 3., and Pl. X. a., No. 13. AB &c. The upper strata are best seen in the sections at Chicksgrove, Wockley, and Chilmark.

The stone is found in the bed of the river at Chicksgrove Mill, and continued without interruption on the south of the valley, beneath a covering of the lowest Purbeck strata, which cap the height at Totterdale, to the vicinity of Wardour-castle, beyond Bridsor. On the opposite side of the river the strata soon begin to dip towards the north; but they rise also slowly west-

* The names in the Ordnance Map here require correction. The word Totteridge ought to be *Totterdale*, and should be transferred to the present place of the word *Highgrove*; the former being the name of the farm.

† Some of the specimens from this place, of a brownish hue, were found by Dr. Prout to consist almost wholly of silex, with slight traces of bituminous matter.

ward, to their final disappearance near Pyt-house. The remoter portions of this formation, on the north-west, form some of the highest ground within the surrounding ranges of green-sand,—as at Higher Lawn, Newtown, Pythouse, Linley, and Summerleaze; rising at the first two of these places, nearly as high as the summit of Stop-Beacon, and out-topping the chalk immediately on the north of the valley. The hill at Newtown is higher than the top of Castleditches.

The disposition of the beds on both sides of the Nadder westward, accords with that in the eastern portion of the valley; the dip at Chicksgrove Mill being about east 25° south; and at an old quarry near the syllable *-ton* in the word *Hazelton* of the Ordnance Map, south about 40° east. On the south of the road from Newtown, immediately below the letters *ho* in the word *Pythouse,* the dip is likewise nearly south, at an angle of about 22°, but this rapid inclination may be, in part, the result of subsidence. On the north of the anticlinal line the beds dip rapidly in an opposite direction. Thus, at Linley on the west of Lower Lawn and Summerleaze, and on the north of Ashley Wood east of the line of Ponds, where the Portland strata come very near to the ridge of Upper green-sand, the dip is almost directly north. In a quarry west of the road from Tisbury to Fonthill, it is north 30° east, at an angle of about 20°, and the beds are much shattered by fissures.

Excellent sections of the upper Portland beds are displayed in the quarries on the ravine between the village of Chilmark and Penthurst Bridge (See Pl. X. a., No. 13, line A B.); where the strata are inclined to the east 10° south, between 3° and 4°. Among the loose matter at the top of these quarries is botryoidal carbonate of lime, passing into compact freshwater limestone,—like the "Cap" of Portland, and the stone called "malm", at Garsington in Oxfordshire. The uppermost Portland beds here afford beautiful specimens of a fine-grained oolite like that of the "roche" in Portland: but the stone in some places alternates with sand, and has, in general, a very sandy character.

The principal quarries of the Vale of Wardour are in the vicinity of Tisbury; and some of the best, when I was in the country, were near the road from that village to Fonthill Gifford. The stone is more like that of this formation in the Isle of Purbeck, than in Portland itself, and of a darker hue. A continuous bed of flint, about 2 inches thick, in one of these quarries (Bevis's) had supplied, I was informed, the beautiful specimens of corals in chalcedony, which are found in collections from this part of England. Among the fossils I obtained at Tisbury are *Astarte cuneata, Ammonites biplex* in chalcedonic flint; *Ammonites giganteus* of great size, *Nerita sinuosa, Terebra Portlandica, Turritella excavata* (*Cerithium? excavatum*). A full enumeration of the species found here, and generally of the fossils of the Vale of Wardour, was drawn up by Miss Benett for Sir R. Colt Hoare's History of Wiltshire; separate copies of which, illustrated by plates of some of the new species, have been presented by that lady to her friends *.

The continuity of the strata hereabouts is frequently interrupted by chasms, locally called "lets", like those of Portland (*supra*, p. 218.) and of Oxfordshire; in which the beds are abruptly broken off, and the intervals filled with rubble and looser materials, to a perfectly level surface, covered with a uniform coat of vegetable soil.

Portland Sand.—I saw no place in the Vale of Wardour in which the beds immediately beneath the Portland stone were exposed; but I believe that the Portland sand occupies a great part of the descent from Pythouse to the plain on the west of it; and in crossing from Newtown to Hazelton this group seems to be disclosed immediately below the latter village, springs breaking out along the line of contact. If this be correct, the bluish gray strata, occasionally visible in the

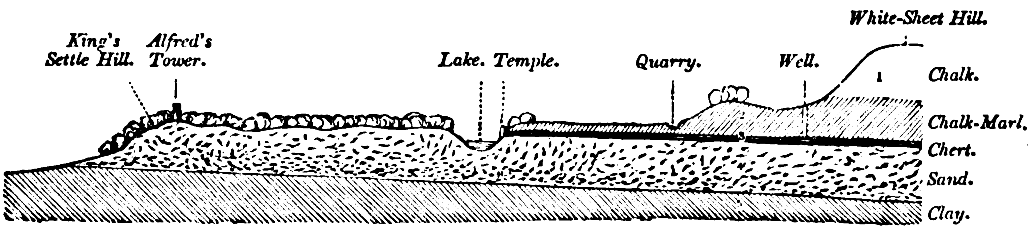
* "A Catalogue of the Organic Remains of the County of Wilts," 4to, Warminster, 1831.

streams on the north and east of that point, must be referred to the Portland sand; which, therefore, seems here to be more like that of the coast than of Oxfordshire and Bucks. At Tisbury, I was informed, sand is found, but not more than 18 inches thick, beneath the lowest beds of the Portland stone.

Kimmeridge Clay.—The whole of the level tract on the west of the opening of the vale seems to be occupied by clay; and this I have referred to that of Kimmeridge, on the following grounds, which, it must be acknowledged, are not very satisfactory. The gault and this clay come into contact, on the north of Shaftesbury, and beneath the heights of green-sand at East and West Knoyle,—in consequence of an overlapping of the whole cretaceous group, analogous to what is observable in Devonshire. The lower clay, which is used for brick-making on the west of Shaftesbury, contains *Panopæa depressa*, and casts of Ammonites like those of Kimmeridge, with other fossils, and includes a band of Septaria, there called "Turtle-stone". I myself found a Pullastra? about a mile south-west of Pythouse, at the brick-field of Great Mead (or Moat) on the north of Semley; and Miss Benett states that clay with the Kimmeridge fossils occurs at Binley Farm (*Quæ.* Linley of the Ordnance Map?), on the west of Pythouse. I did not hear of any bed of stone between the heights of Shaftesbury and Knoyle. It is not, however, improbable, that outliers of the gault or Upper green-sand may exist within that tract. But whether the Oxford clay also does not occur in the remoter part of the low country on the west of the escarpment,—the Oxford oolite as well as the Portland strata being wanting there,—I could not ascertain.

(136.) *Stourhead.*—I regret that it was not in my power to examine the heights on the west of Mere, which, according to Mr. Greenough's Map, consist of the green-sands projecting beyond the chalk escarpment; since, from the information of a friend, to whom I am indebted for the subjoined sketch and list of the strata, the Lower green-sand may be more conspicuous there than on the confines of the Vale of Wardour; which would prove that this group, like the Upper sand, is alternately expanded and again reduced in bulk and development.

The subjoined section extends from the chalk on the east of Stourhead, to the clay beneath the hill on which Alfred's Tower is placed, which is said to be 817 feet above the sea.



1. Represents the Upper *Chalk*. Feet.

2. *Chalk Marl*, here called "Malm". In this a well had been sunk, which afforded the following strata, by report of the well-sinker:—

a. "Malm"; like the chalk-marl of Lewes in Sussex, full of the characteristic fossils: sharks' teeth in great abundance	100
b. "White Stone"; so called, but in reality rather gray or green: full of Ammonites, many of which preserve their iridescent coats	4

Feet.
3. c. "Chert". At the lower part rubbly; and there the water rose 30
This stratum is visible in immediate contact with the sand (4.), above the Temple, on the brow overhanging the lake.

4. *Sand*; constituting the whole of the elevated platform on which Stourhead House is placed, and extending westward about two miles, to Alfred's Tower. It is a loose sand, with huge concretional masses of stone of similar composition. [*Quæ.* the "cowstones" of the Devonshire coast?] Fossils are abundant in the upper beds: the lower are more ferruginous.

5. *Clay*; probably that of Kimmeridge?.—(or Gault?)

From a comparison of this list, with the sections in the Vale of Wardour, of which the beds here represented are a prolongation, I should have been disposed, but for the opinion of my correspondent, to regard the series as coinciding with that of Ticklepath Hill (Pl. X. a., No. 13., line G H), and East Knoyle: the *Lower* green-sand being indistinct or wanting;—which is probable from the absence of gault between the "chert" (3.), and the sand below it. In this case, the gault would be inferior to the sand (4.), and perhaps a portion of the "clay" (5.). If the clay be exclusively that of Kimmeridge, the gault must be looked for above; and a part of (4.) might then represent the Lower green-sand, which, we shall find, occurs distinctly in the vicinity of Devizes, about twenty miles from this place.

(137.) *Vale of Warminster.*—The relations of the strata here are shown in the section, Pl. X. a., No. 14., on a line nearly from north to south. The denudation in this valley having cut less deeply than in the Vale of Wardour, the Gault is the lowest bed brought into view; and this only in the deeper parts of the streamlets. Excellent sections of the *Upper green-sand* are visible around the town of Warminster; the beds which contain chert being, in all cases, near the top, and the lower part almost pure gray or greenish sand.

The *Gault*, at Crockerton, is a somewhat micaceous bluish clay, affording many of the characteristic fossils; and along with these Miss Benett has obtained masses of a gum or resin, supposed to resemble that found in the London-clay at Highgate, which has obtained the name of Fossil Copal*. I refer to the subjoined list, for the fossils which I myself obtained here; and to Miss Benett's Catalogue already quoted, and that annexed to Mr. Lonsdale's paper hereafter mentioned †, for a much more complete enumeration.

(138.) *List of Fossils of the Vales of Wardour and Warminster, in South Wiltshire.*

[*Upper Green-sand.*]

Ammonites monile. Vale of Wardour, at the contact of the Upper green-sand and the gault; in conglomerate of green-sand.

A——— varians. Ridge; in a compact fine-grained rock, approaching to what is called "marlstone" at Dean's Farm, west of Farnham in Surrey (page 150, line 10, &c.). East Knoyle, between Upton and Chapel Farm, in the lowest chalk.

* Aikin's Manual of Mineralogy, 2nd edition, p. 44.; W. Phillips's Mineralogy, 3rd edition.

† Geol. Trans., Second Series, vol. iii. p. 276.

Exogyra conica. In great abundance. Vale of Wardour: Castleditches Hill: Norton Bavant; and Hernsham Street. Vale of Warminster.

Gryphæa vesiculosa. Vale of Wardour: between the Bull Inn and Sutton Mandeville; between Barford Street and Baverstock Church; Castleditches; Fovant, lowest beds; Ridge; Dinton, upon *Turritella granulata?*.

Inoceramus? Between Upton and Chapel Farm. East Knoyle; in the lowest chalk, with green particles.

Natica? In green-sand rock; somewhat slaty: Fovant? or Teffont.

Ostrea. Between the Bell Inn, and Sutton Mandeville.

Pecten orbicularis. Vale of Wardour: Hernsham Street; Fovant Quarry: Castleditches?

P—— quadricostatus. Vale of Wardour: Hernsham Street, in soft green sandrock.

Spatangus Bucardium? (Goldf., Tab. 49, f. 1.) Vale of Warminster.

S——— granulosus? (Goldf., Tab. 45. f. 3.) Vale of Warminster.

Turritella granulata? Vale of Wardour: Dinton.

Vermetus umbonatus. Ridge.

[*Gault.*]

Ammonites auritus. Vale of Warminster: Crockerton?

A——— Benettiæ. Vale of Warminster. Crockerton. A large specimen surrounded with branched vermicular stems, composed of greenish sandy shale: preserving its iridescence.

A——— Beudantii. Vale of Wardour: Ridge.

A——— dentatus. Ridge; with nodules of phosphate of lime. Crockerton; in a mass composed of phosphate of lime.

A——— new: allied to *dentatus.* Crockerton.

A——— lautus. Crockerton.

A——— monile. Crockerton. Interior occupied by chalcedony; the thin coating which remains in the place of the shell itself is opake, white, effervescent, and has the pearly lustre.

A——— planus. Crockerton: shell iridescent.

A——— Rhotomagensis. Ridge.

A——— Selliguinus? Ridge.

A——— tuberculatus. Ridge.

A——— varicosus. Ridge.

Astacus. The abdomen, and portions of a claw. Ridge.

Auricula inflata. Pl. XI. f. 11. Ridge?

Belemnites attenuatus. Ridge?

Caryophyllæa. Ridge.

Cytherea parva? (*Venus*, Min. Con.) Ridge.

Dentalium decussatum. Ridge.

D——— ellipticum. Vale of Wardour.

Hamites attenuatus. Vale of Wardour.

Inoceramus concentricus. Vale of Wardour.

Inoceramus sulcatus. Vale of Wardour.

Natica. Two indistinct specimens, probably of different species. Vale of Wardour.

Nucula pectinata. Crockerton.

Pecten orbicularis. Crockerton.

Pectunculus umbonatus. Ridge. Crockerton: bottom of the clay.

Pentacrinus, joints of. Pl. XI. fig. 4. Vale of Wardour: same species as at Folkstone.

Plagiostoma elongatum. Ridge.

Rostellaria carinata. Pl. XI. fig. 19. Ridge.

Serpula. Crockerton: filled with phosphate of lime, in clay.

Solarium conoideum. Pl. XI. fig. 14. Vale of Wardour: preserves its iridescence.

S——— ornatum. Pl. XI. fig. 13. Vale of Wardour: probably from Ridge.

Terebratula ovata? Crockerton: in pyrites.

T————. Ridge: in a Septarium of phosphate of lime, with thin veins of calcareous spar.

Trigonia alæformis. Vale of Wardour: below Fovant? in clay, with numerous green particles.

Venericardia tenuicosta. Pl. XI. fig. 7*. Vale of Wardour: in Crockerton.

Venus parva? (See *Cytherea.*)

FISH. Teeth: Vale of Wardour. Vertebræ and rays: Ridge.

[*Purbeck Strata.*]

Cardium? Castleditches: Purbeck (or Portland ?) stone.

Corbula? Between Dallard's Farm and Catherine Ford: with Cyclas.

Cyclas angulata. Pl. XXI. fig. 12. Between Dallard's Farm and Catherine Ford: with *Cypris granulosa*, Pl. XXI. fig. 4. in slaty Purbeck stone; with Corbula and Ostrea. Lane above Benston, near Chicksgrove: with Cypris and Modiola.

C—— elongata. Pl. XXI. fig. 9. Teffont: with *Cyclas membranacea.*

C—— *major?* Between Dallard's Farm and Catherine Ford. Purbeck;—or Hastings sand?

C—— *media.* Pl. XXI. fig. 10. Between Dallard's Farm and Catherine Ford: in slaty limestone; some specimens of which are almost composed of this shell. Dashlet, between Teffont and Penthurst, with Cypris. Ladydown Tile-pits, composing nearly the whole of the slaty stone. Between Ham-cross and Chicksgrove, with *Cypris Valdensis.* Fovant Wood. Teffont: in slaty limestone, apparently the top of the Purbeck, with *Cypris Valdensis.*

C—— *media*: A gibbose variety; as at Penhurst, near Battle in Sussex, (*supra*, p. 177.) Pl. XXI. fig. 11. Vale of Wardour, with *Cypris Valdensis.*

C—— *membranacea.* Teffont: with *Cyclas media* and Ostrea.

C—— *parva?*. Pl. XXI. fig. 7. Between Ham-cross and Chicksgrove: with Cypris and *Paludina elongata.* Dallard's Farm, where many of the Cyclas casts are full of the valves of Cypris.

Cypris granulosa. Pl. XXI. fig. 4. Between Dallard's Farm and Catherine Ford: with Cyclas, in slaty Purbeck stone; also with Cyclas and Modiola, in gray freshwater limestone. Dashlet, between Penthurst and Teffont.

C—— Valdensis. Pl. XXI. fig. 1. Vale of Wardour. Ladydown Tile-stone pits: with a variety of *Cyclas media*. Between Teffont and Penthurst. Between Ham-cross and Chicksgrove; Teffont; and stone pits south of Ridge; with *Cyclas media*.

Modiola. Dashlet; between Penthurst and Teffont: in decomposed slaty limestone. Between Dallard's Farm and Catherine Ford: with Cypris, in gray freshwater limestone.

Ostrea distorta. Pl. XXII. fig. 2. Quarry, below Fovant; in very compact stone, like mountain limestone. Between Dallard's Farm and Catherine Ford: with Cyclas. Teffont: with *Cyclas media*, and *C. membranacea*.

Paludina elongata. Between Ham-cross and Chicksgrove: with *Cyclas media* and *Cypris Valdensis*.

P—— a minute species; as at Combe-wood, Oxfordshire. Stone-pit south of Ridge.

FISH. Remains of the following species of Agassiz :—

Lepidotus minor. Ladydown Tile-stone pits: some very fine specimens, like those of the Isle of Purbeck.

Pholidophorus ornatus, *Ag*. Imperfect remains of a new species. Chicksgrove-mill Quarry: In white slaty limestone, full of fragments of shells.

[*Portland Stone*.]

Ammonites biplex. Tisbury: in chert; the shell chalcedony.

A—— *Brodiæi*. Fonthill Gifford.

A—— *giganteus*. Vale of Wardour: in chalcedony. Chicksgrove-mill Quarry: in gray limestone like chalk. Same place: in stone coated with rhomboidal carbonate of lime. Tisbury: in chert; the shell chalcedony.

Astrea Tisburiensis (*Madrepora Tisburiensis* of Miss Benett). In dark chalcedonic chert: a concretional bed subordinate to the Portland stone, near Tisbury.

Astarte cuneata. Chicksgrove-mill Quarry. Chilmark Quarry. Tisbury: with *Cerithium ? excavatum*.

Buccinum naticoïde. Pl. XXIII. fig. 4. Vale of Wardour.

Cardium dissimile. Vale of Wardour. From the lane above Berston: with *Trigonia gibbosa*. Tisbury: in white uniform chalk-like stone.

Cerithium ? excavatum (olim *Turritella*). Vale of Wardour. Tisbury: with *Astarte cuneata* and *Trigonia gibbosa*. Ladydown.

Cancer ? or *Astacus ?*. Claw, with *Trigonia gibbosa*. In slaty limestone. Lane above Benston.

Cytherea ? rugosa. Pl. XXII. fig. 13. Chicksgrove-mill Quarry.

Echinus. Tisbury.

Exogyra (new). Vale of Wardour. Portland-stone?

Lucina Portlandica. Pl. XXII. fig. 12. Lawn Quarry: in sandy Portland stone.

Modiola. Vale of Wardour: in compact sandy Portland stone, Bevis's Quarry near Tisbury; with Ostrea, Serpula, and palate bones of fish.

Mytilus. Ashley Wood, near Fonthill Gifford: in compact Portland rock.

Natica elegans. Pl. XXIII. fig. 3. Miss Bennett's collection. Vale of Wardour.

Nerita sinuosa. Chilmark Quarry and Tisbury.

Ostrea expansa. Vale of Wardour; Chicksgrove-mill Quarry; in white chalk-like stone.

O—— falcata. Pl. XXIII. fig. 1. Chicksgrove-mill Quarry:—Top of the Portland.

O—— *undulata.* Vale of Wardour: in white chalk-like stone.

Pecten lamellosus. Vale of Wardour. Chicksgrove-mill Quarry. Shaver's Bridge, Tisbury Parish: with Ostrea, very young. Fonthill. Lawn Quarry; with *Lucina Portlandica*, in sandy Portland stone.

Serpula. Bevis's Quarry, near Tisbury: with Modiola, and palate-bones of fish; in compact sandy Portland stone.

Terebra Portlandica. Pl. XXIII. fig. 6. Tisbury: casts of interior, not effervescent.

Trigonia gibbosa. Vale of Wardour: Castleditches; with a minute Turbo. A lane above Benston, near Chicksgrove; with *Cardium dissimile*, crab's claws, and an Ostrea, in white chalk-like limestone. Chicksgrove-mill Quarry. Teffont. Tisbury. Fonthill Gifford: in chalcedony.

T——— *incurva.* (Miss Benett.) Vale of Wardour.

Turbo (minute.) Castleditches: with *Trigonia gibbosa.*

Turritella excavata. (See *Cerithium.*)

Fish, part of a palate. Tisbury.

[*Portland Sand* (*or Kimmeridge Clay*?).]

Ammonites biplex. Chicksgrove Mill: in sandy clay at the bottom of the quarry.

A——— Cast. Brickyard near Shaftesbury.

Panopœa depressa. (*Mya*, Min. Con.). Pl. XXIII. fig. 9. Near Shaftesbury: in clay. Some specimens very large.

NORTH WILTSHIRE.

(139.) *Devizes, Calne.*—My knowledge of the country from the Vale of Wardour to the vicinity of Calne is due to my friend Mr. Lonsdale, with whom I had the pleasure of going over a part of it, in the year 1827. Mr. Lonsdale himself has since published a very important paper on the oolitic district of Bath, which is accompanied by sections, three of which include the strata under consideration in this paper*; and he has been so kind

* Geol. Trans., 2nd Series, vol. iii. p. 243, Plate XXXII. The course of these sections is expressed in the Map, Plate IX., by the dotted lines adjacent to No. 15. and 16.

as to furnish me with two additional sections, Nos. 15. and 16. (Plate X. a.) which may be considered as supplementary to those above mentioned; the first, No. 15., running east and west, from Etchilhampton Hill south-east of Devizes, to the Kimmeridge clay beneath the green-sand which caps the heights of Poulshot Green: the second, No. 16., from the lower chalk at Beacon Down, through Sandridge Hill, which is capped with the Lower green-sand over Kimmeridge clay and Oxford oolite, to the Oxford clay around Melksham, where the canal is about 154 feet above the sea*. The sections themselves sufficiently explain the general relations of the strata; and for an account of their composition I refer to Mr. Lonsdale's paper; regretting only that his colouring of the Ordnance Maps of that part of England still remains unpublished.

The town of Devizes stands upon a platform of the Upper green-sand, which is there about 430 feet † above the sea, and is overlooked by the chalk of Etchilhampton Hill and the adjacent heights. And here, as throughout the tract from hence to Swindon, the contrast between the upper and lower chalk is very remarkable, both in external features and agricultural character.

The ground near Westbury rises with such rapidity, that the distance between the outcrop of the upper chalk and of the Upper green-sand is less than a mile; and on the north-east of that town the slope is still more rapid. But, thence towards the north and east, a great superficial extent of the lower beds is exposed in the Vale of Pewsey, which consists of the Upper green-sand surmounted by detached portions of the chalk-marl and lower chalk, the latter, in some cases, rising into summits of considerable elevation.

The outcrop of the Upper green-sand and Gault has, in general, though irregularly, a northern direction, from about Great Cheverell, through Pottern,—to Heddington, about three miles north of Devizes. On the south of the Vale of Pewsey, the Lower chalk is disclosed by denudation, on a line almost due east from Easton Hill,—through St. Ann's Hill, Milk Hill, Golden Ball, Hewish, Martensell, and Terrace Hills; and thence westward through Easton, Milson, Pewsey field, Upavon, Cleeve Hill, and the slope thence towards Urchfont, and southward to the upper part of West Lavington. The outcrop of the Upper chalk, after forming a bold escarpment, between Westbury and Cheverell Hill, is thrown back towards the east, forming the heights, along which the *Ridgeway* is conducted, between Gincross by Bushton Down to Wivelsford. The Ridgeway, which runs on the verge of the ridge bounding the wide tract of Blackheath, is first directed

* This and some other heights mentioned hereafter, are derived from Bradshaw's map of the canals of England, and are counted from low-water mark at Liverpool. (See Appendix C.)

† 429 feet 6 inches above low-water at Liverpool. At this level the Kennet and Avon canal is continued in a direction nearly parallel to the heights of chalk, as far east as the vicinity of Wooton Rivers, where it rises to 462 feet 6 inches (the summit level) to surmount a narrow neck of elevated ground on the north of Burbage:—and thereabouts the streams divide; one group running west, throug Pewsey, to join the Avon near Upavon; the other north-eastward, along a valley descending rapidly from north to south, through Great and Little Bedwin; and thence through Salisbury to the sea at Christchurch.

to the east of north, between Gore Cross and Bushton Down, but turns suddenly eastward immediately on the south of Urchfont. On the east of the Avon, the range of the upper chalk is less distinct; but it is directed towards the parting of the streams on the south of Burbage.

The difference between the upper and the lower chalk is very well expressed in the Ordnance Maps, especially in the more recent sheets, which are engraved with more lightness and delicacy of expression than some of their precursors. The great natural district of Salisbury Plain, more than twenty-five miles in extent from west to east, and twelve miles from north to south, though diversified by numerous irregularities, is almost wholly destitute of streamlets; and would be without running water, but for the presence of the more considerable rivers, which, in many cases, do no more traverse the surface of this region, the greater part of their supplies being derived from a different soil, and remote situation. This point of structure is known to be so characteristic of the Upper chalk, both in England and France, that good maps alone,—such as that of the Ordnance, or even of Cassini's map of France, would be sufficient to indicate the space occupied by this stratum. In the tracts, on the contrary, occupied by the Lower chalk—and still more decisively in the Chalk marl, few, even of the smaller valleys, are without streams; and hence, as well as from the difference in soil, the vegetation also is different, and the fertility of the lower regions forcibly contrasted with the naked and barren aspect of the higher downs. Were it not that the colour is so nearly alike, these two groups would no doubt have been distinguished in geological maps by different hues; and they ought to be so, wherever the scale is sufficient to express the distinctive features above mentioned.

(140.) *Vale of Pewsey.*—The general structure of this tract is fully described in the excellent paper of Dr. Buckland to which I have already referred. It is, in fact, a valley of elevation: its eastern and narrower portion being a continuation of the anticlinal ridge, which Dr. Buckland has described as extending from the south-east of Inkpen in Berkshire to the west of Shalbourne and Ham; where the Upper green-sand has been brought to the surface by subterraneous force, but is separated by a sort of bridge of the Lower chalk, about Burbage, from the portion of the former stratum which has been elevated in the same manner within the Vale of Pewsey itself. At the opening of the Vale, however, between Great Cheverell, Urchfont, and Devizes, no derangement is apparent, though it is very probable that the surface is disjointed by less perceptible fissures;—the Lower green-sand, continuously, occupying the whole of the entrance of the vale; as is expressed on the map, and more distinctly shown in fig. 4. of Mr. Lonsdale's sections. It will be observed that the beds immediately below the chalk are here more fully developed than in the Vale of Wardour, the Lower green-sand being perfectly distinguishable; as might have been expected, from the proximity of this place to the great expanse of that stratum in Surrey and Hampshire: and these subdivisions continue to be distinct through the northern counties as far as the coast of Norfolk. The small number of fossils which I could obtain, in addition to those enumerated in Mr. Lonsdale's paper*, are men-

* Geol. Trans., 2nd Series, vol. iii. p. 266, &c.

tioned in the list subjoined. One of the most remarkable is the *Diceras Lonsdalii*, Pl. XIII. fig. 4, for some very fine casts of which I am indebted to Mr. Goodhall.

No trace of any member of the Wealden group, nor of the Portland series, has yet been observed in this quarter; and it will be seen from the Section, No. 16., that the Kimmeridge clay and Oxford oolite thin out rapidly in rising towards the west at Sandridge Hill.

(141.) *Swindon.*—I am indebted also to Mr. Lonsdale for my first information as to the existence of the Portland stone and sand at this place,—and the occurrence there of large nodular masses of stone identical with those of Shotover in Oxfordshire, and of the French coast near Boulogne. The Section, Pl. X.a., No. 17., explains the succession and general relations of these strata. It will be remarked, that the Lower green-sand is distinguished from the Upper by the interposition of the Gault*: but though the Portland stone forms one of the most prominent features of this Section, no trace either of the Weald-clay or the Hastings-sands has yet been observed above it, and the indications of the Purbeck strata are inconsiderable.

Chalk.—The remarks above stated on the contrast between the spaces occupied by the Upper and the Lower chalk, apply with even greater force to the tract between Calne and Swindon,—or more properly between Cherhill and Liddington,—than to Salisbury Plain. The heights from Hackpen to Barbury Hill, that of Liddington Castle, and the high range thence to Polton Down, forming prominences above the lower chalk on the west and north-west, and bounding an extensive district, distinguished by the absence of streamlets and other characters from the more fertile regions of the lower chalk and chalk marl.

Between Barbury and Liddington Castle, the Upper chalk retires to the south and east towards Ogbourn St. George, so as to form a sort of amphitheatre. The outline of the higher summits when seen from sufficient distance, is in many cases almost rectilinear and horizontal; of which the ridge between Ogbourn St. George and Ogbourn St. Andrew affords a good example.

The Lower chalk forms a lower and uniform escarpment from Compton Basset on the east of Calne to the village of Liddington, and thence northward nearly to Little Hinton and Bishopstone. From the lower beds at Liddington a copious spring breaks out, in a position analogous to that of Lydden-spout on the coast near Folkstone (8.), and of the range of springs which everywhere appears at the foot of the chalk downs (70.)

Enormous masses of siliceous grit (Grey wethers), like those which occur in profusion near Marlborough, and in several places over the great chalk district on the south of that place, are sometimes found here beyond the chalk escarpment. One of these, about 12 feet by 8 in its diameters, was about a mile from the chalk-hill at Burdrop Wood; and with these, in some instances, are masses of siliceous conglomerate,—the Hertfordshire pudding-stone.

* In the first edition of Mr. Greenough's map, the spaces assigned to the Chalk and Greensands here, are erroneous: the boundary of the latter on the north-west being really that of the lower chalk; and that of the Chalk, as expressed in the map, being truly the limit of the upper chalk only.

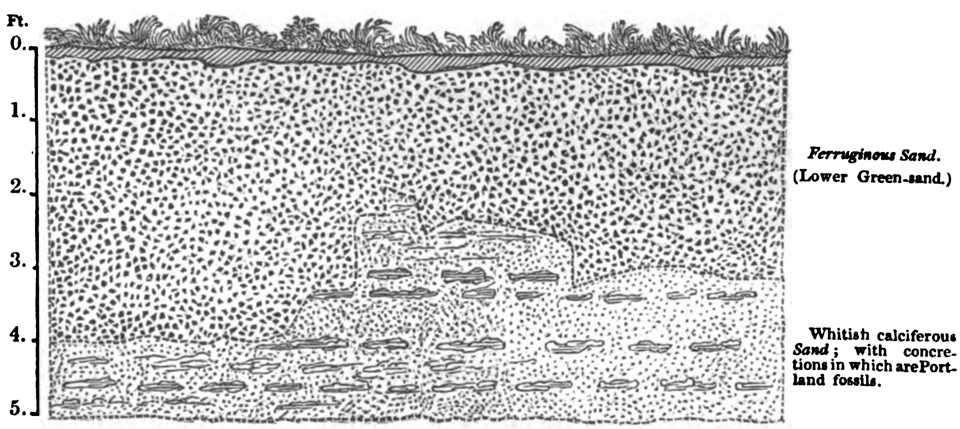
The *Upper green-sand,* from Wroughton to Warborough, includes dark-coloured siliciferous stone, containing mica and green particles. The formation occupies a slightly prominent step beneath the sloping escarpment of the lowest chalk. Its thickness is probably between 30 and 50 feet (see the Section, Pl. X. a., No. 17.); and it may be traced throughout a space of very irregular outline from the road at Burdrop Wood to Liddington.

Gault.—Bluish clay, of a smooth plastic texture, with numerous specks of mica, succeeds the last formation, and occurs at considerable heights in the sloping face of the escarpments. It can be recognised in the lower ground, on the roadsides, from Swindon to Burdrop Park, and to Liddington; but does not here form so distinct a valley or depression, as in Kent and Sussex.

Lower green-sand.—This, though perfectly distinct, can scarcely be said to form a ridge, as in the south-eastern counties, after rising from beneath the gault. It does, however, occupy a slight wave or inequality of the surface, about midway between Liddington and Coate (see the Section, Pl. X. a. No. 17.); and then suddenly thinning off, caps the heights at the latter place and at Swindon. The sand at the upper part is very tough, either from the presence of clay, or a great abundance of oxide of iron. In some other places it is loose and white; and among the substances found within its range is Fuller's-earth.

This ferruginous sand, as it approaches Swindon, rests, in several places immediately upon another sand of a very different character, at the top of the Portland series, and the junction is deserving of notice, the surface of the latter sand being very irregular, as if from erosion by water, and the inequalities or prominences often of such tenuity, as to indicate a very tranquil condition of the fluid beneath which they were formed, as well as of that which deposited the ferruginous mass by which they are at present enveloped:—which is the more remarkable, when it is considered that the interval between the deposition of these two sands must have been, in point of time, sufficient for the accumulation of the whole of the Wealden group.

In one of the quarries, near the top of Swindon Hill, the Section was thus. The boundary



between the two kinds of sand being perfectly distinct and sharp; and the contrast was the more striking, from the lower being composed, in a great measure, of minute fragments of shells, which are wholly wanting in the incumbent matter*.

* In Mr. William Smith's Geological County Maps of Kent, Sussex, Wilts, Oxfordshire, Bucks, Berkshire, and Bedfordshire, the stratum now known as the Lower green-sand is described as "Sand, in the lower part of which the Portland stone is found." To understand the source of this error, it must be recollected that at the period of those publications, the existence

Purbeck strata.—The only indication of this member of the Wealden which I found at Swindon, were detached masses of botryoidal limestone, like the middle of the "Cap", in Portland (p. 222.), and fragments of dark brownish silicified wood,—fallen, I have no doubt, from the top of the quarries, though supposed by the workmen to occur amidst the stone itself. In the looser matter also, near the top of the quarries and above beds of the Portland stone, are masses including very numerous casts of marine shells (apparently Lucina and Cytherea), in which the cementing substance has the aspect of freshwater limestone, and is scarcely to be distinguished from a stone of the same yellowish hue, within the Purbeck series near Ridge in the Vale of Wardour;—but in the latter the casts are those of *freshwater* species, especially Cyclades. In the subjoined sectional list, it will be found that clay occurs in detached portions above the Portland stone, in the great quarry at Swindon; but I was not enabled to determine the formation to which it ought to be referred.

Portland stone.—The upper part of this formation at Dayhouse farm, east of the Reservoir, and at Broom farm on the west of that place (Section No. 17.), abounds in the characteristic fossils, and is immediately subjacent to ferruginous sand. In many of the quarries here, especially in the east of the town, even the uppermost beds contain a large proportion of sand; presenting, in this respect, a striking contrast with the top of the series on the south-east coast, but much resembling that of the Lower Boulonnois, especially of the quarries at Mont Lambert. The stone is generally dispersed throughout this sand, in rugged and irregular concretional masses, which, as well as the sand, contain numerous obscure remains of shells, frequently in the state of a calcareous powder.

The following is a sectional list of the strata in the great quarry on the south-west of Swindon, which occupies a space of no less than fourteen acres; the beds rising from a point a little east of south, at an angle between 1° and 5°*.

Section of the Great Quarry at Swindon.

	Ft.	In.
1. *Soil*	0	6
2. In some places, immediately below the surface is *clay*, occasionally $2\frac{1}{2}$ feet thick, with a slight covering of ferruginous (Lower green) sand. But in several places the thickness of this sand was as much as 4 feet		
3. Loose rubbly stone	3	0
4. A group, as follows:		
a. Limestone full of petrifactions. *Cardium dissimile; Cytherea? rugosa*, Pl. XXII. fig. 13.; *Gastrochæna?; Lucina Portlandica*, Pl. XXII. fig. 12.; *Perna quadrata; Pleurotomaria; Terebra Portlandica*, Pl. XXIII. fig. 6.; *Trigonia gibbosa; T. incurva;* Long bones of Saurians	5	0
b. Bluish grey limestone		
c. Clay		
d. Soft limestone, abounding in casts of shells		

of the Wealden group was unknown; and that in point of fact, the Portland stone *is* found in many parts of the counties above mentioned, *at the bottom of the Lower green-sand*, and in a group which is itself in part composed of sand:—so that where the latter sand is not well distinguished, as in the section represented in the woodcut on the last page, the whole might easily be mistaken for one continuous stratum. What is stated above, explains, I believe, the true relations of these sands, to each other and to the Portland stone.

* A mill on the north of the hill was deprived of water in consequence of the springs which appear at the junction of the Portland sand with the clay, having been opened on the south-west side of it,—so as to tap, as it were, the summit, and draw off the whole of the water; the retentive surface of the clay being inclined towards the south. This fact proves also the continuity of the beds which form the top of the hill, and the absence of fissures—of such depth, at least, as to penetrate the clay.

	Ft. In.
5. Alternate ranges of sand and stone.	
a. Sand, in many places cream-coloured, abounding in fragments of shells, which decompose into a white powder. This includes *b.* .... *b.* Stone, resembling that of the Portland formation in the Isle of Purbeck, evidently nothing more than sand consolidated by calcareous matter. The masses, when discrete, are of very irregular figure. The stone becomes more abundant in descending; and near the bottom contains very large Ammonites, *A. biplex*, *A. giganteus*	20 0
Total ....about	30 0

A depth of about six feet below the bottom of this quarry is said to consist of similar sand and stone.

Portland Sand.—The lower part of this formation is well displayed in an old quarry on the northern brow of Swindon Hill, near the letter *B* of the word *Bowling-green* in the Ordnance Map. The rock consists of rough sandy stone, of a dull bluish grey colour, like that of the upper part of this formation in the Isle of Purbeck, in which are included traces of several fossils converted into carbonate of lime;—*Ammonites biplex, Perna quadrata, Trigonia gibbosa, Trigonia clavellata*; with numerous dark particles of silicate of iron, and worn fragments of black chert or flint, many of them evidently the remains of casts of bivalves (some having the outline of a Venus or Lucina ?), and of Ammonites.

Another form which the Portland-sand assumes here, is that of great nodules of hard greenish and grey calciferous grit, precisely resembling those of Shotover Hill, and of the French coast, especially near Cape Grisnez,—and, as at those places, imbedded in grey sand: above which, is another bed of sand without nodules, containing green particles and numerous fragments of black chert. Mr. Lonsdale had long since mentioned to me these great masses, several of which were then visible on the east of the road from Oxford, close to the town; but when I visited the place, the greater part of them had been broken up and removed. Immediately below the nodules were about four feet of grey sand.

The Portland-sand extends westward from the town of Swindon, and occupies a part of the descent of the hill at Okus and Westleaze, where the high ground overlooks the canal. In the farm-yard at Okus were several large nodules, like those above mentioned*.

Kimmeridge clay.—At the Bowling-green the sand with concretions appears on the surface as the hill descends, and is succeeded abruptly by dark clay, in which I found fragments of oyster-shells; and this is the case also beneath the great nodules near the road from Swindon to Oxford. I have no evidence of the identity of this clay with that of Kimmeridge, but the facts here stated.

(142.) *List of Fossils from the Strata below the Chalk, in part of North Wiltshire.*

[*Upper Green-sand.*]

Ammonites dentatus. Rowde Hill, near Devizes.
A——— varians. Near Swindon; (in the *Chalk marl*).
Mya mandibula. Devizes Canal.
Panopæa plicata? Rowde Hill.

* Toothill, a small eminence, which is conspicuous from this place, consists of clay, as also the hill at Elcomb-house. That of Chaddington, still further west, is said to be capped with sand.

Terebratula nuciformis. Rowde Hill.
Vermetus umbonatus. Rowde Hill.

[*Lower Green-sand.*]

Arca? Lockswell Heath, near Bowood: in ferruginous coarse sand-rock.
Corbula? Lockswell Heath: in ferruginous sand-rock.
Cardium striatulum? Lockswell Heath.
Cucullæa. Lockswell Heath: in ferruginous sand-rock.
Diceras Lonsdalii. Pl. XIII. fig. 4. *a.—d.* Near Calne. Mr. Goodhall.
Modiola. Lockswell Heath.
Mytilus. Lockswell Heath.
Pecten obliquus. Lockswell Heath: in ferruginous sand-rock.
P—— quinquecostatus. Lockswell Heath.
Plagiostoma rigidum. Lockswell Heath.
Terebratula latissima. Lockswell Heath: in ferruginous sand-rock.
T———— nuciformis. Lockswell Heath: in ferruginous sand-rock.
T———— oblonga. Lockswell Heath.
Thetis minor. Lockswell Heath: in ferruginous sand-rock.
Trigonia gibbosa? Lockswell Heath.
Turbo moniliformis. Lockswell Heath: in ferruginous sand-rock.
Venus? Lockswell Heath.

[*Portland Oolite.*]

Ammonites biplex. Swindon.
A———— giganteus. Swindon.
Buccinum angulatum. Swindon. Pl. XXIII. f. 5.
B——— naticoïde. Swindon. Pl. XXIII. fig. 4.
Cardium dissimile. Swindon.
Cytherea rugosa. Pl. XXII. f. 13. Swindon. The predominant shell in the upper bed of the great quarry.
Gastrochæna. Swindon.
Lucina Portlandica. Pl. XXII. f. 12. Swindon: in stone very like freshwater limestone; full of moulds and casts of this shell.
Nerita angulata. Pl. XXIII. f. 2. Swindon.
Ostrea falcata. Pl. XXIII. fig. 1. Swindon.
Pecten. Swindon: in stone, very like the Forest Marble.
Perna quadrata. Swindon.
Terebra Portlandica. Pl. XXIII. f. 6. Swindon. In great profusion, in the stone of the great quarry. Some specimens stained with oxide of iron; with Lucina. The impressions of the interior sometimes beautifully preserved.
Trigonia incurva. (Miss Benett.) Pl. XXII. f. 14. Swindon. Tuberculated ridges.
T——— gibbosa. Swindon.
Trochus? Swindon.

Wood. Silicified specimens of coniferous wood, in fragments, the cavities of which are lined with minute crystals of quartz, are found in the debris of the great quarry at Swindon: they are supposed by the quarrymen to have been found within the solid stone; but there can be scarcely a doubt that they have fallen from the beds above, the place of which corresponds to that of the group which affords the silicified trunks in Portland.

[*Portland Sand.*]

Ammonites biplex. Swindon.
Ostrea (deeply concave). Swindon.
Pecten. Swindon.
Perna quadrata. Swindon: with Mya?
Pullastra. Swindon.
Trigonia clavellata. Swindon: in bluish sandy clay; with pebbles of black flint or Lydian stone.
T——— gibbosa. Casts in dark flint, with Pecten or Lucina?

Bone. Portions of a long bone of a Saurian.

[*Kimmeridge Clay.*]

Ammonites. Near Steeple Ashton: in slaty lignite, like the Kimmeridge "Coal".

Berkshire, Oxfordshire, Buckinghamshire, Bedfordshire.

(143.) The tract between Calne and Bedfordshire derives its exterior character in a great measure from the very slight inclination of the strata, which in their progress towards the north-west from the anticlinal line of the Vale of Wardour, are comparatively undisturbed: no conspicuous faults, at least, have hitherto been detected between South Wiltshire and the northern coast of Norfolk, though it is probable that this region is not more exempt from slight disturbances, than the greater part even of the more uniform tracts in England is found to be, when examined with sufficient attention. One effect of this very gradual rise of the strata is, that some of the beds, shooting out successively to great distances, have been the subject of extensive denudation; so that outliers occur in several places at the distance of some miles from the general line of the escarpments: and on the confines of Berks and Oxfordshire a large tract, entirely denuded of chalk, appears, along the course of the Thames between Abingdon and Reading, breaking in upon the almost uniform and linear course which the outcrop of that formation would otherwise have followed from Calne to the fens of Cambridgeshire. It is not improbable that this wide denudation, and the course of the Thames itself, may have originated in a preexisting fissure, by which the direction of the principal stream may have been determined, and the effect of the denuding waters subsequently modified.

My observations were resumed, on the north of Swindon, in the tract around Hazeley and Garsington; and the country thence through the contiguous counties of Oxfordshire, Bucks, and Bedfordshire, as far as Woburn, is so much alike in geological structure and composition, that the whole may with advantage be considered together. I shall therefore first state generally the order and composition of the strata, and then illustrate the sections Pl. X. a., Nos. 18, 19, 20, and 21, with some details derived from points where the beds are best exhibited. The recent sheets of the Ordnance survey, Nos. 13, 45, and 46, are so well executed as to furnish all the assistance that can be desired in the examination of this part of England: and their aid will be almost necessary in perusing these remarks *.

Chalk.—The most striking feature in the outline of the chalk, north-east of Swindon, is the sudden retreat of the Downs above referred to; by which the escarpment is thrown back towards the south between Woolstone, on the west of Wantage, and Watlington, not less than eight miles. The subsequent direction of the outcrop is nearly parallel to that of Marlborough Downs, and through its whole course thence into Norfolk, the lower chalk and chalk-marl run out far beyond the escarpment of the upper strata, which, near Nuffield, on the main road from London to Oxford, through Nettlebed and Abington, is more than two miles from that of the chalk-marl at Gould's Heath. On the lines through Stoke Talmage and Tetsworth, the distance is nearly four miles; and the space varies between one and four miles all along the range, thence to the north-east of Dunstable, becoming still more considerable in the lower tracts of the east of Bedfordshire and Cambridgeshire, where the beds are less inclined.

The angle at which the strata in this part of England rise, in general towards the west of north, in many cases does not exceed 1° or 2°; and the contiguous beds are frequently so mixed at their junction, as to render it very difficult to define them. An additional source of obscurity occurs between Aylesbury and the road from Dunstable into Bedfordshire; where large accumulations of superficial gravel (comparatively recent, since it includes fragments of chalk,) mask the substrata, or totally conceal them. A remarkable deposit of the same kind in the south and south-west of Oxford, is mentioned by Mr. Conybeare †; and Dr. Buckland has made the transported matter of the Valley of the Thames, the subject of a paper in these Transactions, in which his views of the Theory of its production are fully explained ‡.

Upper green-sand.—This formation is not generally so prominent in this tract, as in the counties near the coast; but its representative is found along the base of the chalk marl in all the places which I myself examined. Thus, on the line of the Abington road to Oxford, it appears on the descent from Gould's Heath towards Bensington; and firestone, I was informed, is obtained

* The authorities connected with this tract are, the general maps of Mr. Smith and Mr. Greenough, and the Sections and County Maps of the former. The only published description of the strata is that of Mr. Conybeare in the "Outlines of England and Wales", p. 170.—183, from which I have throughout derived most valuable assistance.

† Outlines, &c. p. 190.

‡ Geol. Trans., 1st Series, vol. v. p. 516—544.

by mining in the lower ground on the north-east of that place, between Rumbold Copse and Whitehouse Farm. The formation is much less distinct at Tetsworth, but is obvious on the south of that village; in the descent of the hill from Chinnor towards Emington; and beneath the lower Icknield-way, at Chadwell Hill on the north-west of Risborough; at North Lee, between Turwick and Bishopstone; and probably in the vicinity of Aston-Clinton. On the north of Totternhoe, great quantities of a soft variety of firestone were formerly obtained from mines of ancient date deeply seated at the foot of the lower-chalk escarpment, between the village and the hill on which is the mound of ancient encampment, called Maiden's Bower. In this latter direction, also, an outlying portion of the Upper green-sand is visible, on the road between Kate's Hill and the Turnpike near the beginning of Hockliffe, forming the base of an outlier, or peninsular portion of chalk, which shoots off from the main body about Chalton, and bears upon it the village of Wingfield;—not improbably crossing the road and forming part of a flat-topped range of heights, which extends westward on the north of Tilsworth and Stanbridge.

Gault.—The gault in this part of the country is very irregularly diffused, in many places forming a distinct valley or depression beneath the Upper green-sand, in others spreading itself towards the west, and thinning off gradually over the top of the Lower green-sand.

Lower green-sand.—This formation, which is indistinctly seen in the lower ground, is best observable near the summit of the heights between Garsington and Shotover on the south-west of Oxford (No. 18.),—and of the corresponding ranges, from Long Crendon to Brill (No. 19.), and from Quainton to Whitchurch, on the north-west of Aylesbury (No. 20. & X. b. fig. 11.) Thence towards Leighton Buzzard, the Lower green-sand is more obscurely seen: but it becomes conspicuous in approaching Woburn, and is found in immediate apposition with the Kimmeridge clay, at Little Brick Hill (No. 21'.), where the whole of the intermediate strata, from the Wealden to the Portland sand, are wanting,—having been either originally deficient, or partially carried away before the deposition of the sand.

The greatest extent of continuous surface which this formation occupies here, is between Leighton* and the west of Woburn. But there can be little doubt that it once extended continuously from its rise beneath the gault to its final outcrop in the heights above mentioned; the greater part having been subsequently removed by denudation.

On the main road from Tetsworth to Wheatley, Section No. 18'., a portion of the gault and of this sand still remains between the 44th and 47th milestones; while on the south-west of the road, a great part of these strata having been removed, the surface is so much lowered as to disclose the subjacent Portland stone, throughout a space which includes the villages of Great and Little Milton and Great Hazeley.

Several outliers of the Lower green-sand in this part of England still remain to be examined; among which the heights near Faringdon seem to be especially deserving of notice. Another detached portion (which, if the chalk range had been unbroken by the chasm of the Thames, would have been nearly at the same distance from the escarpment as that of Faringdon), caps the hills at Bagley Wood and Cumnor, on the south and south-west of Oxford. These have been generally described by Mr. Conybeare (Outlines, p. 190.), who states that the Portland beds do not extend so far: but as the relations of the Wealden group were unknown at the time of his

* A large tract around Leighton, including Wing, Cublington, Aston Abbots, Mentmore, &c., has not yet been described geologically. The late Mr. Bevan of Leighton was thoroughly acquainted with it; and I am not without hope that some of his observations may be published by his son.

publication, it may perhaps deserve inquiry, whether some portions of it may not exist beneath the sands in that quarter.

Wealden.—The traces of the upper members of the Wealden, are here so rare and indistinct, that nothing has yet come within my knowledge which can be referred to them, except on the summit of Shotover Hill, where shells, supposed to be of freshwater species, are found above the Portland strata, in a ferruginous sand or clay; and at Quainton and some other places in Buckinghamshire, where grit like that of Hastings, contains Paludinæ.

The lowest of the Purbeck strata are here fully characterized by their fossils, and precisely resemble the lower beds of this formation in the Vale of Wardour and on the Dorsetshire coast. They consist of slaty limestone, like the "tilestone" of Ladydown in the Vale of Wardour, and the "Slate" of the Sections in the Isles of Portland and Purbeck. With this stone, beds of clay alternate, which become more frequent in approaching the Portland strata, and clearly represent the "Dirt-beds" of that island and the adjacent coast. One of the lowest of these clays, contains thin layers of a species of Mytilus (*M. Lyellii?*) which is found in several detached points of the tract now under consideration. I did not, however, find in any of these beds either silicified trunks of trees, or of the remains of Cycadeæ; but in the corresponding place at Garsington in Oxfordshire, were detached fragments of silicified coniferous wood, like that of Portland. In several cases the more uniform freshwater limestone in this lower part of the Purbeck series is "Travertine"; and like the "Cap" of Portland it includes cavities incrusted with botryoidal carbonate of lime.

The fossils which this formation affords here, as in the Vale of Wardour, are Cypris and Cyclas in profusion, and of two or more species; Mytilus and Modiola; with, more rarely, Astarte and Paludina of two or three species, and some minute spiral univalves.

The *Portland strata* have been found in this part of England, throughout a tract between six and ten miles in extent from south-west to north-east, on the line of its rise from beneath the superior strata, (Pease Farm, near Great Hazeley, in Oxfordshire, to Bierton near Aylesbury, Bucks),—and about five-and-twenty miles, on the course of its outcrop, (from Garsington in Oxfordshire to near Stewkley, Bucks). They, no doubt, constituted at one time a continuous group, but having been cut through by irregular denudation, now exist principally in the upper part of the detached heights, which are separated by low ground excavated in the Kimmeridge clay.

The *Portland-stone* makes its first appearance north of Swindon, on a line directed from about south-east to north-west, through Easington, south of Little Milton and Garsington, towards Oxford. On the south of that line no stone is found; the villages of Chalgrove, Ascot, Stadhampton, and Chiselhampton being supplied with it from the Milton pits. Among the points where I have seen the Portland beds near their first rise from beneath the superior strata, are—a spot near the brook between Peg's Farm and Standhill, on the south-east of Great Hazeley (Section No. 18.); near Cotmore Walls, about a mile west of Thame (No. 19.); near the windmill at Towersey, Bucks; east of Kingsey; Haddenham Field, about half a mile west of the church; about midway between Ford and Moreton's Farm; near Bishopstone; Pistol Hill,—the vicinity of Walton, and of Broughton, near Aylesbury; and the summit of the heights at Bierton. Beyond this last-mentioned place, I could not learn that stone has yet been discovered; though, as it occurs at Church Farm on the road from Wing to Cublington, it may probably be found to rise between the chalk, at Ivinghoe and Totternhoe, and Wing. The Portland sand has been quarried between Tinkershole and Stewkley, and about a mile north of Dunton; and the outcrop of the stone and sand, can be traced along a very irregular line, from the heights at Garsington and Shotover, by Brill and Muswell Hills, Ashendon, Waddesdon, Quainton, and Whitchurch, to the points last mentioned, near Stewkley, which seem to be their limit in this direction.

The *Portland-sand* goes out beyond the stone, on the north and north-west sides of the heights just mentioned. The sand is in some places loose, grey, and yellowish; but in general it abounds in green particles, and is often almost wholly composed of green matter: the bluish half-concreted mass, intermediate between stone and sandy clay, which is the predominating component of this stratum on the coast, being here of rare occurrence*. Near the bottom, the sand includes great nodular concretions of hard greenish grit, like those of Swindon, Shotover, and the Lower Boulonnois; and it contains sometimes worn, polished, fragments of very dark-coloured chert or flinty slate.

The Portland stone and sand are found between the principal ranges of Brill and Whitchurch, (Sections 19. and 20.), and nearly at the same level, in the heights of Ashendon, Lodge Hill, Chearsley, Over-Winchendon, Coney Hill, Cuddington, Dinton, Stone, and Hartwell. But on the north-east of the road from Aylesbury to Winslow they are rarely visible, being deeply seated, and concealed, especially in the vicinity of Leighton Buzzard, by large accumulations of gravel.

The intermediate and lower tracts between the lines of section and the heights above mentioned appear to be occupied by clay, and the whole district is in general undisturbed; no derangements at least, at all comparable to those of the Wealden tract, or of the Dorsetshire coast having yet been observed within it: but in many of the Portland quarries the beds of stone are traversed by fissures, produced by violence long antecedent to the present condition of the surface. An elevation comparatively inconsiderable, but analogous to that which has raised the anticlinal ridges of the south, occurs at Wheatley, between the range of Shotover and that of Brill,—both of which are capped by nearly conformable strata of Portland sand and stone, rising gradually to the north-west; while the beds of the Oxford oolite, which appear in the village of Wheatley, on the main road from London to Oxford, rise more rapidly northward, from beneath the stone and sands of Garsington and Combe Wood. (See and compare the Sections, Pl. X. a. No. 18. and 18′, and Pl. X. b. fig. 10.) A small portion, therefore, of the space between the heights of Shotover and of Brill may be occupied by an anticlinal ridge, or curve, of Oxford oolite.

Kimmeridge Clay.—This is found everywhere, in these sections, beneath the Portland sand; and is conformable to the superior strata. It is best seen on the west of Shotover Hill, where the series of the strata is complete; but near Leighton it seems to come nearer to the Lower greensand; and in the descent from the village of Little Brickhill, (Section No. 20.) it appears within a few feet of the sand, which forms the upper part of the hills there.

The whole of this stratum is disclosed, on the line of Section No. 18, at Headington; and its characters there are described by Mr. Conybeare†. It seems to increase in bulk in advancing northwards, but does not anywhere attain the thickness which it exhibits near Weymouth, in the Boulonnois, and near Scarborough. Its predominant fossil here is *Ostrea deltoidea*: near Aylesbury are found *Gryphæa virgula*, and Aptychus.

Professor Sedgwick has remarked that on the south-east coast near Weymouth, some of the same fossils pervade this clay, the mixed beds near Weymouth, and the oolite beneath them; and it

* Bluish stone, somewhat like that of the sands in Purbeck and Portland, is found near the top of this formation, at Hartwell near Aylesbury.

† Outlines, &c. p. 185.

graduates upwards also into the Portland sands. He supposes, therefore, that certain beds of the series are wanting between the freestone of the Headington quarries and the incumbent Kimmeridge clay; an inference confirmed by the condition of the surface of the freestone,—which Mr. Conybeare describes as exhibiting the appearance of having been marked by the action of water upon it, before the deposition of the clay; "presenting occasionally small cup-"shaped cavities, and perpendicular rents of various breadth, into which the clay had insinuated "itself*." It is not, however, improbable that some of the intermediate strata exist on the line of section from Garsington to Langcombe. See hereafter, p. 278.

Oxford Oolite (*Coral Rag* of Smith).—The characters of this group have been described by Mr. Conybeare. Its general course is nearly conformable to that of the upper strata, and is represented in Mr. Smith's and Mr. Greenough's maps. On the east of Islip a narrow interrupted ridge passes north-eastward, for about nine miles from Woodeaton, as far as Stanhill near Marsh Gibbon, and is separated from the escarpment of the Portland stone and sand at Muswell Hill (Section No. 19.), by a uniform flat, apparently occupied by clay. Blackthorn, a place upon the ridge, affords a bluish oolite, which Smith refers to the Coral Rag. This ridge appears to separate the Kimmeridge from the Oxford clay; but the continuity of the former so far westward from Muswell Hill, where it ascends considerably, implies a thickness much greater than that in the Headington quarries.

The regular course of the Oxford oolite is interrupted by the offset mentioned in the last page, which extends a little eastward of its general direction to Wheatley (see the Transverse Section, Pl. X. b. fig. 10.); the strata there rising towards the north, at an angle of about 9°. The previous dip about Garsington is much less; and that of the general range of this formation in Oxfordshire, according to Conybeare†, not more than 1°. This upheaving seems to be continued eastward for some miles, so as to bring up the Portland sands at a point much closer to the chalk near Thame, than on the north-east of that place.

(144.) *Section* Pl. X. a. No. 18,—*from the Chalk through Hazeley, Garsington, and Shotover, to Oxford;—and* No. 18′. *from Stokenchurch, through Tetsworth, to Wheatley.*—The upper strata between the Gault and the Portland stone on the line of Section 18, are best seen near the summit of the range from Combe Wood to Shotover Hill: and I am indebted to Mr. Hugh E. Strickland, for the following account of the ferruginous sand at that place, which I have not examined myself.

Shotover Hill:—[Lower Green-sand, and Wealden.]

"The bed which crowns the hill and rests on the supposed equivalent of the Portland stone, "consists of a series of sands, mostly ferruginous, but frequently assuming various shades of "yellow, white, grey, and even black, according to the proportion of oxide of iron which they "contain. The sand occasionally graduates into marl and clay; and seams of yellow ochre also "occur, which afford considerable supplies of that article. The stratification of the sands and "marls is often very tortuous and irregular, which seems rather to be owing to the circumstances "of their deposition, than to any subsequent action. In some cases the oxide of iron has been

* Outlines, &c., p. 189.

† Ibid., p. 192.

" so abundant as to concrete the sand into shapeless masses of great hardness, which occur in " local strata a few inches thick. Except in these masses of ironstone, no organic remains have " been noticed throughout the deposit. Taken as a whole, this formation bears a great resem- " blance to the Lower green-sand of Sussex; and the masses of ironstone are almost identical in " appearance with some which exist there: but the fossil shells lately found in it appear rather " to show that it forms a part of the Wealden group. These shells occur only in the nodular " masses of ironstone, which are scattered near the old sand-pits on the west end of the hill; and " were first noticed there by the Rev. H. Jolly of Bath."

[The shells here referred to by Mr. Strickland, appear to belong to five species: three of Paludina; a small bivalve, like a Cyclas; and a larger bivalve, like a Unio. But the specimens hitherto found are all too imperfect to admit of precise determination, and are none of them so unlike some of the species which occur in the Lower green-sand, as absolutely to exclude them from that formation.]

" A small pit had been sunk in quest of ochre at the side of the old London road, about 150 " yards to the east of the old quarry, where the large globular concretions of the Portland sand " occur. This spot may be about 50 feet above that quarry; and the pit presented the following " Section:—

	Ft.	In.
[*Wealden?*]		
" 1. Yellowish clay	4	8
" 2. Yellow ochre	0	4
" 3. Sand and rubbly marl	3	0
[*Portland.*]		
" 4. Very hard brown sandstone, with a few Trigoniæ, and a bone of a crocodile	1	0
" 5. Rubbly stone, with numerous casts of Trigonia, the shells having decayed into a " brown powder	1	0
" Total	10	0

" The first three beds exactly resemble the sandy strata which extend from this point to the top " of the hill, a height of about 50 feet, and which I am disposed to regard as belonging to the " Wealden group. The nodules of ironstone containing the supposed freshwater shells, occur at a " height of about 30 feet above No. 4."

Purbeck Strata.—What remains of the Purbeck strata in this part of the country is best seen in the pits in the southern part of the Shotover range, at Combe Wood and Garsington. The junction of the incumbent strata with the Portland beds, is first disclosed in the quarries at Great Hazeley.

The section at *COMBE WOOD* consists of,—

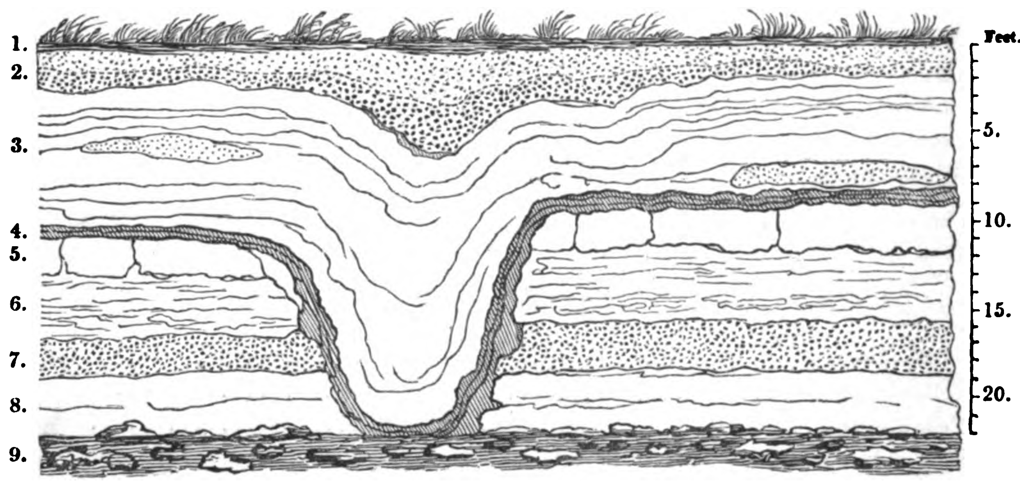
1. Reddish loamy soil, passing into 2.
2. Ferruginous sand (*Lower green*).
3. A thin bed of very tough clay (Fuller's earth?); which, with 2, enters into, and follows the deep erosions and irregularities at the top of 4.
4. *Purbeck.*—Stone, and soft rubbly matter;—(the "Malm" of the pits at Garsington); containing freshwater shells, like those of that place:—Cypris; Mytilus, two species; Modiola; *Paludina elongata*, and perhaps another species?; Planorbis?. Some portions of the stone are compact and uniform, with the usual characters of freshwater limestone; others, though containing the same fossils, are composed of grey and brownish, fine-grained, oolite, in which a very small

univalve—perhaps a Paludina—occurs in such numbers, as in some places to form nearly the whole mass.

5. *Portland stone*; with numerous Trigoniæ and Pernæ.

Great Hazeley.—In the principal quarry at this place the strata dip to about 20° east of south, at an angle of about 4°; and are traversed by joints nearly in the same direction. The order is as follows:

Stone-pit at Great Hazeley.



	Ft.	In.
1. Soil, forming a level and uniform surface		
2. Loam, brown and red; containing fragments of ferruginous conglomerate, (carstone) and of a brown substance, like umber; passing below into ferruginous sand . . 3 ft. to	6	0
3. Thinly stratified firm clay or marl, of a light grey colour, approaching to stone, not effervescent, containing between the folia impressions of plants, and including portions of reddish sand, in horizontal masses of very unequal thickness. It breaks down rapidly in water, like Fuller's earth, and its place corresponds best (so far as my observations went) to that stratum?	6	6
4. Dark brown clay; like the Fuller's earth of Tilburstow (p. 139.), and of the pits near Aylesbury. Some of the masses into which it is easily divided, are polished, by sliding on each other under pressure. At the bottom ferruginous sand alternates with the clay .... 1 ft. to	1	6

[All the preceding beds are much disturbed, and bent irregularly, so as to accommodate themselves to a chasm in the strata below,—here called a "Gull" (gulley?), and quite analogous to those in the Isle of Portland mentioned at p. 218. The manner in which these "gulls" are filled, proves that they must have been excavated before the deposition of the matter which now occupies them. But the surface of the ground above the opening shows no indication whatsoever of disturbance.]

The *Purbeck strata* seem to be wanting here?

[*Portland Stone.*]

	Ft.	In.
5. Stone, called "Curl"; grey calcareous grit. Often blue, in the interior of the masses; containing thick oysters, and Pernæ .... about	2	0
6. Sand and clay, containing fragments of shells, and including at the bottom concretions of calciferous sandy stone, which abounds in petrifactions, especially *Perna quadrata*	4	0
7. Uniform whitish sand, and sandy stone, with *Perna quadrata*, and numerous Serpulæ.	2	6

[In another large quarry, 6. and 7. unite to form one bed about 7 feet thick.]

	Ft.	In.
8. "*Stone*", commonly in two beds; that for which the quarries are worked. It is like the Purbeck-Portland, and contains disseminated spots of pyrites. The under surface is often covered with petrifactions,—Perna, Trigonia, Venericardia, and Trochus. Bones have been found in it, and sometimes lignite	2	6
Bottom of the Quarry.		
9. Below is sand: precise depth and relations unknown ....about	12	0
Total about....	35	0

The principal stone-pits at Garsington, are in the western escarpment of the hill north of the village, overlooking the low ground about Langcomb and Cowley. One of the largest gave the following Section:—

Stone-pit at G*ARSINGTON*.—[*Lower green-sand, Purbeck, and Portland.*]

	Ft.	In.
1. Loamy soil ....about	2	0
2. *a.* Ferruginous brown sand, including portions like umber, and irregular seams of clay, like that of the bed 3. at Great Hazeley, (Fuller's earth?). It contains also patches of greenish sand. *b.* A band of yellow ochre, about half an inch thick. *c.* A thin bed of uniform tough clay (Fuller's earth), in wax-like pieces, polished by motion under pressure	8	0
[These, like the upper beds at Great Hazeley and Combe Wood, follow all the irregularities of the mass below.]		
3. "*Malm*"; an agglomerate, composed of stone and softer marl-like matter, much decomposed. Among the components are,— *a.* Light greenish-grey marl, like some beds of the lowest chalk; containing at the upper part detached fragments of silicified coniferous wood, like that of Portland, and portions of bone. *b.* Firmer pieces of stone, with some oolitic particles, including small spiral univalves,—Paludina, perhaps of two species?; a Planorbis?; Mytilus; and Cypris.. *c.* At the lower part, the mass consists of larger pieces of uniform limestone, in some places like the "Pendle" of the pits at Whitchurch hereafter mentioned, and including small Paludinæ, with other small spiral univalves, Mytili and Cypris. Some of these pieces have the botryoidal structure of part of the Portland "cap" (Travertine); of which bed (or of the "Skull-cap") they seem for the greater part to be the representative: but others consist, as at Combe Wood, of fine-grained oolite, passing, however, into the compact stone, and containing the same fossils ....Total about	4	0
[The irregular cavities and waves at the top of this mass are very remarkable, resembling the erosions at the top of the chalk.]		
4. The *Portland stone* of these pits requires no particular description.		

The upper part of another pit, about half a mile east of that which furnished the preceding list, was nearly the same, but still more like that of Great Hazeley. A third pit close to it contained a "gull", as at p. 276.

The *Portland sand* is not visible in the descent from Garsington, but is very well seen in the escarpment of Shotover Hill; where the order, at the lowest part of the Portland series, is as follows:—

Escarpment, SHOTOVER HILL.

Ochre; about 8 feet above the sand, 1.
1. Greenish-sand (*Portland*).
2. A bed of concretional masses of grit.
3. Greenish sand.
4. Beds of clay, about 3 feet thick.
5. Sand.
6. Great nodules of grit, with *Perna quadrata*, &c.
7. Greenish yellow sand.

Below is *Kimmeridge clay*.

(145.) The beds connecting the Portland strata with the subjacent Oxford oolite are exposed, in detached places, on the descent of the hill from Garsington to Langcombe and Gasson's Barn, where the following strata occur, beneath a considerable thickness of *whitish* sand, which, however, is probably a part of the Portland group.

Pits near LANGCOMBE.

	Ft.	In.
1. Soil, including carstone.		
2. Rubbly stone (*Portland*).		
3. Yellowish sand, with petrifactions and calcareous matter interspersed	1	0
4. Sand, with Trigoniæ; concreted at the bottom		
5. Sand, including at the bottom 6..	1	0
6. Stone, in irregular concretions..	0	9
7. Sand; continuous (except where there is stone) with 5. and 9.	2	0
8. Concretional stone.... 6 feet to	8	0
9. Sand, as above.		
Total thickness ......15 to	20	0

[The preceding part of this section represents the Portland stone and sand of Mont Lambert in the Boulonnois.]

	Ft.	In.
10. Clay, (*Kimmeridge*) ......about	12	0
11. Blue grit in irregular concretions, with shells and stems of Siphonia?	3	6
12. Clay continuous with 10.; when dry, it is yellowish brown, approaching to ochre yellow .. about	40	0

This clay rises slowly towards the quarries at Langcombe, the distance of which from Garsington is about a mile.

After a thickness of between 40 and 50 feet of clay as above mentioned, there were, at *Gasson's Barn*, the following beds, abounding in Pectens and other smaller shells.

	Ft.	In.
1. Rubble full of broken shells	1	0
2. Rubble, somewhat slaty....about	10	0
3. Coarse yellowish sand, with whitish ranges, containing numerous fragments of shells................	1	6
4. Stone in concretions		
5. Sand nearly as above, but finer, somewhat concretional..........	2	0
6. Stone; a congeries of shells, mixed with sand concreted by calcareous matter, and containing black flint pebbles, Pernæ, numerous small Gryphites and Pectens, and large flat bivalves.		
7. Sand connected with 5.	2	6

The lower part of this group seems to represent the Weymouth beds, or the upper part of the Coral rag.

(146.) *Kimmeridge Clay.*—In one of the quarries at Headington, the clay over the Oxford oolite was thus:—

Clay-pits, HEADINGTON.

1. (Surface) "*Loam*"	5	6
2. "*Brick-clay*," with fragments of Oysters and Gryphites:—about 3 feet from bottom, full of small shells	6	6
3. "*Blue-stone*," in concretions, on an average about a foot in thickness..............	1	0

		Ft.	In.
4. "Clay," dark muddy blue	altogether about	11	0

At top containing Terebratulæ and Gryphites.
About 2 feet from top, a bed of *Ostrea deltoidea*.
At 4 feet from top, a second bed of the same.
About 7 feet, Ammonites and several small bivalves.
In some places Belemnites, at the lower part.

5 "*Rock*;" reddish yellow sandy limestone :—(*Oxford oolite*).

(147.) *Oxford Oolite.*—The section No. 18′ shows the manner in which this group comes in, after the gault and green-sand, on the great road from London; and the transverse section, Plate X b. fig 10., further explains its relation to the Portland stone and sands, which, in the eastern part of Section 18′ are either wanting, or concealed by a prolongation of the gault and green-sands. The Oxford oolite is seen, in the transverse section, to rise from beneath the heights, towards the west of north, at an angle of about 9°; and it is probable that all the strata here, from the Portland downward, decline more to the south than the chalk and the upper members of the series: they seem to form the southern slope of a curve or saddle, the opposite side of which would descend towards the north, somewhere between Wheatley and the Brill-hill range. The lower beds here are much harder than the rest; they consist of sparry limestone, including oolitic grains, and the masses are blue in the middle: I obtained from them an Ostrea; *Terebratula media*; *Melania Heddingtonensis*; and a Spongia.

(148.) *Section*, Pl. X. a. *No.* 19. *From the chalk, through Thame and Long Crendon, to Brill and Muswell Hill.*—The characteristic of the section on this line, is the distinctness with which the Portland sand is exhibited, almost throughout its course. The superior strata are best seen in the quarries around Brill, and at some points on the ridge between that place and Long Crendon.

The tract on the north and east of Chinnor, on the line thence to Thame, has very obviously been at one time the bottom of a sea or lake, over which the chalk impended as a lofty shore; and near which the tides or currents acted with such uniformity as to level down the ridge of the lower green-sand;—while on the west, the ranges of Brill, Quainton, Whitchurch, and other less prominent summits, stood out as banks or islands, at a short distance from the land. These relations are all very well seen from the ground about Barley Hill, on the north-east of Thame.

Gault.—At a point on or near the section, between Black Ditches Hill, Cotmore Walls, and Sydenham-hurst, a well had been sunk forty feet, and then bored to fifty more, entirely in tough dark blue clay, beneath which was sand rock.

Lower Green-sand.—In a great number of the quarries in this part of the country, the ferruginous sands at the upper part are separated from the rubbly stone beneath, by dark tough clay, 4 to 9 inches thick, which follows the irregularities of the mass below, and coats the bottom of cavities like the "Gulls" of Hazeley, (p. 276.). The stony matter seems to be either the "Malm" of Garsington and Combe Wood, or the representative of some other portion of the Purbeck series.

Sections at BRILL.

A.—In a pit at this place, open in 1827, the following beds were visible above the Portland strata:—the whole (perhaps from subsidence) inclining towards the north-west.

[*Lower Green-sand.*]	Ft.	In.
1. Grey and yellow sand .... about	6	0
2. Alternate layers of ferruginous sand, and of clay used for making tiles. Near the bottom the seams are oblique to the stratification	15	0
3. Black and grey, alternating with whitish and ferruginous, sand, and including flakes of yellow ochre	0	2
4. A thin course of clay (Fuller's earth), of various colours, green, wax-yellow, and reddish, with a subconchoidal fracture, and a wax-like, almost resinous lustre externally, like jasper. The polish of the pieces is evidently the result of movement under strong pressure.—See the description of a similar clay at Tilburstow in Surrey, *supra*, p. 139. .... about	0	6
5. Sand, increasing in firmness as it goes down	4	0
[No indication here of the *Purbeck strata.*]		
6. *Portland stone,*—containing Trigoniæ and other characteristic fossils, among which *Pecten orbicularis* is one of the most abundant		

B.—At a clay pit about 20 feet below the road on the south-west of Brill, the beds, declining to the west and south, were thus:—

[*Lower Green-sand.*]	Ft.	In.
1. Sand; white at top, yellow, and ferruginous below .... 6 0 to	7	0
2. Gravel, with concretions of "Carstone"; coarse quartz sand, cemented by oxide of iron	1	6
3. Yellow ochre, of very good quality, much used in commerce .... 1 8 to	1	10
4. Clay; containing thin bands of ochre, a quarter of an inch and less in thickness...about	1	0
5. Clay; light bluish grey, uniform: here visible to a depth of .... about	5	0

No shells of any kind are known to occur in this bed; but about six feet down an entire tree was found, converted into lignite much mixed with pyrites. The trunk, about a foot in diameter, and full 40 feet long, lay almost horizontally, nearly east and west; and branches extended to about 10 feet beyond it on both sides, beginning about 25 feet from the extremity. It was preserved and shown in an adjoining house as an object of curiosity; and though in a state of ruin, when I saw it, from the decomposition of the pyrites, was one of the finest fossil specimens I had ever seen. Beneath the tree, it had been ascertained by boring, that clay, but of darker colour, extended to about 12 feet in depth.

C.—In another pit, on the outside of the inclosure where the tree was found, the strata were:—

	Ft.	In.
Grey sand .... about	5	0
(5.) Clay, said to be the same with (5.) of the list above; but darker and of more slaty structure. It is very like 4. of the List A. above, and breaks into pieces with polished surfaces: the lower part for about two feet alternates and is mixed with yellow ochre	4	6

The place of this clay in the series seems to correspond best to that of the Fuller's earth at the bottom of the Lower green-sand; and it falls to pieces slowly, in water, like that substance: but I could not determine its relations to my own satisfaction.]

6. Yellow ochre, of a duller hue than (3.) above; some Fuller's earth at the lower part..about	0	4

	Ft.	In.
7. Under the ochre are irregular flattened ovoid masses, about 18 inches thick, consisting of stratified matter which contains shells. These masses were divided thus:— *a.* Thinly stratified, greenish grey, Fuller's earth, decomposed. The lowest part sometimes including thin seams of coaly matter, the remains, apparently, of highly compressed stems of plants; with fragments of shells. *b.* Thinly stratified, dark grey, alternating with lighter-coloured, sandy clay. Like the alternation which is frequent at the bottom of the lower green-sand, and in the Wealden, described above at p. 168. (83.)	1	6
8. Greenish matter, often stratified;—coarse Fuller's earth	3	0
[*Portland stone*:]—		
9. Whitish rubbly stone, not unlike freshwater limestone, but containing *Perna quadrata*, with ribbed and tuberculated Trigoniæ .... 1 3 to	1	6
10. "*Pitching-stone**", consisting of— *a.* Hard compact grit: sand concreted by a very large proportion of calcareous matter .... about 0 9 *b.* Fuller's earth, yellowish-green .... 6 in. to 0 8 *c.* Compact grit;—more siliceous than *a* 0 7	2	0
11. Grey clay, in about three layers	0	6
12. Limestone in two beds, including Pernæ .... about	2	6
13. "*White limestone*"; as below. *Pecten orbicularis* abundant .... 3 ft. to	4	0

D.—At a pit on the south-west brow of Brill Hill, (a continuation downwards of beds above enumerated), the following is the order:—

	Ft.	In.
(13.) "*White limestone*" (like the "*Chalk*" of Chicksgrove, 7. p. 253.) used only for making lime; sometimes harder and bluish. It occurs in irregular masses, and has the aspect of freshwater stone, but contains numerous *Trigoniæ* .... about	3	0
14. "*Cap of the Greys*". Brownish clay, full of fragments of shells 15. "*Greys*". Good stone for building, full of Pernæ. Some of the beds contain stems, like those of Siphoniæ	1	0

Below the "Greys" are about 9 feet of alternate courses of indifferent stone and of yellowish grey sand, with Portland fossils—*Cardium dissimile*, *Pecten lamellosus*, *Trigonia gibbosa*. These are succeeded by sand charged with green particles, which, in the following list, is referred to the Portland sand; in which *Ammonites giganteus* is frequent, in some specimens with Oysters attached.

In some places here also, are erosions or cavities in the upper part of the stony strata, like the "Gulls" of Great Hazeley, (p. 276).

Portland Sand.—Good sections of this group are to be found in all directions around the village of Brill; in the descent of the hill from Long Crendon towards Thame; and on the north-east of the latter village.

Sections at LONG CRENDON, *and thence on the Descent towards* THAME.

One of the principal quarries at the upper part of the hill at Long Crendon exhibited the following beds:—

	Ft.	In.
Tough loamy clay .... about	2	0

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* I have, in these lists, inserted the names in use among the quarrymen, as they may assist in identifying the strata in other parts of the country; the same pits seldom remaining open more than a few months.

		Ft.	In.
	[Lower Greensand.]		
1.	*a.* Ochre and ferruginous matter .... 0 9 *b.* Dark grey clay .... 0 4 to 0 9	1	6
	These substances, as at Great Hazeley &c., vary much in thickness, filling up eroded cavities in the top of 2, next below.		
	[Purbeck.]		
2.	Rubble (the " Malm " of Garsington and Combe Wood); passing at the lower part into firm, slaty, cream-coloured limestone, in which green matter is diffused,—but not in grains; as in some of the upper Purbeck beds on the Dorsetshire coast.		
3.	Clay:—uniform, without the stony fragments of the Portland " Dirt." I could not learn that any petrified wood had been found here in this situation.		
	[Portland stone.]		
4.	Stone, with Portland fossils, beneath which is sand .... here about	8	0
	[Portland sand.]		
5.	Below the foregoing beds, on the descent towards Thame, are,—		
	a. Sand, with very numerous green particles, about 18 inches; enveloping coarsely concreted nodules, about 9 inches thick	2	9
	b. Rubbly, somewhat sandy, grey stone, with green particles,—like Kentish rag: under which are knobby concretions, of a marly stone with green particles, containing clavellated Trigoniæ .... 12 0 to	18	0
6.	Greenish grey sand. At its junction with 5, and for about 6 or 8 inches downwards, are worn fragments of black flint; with Trigonia, Perna, and an oblong bivalve—a Panopæa .... about	30	0
	The whole thickness of the Portland-sand here is about	50	0
7.	Beneath is clay.		

The greatest superficial extent of the Portland sand in this part of the country occurs near the village of Thame; extending from Scotsgrove and Scotsgrove Hill on the north, to Priest-end and Morton on the south; and from Dropshot, near Cotmore Walls, west of Thame, to the flat between the river and Long Crendon. The apparent range of the formation thence, by North Weston, Rycote, and Albury, to the heights above Wheatley, I did not examine.

Pit at Barley Hill, east of Thame.

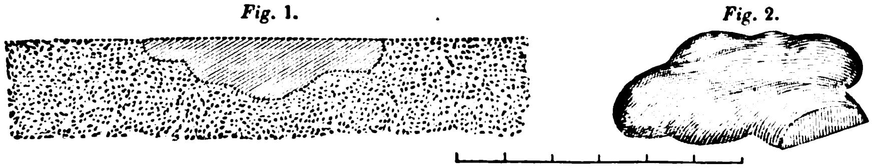
The strata dip at an angle of about 5°, towards a point about 10° south of east.

		Ft.	In.
1.	Soil and loam .... 2 ft. 6 in. to 2 ft. 9 in.	2	6
	[Portland Sand.]		
2.	Irregular concretional lumps of calcareous stone with green particles, interspersed in sand. Petrifactions numerous:—Pernæ, with Lithodomi, and Ammonites; *Plagiostoma rusticum*, (near Towersey) .... about	6	0
	[This is evidently a continuation of the group at Long Crendon, on the opposite side of the valley of the Thame. It precisely resembles part of the cliff immediately north of La Creche, on the French coast near Boulogne.]		
3.	Sand; becoming greener as it descends. At the top, few concretions of stone. At the bottom, the whole consists of greenish matter, not to be distinguished from that of the Lower green-sand near Folkstone. Serpulæ very numerous	1	0
4.	Coarse stone interspersed in sand; with numerous fossils, especially Ammonites, and *Trigonia gibbosa*	1	3
5.	More compact and uniform greenish or bluish rock, with green particles; like soft Kentish rag. In some of the quarries it is fit for building	1	0

	Ft.	In.
6. Sand; 30 feet (at least). The top only is visible here, but in other pits nodules of great size are scattered in it irregularly, close to the stone 5....................	30	0

These nodules are distinctly seen at an adjacent place called Dropshot. They are from 2 to 4 feet in length, and about 18 inches thick, and consist of large subglobular masses of hard, bluish green, sometimes highly calcareous, crystalline, grit, (here called "Bluestone"), like that of the concretions at Shotover. In some cases it is remarkable that they are flat at the top, while the form beneath is subglobular, (fig. 1. of the subjoined cut); pebbles of dark brown or black flint adhering to the upper surface, in a gravel-like crust. They are sometimes traversed by vertical cracks and veins, as in the quarries at Mont Lambert in the Boulonnois; and when broken, these exhibit flat surfaces,—as in fig. 2, which represents a large nodule, inverted, to show the form of the lower side*.

Fig. 1. *Fig.* 2.



Muswell Hill.

This hill, which forms the extreme promontory of this range, was one of the principal Ordnance stations, and is 744 feet above the sea. The summit, I was informed, is composed of:—

1. *Lower green-sand.* Reddish sand, including concretions of a dark brown ferruginous conglomerate ("carstone"), which occurs also in large masses, and in thick beds, under a very reddish and ferruginous soil ....8 ft. to	10	0

[The *Portland stone* appears to be wanting here.]

2. *Portland Sand,* with green particles; Pernæ, Trigoniæ, Sphæræ, &c.
3. *Kimmeridge clay*: springs breaking out at its contact with the sands. No stone, I was informed, occurs between this place and Blackthorn: that which is employed in all the flat country on the south-west of the range, coming from Muswell Hill and Brill.

From Muswell Hill there is a fine view to the west and north-west, of the great plain occupied by the clays; and westward over Otmoor, which is crossed by a Roman road from Oxford to Bicester.

Oxford Oolite.—The stone of Blackthorn, about $3\frac{1}{2}$ miles west of Muswell Hill, is a variety of oolite or pisolite, consisting of oolitic grains disseminated through sparry limestone of a bluish colour.

(149.) Section, Pl. X. a. No. 20.—*From the Chalk near Wendover, through Aylesbury and Whitchurch in Buckinghamshire.*—The two great roads from London into Buckinghamshire cut through the chalk, one by the vale or defile of Amersham and Wendover, the other and more northern, by the Vale of Berkhampstead and Tring, the general altitude of which above the sea is about 350 feet; that of the adjacent heights of the chalk rising to

* *Fig.* 1. is intended to represent a vertical section of a concretional mass of stone imbedded in sand; of a subglobular or kidney-like form below, but flat at the top.

Fig. 2. is a sketch of another nodule, with a vein at right angles to the mass; through which a part has been broken off.

more than 600 feet. The summit level of the Grand Junction Canal at the opening of this vale to the north-west, is $404\frac{1}{2}$ feet above the sea: and a branch of the canal is conducted at the same level along the foot of the chalk range to Wendover. The line of Section No. 20. runs from a point about two miles west of that town, above which Combe Hill, or (as it is called in the Ordnance Map) *Wendover Hill,* rises to 905 feet above the sea; and thence the ground descends rapidly towards Aylesbury, the height of that place being about 380 feet above the sea*, and a few feet above the flat occupied by the Kimmeridge clay on the north-west of the town. The slope and undulating ground from the chalk-range to Aylesbury are occupied by the strata between the chalk and the Portland stone; and the corresponding tract, from Thame on the south-west towards Leighton on the north-west, which is emphatically called "the Vale of Aylesbury", consists of the same strata. The Portland stone forms a distinct ridge from Hartwell to Scotsgrove, on to the road from Aylesbury to Thame, of which the highest point near Dinton Castle is not much inferior in elevation to many parts of the chalk range. Between Aylesbury and Leighton the first rise of the Portland beds is obscured by accumulations of superficial gravel.

The Vale of Aylesbury in general has been lowered and levelled by the agency of water; but several detached portions of the beds between the Gault and the Portland stone, are still found on the higher parts of the ridge about Stone, and on the summits of the insulated heights beyond it. The strata seem to increase in thickness in approaching their outcrop, but this enlargement is probably no more than apparent, and produced by their better preservation near the most elevated points. If these places were once detached summits, or islands, in a shallow sea, of which the chalk escarpment formed the shore, the waves would naturally wear down and carry away the strata in the lower ground, while the portions above the reach of their action would remain.

(150.) The members of the series illustrated by the sections visible in this country, near to the line of No. 20, are:—1. The Lower green-sand; 2. The strata thence to the Portland-stone,—including some doubtful traces of the Hastings-sand, and the Purbeck strata; 3. The Portland stone itself, with the usual fossils; 4. In a few places, the Portland sand; 5. The Kimmeridge clay. The following details could not be arranged in exact succession, as portions of many different groups are frequently found in the same pits; but the ists are as far as possible disposed in the descending order of the strata, beginning with the Lower green-sand.

* The top of the church tower at Aylesbury is, according to Mr. Bevan, 425 feet above the sea.

Lower green-sand.—A considerable thickness of sand occurs at the top of the ridge above mentioned, in the space between Stone, Dinton, and Cuddington. It attains its greatest height near Stone, where there is a knoll apparently composed of sand; near which the following beds were found;—

Sand-pit at Stone.

		Ft.	In.
	Vegetation and soil .... about 1 ft. to	3	0
1.	Greenish clay, like Fuller's earth .... 6 in. to	0	9
2.	Grey sandy clay .... 9 in. to	1	3
3.	Rust-coloured sand, passing downwards into grey: the lower boundary is ill defined and irregular .... 1 ft. 6 in. to	2	0
4.	Whitish uniform sand, marked by nearly horizontal but irregular lines, of darker hue, grey, yellow, brown, and nearly black .... about	8	0
	Total depth	15	0

Some remains of the Lower green-sand appear also at the top of most of the sections following, which are only a selection from a great number of lists. The series in all parts of the country is very nearly alike: but the pits being worked for the sake of the Portland stone, have not, generally, been opened in the places most favourable to the display of the superior strata.

The circumstance most deserving of notice in the sections at Ford, and thence towards Dinton, is the occurrence, near the bottom, of dark clay which includes a layer of iridescent Mytili, corresponding precisely in its character and situation to that at Bishopstone, Whitchurch, and other places hereafter mentioned.

Dinton Quarries.—One of the most remarkable quarries in this part of the country, is on the south-west of the cross-road from Dinton to Cuddington, where the works have been carried on for more than 200 years, the stone being of excellent quality. The Section was as follows:—

Stone-pits at Dinton.

All the beds inclining a little to the east.

1.	Vegetable soil, and reddish loam .... about	2	0
2.	Ferruginous sandy loam	0	6
3.	Greenish grey clay	0	9
4.	Brownish and grey clay .... 1 ft. 3 in. to	3	0
	[The great variation in thickness of this bed arises from its entering at the bottom into the irregularities on the surface of 6. which are coated throughout with the intermediate thin bed of clay (5.)]		
5.	Dark, umber-brown, tough clay, with much oxide of iron .... 2 in. to	0	4
	At the bottom of the bed are Mytili, and decomposed fragments of other shells.		
	[*Purbeck Strata.*]		
6.	Grey clay and soft stone (freshwater limestone) becoming white at the bottom by decomposition: at the lower part more continuously laminated, but including throughout irregular masses of stone, in some places penetrated by minute tubular cavities, slightly bent and of uniform diameter,—probaby the work of lithophagous animals, or such as might be produced by the removal of slender twigs. The decomposed parts of this stratum pass into the firmer masses; as in the "Malm" of Garsington. It contains a few spiral univalves like those of that place and Combe Wood, including *Paludina* (*elongata*?), with small Modiolæ, and a Cyclas? .... (3 feet thick in an adjacent pit)	3	0
7.	Between 6. and 8. is a thin bed of tough, dark, somewhat ferruginous? clay, with iridescent Mytili (*M. Lyellii*?) at the bottom		

			Ft.	In.
8. Whitish beds of nearly uniform aspect.				
a. Soft fissile marl or limestone in about six beds; the divisions, however, seem to be the effect of decomposition .... 3 ft. to	4	0		
b. Uniform hard grit or sandstone, consisting of quartzose sand in a calcareous cement	1	0	5	0
9. Stony concretions, in greenish very fissile sandy clay;—3 to 5 beds; passing into, and continuous with 10			1	0
10. Fissile sandy matter; and grey, sandy clay, passing into 11			1	6
11. Fissile, tough, yellowish, sandy clay, containing much calcareous matter, and including Cypris, Mytili, and Modiolæ				
[*Portland Stone.*]				
12. Beds of good stone: grey without, blue within.				
a. "*Capping*," full of shells; like the "Roche" of Portland ...... 8 in. to	0	9		
b. Solid stone, the best				
c. Soft stone, bluish, full of remains of shells; *Ammonites giganteus*; *Exogyra nana*; Ostrea, two species; Plicatula				
Bottom of the Quarry				

The proportion of sand to the stone, in these quarries, is much greater than in those of the coast, the Portland stone here appearing generally in the form of concretions in the sand: and this is the case also in the Boulonnois. Near Dinton Castle the stone assumes the form of insulated, subglobular, or potatoe-shaped concretions, containing great numbers of Oysters, with other fossils.

(151.) One of the most prominent circumstances in the upper part of the preceding sections, is the contrast between the arrangement of the sands and Fuller's earth, or ochreous clay, and that of the beds which represent the Purbeck formation immediately below; the upper surface of the latter being commonly indented or eroded into cavities and inequalities, from a few inches to four or five feet in depth, which are generally coated with a thin stratum of clay, and then filled up with sand and gravel. These appearances, which are perfectly analogous to that represented at p. 276, in the cut of the "Gulls" of Great Hazeley, and to the discordance of the two sands at Swindon, p. 265, are observable in all the pits of this country. They clearly show that an interval must have elapsed between the deposition of the Purbeck strata and that of the Lower green-sand, during which the surface of the former was disturbed, by the operation no doubt of water.

(152.) The tough clays, near the junction of the incumbent strata with the Portland beds, are well seen in many of the pits of the lower country, as at Bishopstone and Southwarp, and in the heights about Whitchurch and Quainton. It is difficult or impossible, in some cases, to determine whether they are to be referred to the Fuller's earth of the Lower green-sand,—to some of the beds subordinate to the Weald-clay and Hastings-sand, or to the Purbeck series. But it may be remarked that, although these clays alternate with thin slaty limestone, which contain Cypris and other freshwater fossils, no bed strictly resembling the "*Black Dirt*" of Portland has yet been found here,—none including, like that bed, fragments of *stone*, and exhibiting so obviously the characters of a coarse gravelly soil: nor have I seen or heard of any instance north of Garsington, in which silicified wood has been found in this part of the series. It can only be said, therefore, that the beds above the Portland here resemble those of the coast, in their sudden contrast with the Portland strata, from the abundance of the freshwater fossils which they contain, and the frequent alternations of beds of clay, or mud, with the fissile limestone near the contact.

Pit at Bishopstone:—*in* "*Church Furlong*" *belonging to Dr. Lee.*

			Ft.	In.
1. Soil bearing corn.				
2. Fuller's earth; greenish and brown. Thickness very irregular..............1 in. to			1	0
In this bed are iridescent Mytili, like those of the bed 7. below, and of the sections at Whitchurch; p. 288—289.				
3. Rubble; white, freshwater limestone, decomposed: containing Cypris and casts of small Paludinæ, in calcareous spar			4	0
4. Clay and stone.				
a. Light olive greenish Fuller's earth	0	4		
b. Soft limestone	0	6		
c. Fuller's earth, like *a*..	0	2		
d. Stone, like *b*..	0	3		
e. Fuller's earth..	0	2	1	5
5. "*Sandstone*", so called; firm, grey, and whitish, granular calciferous grit. It has distinct traces of the lines of deposition, and on the surface some approach to ripple-marks. —*Quæ.* does it represent the grit of the Hastings sands?..................6 in. to			0	9
6. Sand, alternating with ochre and clay.				
a. Sandy ochreous clay	0	2		
b. Dark greenish Fuller's earth	0	2		
c. Greenish grey sand, mixed with calcareous matter, and including scales of fishes	0	7	0	11
7. Fissile, calciferous clay, or marl, passing into stone. In the upper part are iridescent Mytili (*Mytilus Lyellii*? Pl. XXI. fig. 18.) like those of 2. above, and of the pits near Whitchurch. *a.* Dark, bluish grey, very fissile clay, containing *Cypris* in great numbers, an oblong Unio, and small scales of fishes (Lepidotus). *b.* Clay; somewhat harder, less plastic. *c.* Clay; lighter-coloured and still harder; approaching to stone. All these divisions contain *Cypris Valdensis* and another species; a small smooth Modiola, a striated species; and *Cyclas parva*, Pl. XXI. fig. 7.			1	6
[*Purbeck.*]				
8. "*Pendle*": fissile, argillaceous limestone; here of a dark grey colour; in another adjacent pit almost white: containing Cypris; casts of *Cyclas parva*, some of which include casts of Cypris; striated Modiolæ; small Paludinæ; and other small univalves, as in the Malm of Garsington .... 4 in. to			0	6

In some of the pits hereabouts, the "*Pendle*" contains also a depressed Planorbis, as at Wockley in the Vale of Wardour, 5. *b.*, p. 252., and at Garsington, 3. *c.*, p. 277.; with *Potamides carinatus*?.

[*Portland.*]

9. "*Bottom Rock*". This, in one of these pits, is an agglomerate of fragments of shells; of a dark bluish hue, specked with white. In an adjacent pit it abounds in Trigoniæ and other Portland fossils.—Thickness not ascertained.

The beds below are not visible, and are unknown to the workmen.

The upper part of several other pits near Bishopstone (as at Southwarp and the vicinity of Dinton,) agrees with the foregoing list, in exhibiting an alternation of clay, more or less like Fuller's earth, with ochre and ferruginous sand: and the very dark clay which includes iridescent Mytili, occurs in so many places that there can be little doubt of its former continuity throughout this part of the country. It is particularly distinct on the side of the road from Whitchurch to Winslow, near the turn towards Dunton, about eight miles from Bishopstone; where, besides the usual Mytilus, it contains a Natica and another spiral univalve (Melanopsis?). Beneath these clays and sands is, universally, thin slaty marl or limestone, with alternate thin beds of clay, containing everywhere the same fossils;—Cypris, Modiolæ, and spiral univalves,—among which are Paludinæ, a Planorbis, and perhaps some other species. The whole group, therefore, clearly represents the strata above the Portland stone at Garsington, and in the Vale of Wardour; and is, no doubt, the equivalent of the "Slate", the "Cap", the "Dirt", and the other lower beds of the Purbeck formation, on the Dorsetshire coast.

Pit near Whitchurch:—A. (*Denchfield's.*)

(Compare with the Section at Quainton, p. 289—290.)

				Ft.	In.
1.	Grass, over vegetable soil .... about			4	0
	[*Lower green-sand and Wealden.*]				
2.	Greenish white, coarse, sandy clay; including rounded pieces of sandy stone			7	0
3.	*a.* Tough, grey, and greenish clay; including *b.* .... about	0	9		
	b. A dark band of very tough clay .... about	0	6		
	c. Clay, like *a.*; the lower surface waved and irregular. This, at its junction with the darker clay above, and for a short distance below, is full of a thin iridescent Mytilus, so fragile that I could obtain only very imperfect specimens	0	9	2	0
4.	A group, which my guide called "*Cornstone?*".				
	a. Grey and greenish sand, irregular in thickness .... 4 in. to	0	9		
	b. Whitish clay, sand, and soft stone	1	5		
	c. Tough, grey, and brownish clay, passing into *d.*	0	5		
	d. Similar clay, including concretions of gritty stone .... about	1	0	3	6
5.	"*Green-stone*", (so called), comprising,—				
	a. A thin bed of hard, brownish clay, like part of 3. above .... 1 in. to	0	2		
	b. Fissile sandy clay, greenish grey .... 4 in. to	0	5		
	c. Hard calciferous gritty stone, in irregular concretions	0	4		
	d. A band of yellowish grey soft sandy clay or marl .... about	1	0	2	0

The calciferous grit, 5. *c.*, which is like that of Bishopstone (5. p. 287.), and of Quainton (9. p. 290.), deserves notice, from its resemblance to the grit of the Hastings sands: and it contains at Quainton casts of a spiral univalve,—Paludina (or Natica?).

[*Purbeck.*]

6. "*Heath*". Green and grey sand, of firm consistence; at the bottom mixed with whitish fissile matter
7. An indistinct bed of soft fissile limestone ("*Pendle*", my guide calls it), which seems to pass below into very hard stone, including Cypris and worn ovoid particles of whitish stone. It contains also small bones and scales of fishes
8. The beds below 7. are here uncertain; but are visible in some other pits.

The Portland strata here, in general, differ from those of Portland Island and of Dorsetshire; no thick beds of good stone occurring, and no flints.

I saw here no traces of silicified wood, nor of Cycadeæ, though I examined everywhere the beds of clay, with the hope of meeting them.

In another pit near Whitchurch the lower beds were visible, the whole being thus:

Pit near Whitchurch :—B.

			Ft.	In.
Rubble.				
[*Weald Clay, and Hastings Sand?*].				
1. Stony matter, much decomposed			4	0
2. Dark brown and grey tough clay, with some layers of sand, including Mytili			1	0
3. "*Cornstone*"; (see 4. of the preceding list)			0	2
4. "*Cheesecakes*"; clay in very thin flakes, alternating with sand. (Compare with the alternation described in (83.) p. 168.)			0	4
5. Rubble and sandy stone			0	10
6. "*Greenstone*"; concreted sand, and grit, like that of Hastings?—(See 5. *c.* List A. last page.) 6 in. to			9	0
7. "*Firestone*"; soft limestone			0	10
8. *a.* Sand; uniform, greenish-grey, coherent	1	6		
b. Dark clay	0	2	1	8
[*Purbeck Strata.*]				
9. "*Pendle*"; soft fissile limestone, including worn rounded particles of stone, which give to the whole the aspect of oolite; and containing Cypris; Modiola, two species; a Mytilus; *Cyclas parva*; and portions of an Astacus			1	6
[*Portland.*]				
10. Limestone; often bluish, abounding in Trigoniæ, Venericardia, and other Portland fossils			0	9
11. Good stone, called "*Builders*";—often bluish			2	6
Bottom of the Pit.		Total about 10 ft. to	12	0

Pits at the top of Quainton Hill,

About a furlong east of the Ordnance Station, which is 754 feet above the sea Beds inclined towards the south at about 3° 30′.—See the Transverse Section, Pl. X. b. fig. 10.

[*Lower greensand, and Wealden?*].				
1. Red sand, with concretions of hard ferruginous conglomerate; ochre at the bottom:—visible about			2	0
2. *a.* Clay and sand; brownish and grey, in thin alternating flakes ....about	1	6		
b. Fuller's earth; wax-like, as at Brill, (4. p. 280.)	0	9	2	3

		Ft.	In.
3.	White, and brown, sand and clay	0	9
4.	Alternate beds of white, reddish, and yellowish sand, and thin courses of grey clay 4 ft. to	6	0
5.	*a.* Dark brown clay, called here "*Black Dirt*" about 0 4; *b.* Alternate beds of tough grey clay and sand 1 0	1	0
6.	Greenish sand, said to be 6 feet thick	6	0
	Total about	17	0

The beds next below are obscure, from subsidence: the order was stated to be as follows:—

		Ft.	In.
7.	"*Black-dirt*"; tough dark clay	0	3
8.	"*Grey dirt*"; grey sandy clay, with fragments of shells about	6?	0
9.	"*Hard stone*", consisting of siliciferous grit or sandstone; containing *Paludina elongata*? and Cyclas?. Has been found in masses 5 feet thick $15\frac{1}{2}$ feet long: used for paving roads (*Quæ.* the grit of the Hastings sand?)	3	0
		26	3

The following, still lower than the beds above detailed, are seen in another part of the hill, under red sand and hard ferruginous conglomerate, (*carstone.*)

[*Purbeck.*]

		Ft.	In.
10.	"*Heath*"; white sand and clay; full of decomposed shells in layers;—Mytilus; striated Modiola; and Cypris	3	0
11.	"*Pendle*". Fissile oolitic stone, containing Cypris, *Cyclas parva*, Mytilus, and Modiola;—as at Dallard's, in the Vale of Wardour, pp. 249, 250	0	6

I did not see any remains of trees, or of Cycadeæ, in these quarries, nor hear of any from the quarrymen. But among the specimens which I obtained in the village of Quainton, said to have come from the hill, was that represented in Pl. XXII. fig. 11, which possibly may have been part of a Cycadeous plant?. The specimen however, differs both from the trees and Cycadeæ of the Dorsetshire coast, in being calcareous, effervescing copiously with acids.

The following beds were seen best in the eastern pits, near the Ordnance Station,—

[*Portland.*]

		Ft.	In.
12.	"*Builders*" limestone, fit for building, containing *Pecten lamellosus* and small Modiolæ 2ft. 6 in. to	3	0

Among the Portland fossils from the quarries of Quainton Hill which I saw in the village was an Ammonite 18 inches in diameter, with a Belemnite imbedded in it.

		Ft.	In.
13.	"*Limestone*", full of petrifactions; *Trigonia extensa*, *T. gibbosa*, *T. incurva*; *Pecten lamellosus*, with Gastrochænæ; Pleurotomaria 5 ft. 6 in. to	6	0
14.	Sand about	6	0
15.	"*Middle Rock*", and Rubble; stone abounding in fossils	5	0
16.	Sand	2	0
17.	Greenish concretional stone, rugged and sandy 1 ft. 6 in. to	2	0
18.	"*Bottom rock*", greenish gritty limestone, with stems of Siphoniæ. The pits are never dug lower.		

The *Portland stone* as it approaches the outcrop in this part of the country, becomes much more sandy at the lower part, and seems to pass into the sand beneath. The quarries on the north-west of Whitchurch, towards North Marston, include, between two beds of stone, a stratum of uniform grey sand, eight feet thick; which preserves its thickness, and is well known to the quarrymen in other parts of the adjacent country. The stone is worked (and perhaps exists) only in a few places on the north and east of Whitchurch; but from its extensive occurrence at

Church Farm on the west of Wing,—and again at North Tinkershole south of Stewkley, on the north of Dunton, and west of Hogstone,—it would seem that the upper part of most of the flat-topped heights thereabouts may have once been occupied by this formation*.

The Portland strata also occur at Weedon on the south of Whitchurch, about midway to Bierton, the western part of which village stands upon them. But I was assured that no stone had been obtained, though often sought for, at Cublington, Aston Abbots, and Wingrove; the two places last mentioned affording only sand and gravel†.

The *Portland sand* is little disclosed near Aylesbury; though it comes to the surface around the town beneath a thin capping of Portland stone. The road from Tring to Aylesbury, a little west of the 37th milestone, is crossed by sand, which includes green particles and worn fragments of black flint; and the subjacent clay makes its appearance close to Aylesbury on the north. One of the most distinct sections of the sand was visible at the entrance of Whitchurch, where the road to Aston Abbots strikes off from the main. A good section also was obtained from combining that of one of the pits at the Warren near Tinkershole on the south of Stewkley, with another north of Dunton.

Whitchurch, at the cross-road to Aston Abbots.

	Ft.	In.
[*Lower green-sand*?]		
1. Yellowish sandy soil.		
2. Greenish and reddish sandy clay.		
[*Portland Sand.*]		
3. Concretional soft stone, in irregular lumps, full of green particles; with numerous shells; Venericardia, Pernæ. Compare with that of the Section near Thame; 2. p. 282. ..	4	0
4. Harder stone, in irregular concretions, abounding in green particles, and containing worn fragments of blackish flint or chert. Very large specimens of *Ammonites biplex*, as on the shore near La Creche, Boulonnois; *Pecten concentricus*; large Venericardia......		
[*Kimmeridge Clay.*]		
5. Dark bluish clay, continuous with that of the descent towards Hardwick, and thence to Aylesbury; here dug to the depth of about 20 feet, and used for making tiles. It contains Septaria, and nodular masses of phosphate of lime,—which, when acted upon by marine acid, afford the peculiar smell of Coprolite, though they have not its form. Among the fossils here are channelled Belemnites.		

Pit at The Warren, south of Stewkley.

Soil and whitish rubble..........................about			2	0
[*Purbeck.*]				
1. *a.* Light yellowish grey clay, passing into stone	1	0	1	9
b. Rubbly limestone..............................	0	9		
[*Portland Stone.*]				
2. Soft, uniform, marly limestone, abounding in fossils;—*Ostrea expansa*; *Pecten lamellosus*, *Buccinum naticoïde*, Pl. XXIII. fig. 4, *Perna quadrata*, Pleurotomaria, Trigoniæ, Venericardia, and large Ammonites ....4 ft. to			6	0

* *Moor Hill*, a height about a mile and a half north-west of the village of Quainton, has a nearly horizontal top; and, not improbably, is capped with Portland stone or sand.

† Smith's map of Buckinghamshire represents the *Gault* as extending to the north-west from between Hulcot and Wing, as far as Cublington and thence to Cottesloe. If this be correct, the Portland beds may exist within that space, at a depth below the surface at least equal to the thickness of the Lower green-sand in this part of the country: but the map near Aylesbury requires much correction.

		Ft.	In.
3.	Uniform, yellowish-grey sand; precisely resembling that which includes the stone called "Les Grises" in the quarries near Boulogne..................visible about	7	0
	[*Portland Sand.*]		
4.	Hard, dark brownish-grey stone, of irregular thickness, containing Pernæ. Approaching to the nodules of Shotover..	2	0
	Bottom of the Quarry.		
5.	Below is green matter, used to form the floors of barns; not visible here at present, but well seen near Dunton.		

In a pit at *Dunton*, the equivalent of the bed 3. is only three feet thick; and that of 4. consists of rubbly calcareous stone, alternating with sand, the whole full of green particles, with small pebbles of black flint,—at the bottom of which is a continuous bed of greenish stone, about 2 feet thick, with dark particles, containing large Ammonites, *Perna quadrata*, and many other fossils. The equivalent of 5. is tough green matter, apparently the same with that which gives the greenish hue to the stone. This has been dug to the depth of about 3 feet.

Kimmeridge Clay.—This clay is sufficiently characterized, at several points near Aylesbury, by its occurring immediately beneath the Portland sand, and by its fossils. On the north-west of the town, towards Bierton, it appears beneath about five feet of brownish sandy clay,—(Portland sand?,) which includes numerous fragments of flint; and it contains Septaria, with Ammonites. The tiles made of it are of a full red colour. Thence to the entrance of Whitchurch on the south, the road appears to be cut wholly in the clay: but there are variations in the hue of the beds exposed along the road, and perhaps some alternating layers of sand. In descending to the streamlet south of Hardwick, were iridescent fragments of shells, with *Gryphæa* (*Exogyra*) *virgula*, (Pl. XXIII. fig. 10), and Aptychus, (Pl. XXIII. fig. 11), in the ditches at the road-side. At Quainton, clay forms the slope of the hill beneath the stone-pits; and a well had been dug, at the village, in clay, to the depth of 60 yards; among the fossils brought up from which, were beautiful specimens of *Ammonites Gulielmi*, like those obtained, along with *A. biplex*, from East Claydon, about three miles north of Quainton, where they were found about 20 feet deep in clay.

The clay-pits beneath the hill at Stewkley, about midway between that village and the Warren above mentioned, also afford Aptychus, and *Exogyra virgula*; with compressed Ammonites of the Kimmeridge clay, and a species supposed to be new.

(153.) *Section No. 21,—from Dunstable through Hockliffe to Woburn;—and No. 21′, Hockliffe to Fenny Stratford.*—The tract occupied by the strata below the chalk, from Aylesbury to the coast of Norfolk, is even less known geologically, than that between Buckinghamshire and the south-eastern coast; the maps of Mr. Smith and Mr. Greenough, and the general description of Messrs. Conybeare and Phillips being the only publications relating to it. The want of correct maps would alone have prevented the complete examination of this district; but this impediment will soon be removed by the completion of the Ordnance Survey from Bedfordshire to Cambridge. The following observations indicate only some of the more prominent facts connected with the beds below the chalk.

The series of strata in Sections 21 and 21′, differs from that of the preceding sections, principally in the absence of all the beds between the lower greensand and the Kimmeridge clay, which are found in immediate contact, at the village of Little Brickhill, on the brow of the descent to Fenny Stratford:—this junction, which was to have been expected hereabouts, from the evident thinning out of the Purbeck and Portland formations in the north-east of Buckinghamshire, is continued thence, through Bedfordshire, into Cambridgeshire, and even to the coast of Norfolk.

The great accumulation of gravel and transported matter, rising in several places into hills and extensively concealing the strata, is another circumstance which distinguishes the vicinity of Leighton Buzzard from the country towards the south-west, and renders the examination of the strata difficult or impracticable. A similar coating of gravel is found not only throughout Bedfordshire, and a great part of the counties on the north-east of it, but far to the east of the chalk escarpment itself*. The fossils, and stony substances, which compose this deposit, have been derived from many different formations, some of them very remote, and are deserving of attentive examination. My collection includes only a few specimens from one of the ravines which descend from Little Brickhill, and from the Platform between Stewkley and Soulbury, about 510 feet above the sea, where the multifarious gravel includes fragments of granite, and a large proportion of chalk. This deposit does not there form an escarpment, like the sands at Brickhill, but declines gradually towards the north, in a series of lower inequalities: on the south and east, it occupies a great part of the surface towards Leighton, Wing, and Cublington.

On the line of the Section, No. 21, the ridge of the chalk attains nearly the greatest height which it anywhere exhibits,—Kensworth Hill, south of the road near Dunstable being 904 feet above the sea; but the general elevation and that of the principal summits both rapidly diminish towards the north-east. Near Tring, the difference in height of the upper and lower chalk escarpments is strongly marked; and the retreat of the former is still more conspicuous near Dunstable; but the boundary of the lower chalk is less distinct.

The Upper chalk forms the elevated range from the Five Knolls, and Kensworth Hill, 904 feet, by the heights above Zouche's Farm, 850 feet, towards Luton, and thence to Whitehill Farm, on

* At Muswell Hill, on the north of Highgate in Middlesex, an accumulation above the London clay, includes worn fragments of granite, porphyry, micaceous sandstone, mountain-limestone, coal, lias, and chalk, with many of the characteristic fossils of those formations: the chalk especially being so abundant, as to give the whole a chalky character.—Mr. Spencer, in *Proceedings of the Geol. Society*, 1835—6; vol. ii. p. 181.

the north of that village, and Lillihoe in Hertfordshire, an Ordnance Station 604 feet above the sea.

The Lower chalk, on which the village of Dunstable is placed, runs from Totternhoe on the south-west of the main-road, through Houghton Regis, Upper Sundon, and Streatley, on the north-east of it.

On the north-east of Totternhoe mines are driven into the hill at the bottom of the chalk, for the purpose of extracting a bed of uniform light greenish-grey, marly and sandy, firestone, from seven to ten feet thick. The strata are traversed by numerous cracks, which seem to pervade the hill, and indicate disturbance,—or perhaps the effect of subsidence.

The Gault, in Smith's map of Buckinghamshire, occupies a large part even of the higher ground between Whitchurch and Wing. The Lower green-sand runs out without interruption from Whitchurch to Winslow, and is continued thence by Drayton, Parslow, and Soulbury, to the south of Leighton. On the north of that line, a denudation on the course of the Little Ouzel river having cut down to the subjacent clay, breaks in upon the outcrop of the sands, which would otherwise have been continuous from Winslow to Brickhill, and the mass of the Woburn sand-hills. Beyond the two tracts at present continuous, several outlying patches of sand, some miles distant from each other and from the general escarpment*, are ascribed to this formation in the map; all of which, as well as the wider tract between Winslow and Leighton, deserve examination, for the purpose of ascertaining whether any of the Wealden beds are to be found there.

The greatest expanse of the Lower green-sand in the midland counties, occurs between Leighton and Ampthill in Bedfordshire; rising, at the Ordnance station on Bow-Brickhill, to the height of 683 feet above the sea,—or about 430 feet above the lowest point in the valley on the west of the escarpment near Fenny Stratford. One of the most remarkable subordinate beds of the formation in this neighbourhood, is Fuller's earth, which, when I was there (in 1824) was brought out by mining from the north-west escarpment of the sand-hills, near Hogstye-end, between the main road from Woburn to Northampton, and that from Hockliff to Stony Stratford.

Fuller's earth Pit, near Woburn.

				Ft.	In.
1.	Sand; nearly uniform, greenish-grey, and yellowish, including consolidated masses of sand-rock, and dipping to the east and south. ....about			130	0
2.	*Fuller's earth.*				
	a. "*Top*" of inferior quality; not diffusing itself in water till after it has been dried: unfit for the purposes of the clothier	3	0	12	0
	b. Ferruginous? clay ....about	0	1		
	c. Fuller's earth, of the best quality, very light olive green; (sold at the pit-mouth to cloth-manufacturers, for one shilling per cwt.) ..7 ft. to	9	0		
4.	"*Bottom*"; hard quartz or sand-rock; the equivalent, probably, of the chert of the Kent and Surrey sand-hills..................................2 ft. to			3	0
5.	Sand, like 1; thickness not ascertained.				

The Geological place of the Fuller's earth is here, therefore, nearly the same with that of

* These outliers are represented on the Buckinghamshire map by patches of colour, each about half a mile in diameter, at Roundhill, Whaddon, Totternhoe, Wroughton, Milton-Keynes, Broughton, Moulsoe, and Astwood. In Mr. Greenough's map, (1st edition,) both Winslow and the heights of Whadden Chase on the north of that town form a portion of the tract coloured as Oxford clay; but this, no doubt, requires correction.

Nutfield described above (141.); which, however, is thicker than this of Bedfordshire, and is continued through a much larger space. I did not find here any of those nodules of sulphate of barytes, which are frequent in the earth of Nutfield; and in neither of these two situations, does this bed contain the great number and variety of fossils by which the Fuller's earth at the bottom of the Lower green-sand is distinguished, at Atherfield in the Isle of Wight. In the sands of this part of Bedfordshire silicified coniferous wood is frequently found in large detached pieces.

These pits have continued to supply Fuller's earth for more than a hundred years. They were described, in 1723, by Dr. Holloway, in a letter to the celebrated Woodward, which is remarkable in the earlier history of stratigraphical geology in England*: the author pointing out the parallelism of the range of sands, to that of the chalk in the Chiltern hills, and suggesting distinctly, upon geological grounds, the probability that other portions of the sand range would afford the same valuable material; which, we have seen, coincides with the result of modern investigation.

The junction of the Lower green-sand and the Kimmeridge clay at Little Brickhill, (Section 21') occurs at the north-west end of the village, in the garden of a small public-house called the King and Queen, on the south of the road. Copious springs break out on the road about 50 paces above this house. The clay, which is here of a dark blue colour, includes very fine specimens of an *Ostrea deltoidea*, with Belemnites; and I was told that sand alternates with the clay for a short distance below this point.

(154.) *North-east of Bedfordshire.*—The Lower green-sand, according to Smith's map, passes through the whole of this county, in a band which is in general parallel to the chalk escarpment, and about five miles in width; but its apparent dimensions vary much, in consequence of the irregular encroachments of the gault over the surface; that stratum, immediately on the north of Section 21, extending northward from the little village of Heath, through Potsgrove and Froxfield, to Steppingley and Flitwick. Again, on the east of Ampthill, an insulated portion of clay, (the colour of which, in Smith's map, is intended either for Gault or Kimmeridge clay,) stretches in a north-eastern direction from around Maulden to South Hill, crossing the great London road to Bedford, about the 43rd milestone. Since, however, the full development of the Lower green-sand in Bedfordshire renders it probable that the subdivisions of the Kentish coast may be found also in this country, it may deserve inquiry whether some of these detached portions, which have been considered as clay,—(especially between Maulden and South Hill) may not belong to the middle, dark-coloured, and retentive member of the sands; and the same question may be applied to a part, at least, of the remoter tract assigned by Smith to the Gault, on the north of Hockliff.

* This document has been inserted in Conybeare and Phillips's "Outlines", p. 138-9. Dr. Woodward himself speaks almost poetically of the value of the English Fuller's earth; which, he says, is beyond that of the Diamond mines of Golconda, &c. :—Edinb. Rev. 1819, vol. xxix.; and London and Edinb. Phil. Mag. 1832, vol. i. p. 155.

The course of the upper chalk is prominent on the north of east, from Dunstable through Hitchin and Baldock, to Royston Down in Cambridgeshire, which is 464 feet above the sea: but the boundary between the lower chalk and the strata next below is not distinctly indicated by the external features of the country. The change occurs on the main road from London to Bedford, between Hitchin and Shefford, about the 37th milestone: and there the difference in the elevation and general appearance of the ground is very slight; in part from the very gradual rise of the strata, but chiefly from the general diffusion of a coating of transported materials, which conceals them.

(155.) *List of Fossils from the Beds between the Chalk and the Oxford Oolite, in part of* Oxfordshire, Buckinghamshire, *and* Bedfordshire.

[*Superficial Gravel.*]

Ammonites (fragments). Chelsey, near Leighton, Bedf. (From the Gault?.)
Belemnites minimus? (fragments). Stone Lane, north of Heath, Bedf.
B———. Gravel-pit north-east of Stewkley, Bucks: with fragments of chalk; top of the high grounds, Brigginton, &c., near Leighton, Bedf.
Gryphæa dilatata (much worn.) Gravel-pit north-east of Stewkley, Bucks.
G——— (fragments). Stone Lane, north of Heath, near Leighton, Bedfordshire.
G——— *obliqua* (much worn.) Gravel-pit north-east of Stewkley.
Ostrea deltoidea (fragments). Stone Lane, north of Heath, Bedf.
Serpula. Gravel-pit, north-east of Stewkley.
Terebratula. In rolled piece of sandy limestone. Gravel-pit north-east of Stewkley.
Spongia? Flint, enveloping Sponges?: worn. (No doubt from the upper chalk.) Gravel-pit north-east of Stewkley.

[*Lower Chalk and Chalk Marl.*]

Ammonites lautus. In pale marly clay (chalk marl). Tetsworth, Oxf.
Terebratula semiglobosa. Tetsworth, Oxfordshire: in flint.

[*Upper Green-sand.*]

Inoceramus. Between Tetsworth and Thame, Oxf.; with Vermetus, in bluish grey firestone.
Mytilus (new species?). Between Tetsworth and Thame: in soft gritty firestone.
Siphonia. Impressions of stems. Totternhoe, Bedf.
Vermetus. Between Tetsworth and Thame: with Inoceramus; in bluish grey stone.

[*Gault.*]

Ammonites decipiens. Compton, Bedf. Mr. Goodhall.
Avicula. Compton, Bedf. Mr. Goodhall.
Crenatula. Compton, Bedf. Mr. Goodhall.

Exogyra conica. Compton, Bedf. Mr. Goodhall.
Inoceramus sulcatus. Compton, Bedf. Mr. Goodhall.
Nucula. Compton, Bedf. Mr. Goodhall.

[*Lower Green-sand.*]

Siphonia, Casts of stem. Quainton pit, east of Ordnance Station: in the "Bottom rock."
Wood, Coniferous, silicified. Woburn Sands, Bedf.

[*Hastings Sand?.*]

Cyclas, impressions of. Quainton, Bucks: pit at the highest part of the hill in grey calciferous grit, "Hardstone."
Paludina elongata? Impressions. Same place and situation.
Serpula?. Coney Hill, Bucks. In grey uniform grit,—"Sandstone".

[*Purbeck Strata.*]

Astacus?. Whitchurch, Bucks. In freshwater limestone, "Pendle", with worn particles like oolite.
Astarte. Same place and situation.
Cyclas media. Hartwell, Bucks; with *Modiola.* Whitchurch; with *Cypris Valdensis.* Weedon; in stone like the "tilestone" of Ladydown, and the "slate" of the Isle of Purbeck.
C—— elongata. Whitchurch, Bucks.
C—— parva. Horton's Pit, near Bishopstone, Bucks; in slaty soft limestone. Bishopstone (Dr. Lee's pits) in soft bluish stone. In great numbers at Weedon, in the "Pendle". Whitchurch; impressions in freshwater limestone, with worn rounded particles. Quainton; Western Pit, in the "Pendle".
C—— (a large species). Quainton, West Pit. Whitchurch, Bucks. Haddenham, Bucks: in slaty limestone. Garsington, Oxf.: in the "Malm".
Cypris Valdensis?. Whitchurch, Bucks. Bishopstone, in soft bluish shale, Quainton.
C—— (species uncertain). Combe Wood, and Garsington, Oxf.: in the "Malm"; with *Paludina elongata.* Denton, Bucks: in slaty soft clay. Weedon; in stone like the "*Tilestone*" of Ladydown, and the "*slate*" of Purbeck. Ford, numerous. Horton's Pits, Bishopstone in sub-oolitic; stone: and in soft bluish slaty stone, at Dr. Lee's pit. Southwarpe. Quainton. Whitchurch.
Limnæa?. Garsington: in the "Malm",—the representative of the "Cap" of Portland.
Melanopsis?. In dark-brown clay above the Portland strata. Road from Whitchurch to Winslow.
Modiola. Remains of two or more species, one deeply striated. Garsington and Combe Wood, Oxfordshire: in the "Malm." Hartwell and Bishopstone, Bucks. Southwarpe: in soft fissile limestone. Whitchurch. Quainton: a small species in tough sandy clay: in the bottom of the "Heath", over the "Pendle".

Mytilus Lyellii? Pl. XXI. f. 18. Bishopstone: Dr. Lee's pit. Near Whitchurch, on the road to Winslow: numerous; in light greenish grey, alternating with dark, tough clay, over the top of the Portland strata.

M——. Another species, smaller and narrower than *M. Lyellii.* Combe Wood, "Malm". Dinton, Bucks. Bishopstone. Horton's Pit; in slaty soft limestone. Dr. Lee's pits. Weedon. Whitchurch. Quainton.

Ostrea expansa. Horton's Pit, Bucks. (*Quæ.* in Portland-stone?)

O—— (thin-shelled). Combe Wood: "Malm".

O—— (fragments of another species). Whitchurch, Bucks; in the "Pendle." Garsington, Oxfordshire: "Malm".

Paludina elongata. Combe Wood, and Garsington: in the "Malm"; casts, with Cypris. Southwarpe, Bucks. Bishopstone, pit near Morton's.

P——. Impressions of another species? Southwarpe, Bucks. Horton's Pit: in freshwater limestone. Quainton: in the grey uniform grit; *Quæ.* Hastings sand.

P—— (a ribbed species). Garsington and Combe Wood, Oxfordshire: in the "Malm".

Planorbis. Garsington and Combe Wood, Oxfordshire: casts in the "Malm"; Horton's Pit, near Bishopstone, Bucks.

Potamides carinatum. (Melanopsis, Min. Con.) Horton's Pit, Bishopstone, Bucks.

Psammobia?. Garsington: "Malm".

Unio. Bishopstone, Dr. Lee's Pits: in soft bluish slaty stone. Quainton.*

Fishes. *Bones*; impressions only. Southwarpe, Bucks: in soft earthy fissile limestone.

Vertebræ. Whitchurch, in freshwater limestone, "Pendle". Coney Hill: in calciferous grit.

Scales. Bucks: Bishopstone, Ford, Horton's Pit, in oolitic stone: Dr. Lee's pits; in soft bluish slaty stone. Whitchurch in the "Pendle", with worn roundish particles. Quainton: pit top of the hill; in the "Hardstone".

Reptiles. Portions of a spongy bone, probably Saurian. Garsington, Oxf.: in the "Malm".

Plants. A specimen, represented in Pl. XXII. f. 11., the nature of which is still doubtful. It was bought at Quainton, Bucks, and said to be from the stone-pits at the hill-top; but the precise place was unknown. Not siliceous: effervescing with acids; and in this respect different from the Cycadeæ of Portland.

* Besides the shells above enumerated, the following were found in the strata representing the Purbeck series, within the tract now under consideration; viz. *Bivalves*—of two or three species probably new, but too indistinct to be determined,—at Combe Wood, Oxfordshire; Bishopstone, Weedon, Whitchurch and Quainton, Bucks. *Spiral univalves*—at Garsington and Combe Wood, Oxfordshire, (specimens exhibiting beautifully the internal column of the shell); at Great Hazeley, Oxfordshire, with oolitic particles; and on the road from Whitchurch to Winslow, Bucks,—(a new Paludina?)

Impressions of very narrow leaves. Great Hazeley, Oxf.; in fissile clay, representing, probably, the Fuller's earth of the Lower green-sand.

Trees. At Brill, the trunk of a large tree converted into lignite, was found in bluish grey clay. A most remarkable specimen, 40 feet long; at first entire, with numerous branches; but when I saw it, split into small fragments from decomposition of the pyrites.

Wood. Coniferous, silicified wood, precisely like that of Portland, is found in fragments, in the "Malm", at Garsington, above the Portland stone, and along with portions of freshwater limestone.

[*Portland Stone.*]

Ammonites biplex. Road near Walton turnpike, Bucks.

A——— giganteus. Oving and Dinton, Bucks: with *Exogyra nana*, in sandy stone.

A———. Langcombe, Oxfordsh. Great Hazeley, Oxf.: in grey concreted sand. The Warren, near Stewkley, Bucks: in limestone.

Arca (new). Stone-pits west of Great Milton: a cast in oolitic stone.

Astarte cuneata. Beneath Garsington, Oxf.: in concretional stone. Brill, Bucks: in hard compact limestone.

Buccinum naticoïde. Pl. XXIII. f. 4. Whitchurch, Bucks. The Warren near Stewkley ?.

B———. Quainton.

Cardium dissimile. Quainton, Bucks. Brill. Long Crendon: a cast, in grey, very sandy stone. Bishopstone, Moreton's pit: a cast. Tring, road near Walton Turnpike. The Warren near Stewkley.

Cytherea? rugosa. Pl. XXII. fig. 13. Southwarpe, Bucks.

Exogyra nana. Dinton; Bucks: with *Ammonites giganteus*: in sandy stone.

E———. Whitchurch: adhering to *Pecten lamellosus.*

Gastrochæna?. Denton, Oxf.: perforating *Perna quadrata.* Garsington: with *Pecten lamellosus?.*

Gervillia aviculoides. Langcombe, near Oxford: in calcareous spar.

Gryphæa dilatata. Langcombe. A young shell; in Portland stone ?.

Lucina Portlandica. Pl. XXII. fig. 12. Southwarpe, Bucks.

Modiola (large). Denton, Oxf. Whitchurch, Bucks: in white stone.

Mytilus. Whitchurch.

Natica elegans. Pl. XXIII. f. 3. Great Hazeley; a cast.

Ostrea expansa. Bucks: Village of Stone; Whitchurch, with *Pecten lamellosus*; Quainton; Brill; Horton's pit, near Ford; the Warren near Stewkley, Bedf.

O——. Remains of a thick-shelled species are found at Great Hazeley, Oxf.: in concretions of gritty stone, in yellowish sand. Haddenham, Bucks. Dinton, with Plicatula.

Panopæa depressa. Brill.

P——— gibbosa. Brill: a cast.

Pecten lamellosus. Oxfordshire: Denton, with *Trigonia gibbosa*; Garsington, with Gastrochæna. Bucks: near Towersey Windmill; Brill, with Exogyra, adhering; Quainton, pit east of Ordnance Station,—in soft limestone; Whitchurch, with Serpula, &c., in white stone; The Warren near Stewkley.

P—— orbicularis. Oxf.: Beneath Garsington; in concretional Portland stone, with *Astarte cuneata*; Langcombe, with *Trigonia clavellata*, in sandy stone. Brill, Bucks.

Perna quadrata. Oxf.: Garsington?; Denton, with Modiola, &c.; Great Hazeley, in gritty stone. Bucks: Towersey, in bluish limestone, with pyrites; Long Crendon, in very sandy stone; Brill; Quainton, "West pit."

Plagiostoma rusticum. Great Hazeley, Oxf.; in calciferous gritty stone.

Pleurotomaria: with large whorls, roundish and flattened. Casts occur at Brill, and at Garsington.

P————. A more acute and larger species, Great Hazeley, Oxf., in calciferous sandstone. Brill; and at the Warren, near Stewkley, Bucks.

Plicatula. Dinton, Bucks: a cast, same as in the "Roche" of Portland.

Pullastra. Remains of shells, perhaps referable to this genus, have been found at Cuddesden, Oxf., in sandy Portland stone; and at the Warren, near Stewkley, Bucks.

Serpula. Remains of. Oxf.: Langcombe; Great Hazeley, in very sandy stone. Bucks: Whitchurch; in white stone; Haddenham, in calciferous sand; Towersey, some specimens of great beauty; Coney Hill.

Siphonia?, casts of Stems: Quainton; Bucks: in soft calcareous sandstone, "Bottom Rock".

Terebra Portlandica. Pl. XXIII. fig. 6. Abundant everywhere in the Portland stone of Oxfordshire and Bucks: at Combe Wood, Oxf.; Southwarpe, Whitchurch, Towersey, &c., Bucks.

Trigonia clavellata. Langcombe, Oxf.: in sandy stone; with a Pecten.

T—— gibbosa. Universal and abundant in the Portland stone. Oxfordshire: Denton, Great Milton, and Combe Wood, immediately in apposition with the "Malm." Bucks: Brill; Long Crendon; Whitchurch; Quainton; Bishopstone.

T—— incurva. Quainton, Bucks.

Venus?. Beneath Garsington: in concretional Portland stone; with *Pecten orbicularis*, and *Astarte cuneata?*. Quainton, pit east of Ordnance Station: in soft limestone*.

Fishes, *Vertebræ of.* Coney Hill: in "sandstone" calciferous grit.

Chimæra Townsendii: (Buckland, Proceedings of Geol. Soc. vol. ii. p. 286.; and Lond. and Edinb. Phil. Mag. 1836. (vol. viii.) p. 4—7.) The beak has been found in the Portland stone at Great Milton, Oxfordshire, by the Rev. C. Townsend.

* Besides the foregoing, fragments of bivalves, too indistinct to be determined, were found in the Portland stone, at Great Hazeley in Oxfordshire; and at Haddenham, Southwarpe, Stone, and Quainton, Bucks.

Reptiles. *Bone of a Saurian.* Great Hazeley: in ferruginous stone.

[*Portland Sand.*]

Ammonites biplex. Oxf.: Dropshot, near Thame, in grey sandy limestone, with numerous green particles, and small pebbles of quartz. Bucks: Dunton, in greenish stone, with dark particles; Quainton, with a Trigonia.

A——— giganteus. Oxf.: Dropshot, (very large specimens): in dark grey limestone, with green particles and pebbles of black chert*; Shotover; in grit. Bucks: Brill; Whitchurch; Dunton; in greenish grey stone, with dark particles. Quainton.

A——— ———? Dunton, Bucks: in greenish grey stone, with dark particles.

Avicula. Oxf.: Shotover, with Serpula and a Pullastra? in sparry grit. Bucks: Whitchurch; large, a cast.

Buccinum naticoïde. Pl. XXIII. f. 4. Brill: a cast.

Cardium dissimile. Oxf.: Langcombe; Dropshot, casts, in matter almost wholly green. Bucks: Hartwell Lodge, with *Trigonia gibbosa*, in bluish grey stone; Dunton; Brill, with Serpula; Whitchurch; Muswell Hill; Quainton.

Cytheræa? rugosa. Pl. XXII. f. 13. Hartwell, Bucks.

Gastrochæna. The Warren, near Stewkley, Bucks: and Shotover Hill, Oxf.: in *Perna quadrata.*

Lucina. Village of Stone, Bucks.

Mytilus (probably a new species). Denton Village, Oxf.: with *Trigonia clavellata.* Brill, Bucks.

Ostrea solitaria. Dunton, Bucks.

O——. Species indistinct. Shotover, Oxf., with Serpula, &c. adhering to *Ammonites giganteus*, and bent into its inequalities. Brill, Bucks.

Panopæa?. Whitchurch, Bucks.

Pecten lamellosus. Dunton, Bucks: in greenish grey stone, with dark particles: and in a mass almost entirely composed of green matter (silicate of iron), with *Perna quadrata.* Muswell Hill; Brill?.

P——. Another species?. Shotover: with Serpula, &c.

Perna quadrata. Oxf.: Dropshot, near Thame, in dark grey limestone, with numerous green particles and pebbles of black chert; Shotover, in sparry grit, perforated by Gastrochæna; with a Venus. Bucks: Muswell Hill, in stone; containing green particles; the Warren; with Gastrochæna, in grey stone; Dunton; in a green friable mass, and in greenish stone, including fragments of black flint, with *Pecten lamellosus.*

Plagiostoma obliquatum. Near Thame, Oxfordshire.

P——— rusticum. The Warren near Stewkley: in bluish grey stone, with minute dark particles.

* At the quarries in the Portland-sand at Barley Hill near Thame, imperfect worn casts of several bivalves, in black flint or chert, are found in the sandy stone, along with pebbles of the same substance.

Serpula. Shotover, with Ostrea; Brill; Coney Hill; Dunton, in green matter.

Trigonia clavellata. Long Crendon; Casts in conglomerate, with siliceous pebbles; and in sandy limestone, with numerous green particles. Dunton, Bucks; with Mytilus.

T—— gibbosa. Denton, Oxf. Hartwell, Bucks; with Cardium, in bluish grey stone. Dunton, and Whitchurch, Bucks.

T—— gibbosa: a variety, less oblique. Brill.

T—— incurva. Brill, Bucks.

Venus. Shotover Hill, Oxf.; with *Perna quadrata.* Hartwell, Bucks; with Trigonia, in soft stone.

[*Kimmeridge Clay.*]

Ammonites biplex. Clay-pits near Aylesbury. Road from Aylesbury to Whitchurch.

A—— biplex (small). East Claydon, Bucks; 20 feet from surface, in clay:

A—— giganteus ?. Clay pits south-west of Stewkley, Bucks: in blue clay.

A—— Gulielmi. East Claydon, Bucks: in clay; beautifully iridescent.

A—— like *Gulielmi.* Quainton, Bucks.

A—— Selliguinus. Clophill, Bedf. Mr. Goodhall.

A—— (probably new). Clay-pits, south-west of Stewkley, Bucks, in blue clay.

Aptychus (Von Meyer). Pl. XXIII. fig. 11. Roadside between Aylesbury and Whitchurch, about a furlong from Hardwick. Clay pits south-west of Stewkley; fragments of very large specimen.

A—— (a smaller species ?). Roadside between Aylesbury and Whitchurch.

Exogyra nana. Between Aylesbury and Whitchurch: with *Ostrea lævigata.*

E—— virgula. Pl. XXIII. f. 10. (*Gryphæa virgula* of Deshayes.) Roadside between Aylesbury and Whitchurch. Clay-pits south-west of Stewkley: good specimens in bluish grey clay.

Gryphæa bullata. Clophill, Bedf., Mr. Goodhall.

G—— dilatata. Wolvercot, Bucks ?. Clophill, Bedf.

G—— virgula. See *Exogyra.*

Mytilus. Quainton.

Ostrea deltoidea. Aylesbury Clay-pits: a distorted form of the shell. Little Brickhill, clay immediately below surface: fine specimens.

O—— lævigata. Between Aylesbury and Whitchurch.

O—————— (young). Thornborough, Oxf.

O—— læviuscula (young). Road from Aylesbury to Whitchurch: in blue clay. Little Brick Hill, Bedf.

O—— near to *deltoidæa*, but wider at the hinge; still very thick. "In a bed of stiff "clay, about two miles north-north-west of Leighton, under the red sand of the "heath, and about 20 feet above the river." Mr. W. Mathews of Leighton: Roadside between Aylesbury and Whitchurch; Bucks.

Panopæa depressa. Headington Quarry, Oxf.

Pecten arcuatus. Vicinity of Aylesbury.

P—— Lens. Little Brickhill. Brow of the hill, in clay immediately below sand.

Pleurotomaria reticulata (*Trochus*, M.C.) Headington; Oxf.
Serpula tetragona. Clophill, Bedf., Mr. Goodhall.
S——— tricarinata?. Roadside between Aylesbury and Whitchurch. "In stiff clay, "about two miles N.N. west of Leighton." Mr. W. Mathews.

FISHES. *Chimæra* Egertoni: (Buckland, Proc. of Geol. Soc. vol. ii. p. 206.; and Lond. and Edinb. Phil. Mag. (1836), vol. viii. p. 4—7.) Shotover-hill, Oxf.
Psammodus reticulatus: (Agassiz; in Egerton's Catalogue of Fossils); Shotover-hill, Oxfordshire.

REPTILES. *Bone of a Saurian*. Clay-pits south-west of Stewkley: part of a flat bone.
Plesiosaurus; Vertebræ. Headington Quarry, Oxf.
Coprolite; or coproid masses of phosphate of lime. Beneath Whitchurch. Clay-pits south-west of Stewkley: one specimen occupying the cavity of an Ammonite.

[*Oxford Oolite.*]

Melania Heddingtonensis. Wheatley, Oxf.: cast of part of interior.
Ostrea? Thornborough, Oxf. Wheatley; in compact, blue, sparry oolite.
Pholadomya deltoidea. Headington (Coral rag).
Spongia?. Wheatley, Oxf.: in sandy stone.
Terebratula tetrahedra? Thornborough, Oxf.; and Wheatley.

*CAMBRIDGESHIRE**.

(156.) In this county, as in Bedfordshire, the Wealden and Portland groups are wanting; and the strata, rising with a very slight inclination from the south of east, and thinning off near their outcrop, are frequently cut through by denudation, so that distant outliers, especially of the lower green-sand, are frequent. Mr. M'Lauchlan, who was engaged in the Ordnance Survey of this part of England, remarks, that the summits of the chalk decline rapidly in

* I am indebted to my friend Professor Sedgwick for the greater part of the following information respecting Cambridgeshire. The only publications connected with the geology of the county, are a paper by Professor Hailstone, Geological Transactions, 1st Series, vol. iii. p. 243, &c.; a short paper on the Northern division of Cambridgeshire, by Mr. Lunn, (1818),—Geol. Trans., 1st Series, vol. v. p. 114, &c.; an account of some verbal communications made to the Cambridge Philosophical Society, London Philosophical Magazine, (1835,) vol. vi. p. 74; and the report of a field Lecture by Professor Sedgwick, which appeared in the Cambridge Chronicle of the 10th of April 1835.

HUNTINGDONSHIRE I have passed over, not having myself examined that county; and I am not acquainted with any publication specifically relating to it, except Mr. Smith's county map. A small space at the south-eastern verge of the county, on the confines of Bedfordshire, is occupied by the Lower green-sand; but all the tract adjoining Cambridgeshire is assigned by Smith to the *Oak-tree clay*, a term which I believe denotes, in this case, the Kimmeridge clay. The strata thereabouts are much obscured by transported matter.

height on the north-east of Bedfordshire: Kensworth Hill, south of Dunstable, being 904 feet above the sea at low water; the hills east of that town 850 feet; Lilleyhoe, 664; Barkway, Windmill-hill, 513; the station near Royston, 484 feet; Balsham, on the east of Cambridge, 380; Newmarket station, 267; Brandon in Suffolk, 190 feet. The summits of the lower chalk successively decline in the same direction; Orwell station being 250 feet, Chapel-Bush, near Haslingfield, 220; Swaffham-Prior (near Reach), 140. And the lower green-sand also falls rapidly: the hills near the outcrop at Bow Brick-hill being 683 feet high; that of Haddenham on the north of Cambridge, 133 feet; and the general surface of the lower green-sand, which tops the hills near that place, ranging from about 60 to 120 feet; at Ely 75 feet. The level of the Cam, upon the gault, at Cambridge, is only 24½ feet above the sea at low water on Lynn Deeps; that of the Kimmeridge clay at Ely Bridge, 14 feet; and of the Cam, at Upware, probably not more than 12 feet. So that if the sea were not dammed out by artificial means, a great part of the marshy tract on the confines of this county, Huntingdonshire, and Norfolk, would be inundated at high water, as appears to have been the case at no very distant period. The hydrography and drainage of this low tract, which are intimately connected with geological principles, have been the subject of some valuable publications, but do not fall within the immediate scope of these pages.

(157.) Another general circumstance which characterizes the north-west of Cambridgeshire, is the great extent and varied composition of the transported masses with which the strata are in many instances thickly invested. This superficial deposit includes worn masses of greenstone, with fragments of many of the lower members of the English series,—and rounded pebbles of chalk, in such abundance as to form a very large proportion of the entire mass. With these stony substances are fragments of the fossils of most of the strata, Belemnites, large Gryphites, the Ostrea (or Gryphite) of the Oxford clay, and portions of the skeletons of Elephants, Rhinoceros, Hippopotamus, Deer of several species, gigantic Oxen, and of the Horse.

The mass thus composed forms many of the hills on the borders of Cambridgeshire and Essex, and occupies a great part of the platform which runs along the confines of the former county and Huntingdonshire; a brown variety of it obscures the junction of the gault and lower green-sand on the west of Cambridge, forming an upland which extends from Bourne by Toft and Hardwick to Dry Drayton, where it declines into the plain *.

* Mr. Hailstone mentions particularly, that the deposits just described are perfectly distinct from that which occurs above the Gault in Cambridgeshire. The former are very well known

These accumulations, it will be perceived, closely resemble those already mentioned in the account of Buckinghamshire and Bedfordshire, especially near Leighton, and at Stewkley. They occupy, in fact, a great extent of the surface, and form one of the most interesting geological deposits throughout the East of England; but there are circumstances respecting their relations to each other, and to the crag of Norfolk and Suffolk, which still remain to be investigated and explained.

(158.) The strata therefore which are found below the chalk in Cambridgeshire, consist of Chalk, Upper green-sand, Gault, Lower green-sand, Kimmeridge clay, Oxford oolite, and Oxford clay; the last occurring only in a few places, and in the remote part of the county, in which it is the lowest member of the series. The sections, Plate X. a, Nos. 22, 23, and 24, explain the general relations of these strata, but have no pretensions to accuracy of local detail. The following notes describe some of the principal appearances connected with the object of this paper; and the publication of the Ordnance maps of the county will no doubt soon lead to the complete examination of it by the geologists of Cambridge.

Chalk.—The upper chalk range passes from the heights near Dunstable, through the north-west of Hertfordshire, by Hitchin and Baldock, to Barkway and Royston Downs, and thence by Balsham and Newmarket into Suffolk. Mr. M'Lauchlan informs me that the chalk ridge at Thorfield (about 570 feet high) is an anticlinal line, and that the overflow of water in Wardington Bottom, near Newsell's-bury Park, while the rest of the country is dry, renders it probable that some of the lower beds are there brought up to the surface. On the Ordnance maps two ridges are distinctly marked, which meet thereabouts at an angle; one passing from Berry Barn through Norfield to Barkway Mill (313 feet high), the other, striking off from Thorfield for about a mile towards the north, turns suddenly to the east, to the group of hills above Royston and Burley, and is continued thence to the north-east through Chishill, 470, and Heydon, 480 feet. The lower tract, in the angle between these ridges, from Newsell's to Known's Folly, may possibly be a valley of elevation like those of Kingclere described by Dr. Buckland.

The outcrop of the lower chalk and chalk marl, is nearly parallel to the range of the upper strata, and to that of the heights above mentioned; its general course being from the neighbourhood of Orwell, through Haslingfield, Cherry Hinton, and Bottisham, to Reach on the margin of the Fens. Thence, from about Milden-hall in Suffolk, near the confines of Cambridgeshire, to Hunstanton, on the north-west coast of Norfolk, a distance of about forty miles, the direction of the chalk escarpment is nearly from south to north.

The chalk which forms the principal part of the lower hills in Cambridgeshire, bears the local name of "Clunch." It is described by Mr. Hailstone as being harder than common chalk, and usually of a grey colour. It affords, as the lower and marly chalk is found to do in many other places, remarkably good lime: and it would seem that some of the lowest beds, which bear the name of Clunch, agree in their properties, as in geological position, with the firestone of Surrey,

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throughout the Isle of Ely under the name of *White Gravel,* (the latter is *Red*); and, Mr. Sedgwick states, are older than the beds of flint gravel in Cambridgeshire.

being applied to the same purposes in the construction of fire-places, &c. Very large pits of clunch have been opened at Reach, on the immediate confines of the Fens, and on the line of Section No. 23.

Upper greensand. This formation here differs from that of some of the more southern counties, in its much smaller thickness, in the absence of chert, and the comparative rarity of green particles, which are here confined to a stratum not more than eighteen inches thick, by which the lowest beds of the chalk are separated from the gault, as is well seen in the section exposed at the Castle Hill, Cambridge. The presence of this green bed, however, is remarkably constant; and it contains many fossils, some of which are common to this formation, and to the chalk,—but others, at least in this country, are confined to the sand; among which, Mr. Sedgwick informs me, Hippurites are found near Bottisham.

Gault.—The term Gault, or "Galt," adopted by Mr. Smith as the denomination of this remarkable stratum, is in Cambridgeshire the popular name for the blue clay, which comes in between the green bed last mentioned, and the ferruginous (Lower green) sand. Its thickness and relations have been well ascertained in this county, from the numerous borings to obtain water, which pierce through the clay to the sand below, especially on the line from Basingbourne north-west of Royston, through Meldrith, and thence towards Cambridge. Its average thickness is about 150 feet*, which is nearly the same as on the south-eastern coast: but the surface of this stratum is much obscured by superficial gravel and a thin coating of the lowest chalk; and good specimens of its fossils are rare, as the upper beds contain but few. Among those, however, which I found between Cambridge and Ely, are the characteristic Ammonites of different species, *A. inflatus*, *A. lautus*, *A. varicosus*; *Exogyra conica*; and spines of an Echinus. In the museum of the Geological Society is a specimen from the Gault near Cambridge, which M. Agassiz has found to belong to a new species of Chimæra†.

Lower green-sand.—This stratum occurs throughout this county between the Gault and Kimmeridge clay, in the form of sand of different shades of grey and brown, but chiefly as a coarse ferruginous compound of quartzose sand, cemented by hydrate and oxide of iron, and more or less indurated. At the top, however, is some green-sand, as appears from the first discharge from the borings through the Gault, after the rod has passed the clay; the water subsequently obtained depositing an ochreous matter, of the colour of the Woburn sands. I have no fossils from this stratum in Cambridgeshire. Its thickness is obviously much less than in Bedfordshire; and its internal composition was not discernible in any of the sections which I saw; but at Ely I found numerous concretional blocks, precisely resembling Kentish rag; which had been obtained, I was informed, from a place near the gallows on the south-west of the town, in a deposit which there forms an extensive outlier over the Kimmeridge clay, and consists of coarse, ferruginous, and siliceous sand and conglomerate, containing a large proportion of brown iron-ore (hydrous oxide of iron), like that of Shanklin in the Isle of Wight. At Ingoldsthorpe in Norfolk, where the thickness of the stratum is probably not greater than at Ely, it is said to contain Fuller's earth‡.

Quitting Potton, in Bedfordshire, Mr. Lunn states§, ferruginous sand is observed within the

* Mr. Lunn supposes the thickness to be 200 to 220 feet.—Geol. Trans. vol. v. p. 115.

† Proceedings of Geological Society, 1835, vol. ii. p. 205, note.

‡ In Mr. Greenough's geological map, sulphate of barytes is mentioned as occurring on the main road from Royston to Huntingdon, at Longstow near Caxton. This mineral, it will be recollected, occurs in the Fuller's earth at Nutfield in Surrey, ((51.) p. 141.); a situation which answers to that of the Lower green-sand on the line of section No. 22.

§ Geol. Trans. 1st Series, vol. v. p. 114, &c.

borders of Cambridgeshire, at Gamlingay, with Gault resting upon it; "and in some of the pits, "the line of junction is as well defined as that of two immiscible fluids"; but the sand contiguous to the clay is more highly impregnated with iron than the lower part, and is cemented by the oxide, so as to form a hard rock. Leaving to the south-west the two villages of Hatley, both on the Gault, the boundary passes between Little and Great Gransdon, and west of Caxton, (which is on the clay), through the north-west sides of the parish of Eltsley, by Passworth St. Everard's, and Passworth St. Agnes, to Hilton and Fenny Drayton. In the parish of Fenny Stanton and that of Croxton, a bed of clay (Gault?) rests on the sand. The sand can be traced across the lower country, in a direction nearly parallel to the chalk, from Caxton (Section No. 22.) by Conington, and Long Stanton, through Cottenham and Denny Abbey, where the surface is occupied by low hillocks of gravel; and on the north of those places it forms the summit of many of the heights of small elevation on the south-eastern verge of the Fens. Thus at Haddenham, the hill, 133 feet high, is capped with sand; and the prolonged height, or ridge thence to Aldreth, called "the Sandy-way," about 122 feet, is likewise composed of it. The junction of the sand and subjacent clay is well seen, Mr. Sedgwick states, at the clay-pit on the east of Ely; and sand is visible in the drains from about the fifth to the ninth milestone, along the road from Littleport towards Downham, cutting across the Fens on the north-east of Ely, in a direction corresponding to the previous course of this formation near Cambridge.

Kimmeridge clay.—This occupies all the lower tract on the north and west of the line of sands above mentioned, as on the course of the Ouse, or Old West river, from Fenny Stanton and Holywell on the west, to its junction with the Cam at Thetford, and thence towards Ely. Sections are of necessity rare; but a very good one, exhibiting the junction of the clay and Lower green-sand, is exposed in the pits east of Ely. On the west and south-west of Ely the clay is capped in many places by sand, in the form of outliers, on the summits of the heights, which here range from about 120 feet to 50 (see the list in the Appendix C.): and the clay is continued uniformly through their bases, to a point north-west of Haddenham, on the road to Chatteris, where it is succeeded by the Oxford oolite.

Oxford oolite.—A remarkable exception to this uniformity of structure occurs at Upware, on the Cam, about three miles north-west of Reach (see the Section, Plate X. a. No. 24.); where the upper strata of the Oxford oolite make their appearance, in a low ridge extending for about three miles north of Upware, in a direction nearly parallel to that of the Cam, which is here not much more than 12 feet above the sea at low water. The stone beds have been opened here in two or three quarries; a very large one being near the river, and on the line of the section 24. The strata are slightly inclined to the west of north, in a direction opposite to that of the beds below the chalk. The stone here laid bare to a depth of about 10 or 12 feet, consists of a loose rubbly limestone, of a cream colour, in some places coarsely oolitic, and containing many of the characteristic fossils, for a collection of which I am obliged to Professor Sedgwick and Mr. M'Lauchlan:—Spines of Cidaris; Corals; an Arca; Fusus, a new species; *Gervillia aviculoides*; Isocardia, an acute species; Modiola; *Ostrea gregarea*; *Pecten viminalis*; Plagiostoma; Plicatula; *Turbo muricatus*, &c.

The coralline beds (the proper "Coral rag" of Smith) do not come up to the surface at this place; but they break out, Mr. Sedgwick informs me, beyond Haddenham, going towards Chatteris; and he suspects that the shelly beds of this formation occur in some other places in the county, between the Kimmeridge and the Oxford clays, from the occurrence of numerous bits of the coral rag and of its fossils in the brown clay, which masks so much of the surface of Huntingdonshire and Cambridgeshire, and in a condition which makes it probable that they had not been drifted far.

Oxford clay.—The Oxford clay succeeds to the coral rag on the north-west of Haddenham, as has been mentioned, and of Ely. It is the lowest stratum in Cambridgeshire, and forms the base of the Great Bedford Level.

(159.) *Chalk in Rutlandshire.*—The rise of the strata last mentioned, combined with the general features and structure of Cambridgeshire, would seem to indicate the final outcrop and disappearance of the upper members of the Series; but from a passage in a paper by Mr. Barker, published in the Philosophical Transactions for 1791*, and quoted by Dr. Buckland†, it appears that chalk has been discovered at Ridlington in Rutlandshire, about forty miles from the general range of the chalk hills in Cambridgeshire and Norfolk‡. So that if this statement be correct, we might expect to find some of the beds below the chalk, in the wide tract of intervening country. The only circumstance mentioned by Mr. Barker which throws doubt upon the supposition that this chalk is in its original position, is, that the *flints*, which he states to occur "in rows, lying in it as is usual in the South of England," are "broken, and not whole ones." So that it is possible that the entire mass may consist of transported fragments of chalk, and be analogous, but on a much larger scale, to the loose pieces of that substance found by Mr. Conybeare in my presence during an excursion in Northamptonshire, near Sywell; a place about thirty miles distant from the nearest point of the chalk escarpment. Ridlington, where this patch of chalk is stated to have been observed, is placed in Smith's map of the county, on the verge of a platform of the Lower oolite, resting immediately on the blue marl at the upper part of the lias; and the map bears no indication whatsoever of any other stratum.

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* Vol. lxxxi. p. 281. † Geological Transactions, 1st Series, vol. v. p. 539.

‡ I shall here insert the whole passage, as the best mode of presenting the facts to the reader. Mr. Barker, writing at Lynden, near Uppingham in Rutlandshire, says: "I did not know till lately "that we had any chalk nearer us than Moddingley"—(see Pl. X. a. No. 22.); "but several years "ago the people of Riddlington in Rutland, digging for stone to mend the roads, met with a bed of "chalk, at which they were much surprised, and did not know what it was, never having seen a "chalk-pit before. After I had heard of it, I went to examine the place, and found a regular chalk "pit, with rows of flints lying in it as they are wont to do in England. The chalk is not soft, like "that they write with, but very much like that they dig about Baldock: nor are the flints so black "as those in the South of England, but veined, of a light-coloured flint, and white; some parts "much mixed with chalk, and are broken, not whole ones. They may have dug the pit six yards "long and two deep, but how far the chalk reaches I do not know." Mr. Barker adds, that he had seen a little patch of chalk a few yards long, in a bank by the road side, along the turnpike road near Stukely, about three miles north-west of Huntingdon, which place is about twenty miles from the nearest chalk-hills.

Traces of the Wealden in Northamptonshire.—The preceding statement is rendered more interesting by the discovery at Wansford in Northamptonshire, a place about ten miles east of Ridlington, and thirty from the chalk-hills in Cambridgeshire, of a mass of calcareous grit, containing an impression of *Lonchopteris Mantellii* *, a fossil species found by Mr. Mantell in the grit of Tilgate Forest, Sussex, and hitherto peculiar to the Wealden strata; indicating therefore the presence of that group at the distance of more than forty miles from the nearest point on the south, at which its existence has yet been ascertained in England. For an opportunity of examining the specimen in question, I am indebted to the kindness of Mr. Woodward of Norwich, to whom it belongs; and I find it to consist of crystalline calciferous grit, of a yellowish grey or drab colour, containing a very large proportion of carbonate of lime,—which may very well have formed a part of one of the concretions of grit subordinate to the Hastings sands. The form of leaf of the plant is beautifully impressed upon the stone, and very well represented in the plate of the Fossil Flora: and the only question is, whether the locality has been correctly stated, which Mr. Woodward has no reason to doubt. It may be added, that the existence of the Wealden in this new situation is rendered more probable by the occurrence of chalk in Rutlandshire, at a point not less remote from the great body of that formation in the South-east of England.

NORFOLK †.

(160.) The strata below the chalk appear only on the west of this county, and the series is generally the same with that of Cambridge; but the Upper green-sand soon ceases to be conspicuous, or disappears altogether; and the Gault is so much reduced in thickness, and changes its character so remarkably, that it is only by means of its fossils and by tracing its continuity with the more usual form of the stratum, that its identity can be ascertained. The ferruginous beds of the Lower green-sand are sufficiently distinct, but the formation is much thinner than in the south-eastern counties. No traces of the Wealden or Portland groups have yet been found, nor are there any

* Lindley and Hutton's *Fossil Flora*, (1835) vol. iii. p. 372. Plate 171.

† The publications on the geology of Norfolk, besides the general maps of Smith and Greenough, and the County map of the former, relate principally to the eastern portion of the county. But since these pages have been at the press, an excellent account of West Norfolk, by Mr. R. C. Rose, of Swaffham, has appeared in the London and Edinburgh Philosophical Magazine[1], to which I beg to refer the reader who wishes for detail. The preceding papers relating to this part of the county, are Mr. R. C. Taylor's plate and description of Hunstanton Cliff, 1823[2]; a paper by the same author, on the alluvial strata and the chalk of Norfolk and Suffolk[3]; and a list of the fossils of Hunstanton, in Mr. Woodward's Geology of Norfolk[4]. Some occasional notes connected with the west side of the county, may also be found in the tracts more immediately relating to the beds above the chalk.

[1] Vol. vi. and vii. 1835—1836.

[2] Phil. Magazine, 1823, vol. lxi. p. 81—83; republished in a tract on the Geology of East Norfolk, 8vo, 1827.

[3] Geol. Trans. 2nd Series, vol. i. p. 374—378.

[4] "An Outline of the Geology of Norfolk," 8vo, 1833.

distinct indications of the Oxford oolite, between the Kimmeridge and Oxford clays.

The line of hills, nowhere probably exceeding 600 feet in height, which stretches for about forty miles from the chalk range of Cambridgeshire to the north-west coast of Norfolk, bounds the fen-country like the low shore of a sea; and a very slight change of level would again convert the fens into a shallow estuary, by the waters of which these hills would be washed at their base. At present, the face of the heights is covered with vegetation, so that it is only in detached spots casually exposed, that the strata can be seen.

Not having, myself, any good section of this part of the district, Mr. Rose has been so good, at my request, as to prepare an enlarged copy of the sketch annexed to his paper on West Norfolk, on the line from Swaffham to Lynn, (see Pl. X. a, No. 25.); and I have inserted also a section and a sketch of Hunstanton Cliff, (Plate X. a, No. 26; and X. b, fig. 12, *a*, *b*, and *c*,) the only natural section that is visible upon the coast.

Deposits above the Chalk.—The portion of the fens immediately adjacent to the chalk-hills in West Norfolk, bears the name of Marshland. It is composed of alternating beds of lacustrine silt and peat, covering, in the vicinity of Lynn, a deposit of marine silt; the whole resting upon a stiff clay, which incloses small nodules of chalk, and is obviously the same with the superficial deposit, already described as including chalk fragments and being generally of similar composition, in Cambridgeshire and near Leighton; beneath which are the strata of Kimmeridge in Oxford clay.

In a well, sunk and bored at Lynn, to the great depth of 630 feet, the detail of which will be mentioned hereafter, a bed of the clay containing portions of chalk, was found beneath about 23 feet of sand, loam, and peat, and marine silt; and the clay was, at the bottom, in immediate contact with what Mr. Rose considers as the Oxford-clay, but with some doubt whether it may not be that of Kimmeridge. For an account of the newer subaqueous deposits, and of the more recent changes which the surface here is proved, by historical documents, to have undergone, I refer to the publications of Mr. R. Taylor, Mr. Woodward, and Mr. Rose, in which references will be found to preceding authors, some of whom are of very ancient date.

Chalk.—An account is given in the publications of this Society, of two borings in the south of Norfolk, which illustrate the relations of the chalk to the beds immediately beneath it. One of these, described by Sir H. Bunbury, was made at Mildenhall in Suffolk*, a spot about twenty miles north-east of Cambridge, and thirteen from Ely, near the point where the chalk range changes its direction from about south-west and north-east, and runs northward, to join the sea at Hunstanton†. Another sectional list has been published by Mr. John Taylor, derived from a boring at

* Geol. Trans. 2nd Series, vol. i. p. 379.

† The general course of the chalk escarpment in the Wolds of Lincolnshire (see a paper by Mr. Bogg, Geol. Trans. 1st Series, vol. iii. p. 392.) and of Yorkshire, is from south-east to north-west; so that the line of its course in Norfolk may be considered as forming the bottom or most eastern shore of a deep bay, (and the lowest part also of the range, with reference to the level of the sea); from the extremities of which the escarpment diverges in both directions;—north-westward, for about ninety miles, to its final termination on the parallel of Flamborough Head; and towards the south-west, for more than two hundred miles, to the coast of Devonshire.

Diss, on the confines of Norfolk and Suffolk*, about five-and-twenty miles east of Mildenhall; through which place if a line were drawn on the line of dip, it would pass nearly through Downham on the margin of the Fens. In this section, the entire thickness of the chalk was cut through, and combining it with that at Mildenhall, the result stands thus;—subject, however, to some uncertainty, from the imperfect condition of the specimens brought up in boring.

Diss.	Feet.	
1. *a.* Clay	50	
b. Sand	50	100
2. *Chalk.*		
a. Without flints, soft, marly	100	
b. With flints, in layers about a yard from each other	330	
c. Grey, with occasional layers of white: no flints	60	
d. Light bright blue chalk, approaching to clay, with white chalk stones	20	510
[On penetrating the light blue clay, the boring-rods sank rapidly, and water rose to within 47 feet of the surface.]		
3. *Sand*;—characters not stated		5
		615

Mildenhall.		Feet.
I. Sandy loam		1
II. *Chalk.*		
a. White, without flints	35	
b. Yellowish, gritty	5	
c. Grey, hard	136	176
III. *a.* Blue clay	54	
b. Ditto, darker and harder	10	
c. Ditto, mixed with green sand	10	74
		250
IV. *Green sand*, with many fossils		11
V. *Blue clay*, abounding in fragments of large shells, having a high polish		9
[Water coming in here, the work was discontinued.]		
		270

The section at Diss is valuable, as it cuts through the entire thickness of the chalk, which is here 510 feet; of which, it will be remarked, the uppermost 100 feet are marly and without flints. The light blue stratum, 2. *d*, referred by Mr. Rose to the Gault, may, perhaps, rather correspond to the lower portion of the chalk-marl, and to part of III. in the Mildenhall section; in which case 3. at Diss would represent the Upper green-sand. V. at Mildenhall is distinctly referred by Sir H. Bunbury to the *Gault*, which he supposes to occupy the flat surface of the adjacent fen.

Mr. Rose states that the chalk range in West Norfolk dips to the south-east, about five yards in a mile; or about 1 in 350. He has requested me to mention that he considers the estimate of the heights given in his paper as probably exceeding the truth; and at my suggestion, derived from the levels in Cambridgeshire, he has reduced the altitudes in the section, Pl. X. a. No. 25.

The upper chalk of Norfolk includes the usual flint nodules; and among the larger flinty masses are some like those described by Dr. Buckland, under the name of Paramoudra. Many of the fossils of the uppermost strata, according to Mr. Woodward, are different from those of what he has called the *medial chalk*, which also contains flints. Near Swaffham, the chalk without flints, which seems to belong to some intermediate beds between the upper and lower

* Proceedings of the Geol. Soc. (1833-4), vol. ii. p. 93.

groups, forms a range of somewhat lower hills, on the west of that constituted by the superior strata. It is hard enough to be used as a building stone, divides naturally into rhomboids, and contains horizontal seams of argillaceous matter; but Mr. Rose remarks, that although the hardness increases progressively downwards, the increase is not regular nor uniform, some portions as hard as any of the lower occurring in the upper part of it. His list of fossils from the chalk with flints contains about 78 species; of which, according to Mr. Mantell, only 40 occur in the corresponding part of the formation in Sussex.

The relations of the lower strata of the chalk are best exhibited in the section at Hunstanton Cliff, which will be presently described. Mr. Rose's list of fossils from the chalk without flints, includes altogether 54 species; of which 30 are found in the upper part of Hunstanton Cliff:—of the whole number only 15 species are wanting in Mr. Mantell's catalogue of the Sussex chalk fossils*.

Upper green-sand.—It is probable that attentive examination would discover the usual green matter on the confines of the chalk and the representative of the gault in this county: but generally the Upper green-sand is scarcely perceptible. In the section at Mildenhall, inserted above, 10 feet of clay mixed with green particles, precede 11 feet of (upper) green-sand with many fossils, which rests on blue clay, no doubt the Gault: and the five feet of sand which occur at the bottom of the boring at Diss may also (possibly) belong to the former. Mr. Murchison considers one of the beds at Hunstanton, as the representative of the malm rock of Western Sussex; and Mr. Rose also mentions a rock like firestone, on the confines of the chalk, a resemblance which I find is indicated in my own notes.

Gault.—This stratum is very distinct at Mildenhall, below green-sand; and is represented in Smith's map, as occurring all along the line of escarpment, between the lower chalk and the lower ferruginous sand. I have myself seen it with the characteristic fossils at East Winch and several other places. Thus at Mosshill Farm ("*Muzzle*" of the Ordnance Map), west of the house, towards Denver, are several pits, in a patch, or cap of bluish clay, over the Lower green-sand: the former including Belemnites in great numbers, phosphate of lime in kidney-shaped (coproid) concretions, a few specimens of Ammonites, and fragments of Inocerami in great numbers. On the heights between Middleton Tower and Devil's Bottom, north of the section, Pl. X. a. No. 25, are patches of white and yellowish grey clay, containing many of the Gault fossils;—Belemnites, Inocerami in fragments, Echinus-spines, and portions of Encrinites. In fact, most of the heights in this part of the country, are thinly covered with gault; while the sand beneath it rises slowly towards the west.

The average thickness of the Gault in West Norfolk is not more than 15 feet, according to Mr. Rose, who has traced the connexion between the detached portions, indicated in Smith's map, as far as West Newton, about three miles south of Ingoldsthorpe. The valley between the chalk and Lower green-sand is there interrupted by an advance of the chalk, and beyond that point the *blue* Gault is no longer observable; its place being occupied by the red marly stratum of Hunstanton Cliff. The position of this red matter falls in with the strike of the blue Gault in the southern part of the range, at Newton; and it has been detected, between that place and Hunstanton, at Dersingham Mill, and at Ingoldsthorpe, where I myself have seen that the red stratum is immediately succeeded by sand, the blue beds being wanting.

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* Geol. Trans. 2nd Series, vol. iii. p. 201, &c.; and Geology of the South-east of England, (1833.) p. 370, &c.

Lower green-sand.—This formation here consists, at the upper part, of highly ferruginous coarse sand, one of the most remarkable components of which is Titaniferous oxidulated iron*. The sand abounds in hard concretions of siliceous grains cemented by ferruginous matter, in the form of thin flakes or bands, irregularly ramified, which, in Norfolk, are called "Carstone";—beneath which is finer sand of different shades of grey, yellowish, and white. The course of the outcrop is generally parallel to that of the chalk: the chief localities and the local varieties are indicated in Mr. Rose's memoir.

In descending a hill on the road from Lynn to Snettisham, about a mile from the village of Dersingham, is *white* sand, under yellow slightly consolidated sand; and near the line of the section No. 25, between 38 miles and 39 from Norwich, about half a mile from Middleton, are pits of yellowish and white sand, with ferruginous concretional bands, apparently belonging to the upper member of the Lower green-sand; and very like the Woburn sands.

Organic remains must be very rare in this formation, as Mr. Rose states that he had not obtained any specimens. At Ingoldsthorpe, however, in a brick-field near *Mount Amelia*, I found casts of the following shells, in masses of agglutinated ferruginous sand, like those of Parham-park in Western Sussex, and of the cliff on the west of Shanklin Chine in the Isle of Wight; *Auricula incrassata*; *Avicula*, a new species; *Corbula striatula*; *Mya plicata*; *Rostellaria calcarata*; *Turritella granulata*; *Venus Faba*; and some other indistinct bivalves and univalves.

No indications occur in the sections of this formation which I saw, nor in those mentioned by Mr. Rose, of the threefold subdivision of the Kentish coast; but in the lower part are thin courses of Fuller's earth, not more than an inch in thickness. The lower beds are stated by Mr. Rose generally to contain thin strata of Fuller's earth; as in Surrey and at Woburn.

(161.) *Hunstanton.*—The cliff at this place exhibits an epitome of all the lower strata above described: the section is very distinct, and the difference in the characters and proportion of the beds from those of the southern counties is so remarkable, that I think it necessary to give an account of them, although the place has been already described by Mr. R.C. Taylor† and Mr. Rose.

Pl. X. a. No. 26, represents the cliff, on the same scale with the other sections in that plate, and with Plate X. b. fig. 12. *a*, which is copied from a portion of the Ordnance Map of Norfolk. Fig. 12. *b*. is a sectional elevation, for which I am indebted to Mr. Murchison; and fig. 12. *c*, a sketch of part of the cliff, by Mr. Whewell, with whom and Professor Sedgwick, I had the pleasure of examining the place in 1827.

The following is Mr. Murchison's description of his section, (Pl. X. b. fig. 12. b.), with some additions from my own notes. The dip is, generally, to the north-east; but it will be observed that there is an angle in the coast; so that the section is strictly divisible into two portions, in different planes, neither of them coincident in direction with the line of dip.

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* London and Edinburgh Phil. Mag., 3rd Ser., vol. vii. p. 179.; Phillips's Mineralogy, 3rd edit. p. 223.

† Geology of East Norfolk; and Phil. Mag. 1823, vol. lxi. p. 81.

Section at Hunstanton Cliff.

			Ft.	In.
1. Dunes* of loose blown sand.				
2. Reddish clay, passing downwards into fine laminated sand; with bands of small pebbles .... 9 0 to			10	0
3. Chalk, increasing as it rises, and attaining its greatest thickness in the cliff under the lighthouse. It is there about 30 feet thick, and divisible into three:—				
a. Grey chalk, in thin beds	20	0		
b. Grey chalk, in beds, from 1 to 3 feet in thickness	3	0		
c. The lower part, for about 8 or 10 feet, includes myriads of Inocerami, chiefly in fragments, with large Ammonites ...... 6 0 to	8	0		
		about	30	0

In my own notes I find it stated, that some of the gritty portions of the beds in this part of the cliff are very like the Surrey *firestone.*

[*Upper green-sand*??]

			Ft.	In.
4. A "hard grey bed" like the malm-rock of Western Sussex (the upper member of the Upper green-sand), including great numbers of ramified stems.—*Quæ.* of Siphonia? .... 1 6 to			2	0

[*Gault*??.]

			Ft.	In.
5. Red calcareous and argillaceous matter; with multitudes of *Belemnites Listeri*, Inoceramus, *Pecten orbicularis*, and some Terebratulæ; generally divisible into two beds. This is essentially a conglomerate, or breccia; being composed of angular fragments of black flint or flinty slate, imbedded in a very large proportion of hard, marly, chalk-like matter, and varying in hue from a full to a pale brick-red. The colour is not improbably caused by oxide of iron derived from the ferruginous sands below			4	0

[*Lower green-sand.*]

			Ft.	In.
6. *a.* Yellow sandstone, rather incoherent, with hollow concretions, and curved bands of bluish oxide of iron (the "*Carstone*" of Norfolk, "*Clinkers*" of Hampshire), with quartz pebbles the size of beans. Some stems of Siphonia in the upper portion .... 10 0 to	12	0		
b. is composed of siliceous pebbles and broken fragments of flint, united by a very large proportion of dark brown ferruginous matter; which, under the salt water becomes nearly black. The mass is traversed by fissures, which divide it into oblong blocks, and are sometimes occupied by carbonate of lime. Continued downwards: about 14 feet are visible	14	0	26	0
Total thickness of the Section†			60	0

On the shore at the west end of the cliff, I observed numerous concretional masses of a green conglomerate; obviously part of a bed, like that of the shore below the cliff at Shanklin, and at Sandown Bay, in the Isle of Wight.

The *Chalk without flints*, which forms the upper part of the cliff at Hunstanton, rises, according to Mr. Rose, about 15 yards in a mile; the general inclination of the strata around Swaffham (Section No. 25.) being about 5 yards in a mile. This part of the chalk at Hunstanton comes down into contact with the *Red* Chalk (the Upper green-sand being wanting), and, according to Mr. Rose, admits of subdivision into three portions. 1. Chalk, of a pure white colour. 2. Grey chalk, of a sandy texture,—(No. 3. of Mr. Muggridge's Section given in the note below). This

* This word is in some parts of Norfolk written "*Denes.*" In the village of Hunstanton are loose blocks of green-stone and basaltic porphyry, of considerable size and worn at the edges; and in the transported matter, at the signal end of the cliff, were some pieces of mountain limestone.

† The measurements of Mr. Taylor and of Mr. Muggridge (published by Mr. Rose) coincide

contains very hard masses distributed through softer matter, and is stated by Mr. Woodward, to include a mixture of the fossils of the Upper green-sand with those of the chalk marl. 3. A bed of hard chalk, composed entirely of a ramose zoophyte;—(No. 4. of Mr. Murchison's Section and part of 4. of Mr. Muggridge's mentioned below).

The beds between the white chalk and the Lower green-sand here, differ much from those of the southern counties. The Upper green-sand, if it be present at all, is very indistinct: the green particles which, in other places, abound in this part of the series, are wanting; and the thickness, which in the Isle of Wight is 60 or 70 feet, is here reduced to 2 feet. The Gault has but a doubtful representative; and instead of resembling the blue clay of the South, appears under the form of *reddish* marl, not more than 4 feet thick*.

Mr. Woodward gives a list of 16 species of shells, from this red matter at Hunstanton; of which number only five occur in the Gault of the southern counties: seven are found in the Chalk; four in the Upper green-sand, at some other places; three in the Lower green-sand; and the five following occur only in the red chalk,—*Ammonites alternatus, Spatangus planus, Spongia paradoxa, Terebratula pentangulata, T. triplicata.*—Geology of Norfolk, p. 54.

Kimmeridge clay.—This stratum, in West Norfolk, succeeds immediately to the Lower green-sand, all along the line of escarpment. It can be seen in several detached points, between Southrey, about the tenth mile on the road from Ely to Lynn, and the shore beneath Hunstanton

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very nearly, with those of Mr. Murchison and myself, though their divisions of the strata are not quite the same.

Taylor, 1823.	Ft.	In.	*Muggridge*, 1835.	Ft.	In.	*Murchison*, 1831;—*Fitton*, 1827.	Ft.	In.
1. Soil and diluvium ... 6 in. to	4	0	1. Soil and diluvium...............					
2. Chalk, with few organic remains ... 36 0			2. Lowest chalk......... 28 0					
3. —— Very hard ... 3 0	39	0	3. Chalk marl... 2 6 to 3 0	31	0	No. 3.	20	0
4. —— White, with a ramified zoophyte, like roots of trees	1	6	4. White zoophytic bed...1 4 to	1	6	No. 4. 1 6 to	2	0
5. Deep red matter; 1 in. to......	0	6	—— Seam of red argillaceous matter 0 2 to 0 3			No. 5..........	4	0
6. Red chalk 2 0			5. Red zoophytic limestone, (representing the gault,) in two beds............ 3 10	4	1			
7. Red chalk; darker and more compact than 6............... 2 0	4	0						
8. Sand, light brown ferruginous, containing titaniferous iron ore..............................	10	0	6. Lower green-sand .... 7. Carstone	8	9	No. 6. *a.* 10 ft. to	12	0
9. Puddingstone and sandy breccia, very dark brown...	40	0	8. Sandy breccia 14 0			*b.*	14	0
10. Very dark puddingstone, in some places almost black: discernible only at low water .... visible about	20	0						

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* Similar beds of Red marl occur in the corresponding place beneath the chalk-wolds of Lincolnshire, (see a paper by Mr. Bogg, Geol. Trans. 1st Series, vol. iii. p. 392, &c.); and appear again at Speeton, near Flamborough Head, on the Yorkshire coast;—where, however, they are distinctly superior to the blue gault, and are regarded by Mr. Phillips, as forming part of the chalk.—Geology of Yorkshire, (1st ed.) p. 75; and Section No. 3.

Cliff, where its occurrence is mentioned by Mr. R. C. Taylor; and Mr. Woodward states, that beneath 13 feet of brick-earth, near the former place, a few inches of bituminous shale were found, which burned readily and contained between its laminæ impressions of an Ammonite, and a small bivalve, (Tellina?).*

At Southrey, I found in the clay many of the characteristic Kimmeridge fossils, among which are *Ostrea deltoidea*, *Ammonites Lamberti*, Aptychus, like that of Buckinghamshire (Pl. XXIII. fig. 11.), and a Vermetus; with fragments of the teeth and bones of Saurians.

In a brick-field beneath Downham Market, where 5 or 6 feet of clay were exposed, I found *Ostrea deltoidea*, another large bivalve, and a great number of Ammonites (*A. biplex*?) much compressed. In a section at Denver Sluice, near Downham, the order was as follows†:—

	Ft.	In.
1. Sandy loam, peat and clay; containing roots of plants	23	0
2. Dark ferruginous sand	3	0
3. Clay; which, from its position and contact with sand, seems to be that of Kimmeridge	7	0

The *Oxford oolite* has not been found in this part of the country; nor the subjacent calcareous grit.

The only mode, therefore, in which the presence of the *Oxford clay* can be ascertained, is by its fossils; for, although the great depth of clay passed through at Lynn, in the well sunk and bored at Mr. Allen's brewery, exceeds the average thickness of the Kimmeridge clay, even when combined with the Weymouth strata, identity cannot be safely denied, on the evidence of thickness alone. More than 630 feet of clay were cut through in this well, after passing through between 40 and 50 feet of loam, peat, clay, and marine silt. Of this great thickness a part no doubt belongs to the Kimmeridge clay; and the fossils obtained from the lower beds, now in Mr. Rose's possession, offer no very decisive proof that the Oxford clay is there. But on the other hand, none of the more characteristic fossils of Kimmeridge occur in it, except, *Ostrea deltoidea*;—no *Gryphæa Virgula*, nor Aptychus. The list given by Mr. Rose, includes *Ammonites decipiens*; *A. excavatus*, and another very small species; *Belemnites abbreviatus*; *Gryphæa bullata*, with *Serpula tricarinata* attached to it; *Mya depressa* (a Kimmeridge clay fossil?); a *Pecten* impressed upon a Venus; and a muricated spine of an Echinus. Among the specimens from the deep well which I find mentioned in my notes of 1827, are a *large* Ammonite; two others of small size (one very like *A. Kelloviensis*); *Gryphæa dilatata*, with another bivalve adhering; *Ostrea deltoidea*; two indistinct bivalves; and part of a flat bone.

(162.) *List of Fossils of the Beds below the Chalk, in* BEDFORDSHIRE, CAMBRIDGESHIRE, *and* NORFOLK.

Gault:—including the red stratum at Hunstanton.

Ammonites dentatus. Ingoldsthorpe, Norfolk: in grey sandy clay.
A——— inflatus, young. Between Cambridge and Ely.
A——— lautus. Between Cambridge and Ely: in green sand, at the bottom of the Gault.
A——— varicosus. Between Cambridge and Ely?

* Rose, p. 176.

† Ibid., p. 173.

Belemnites attenuatus. Ingoldsthorpe, Norfolk.

B——— minimus. Ingoldsthorpe: in very light gray marl, with an Inoceramus. Hunstanton: a very large specimen, in the red marl.

Dentalium, with *Exogyra conica.* Between Cambridge and Ely.

Echinus; spine and fragments. Between Cambridge and Ely: in gray marly clay; Ingoldsthorpe. Hunstanton.

Exogyra conica. Between Cambridge and Ely: with part of a Dentalium.

Gryphæa globosa. Hunstanton: with fragments of Inoceramus, and numerous quartzy particles, in red marl.

Inoceramus concentricus? Hunstanton: in red marl.

I——— Cripsii: (Mantell). Hunstanton: red marl.

I——— intermedius? Hunstanton.

I——— sulcatus. Woburn, Bedfordshire.

I——— (indistinct.) Ingoldsthorpe: in light gray marl; with *Belemnites minimus.* Hunstanton: shell very thick, in red marl; with *Belemnites minimus?*

Pecten Beaveri. Hunstanton: with stems of Siphonia?

Siphonia. Hunstanton: in gray marl; (*Lower chalk?*)

Terebratula biplicata. Hunstanton; in the red marl.

T——— subundata. Hunstanton; in the red marl.

Lower Green-sand.

Auricula incrassata. Brick-field, near Ingoldsthorpe, Norfolk; in ferruginous masses, like those of Parham Park, Sussex,—with the following:—

Avicula (new); *Natica*; *Panopœa plicata*; *Rostellaria calcarata*; *Turritella granulata*; *Venus Faba.*

Kimmeridge Clay.

Ammonites biplex. Asplay, near Woburn: in gravel.

A——— Lamberti. Between Cambridge and Ely: in clay, probably that of Kimmeridge.

Aptychus; Von Meyer:—(Trigonellites of Parkinson.) Pl. XXIII. fig. 11. Roadside between Cambridge and Ely. The same as near Whitchurch and Stewkley, Bucks; supra, pp. 292 and 302.

Ostrea; fragments. Between Cambridge and Ely.

Oxford Oolite.

At Upware, on the banks of the Cam, about eight miles below Cambridge, the following fossils are found, in coarse limestone:—

Arca. *Astrea.* *Cidaris*; spine. *Cucullæa*; with Pecten and other fossils. *Fusus.* *Gastrochæna.* *Gervillia aviculoides*; with *Turbo muricatus.* *Isocardia* (new); very acute. *Littorina muricata.* *Modiola* (indistinct.) *Ostrea gregaria.* *Pecten vimineus.* *Plagiostoma cardiiforme.* *Plicatula.* *Trigonia Pullus.* *Turbo* (indistinct). *Turritella muricata?* *Venus* (cast, imperfect).

SUMMARY AND GENERAL REMARKS.

(163.) The order of the strata mentioned in the preceding pages is represented generally in the abstract Section, Pl. X. b. fig. 13.

Thickness of Strata.—I have not inserted in the engraved section the thickness of the groups; both because it varies much in different places, and that in general my estimates are so loose as not to be relied upon. Accurate measurements of the thickness of the English strata have very seldom been made. The following are approximate numbers, derived however, principally, from estimates by the eye.

Chalk.—The entire thickness of the chalk is exposed in many of the sections on the south-eastern coast; but westward of the Isle of Wight the beds are convergent and much reduced in bulk. Between Deal and Folkstone, Mr. W. Phillips has estimated the total thickness at 820 feet[1]. The two sections at the extremities of the Isle of Wight, between Whitecliff and Sandown Bays on the east,—and between Alum Bay and Broadbench, at the western extremity of the central ridge, furnish good evidence; the strata being so nearly vertical, that the horizontal line across their direction, does not very much exceed the perpendicular to their surfaces. Mr. Greenough has accordingly estimated the thickness at Culver at 1300 feet[2]; and the interval on the Ordnance map, which is very nearly the same at the two extremities of the island, (being in both places about 2 furlongs, or 1320 feet,) may probably be considered as somewhat exceeding the maximum thickness of the chalk in England.

Mr. Conybeare estimates the chalk as ranging between 600 and 1000 feet[3]; and Mr. De la Beche at 700[4]. The height of the cliff at Beachy Head, which includes at top part of the flinty chalk, and goes down very nearly to the Upper green-sand, is only 535 feet[5]; but if 250 feet be added, for the remainder of the flinty chalk, (350 being the thickness of that division near Dover[6],) the aggregate thickness on the Sussex coast will be about 800 feet.

At Wendover Hill, the summit employed as the Ordnance Station is 905 feet above the sea[7]; and the canal at Wendover being 404½ feet, and still within the chalk, the difference, 500 feet, is certainly less than the total thickness at that place.

But the whole of the chalk passed through in the boring above mentioned, at Diss in Norfolk[8], (which includes at the top 100 feet without flints,) was only 510 feet.

The wide range of variation in thickness above stated (supposing the measures to be correct), arises in a great measure from the unequal abrasion and removal of the upper strata; but must in part also be ascribed to original inequality in the thickness of the chalk itself.

Upper green-sand.—The thickness of this group near Folkstone does not exceed 30 feet, and is probably much less[9]; but it swells out considerably near Godstone, and Merstham, and at the latter place is upwards of 30 feet thick[10]. The depth of the wells sunk through it, in the Malm rock strata of Hampshire, varies from 60 to 100 feet[11]. In Western Sussex the thickness

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[1] Geol. Trans., 1st Ser. vol. v. p. 18. [2] Conybeare, Outlines, &c. p. 85. [3] Ibid. [4] Tabular View, 2nd edit. [5] Section, No. 6. Plate X. a. [6] Phillips, Geol. Trans., 1st Ser. vol. v. p. 18. [7] Supra (149.), p. 284; and Sect. 20, Pl. X. a. [8] (160.), p. 311. [9] (9.), p. 107. [10] (49.), p. 140. [11] Murchison, Geol. Trans., 2nd Series, vol. ii. p. 99.

is between 70 and 80 feet[1]; in the Isle of Wight, about 70 feet[2]. At Blackdown the thickness of the sand is about 100 feet[3]; in the Vale of Wardour, probably from 60 to 80[4]; near Swindon, 30 to 50 feet[5]: but at the Castle Hill, Cambridge, it is not more than 18 inches[6]. Thence through West Norfolk, the stratum is not anywhere distinctly seen; and at Hunstanton, the only beds which can be supposed to represent it, are not more than 2 feet thick[7].

Gault.—The thickness of this stratum near Copt Point, derived from barometric measurement, is about 130 feet[8]. In the interior it is difficult to obtain good estimates, and accurate measures can be expected only in wells. At Merstham it is about 150 feet thick[9]; in the Isle of Wight probably about 70 feet[10]: at Ridge, in the Vale of Wardour, it is about 75 feet[11]; at Cotmore Wells near Thame, 90 feet[12]. In Cambridgeshire, the entire stratum has been cut through repeatedly in wells and borings, which give an average thickness of 150 feet[13]; but at Mildenhall in Suffolk, the blue clay, which seems to represent it, is only 9 feet[14]. In West Norfolk Mr. Rose considers that the utmost thickness cannot be more than 15 feet[15]; and at Hunstanton the red marly beds which are supposed to contain Gault fossils, are only 4 feet thick[16].

Lower green-sand.—The measured thickness of this formation can be most easily obtained on the shore between Copt Point and Hythe, where the uppermost subdivision is about 70 feet thick[17]; the middle group, 70 to 100 feet[18]; and the lowest, 60 to 80 feet[19]; the total thickness consequently about 250 feet. In Western Sussex, Mr. Murchison states that nearly 400 feet of sand were passed through in a boring, at Petworth Summerhouse[20]; and Mr. Martin conceives that the two lower members may be together about 150 feet thick[21]. In the Isle of Wight the thickness, between Bonchurch Cove and Sandown, Rocken End and Atherfield Rocks, cannot be less than that of the formation near Folkstone, and seems to be much greater. At Brill, in Buckinghamshire, about 26 feet remain[22]; in West Norfolk, Mr. Rose considers the thickness of the whole formation to be about 80 feet[23].

Wealden.—No measures, on good estimates, of the thickness of the strata in this group have yet been obtained. Mr. Martin assigns 281 feet to the *Weald-clay* cut through in boring, at Petworth in Western Sussex[24]; but in the section at Tiepit and Cowleaze Chine in the Isle of Wight, the clay seems to be no more than 140 feet thick[25].

The section of that part of the *Hastings-sands* which is visible between St. Leonard's Church and the top of the great sand rock bed, may be about 200 to 250 feet; the sand rock bed itself, under the castle, about 80 to 120 feet; and thence to the lowest point upon the coast, east of Hastings, about 200 or 250.—Total thickness, between 400 and 500 feet[26].

It is difficult, from their contortions, to estimate the thickness of the *Purbeck strata* on the coast. Mr. Webster has given in detail the stratification of a portion of them, which amounts to 124 feet, 8 inches[27]; to which may be added about 150 feet,—making a total of about 275[28]. In the Vale of Wardour, the total remaining thickness of the group appears to be from 40 to 60

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[1] Martin, p. 20,—who states, however that 100 feet would probably be no exaggeration of the thickness, where the stratum first emerges from beneath the chalk. [2] Webster, Letters, &c., p. 140.: and supra (93.), p. 183. [3] Supra (120.), p. 236.; and (93.) p. 183. [4] (128.), p. 216.; (129.), p. 247. [5] (141.), p. 265. [6] (158.), p. 305. [7] (161.), p. 314. [8] (11.), p. 109. [9] (49.), p. 140. [10] (93.), p. 184. [11] (129.), p. 247. [12] (148.), p. 279. [13] (158.), p. 306. [14] (160.), p. 311. [15] Rose, p. 181. [16] Supra (161.), p. 314. [17] (17.), p. 116. [18] (25.) p. 122. [19] (32.) p. 126. [20] Geol. Trans., 2nd Ser. vol. ii. p. 102. [21] Martin, p. 36—40. [22] (148.), A. p. 280. [23] Rose, p. 176. [24] Martin, p. 36. and 40. [25] Supra (100.), p. 198. [26] (80.) to (84.), p. 163—172. [27] Geol. Trans., 2nd Ser. vol. ii. p. 39. [28] Supra (104.), p. 209.

feet[1], and in Buckinghamshire still less[2]. Mr. De la Beche estimates the whole formation at 250 feet[3]. The aggregate thickness, therefore, of the three groups which compose the Wealden, cannot, probably, be less than 800 feet.

Portland stone.—This formation being well defined and fully exposed, its thickness is well ascertained; and in Portland Island it seems to range between 60 feet[4] and about 70[5]; at Swindon it is about 60 to 65[6]: at Great Hazeley in Oxfordshire 27 feet[7]; at Brill, about 23 feet[8]; near Quainton and Whitchurch in Buckinghamshire, from 4 to 20 feet[9].

Portland sand.—Near St. Alban's Head, Isle of Purbeck, 120 to 140? feet[10]; in the Isle of Portland, 80 feet[11]; near Thame in Oxfordshire, about 50 feet[12].

Kimmeridge clay.—The thickness of this group is uncertain, and seems to vary much in different places. On the coast Messrs. Buckland and De la Beche assign to it 600 feet, at Kimmeridge Bay[13]; but they state the thickness at Ringstead Bay to be only 300 feet[14]. At the Headington quarries in Oxfordshire, I found, in one of the pits, only 20 feet of clay[15]. The general thickness is stated by Mr. De la Beche to be 500 feet[16].

Oxford oolite.—On the coast near Weymouth, 150 feet[17]. The whole, in Wiltshire, according to Mr. Lonsdale, about 200 feet[18]; Mr. De la Beche, 150 feet[19].

Oxford clay.—On the Dorsetshire coast, near Weymouth, 300 feet[20]: at Lynn in West Norfolk Mr. Rose assigns to this formation the whole depth of a well, which would make the thickness about 630 feet[21]; but part of this depth may possibly be Kimmeridge clay. Mr. De la Beche's estimate for the whole formation is 600 feet[22].

(164.) *Order of Geological Events.*—The succession of events which the preceding pages demonstrate, has been already detailed in some other publications*; but they are too important not to be recited here. The evidence bearing on the following propositions, derived from the South Eastern Coast, the Vale of Wardour, and Buckinghamshire, is all in perfect harmony; and the inferences are so directly connected with the facts, as to be rather corollaries than deductions from them.

1. Deposition, beneath the sea, of the following groups of strata, beginning with the lowest:— *a.* Oxford oolite. *b.* Weymouth and Kimmeridge strata. *c.* The Portland sand and stone.
2. Elevation of the Portland strata above the sea.
3. *Submersion*, by fresh water, of the newly disclosed land.
4. Deposition beneath fresh water, above the Portland strata,—first, of a thin bed of clay; and then of a crust of freshwater limestone, the "skull-cap." (111.) p. 224, and (113.) p. 226.

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[1] Supra (132.), p. 251. [2] (150.), p. 285-6. [3] Tabular View. [4] Webster, Geol. Trans. vol. ii. p. 42, 43; and Pl. VI. fig. 3. [5] Buckland and De la Beche, Pl. III. fig. 1. of this volume. [6] Supra (141.), p. 267. [7] (144.), p. 276-277. [8] (148.), C. p. 280-1. [9] (152.), p. 288, 290. [10] (106.), p. 212.—Section, fig. 5. Plate X. b. [11] Buckland and De la Beche, p. 19. of this volume. [12] Supra (148.) p. 282-3. [13] Page 19. of this volume.—This estimate, however, appears to be too great: see above, (107.) p. 212-13. [14] Pl. III. of this volume, fig. 1.; and p. 22, l. 6. [15] Supra (146.), p. 278-9. [16] Tabular View. [17] Buckland and De la Beche, p. 23. of this volume, l. 2. from bottom. [18] Geol. Trans. 2nd Series, vol iii. p. 261. [19] Tabular View. [20] Buckland and De la Beche, p. 28. of this volume. [21] Rose, p. 174.; supra (161.) p. 316. [22] Tabular View.

* See the works of Mr. Mantell; Dr. Buckland's and Mr. De la Beche's paper in the present volume; and the "Geology of Hastings", p. 79, &c.

5. Deposition upon the "skull-cap" of a bed of "dirt", (110.) p. 223.; and exposure of it as dry land.
6. Growth upon this land, of the Cycadeæ now found in the Dirt-bed, *in situ*, and in the upright position. 10: p. 223-4.
7. *Second submersion* (at least), of the land, in fresh water; proved by the deposition and existence of the "cap". (111.) 9, p. 222, 3; and (113.) p. 226.
8. Exposure of the surface of this "cap" as land; and growth upon it of coniferous trees, and of Cycadeæ. (111.) 8, p. 220-22.
9. Ravages (from the effects of currents of wind, or water,—or from earthquakes), by which the trees were overthrown, or broken off at short distances above the roots.
10. *Third submersion*, in fresh water; and deposition of slaty limestone, containing freshwater fossils only, but near the bottom alternating with clay*. (111.) p. 219, 220.; and (113.) p. 226.
11. Alternation of Oysters with freshwater fossils in the slaty Purbeck limestone; proving access of the sea†, apparently in an estuary (104.) p. 208; and (113.) p. 226.
12. Continuance of the estuarine condition during the whole remaining epoch of the Wealden; proved by the occasional presence of oyster-shells, throughout the Hastings-sands and Weald-clay. (98.) p. 190.; and List of Fossils, p. 178.
13. Sudden, or rapid, depression of the entire Wealden, to such a depth as to be covered with salt water; proved by the sudden and exclusive appearance of marine productions and fossils, above and in immediate apposition with strata containing only freshwater fossils, though mineralogically of the same composition, (100.) p. 196-7.

(165.) *Local Distribution of the Strata.*—If a line drawn from the coast at Folkstone, touching London on the north, and thence towards Newport Pagnell; and another line from about Atherfield in the Isle of Wight towards Faringdon in Berkshire, the tract intervening will comprise the space throughout which the beds immediately below the chalk are most fully developed: and if the standard be taken from the condition of the strata when possessed of their greatest bulk, that of the Green-sands and Wealden may be said to occur in Kent, Sussex, and the Isle of Wight; from which central tract these groups appear to thin out in every direction.

The whole series immediately below the chalk is finely developed between

* The alternations, in this case, are distinguished from those of the coal formation, (in which also the remains of terrestrial and freshwater productions alternate—in some instances repeatedly—with those of marine origin), by the *growth of plants upon the surface* of some of the alternating strata; a proof of their exposure, as dry land, between successive immersions. Mr. Prestwich, in a valuable paper on the coal-field of Coalbrook Dale, has justly remarked, that the repeated alternations in that district are no proof that the tract itself was *raised above the sea and again depressed*, as many times as the freshwater remains alternate with the marine;—since the facts may be accounted for by supposing that the strata were accumulated in an estuary liable to freshes from a river of considerable size.—Proceedings of Geol. Society, 1836, vol. ii.

† Lamarck (Animaux sans Vertèbres, vol. vi.) mentions altogether 81 species of the genus Ostrea; 48 of which are of existing species, 33 known only in the fossil state. Of the 48 recent species, 40 are marine, and 8 uncertain, but also probably marine. In the present state of our knowledge therefore, the occurrence of Oysters may fairly be considered as proof of the former access of the sea.

Farnham and Petersfield and around the west end of the Wealden denudation; the Lower green-sand, especially, is nowhere better disclosed, except in the Isle of Wight. It is not improbable, that the part of these groups which once intervened between the Isle of Wight and the Sussex coast, and is now concealed by the sea, was likewise fully expanded; but at Folkstone the Upper green-sand has already become much thinner.

It remains yet to be ascertained whether in their prolongation northward in England, and towards the east on the continent of Europe, these groups again assume their more bulky and varied form, as our Upper green-sand is observed to do after reduction, even within very short distances; and whether, if they do so expand, the relative proportions of the component members be the same in remote countries; an inquiry which is the more interesting in the case of the green-sand formation, from its very wide diffusion, and the great space which it occupies in different parts of Europe.

Details.—The following are some of the local variations in the strata composing the groups above referred to:—

Chalk.—It may be remarked that the chalk rises much more rapidly towards its outcrop, between Wiltshire and Hertfordshire, than in the more northern counties of the South East of England. In departing from that central tract, both towards Devonshire on the south, and northwards, the rise is comparatively small; the beds shooting out very gradually, and occupying very wide spaces of uniform, flat country. The disturbance, by which the ridge of the Wealds and the parallel range of elevations through the Isle of Wight and Dorsetshire were produced, wasprobably the principal cause of this variation: and the mean course of the Thames itself, from the point where it cuts through the chalk, may possibly be connected with that derangement. But in the chalk itself, on the south-west of London, much local variation is found in the angle and direction of the dip; and from the facts mentioned by Mr. De la Beche, respecting the faults in Devonshire, and what I have seen of the minor irregularities on the shore near Hastings, it is probable that if the whole surface in this part of England were examined with equal attention, it would prove to be pervaded by cracks and slight dislocations.

The *Upper green-sand* is especially remarkable for great variation in its thickness and composition; and it is everywhere so intimately connected with the lowest beds of the chalk, that if we had more accurate measurements of our strata, the *total* thickness of that formation, including the Upper green-sand—might, perhaps, be found to be nearly uniform. The latter passes most commonly by insensible gradation into the soft dark-coloured marly chalk. In many cases, it forms a very thin and scarcely distinguishable group,—as near Folkstone, where it is not more than 20 feet thick; in others, the chert which it contains becomes conspicuous, and it affords also beds of firestone, which together giving it firmness and durability, cause it to project as a step or prominence beyond the foot of the chalk range.

On the west of Portland, the green-sands thin out so rapidly, that at Blackdown a series about 200 feet thick is their only representative; and it is difficult to decide whether this be a condensed equivalent, of the whole group between the chalk and the lowest green-sand,—or, (which seems to be more probable,) only a continuation of the lower part of the *Upper* green-sand, from the Vale of Wardour. In following the range of these formations towards the north-east, a similar reduction of the green-sands is observable, as the section at Hunstanton remarkably proves; but the diminution is by no means uniform throughout the intermediate space. Along the coast of Devonshire, the beds at the bottom of the *upper* sand seem to adopt the characters which the Lower green-sand exhibits in other places; and the latter, as well as the usually intervening gault seems to be wanting. In the Vale of Wardour also, where the Lower sand is scarcely apparent, the Upper green-sand exhibits many of its characters; but the Gault is very distinct between them.

The *Gault* is seen in the greatest perfection on the coast at Folkstone, where its fossils are especially beautiful and numerous. It seems to be thinner and to contain few fossils in the Isle of Wight, and is almost wholly wanting on the west of Purbeck. But in the interior—in the Vale of Wardour, and thence northward to the sea at Hunstanton,—this stratum everywhere appears, and contains throughout many of the same fossils, though it changes its character and is much reduced in bulk in Norfolk.

The almost constant presence of this distinct band of clay between the chalk and Lower green-sand, considering its small relative thickness, is a remarkable fact: and its retention, both in England and on the Continent, of the same mineralogical characters and fossils, renders the Gault a very important member of the series. I have seen it in its proper place, and in the form of bluish clay, all around the Lower Boulonnois; in the vicinity of Aix-la-Chapelle; and in the country between that place and Liege.

The *Lower green-sand* thins out remarkably towards the west, from the central tract just mentioned, (p. 321-2.). The traces of it in the Vale of Wardour are obscure, but they become gradually more distinct towards the north. The subdivisions of the Kentish coast, detailed in (16.) to (35.) and in Sussex (72.), deserve comparison with the more expanded equivalents of this formation in other countries. Their existence in the Isle of Wight is almost certain; and they will probably be found in Bedfordshire: but thence, north-eastward, the sands again become thinner, though they still preserve their relative place.

The Wealden.—This group, also, is best developed near the central tract already pointed out. The Weald-clay is seen in the greatest perfection in the Isle of Wight; and the Hastings-sand in the Forest ridge of Kent and Sussex, &c. But the Purbeck strata are fully expanded only in the Isle of Purbeck, and on the adjacent coast of Dorsetshire. No traces of any member of this group have been found west of the Isle of Portland; nor eastward of that island, near the coast, except in the vicinity of Battle in Sussex. In the Vale of Wardour, the Weald-clay and Hastings-sands are reduced almost to nothing; and they have not yet been found along the line of the green-sands between that place and the neighbourhood of Oxford*. Thence, to Quainton and Whitchurch in Buckinghamshire, the representatives of the Purbeck strata, though perfectly distinct, are but a few feet in thickness, and belong to the lowest beds of the formation. Other indications of the Wealden may be looked for, north of Whitchurch, in the detached portions of sand represented in Mr. Smith's maps of Buckinghamshire and Bedfordshire: and the specimens of Lonchopteris said to occur at Wansford on the north-east of Northamptonshire, (if they be really found *in situ*), would prove that the Hastings-sands exist at that place.

* The subdivisions of the Wealden, especially at the upper part, being in some measure arbitrary, it is often difficult to determine which of the three groups any given portion of unconnected strata ought to be referred to. The same fossils pervade the whole; and beds of sand, clay, and stone, almost identical may be produced from all parts of the series; so that collective evidence alone can be resorted to for the purpose of distinction.

The places beyond the limits of the tract described in the preceding pages, in which the existence of the Wealden has been ascertained, or rendered probable, are mentioned hereafter, (168.) p. 326.

The sudden change from the marine fossils of the Lower green-sand to the freshwater productions of the Wealden is remarkably exhibited at Atherfield in the Isle of Wight (100.) p. 196; where the former stratum contains nearly thirty species, of about twenty genera; while the Weald-clay, not more than ten feet vertically beneath, contains scarcely any other shells than Cypris, Cyclas, and Paludina*. The contrast, in descending from the Wealden group, is equally striking and abrupt;—the Purbeck strata near their junction with the Portland affording scarcely any fossil but Cypris, while the "Roche" at the top of the Portland group, within a few inches of the freshwater limestone, is full of marine remains. (111.) p. 224.

The Wealden strata, though differing so widely as to their fossils, appear to be conformable to those of the adjoining formations, both below them and above. On the Dorsetshire coast, in the Vale of Wardour, and in Buckinghamshire, the Purbeck beds correspond exactly in dip and direction to the Portland stone beneath; and at Hythe in Kent, and in the Isle of Wight, the lowest beds of the green-sand are perfectly continuous with the upper beds of the Weald-clay, (98.) p. 189. The only place with which I am yet acquainted, where a want of conformity is indicated between these formations, is at Stopham in West Sussex, adverted to in (74.) p. 156. But the eroded cavities, filled with what seem to be green-sand and Fuller's earth, in the upper part of many of the quarries in Oxfordshire and Buckinghamshire, (of which those at Great Hazeley and Dinton are good examples,) indicate an interval and some intervening disturbance, between the periods of their production. (114.) p. 276; and (151.) p. 286.

(166.) *Theory of the Wealden.*—The mode in which the Wealden is disposed, in the South-east of England, accords with the hypothesis of its having originated in a lake of fresh water, or in the estuary of a large river. It remains to be determined whether similar deposits are found to occupy a corresponding situation in other parts of the great European basin, of which England is but a small portion.

The chalk and green-sands in England are so frequently prolonged beyond the limits of the beds below, concealing their outcrop, that no certain

* Woodward, so long ago as in 1702, pointed out the resemblance of the Wealden Paludinæ, to some recent freshwater species[1]: and Mr. Sowerby, about 1812, after mentioning their occurrence at Bethersden in Kent, remarks that "from these different localities of shells, apparently of the same genus, we must conclude, either that analogy is not sufficient to prove that "these fossils are of freshwater origin; or else that there are more freshwater formations than "are generally supposed[2]". Mr. Webster, about the same period, distinctly mentioned the existence of freshwater shells in the Purbeck strata, and the probability that a part of that formation had been deposited from fresh water[3]. In 1822, Mr. Mantell reasoned with great sagacity upon the inferences derivable from the fossils, discovered by himself at Tilgate Forest[4]: but the geology of the strata connected with that group was then undetermined; and the difficulties, I believe, were not removed till 1824.

[1] "History of Fossils"; quoted by Webster,—Letters, &c., pp. 142, 192. [2] Min. Con. vol. i. p. 76. tab. 31. [3] Letters, &c. to Sir Harry Englefield, pp. 192. and 237. [4] Illustrations of the Geology of Sussex, 4to, 1832.

inference can be drawn with respect to the continuity beneath them of the Wealden and Portland strata. It is not improbable that what now appear to be detached portions, may in many cases be united; but it seems to be consistent with the mode in which freshwater deposits have been formed, whether in lakes or estuaries, that they should, in more extensive regions, occur in detached, rather than continuous portions; and that the outlines of the spaces which they occupy should be irregular. The former existence of the upper Wealden strata in the interior of England, is rendered probable by the erosion of the Purbeck beds in many places where the Lower green-sand comes into contact with them, (151.) p. 286,—which has clearly been effected by the action of water, and proves that something was carried away, before the sand was deposited: the argument from these appearances being the same as that derived from the erosions on the surface of the Oxford oolite and of the chalk, (143.) p. 274.

The great extent of the surface occupied by water in North America is a striking feature in every ordinary map. Dr. Richardson, in his observations on the geology of that region, has remarked that a large tract near the confines of the primitive and secondary regions is occupied by lakes of the most varied outlines and dimensions;—in which the deposition of shells and other exuviæ of organized beings has been going on ever since the surface of the globe assumed its present aspect. If that part of the northern hemisphere were now to be sunk beneath the sea, we should probably have, after a short time, one universal sheet of marine strata, lodged upon the surface of the present land, so as to conceal not only the deposits of the several lakes, but the intervals between them: and if we could, then, examine the internal structure of the tract, we should find it to be occupied by a numerous series of *Wealdens*, detached from each other, and bordered, it is more than probable, by deposits analogous to those of the dirt-beds of Portland, wherever the fluctuations of the lacustrine waters left time and space for the growth of plants upon their margin. The external boundaries of these deposits would be as various and irregular as that of the lakes which now diversify the map of North America: and we should expect, in such cases, that the mineral components in the deposits of the lakes, would vary according to the nature of the surrounding land. Their fossil contents would, probably, have a great general resemblance throughout large districts; but, in the remoter tracts would differ as much as the productions of modern lakes are found to vary;—as those of the lakes in the North of England differ from those of Switzerland, and both from those of the South of France, &c.; or, as in America, those of *Slave-Lake* differ from the productions of *Lake-Superior* or *Lake-Erie.* The lacustrine deposits, again, would be occasionally diversified by the presence of the products of estuaries, such as those of the St. Lawrence and of other rivers around Hudson's Bay and the north-east coast of America; and in these we should probably find, along with the species of shells which usually inhabit the mouths of large rivers and the borders of the sea, some scattered remains of the products of the adjacent shores,—the plants and animals of the land, with some admixture of freshwater shells.

(167.) ***Wealden in other Districts.***—The following are the places beyond the limits of the tract described in the preceding pages, in which the presence of the Wealden strata has hitherto been ascertained, or rendered probable.

SCOTLAND.—In the *Isle of Skye* Professor Sedgwick and Mr. Murchison discovered, in cliffs of blue shale associated with trap, on the eastern shore of Loch Staffen, flattened masses of limestone, containing several species of shells; some of which are identical with fossils which I had found in the upper beds of the Weald-clay at Swanage Bay on the Dorsetshire coast; and all the rest are freshwater species belonging to genera found in the Wealden of the south*. The coincident species are the following; some of which are figured in the plates subjoined to these pages:—*Cyclas media* (Plate XXI. fig. 10.); *Cyclas*, a larger species (*C. major*, Pl. XXI. fig. 13., Isle of Wight); *Cyclas obovata*?; *Neritina Fittoni*, Mantell (Pl. XXI. fig. 7.); *Ostrea distorta*, found with Cyclades in the Isle of Wight, (Pl. XXII. fig. 2.); *Paludina elongata*; Isle of Wight and Swanage Bay; a transversely elongated Bivalve, (Isle of Wight); an *Unio*, or Anodon.

There can be little doubt, therefore, as Mr. Murchison has inferred, that this deposit was contemporaneous with the English Wealden.

CONTINENT OF EUROPE.—The places out of England, where the equivalents of the Wealden beds have hitherto been found, are the two following.

1. In the *Lower Boulonnois* the presence of the lower member of the group, at least, is certain; the strata being almost identical with some of those upon the confines of the Purbeck and Portland formations in Dorsetshire and the Vale of Wardour. Having given an account of that part of the French coast on another occasion†, it will be sufficient to mention here, that the line of the cliffs from Equihen on the south of Boulogne to Cape Gris-nez on the north of that place, is capped at intervals with a thin crust of the Purbeck strata, resting upon those of Portland, and consisting of slaty beds of limestone, which contain freshwater shells, and include a bed of tough dark-coloured clay, in which are numerous fragments of silicified coniferous trunks not distinguishable from those of the Isle of Portland. It is highly probable that a more exact examination of this part of the series, in the cliffs near Boulogne, may lead to the detection of these trunks in the upright position; and of the Cycadeæ by which they are accompanied on the Dorsetshire coast.

2. The *Pays de Bray*, near *Beauvais*, is a narrow tract on the line from Dieppe to Beauvais, extending in length, from the north-west of Neufchatel to the south of the latter city, a distance of about thirtyEnglish miles, and in breadth, at the widest part near the middle, about eight English miles. (See the annexed Map, Plate IX.) It is an opening, or valley of elevation, in the chalk,

* "Supplementary Remarks", &c., (1827,) Geol. Trans., 2nd Series, vol. ii. pp. 352 and 366.
† In a paper including some account of the Lower Boulonnis: See the abstract; Geol. Soc. Proceedings, Dec. 1826, vol. i. p. 9.

within which a very slight elevation of the central tract has brought into view the subjacent strata, as far down as those which immediately precede the representative of our Oxford oolite, with perhaps the mountain limestone beneath. I have not myself examined this interesting district; and the only publications relating to it that I have seen, are the report of the proceedings of the Geological Society of Paris during their excursion to Beauvais in 1831 *, and the splendid work of M. Passy on the Geology of the Department of the Lower Seine † :—but from the notes and sectional sketch of M. Cordier in the former of these works, and the full descriptions of M. Passy, there can be no doubt that the strata in the Pays de Bray are the same with the upper part of the series in the Lower Boulonnois.

The following is the order of the strata in the Pays de Bray, with what appear to me to be their equivalents in England; my list of equivalents, I am glad to find, coinciding very nearly with that of M. Passy himself ‡.

1. *La Craie.*—(*Chalk*).

2. *Glauconie sableuse de la craie.*—(*Upper Green-sand*).

Fossils said to be the same as of the Lower Chalk.

3. *Marne micacée et Marne bleue.*—(Gault).

Divisible, (at Ferte en Bray) into two portions:—1. Brown and micaceous. 2. Blue. At Meulin the *blue* marl is about 50 feet thick; it abounds in iridescent fossils, among which are, *Ammonites splendens*; *Hamites intermedius*; *Inoceramus sulcatus*; *Nucula pectinata.*

4. *Grès, et sable, Glauco-ferrugineux.*—(Lower Green-sand).

At Cap la Hève are two beds of sand and ferruginous conglomerate, separated by a micaceous and glauconious marl. *Quæ.* the three subdivisions of Folkstone ??. At Forges and Neufchatel the ferruginous sand is 70 feet thick: it occurs above the Argile bigarée, mentioned hereafter, and contains, among other fossils, *Gryphæa sinuata.* At Les Friches de St. Germain is iron ore in grains, including small portions of ochreous hydrate of iron, with marine shells.

5. *Argile bigarée* (*Glaise Marbré.*)—*Variegated marl clay, and, sand,*—(*of* the Wealden; —or *Beds subordinate to the* Lower Green-sand.)

This deposit, which, according to M. Passy, is found everywhere in the Valley of the Pays de Bray, seems from the description to be very like the variegated sandy clay of the Wealden; but at St. Paul, near Beauvais, it is said to contain *marine* shells, the species of which, however, are not mentioned. Its place is commonly below the first stage of ferruginous sand and grit, and above the *Argile à fougères*; a situation corresponding to the place of some of the Wealden marls.

6. *Argile à creusets*; *Argile de Forges*; *Argile à fougères.*—(Weald-clay).

This clay in one place, at Neufchatel, is extracted by means of a shaft 70 French feet in depth, and occurs beneath sand of different shades, belonging to the Glauco-ferruginous beds, No. 4. above.

At St. Germaine la Poterie, a bed of slaty clay (lignite) is found, containing impressions of *Lonchopteris Mantellii*, and from one to two metres thick §: and among the beds found by M. Graves near Songeons, is one, described as "Marbre d'eau douce à Paludines," and referred by him to the *Purbeck* strata ||.

There can be little doubt, therefore, that some equivalent of the Wealden beds exists in this tract; but M. Passy appears to me to be in error when he is led, (no doubt by the indistinctness with which the strata are developed and exposed in the Pays de Bray), to regard the Wealden

* *Bulletin de la Société Géologique de France*, 1831, p. 1. to 23.

† *Description Géologique du Departement de la Seine Inférieure*, 4to, Rouen, 1832.

‡ Passy, p. 237 to 272;—and Plates I. II. III. IX. and XVII. fig. 1.

§ Passy, p. 255.

|| Ibid., p. 257.

generally, in England, as no more than in a particular and subordinate bed of the Glauco-ferruginous sands*.

7. *Grès glauconnieux*; *Grès vert*.—(Portland-stone and Sand.)

These terms are applied to green-sand passing into grit, which again passes into a *calcaire glauconnieux*. Both the grit and limestone are full of green particles: they alternate with beds of sand, and are generally quarried throughout the Pays de Bray: and the *grès calcaire* is stated to be identical with that observed by M. Rozet, at Mont Lambert in the Boulonnois. Among the fossils are Ammonites; Crassatella; Cucullæa; Ostrea; Serpula; Trigonia; and teeth of the Diodon.

M. Passy justly expresses doubt whether this grit has hitherto been recognised in England. I believe it to belong to what I have proposed to call the Portland-sand; the characters and relations of which, though long since generally intimated by Mr. Conybeare, have not hitherto been fully understood in England: and, from my own observation, I have no doubt that some of the concretional masses of the Boulonnois belong to this part of our series. It will be observed, on comparing M. Passy's sections with those in the interior of England, that the lower *greenish* grit (Portland-sand) of M. Passy†, is not conformable to the beds above;—a fact analogous to the existence of chasms and "gullies", in the Lower Purbeck, and upper part of the Portland strata, in Oxfordshire and Bucks:—supra (111.), p. 218; (141.), p. 265; (144.), p. 276, (151.).

8. *Calcaire glauconnieux*;—a limestone composed of *fragments* of shells, united by sparry carbonate of lime, containing green particles, rolled grains of quartz, and flints of different hues. The fossils include *Ostrea gregarea*, and other indistinct species; *Trigonia*; and *Crassatella*. The limestone in this group alternates with grit, and includes a bed of green or bluish marl. The whole belongs to the group between the Portland-sand and the Oxford-oolite in the Lower Boulonnois and is represented in England by part of the series on the coast near Weymouth.

9. *Marne et calcaire marneux*;—*à Gryphæa Virgula*; *Calcaire lumachelle*.

The strata of this group are described as occurring unconformably—("étendues en couches discordantes"), beneath the ferruginous sands: a statement which accords with the relations of the group to the Upper green-sand,—but *not* to the sands of Portland. The formation is characterized by *Gryphæa Virgula*, and some of the beds contain *Ostrea deltoidea*. On the coast, from Havre towards Henqueville, it occupies a thickness of 30 metres (about 100 English feet), between the chalk and the oolite‡; and it seems to be the equivalent of the series of shale, limestone, and calciferous grit abounding in petrifactions, which connects the Kimmeridge-clay with the Oxford oolite, on the coast of the Boulonnois, and of Dorsetshire.

10. The lowest strata of the Pays de Bray "*consist of blackish compact limestone*, like that of "*Marquise* in the Lower Boulonnois;—*the carboniferous limestone of England*:" and these succeed immediately to the group last mentioned. If this be so, the oolitic series, from the Oxford oolite to the bottom of the lias, is wanting; together with new red sandstone and the coal formation:—another point of resemblance to the Lower Boulonnois.

(168.) *Marine deposits coeval with the Wealden.*—It is obvious that, during a period of time sufficient for the accumulation of the Wealden, the deposition of matter in the adjacent seas could not have been inconsiderable; so that we might expect to find, interposed between the strata which then formed the

* "....que l'argile Veldienne qui contient les coquilles d'eau douce, n'est qu'une couche "particulière de terrains glauco-ferrugineux d'Angleterre."—p. 256.

† Passy, p. 272; and Plates I. and II.

‡ Ibid., p. 262, 265.

bottom of the sea, and the Lower green-sand, a series of beds coeval with the Wealden in point of date, but differing from it in possessing the characters of a marine deposit, and including marine shells and other productions of salt water;—with which, near the shore, the productions of the land, or even the freshwater shells of the rivers, might be occasionaly intermixed. And if the Portland strata constituted at that epoch, both the dry land, and the bottom of the sea, and were afterwards submerged, we ought now to find the Lower greensand, in some places immediately in contact with the Portland,—in others with the Wealden,—and in others again with the marine equivalent of this latter group.

Two results would probably attend the state of things here supposed, which are deserving of notice: 1st, That the Wealden and its marine equivalent could not both be found in the same place; and consequently, (since we have the former in England), that the *marine* beds of that date are not to be expected generally in this country: 2ndly, That the marine fossils of the beds cotemporaneous with the Wealden would probably be distinct, both from those of the Portland group beneath, and of the Green-sands above them; a consideration which gives peculiar interest to the fossils of this intermediate group.

The strata between the chalk and the oolitic system on the continent of Europe have not yet been sufficiently examined, to furnish all the evidence that may be expected upon this subject; but indications of such an equivalent to our Wealden as has been mentioned, have been already found in so many detached points, that its occurrence in other places, or even the existence of a continuous marine deposit of that age, is by no means improbable. Mr. De la Beche* has brought together evidence which shows that such a group exists in the department of the Haute Saône, in France; at Candern, in the Brisgau; near Aarau; in Poland; and on the confines of Silesia. To these may be added the Isle of Bornholm in the Baltic, and the vicinity of Helsingburg, in Scania, which have afforded specimens of fossil plants resembling those of our Wealden, along with marine shells; but at Bornholm, although the shells are also marine, they are generally such as may be supposed to have inhabited, either the estuary of a large river, or the seas immediately adjacent to the coast.

In most of the cases mentioned by Mr. De la Beche, a group of strata between the chalk and the oolitic system is found to contain pisiform iron ore; but the fossils which accompany that mineral are marine. A very extensive deposit of this kind in Poland and Silesia is described by Professor Pusch, which includes also argillaceous iron ore; and among its fossils are the genera Ammonites,

* Geological Manual, (1833.), p. 309.

Cardium, Venus, Trigonia, Sanguinolaria. The pisiform ore of the Haute Saône appears from the statements of M. Thirria to be above the Portland strata; but its relations to the superior formations are less distinct. It contains Ammonites, Hamites, Nerinea, Cirrus, Terebratula, and Pentacrinites, with teeth of fishes and of Saurians: and it is observable that the uppermost stratum in the group supposed by M. Thirria to represent the Portland stone, is "a compact conchoidal "limestone, a little tubercular, which contains a species of Paludina? near to Vivipara fluviorum "of Sowerby;"—a description which might very well be applied to some of our Purbeck strata.

M. Walchner has ascertained that the pisiform and reniform iron ores of Candern, belong to two distinct formations, of very different date. The lower rests upon beds of "Jura limestone", which he refers to the Coral-rag or Portland-stone, and which are decidedly below the molasse of Switzerland. The second and more recent pisolitic deposit occupies eroded cavities on the surface of several different formations; it consists of transported matter containing fossil bones, and is not covered by any solid strata. M. Merian is cited by M. Walchner in support of this view of the relations of these deposits; but in the description given by the former, of the strata which immediately cover the pisiform ore of Aarau, there are features very like those of our Wealden itself: for they are mentioned as consisting of "grit and bituminous schist passing into lignite, and "containing a great number of petrifactions, among which, though commonly indistinct, are a "Planorbis, and other freshwater shells."

The doubt which obviously presents itself with respect to the evidence above mentioned, is, whether a formation thus contiguous to the green-sands, and so very nearly coeval with them, may not really be a part of that formation itself; the presence of some fossils distinct from ours, not being sufficient to prohibit this identification. But the peculiar character and abundance of the iron ore, are important circumstances of difference.

The evidence respecting Bornholm occurs in a paper read before the Geological Society by Dr. Beck of Copenhagen*, who states that the beds below the cretaceous group in that island, exhibit many of the characters of a coal formation, containing coal and numerous impressions of ferns, among which are several of the genus Pecopteris; and with these was found the seed vessel of a Restiacea, considered by Dr. Beck as identical with one from the Hastings-sand at Heathfield in Sussex, which he himself had seen in Mr. Mantell's collection. The existence in the vicinity of Hoer, of fossil plants *analogous* to those of the Wealden, but probably belonging to the oolitic series, had been previously pointed out by Mr. Adolphe Brongniart†: but from what has been very recently mentioned to me by Professor Nilsson of Lund, after he had examined some of our best collections of the Wealden fossils, it is probable that a deposit contemporaneous with that formation may be found at Helsingburg in Scania, between the chalk and green-sands which occur near the coast of the Baltic, and the Lias, known to exist on the north-west of that place

The observations of M. Boblaye in the north‡, of M. Desnoyers § in the north-west, and of M. Dufresnoy||; in the south-west of France; with those of M. Elie de Beaumont, on the boundary of the Paris and London Basins¶; of Mr. De la Beche**, M. de Caumont††, M. Desnoyers‡‡,

* "Proceedings" (1835-6) vol. ii. p. 217. † *Annales des Sciences Naturelles*, 1825.
‡ Ibid., 1820, t. xvii. p. 35. § Ibid., 1825, t. iv. p. 353. || Ibid., 1829, t. xvii. p. 192
¶ Ibid., 1829, t. xvii. p. 354. ** Geol. Trans. 2nd Series, vol. i. p. 13.
†† *Mém. de la Soc. Linn. du Calvados*, t. i. 1824, p. 49 et 67; t. ii. 1825. p. 447, &c.
‡‡ *Mém. de la Soc. d'Hist. Nat. de Paris*, t. ii. 1825.

M. Constant Prevost[*], and M. Passy[†], on the coast of Normandy and the adjacent district; and more recently of M. Thirria, in the department of the Haute Saône[‡], have shown that many of the beds between the chalk and the oolitic system in the different provinces of France, agree with each other, and with those of England, perhaps as nearly as the more distant portions of the same formations are found to do in our country: the Portland strata, which form the lower boundary of the Wealden, occurring at several detached points along their course; while above them, the chalk affords a limit which cannot be mistaken. It may deserve the inquiry, therefore, of resident geologists, whether traces at least, of all the intermediate groups between the Portland and the chalk may not be detected generally along the line of connexion; and I am not without hope that the task of comparative examination may be assisted by the preceding pages.

Among the points deserving of notice by those who examine the beds below the chalk in districts imperfectly known, I would mention especially the characters of the *Portland Sand*;—from the facility with which that formation may be confounded with other sands, likewise charged with green particles. I have reason to believe that a neglect of the distinctions between these different sands, and a consequent ignorance of the distance by which they are separated in the series of strata, has produced difficulty, and led to much confusion in the arrangement of the groups between the chalk and the oolitic system.

(169.) *Beds below the Wealden.*—The groups next below the Wealden, in the tracts described in the preceding pages, are connected by several characters; the Portland sand forms a transition to the Kimmeridge clay; and the latter, at its lower part becomes charged with sand and calcareous matter, and passes insensibly into the Oxford oolite. The fossils, also, of these associated groups are very much allied, and there is no reason to suppose that the deposition of this part of the series was interrupted by any important change of circumstances.

Portland strata.—The space occupied by the Portland strata, so far as they have yet been discovered in England, is bounded on the west by a line passing from Portland to the outcrop of the Portland stone in the Vale of Wardour, and thence towards Swindon. On the east of that line the Purbeck and Portland formations are visible only in the remaining portions of the once-continuous sheet, which seems originally to have invested a great part of Oxfordshire and Buckinghamshire. Whether the Portland beds exist, or ever have existed, under the sands of the Isle of Wight, Sussex, and Kent, it is now impossible to say; though it is probable that they did so, from their occurrence on the opposite coast of France, and their thickness in that quarter.

The peculiar circumstance relating to the junction of this formation with the Purbeck beds, is the distinct character of superficial soil, which the bed in which the trees and Cycadeæ are found, exhibits in the Isle of Portland. Trees and plants have occurred in the upright position in many other places, and in other parts of the series of strata; but the soil in those cases had lost its recent character, and been in a great measure assimilated to the surrounding matter. Some other thin beds alternating with the lowest strata of the Purbeck limestone, have likewise more

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[*] *Mém. de la Soc. d'Hist. Nat. de Paris*, t. ii. 1825. p. 389.
[†] *Sur le Département, &c.* 4to, Paris, 1833.
[‡] *Mém. de la Soc. d'Hist. Nat. de Strasbourg*, 1830, t. i.

or less of the character of a mechanical agglomerate; but none of them approach to the gravel-like texture and composition of the "Black-dirt" of Portland and the adjacent coast.

The small extent which the Portland strata occupy with reference to the Kimmeridge clay, is a remarkable fact; showing either that the former, like the Coral-rag, was originally deposited in detached portions;—or that the portions of the Portland group that we now see, are only the remaining and eroded borders of one continuous coating originally lodged upon the clay.

It is remarkable, also, that the *Wealden* has not yet been found beyond the limits of the Portland group; never reposing, as the green-sands are frequently seen to do, on any of the formations beneath the Portland stone: but before this exclusion be adopted, it will be necessary to examine more completely the counties on the north of Buckinghamshire. Reciprocally, in all the places where the Portland beds have hitherto been found, one or more members of the Wealden group are connected with it. It is possible, therefore, that the Portland strata formed the only land, at the period when the freshwater beds of the Wealden group began to be deposited.

The *Kimmeridge clay* thus more widely diffused than the Portland and the Wealden, forms the continuation upwards, of a long series of alternate strata of oolitic limestones, sand, and clay. The extent, thickness, and development, of this formation, vary much in different places, the upper beds alone being visible at the point from whence the name has been derived. The relations of the groups are fully seen on the coast near Weymouth, and still more completely on the shore of the Boulonnois, and near Scarborough: but, although the clay extends, without interruption, from Dorsetshire to Norfolk, it is seldom seen to advantage in the interior of England. Near Oxford, the lower members, which form the transition from the bituminous clays of Kimmeridge to the Oxford oolite, are evidently wanting; and the surface of the calcareous reestone beneath the clay, is deeply worn and eroded.

(170.) *Composition of Strata.*—Among the circumstances relating to the composition of the strata above mentioned, below the chalk in the South-East of England, the following are deserving of attention.

1. Proofs of the formation of stone, in the midst of strata of gravel, sand, and clay, distinctly of mechanical origin. This fact, which is of universal occurrence throughout the series of secondary strata, is especially remarkable in the Lower green and the Hastings sands of Kent and Sussex: sex: the former containing masses of siliceous grit, chert, and chalcedony, and concretions of chert, evidently formed subsequently to the division of the beds which inclose them, yet traversed by the same lines of false stratification which pervade the looser matter:—(22.) and (23.)

2. The change, in the fossil trees of Portland, of the original woody substance into silex; and the contrast of their composition with that of the surrounding matter in the "Dirt-bed", in which fragments of soft limestone are abundant; the strata, both above and below, likewise, consisting principally of carbonate of lime. In the Lower green-sand also, at Woburn, the petrifying petrifying matter of the coniferous wood is silex*.

3. The shells preserved in the green-sands of Kent, consist of carbonate of lime; but in the sands of Blackdown, though shells occur in still greater numbers, the calcareous matter has almost entirely disappeared, and with very few exceptions has been replaced by chalcedony; and the surrounding sand, instead of effervescing with acids, imbibes them tranquilly.

* The fact remarked by Mr. Brown, that all the fossil wood hitherto discovered in the strata mentioned in these pages, is either monocotyledonous, coniferous, or cycadeous, has been already adverted to: (112.) p. 225.

4. The occurrence of oolite containing freshwater shells, near the bottom of the Purbeck strata at Combe Wood (144.), p. 275-6, is another fact deserving of notice, and may perhaps explain some doubtful appearances in the uppermost bed of the Portland Series (the *Roche*); which, although full of marine petrifactions, and commonly oolitic, has very much the aspect of freshwater limestone. It can easily be imagined that the bank, or land, consisting of the Portland strata, when first raised above the sea, was covered with marine remains, which might subsequently have been cemented together, at the bottom of a freshwater lake.

5. The existence of pisolitic (or granular) oxide of iron, in the Wealden, is probably not confined to the coast near Hastings, where I found it to be generally diffused; p. 166. The fact of its occurrence in this formation is the more deserving of notice, from the great abundance of that ore in the *marine* deposits supposed to be contemporaneous with our Wealden, in other parts of Europe: supra, (168.) p. 330.

(171.) *Similarity of Deposits of different Epochs.*—The mineralogical resemblance between some of the strata above and beneath the Wealden, is very remarkable.—The upper part of the Portland formation in the Vale of Wardour is so like chalk, that it bears that name in some of the quarries; and both there and upon the coast of Dorsetshire it contains flint nodules, not distinguishable from those of the chalk.—The Portland sand abounding in green particles, cannot, in itself, be distinguished from the green-sands above the chalk, nor from those below; the green matter in all is of the same nature; the calcareous concretions are like those of the "Kentish-rag": yet the deposition of these groups was separated by intervals of time sufficient, in the first two cases, for the accumulation of all the Wealden strata, and in the two latter, for that of the chalk.—The strong resemblance of the variegated sands and marl of the Wealden to those of the new red sandstone, and of both to the tea-coloured and variegated marls of the beds above the chalk in the Isle of Wight, has been already mentioned. —The Wealden, again, has many striking points of resemblance to the coal measures. The shale, sandstones, and clay iron-stone of the latter are not distinguishable from those of the Hastings-sands, which are, in fact, a coal formation: and in addition to the Unios and other freshwater shells long known in the coal formations, the recent discovery of Cypris, in freshwater limestone, among the coal measures in Scotland*, is another point of agreement.

These resemblances, of which other examples might easily be given, in deposits separated by great intervals of time, demonstrate the identity of the processes which are still going on with those of the more ancient epochs,

* See, however, upon this subject, the remark of Mr. Sowerby, as to the possible resemblance of the fossil crusts of the *marine* genus Cytherina, to those of Cypris: Appendix, p. 345, under the head *Cypris Valdensis.*

and prepare the mind for the reception of other proofs of that continuity of action, which has of late been so ably discussed.

(173.) *Fossils.*—A systematic list of all the fossils mentioned in the preceding pages* is given in the Appendix B: and I have connected with it a series of columns, exhibiting at one view the stratigraphic distribution of the several species. My collection is so incomplete, that many of the columns are unoccupied; and most of them afford very inadequate representations of the facts: but it will be advantageous to keep in view the completion of such a list, whenever sufficient materials shall be obtained to fill it up. The number of specimens collected from any given district or series of strata, depends on so many circumstances purely accidental,—the texture of the matrix, the number of open quarries, the relative skill and activity of collectors,—that the richest collections can very seldom be regarded as fairly representing the fossil contents of the groups from which they are obtained; and there still are large tracts, in every part of the English series, the fossils of which are unknown. The proportion, therefore, which the species we are acquainted with, bear to the whole number contained in the strata, is so far from being determined, that any general reasoning upon this subject at present would be of little value.

From the imperfect lists of fossils given above, it would seem that even short distances are attended with greater variation in the contents of the strata, than might have been expected; and that although some species pervade the whole range of the formations in which they are found, others occur in several of the tracts described which have not yet been obtained elsewhere.

I cannot conclude these pages without expressing my great obligation to Mr. Lonsdale, for his kind and unremitting assistance during their passage through the press; which has been doubly acceptable, from its having been conferred on me by one of my most valued personal friends.

W. H. F.

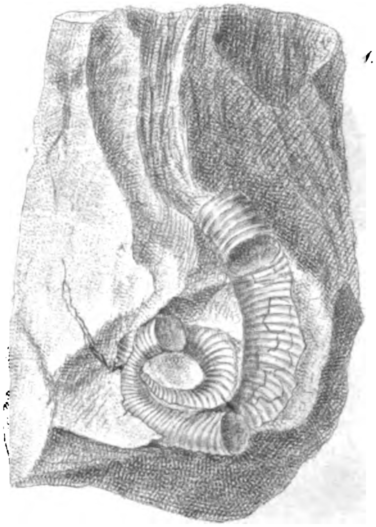
London, August 16, 1836.

* It may be proper to mention here, that the whole of the author's collection referred to in the preceding lists, has been presented to the Geological Society, and will be found in their Museum.


CHALK-MARL.
UPPER GREENSAND.
GAULT.
LOWER G.S.
1.
2.
3.
a.
b.
4.
5.
5.*
6
6.*
7.
7.*
8.
9.
10.
11.
12.
a.
b.
c.
13.
14.
15.
a.
b.
16.
17.
18.
19.
20.
21.
22.
23.

GAULT. (continued.)

1.



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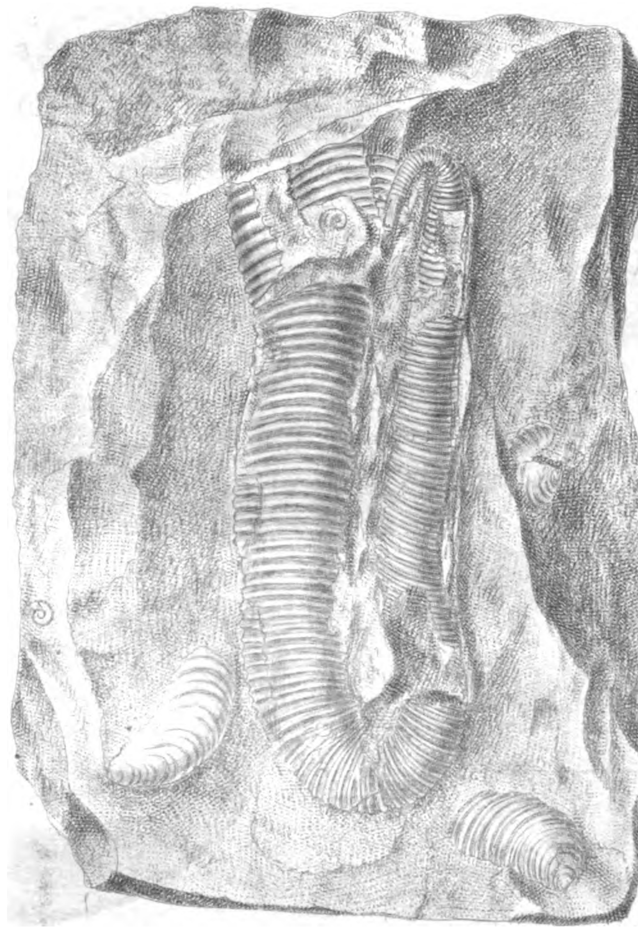

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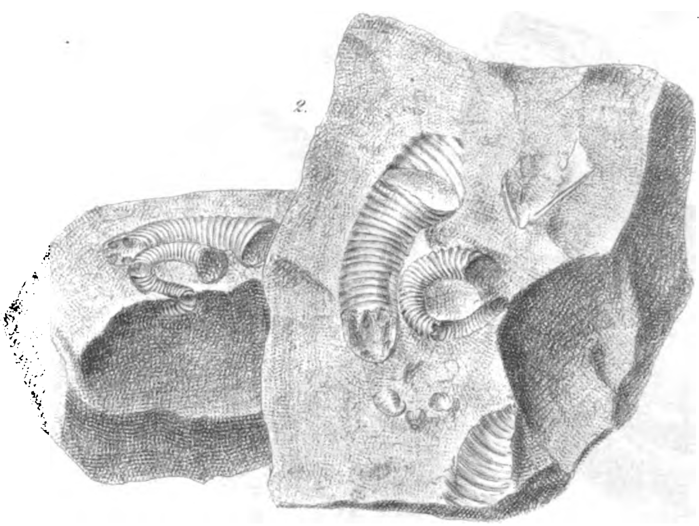

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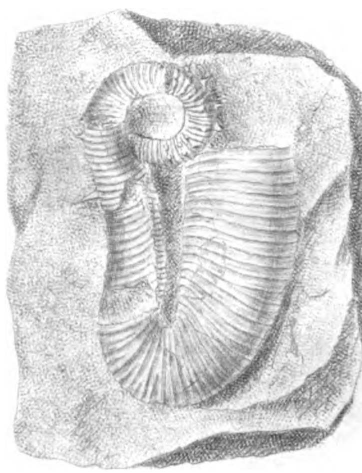
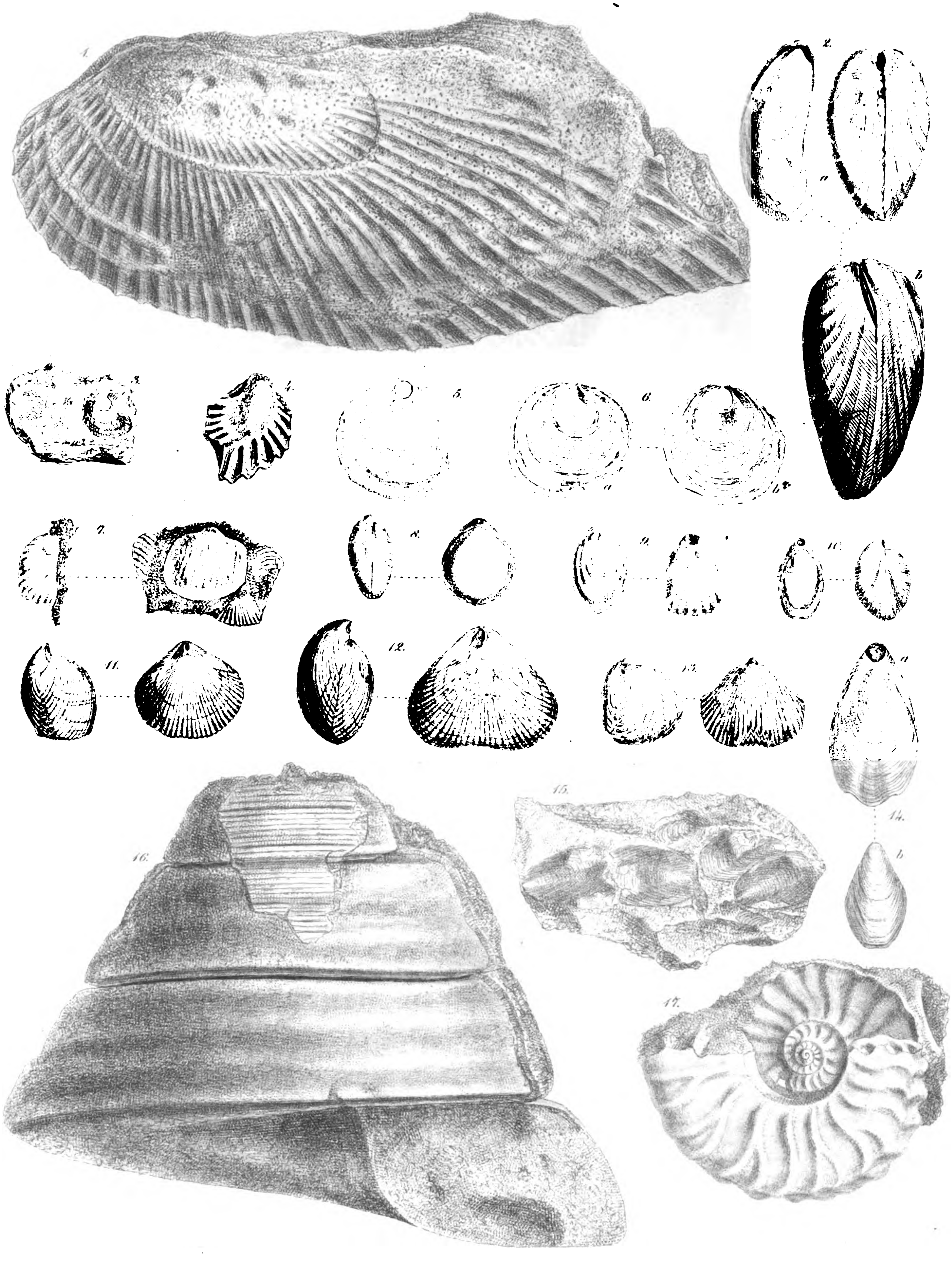


J.D.C. Sowerby fecit

LOWER GREENSAND.

J.D.C. Sowerby fecit

LOWER GREENSAND (continued)



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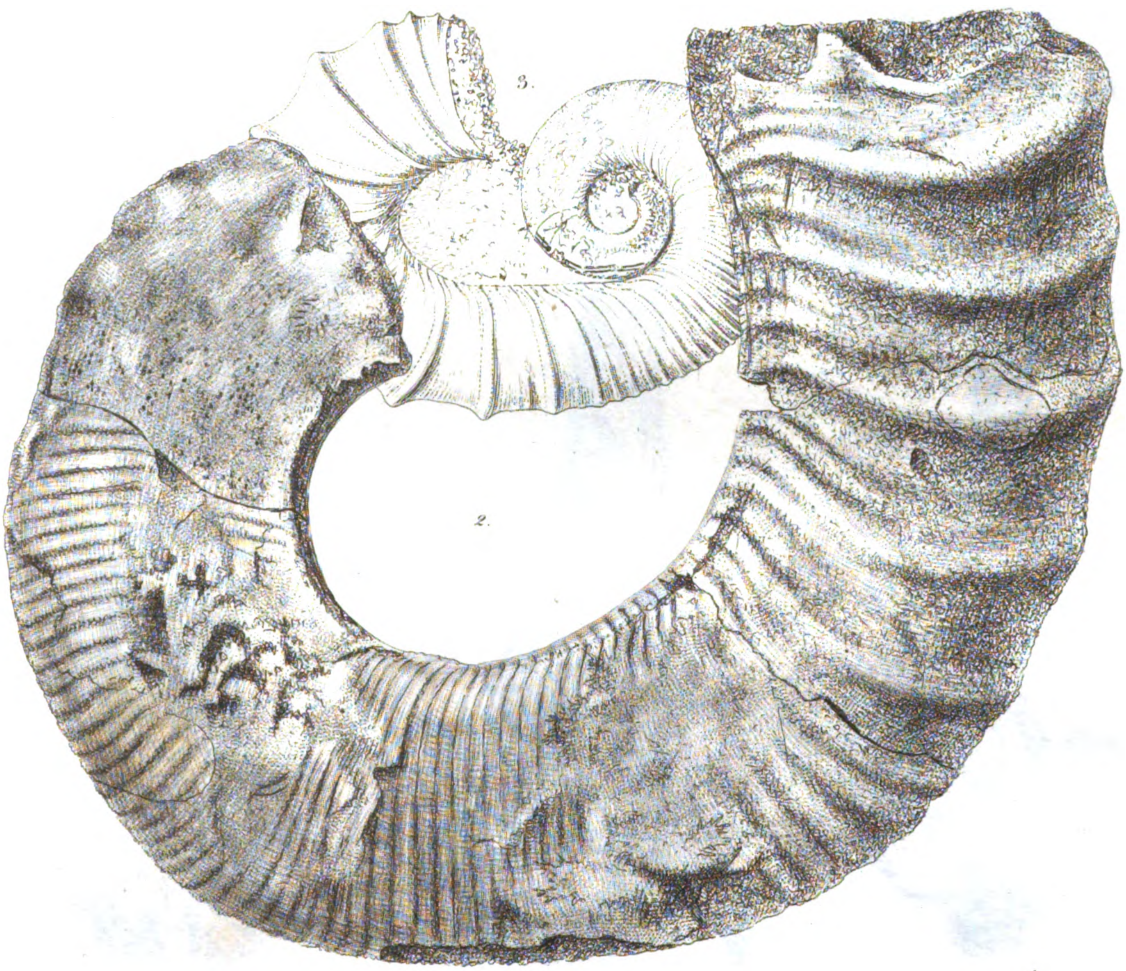
LOWER GREENSAND_(continued.)

1.

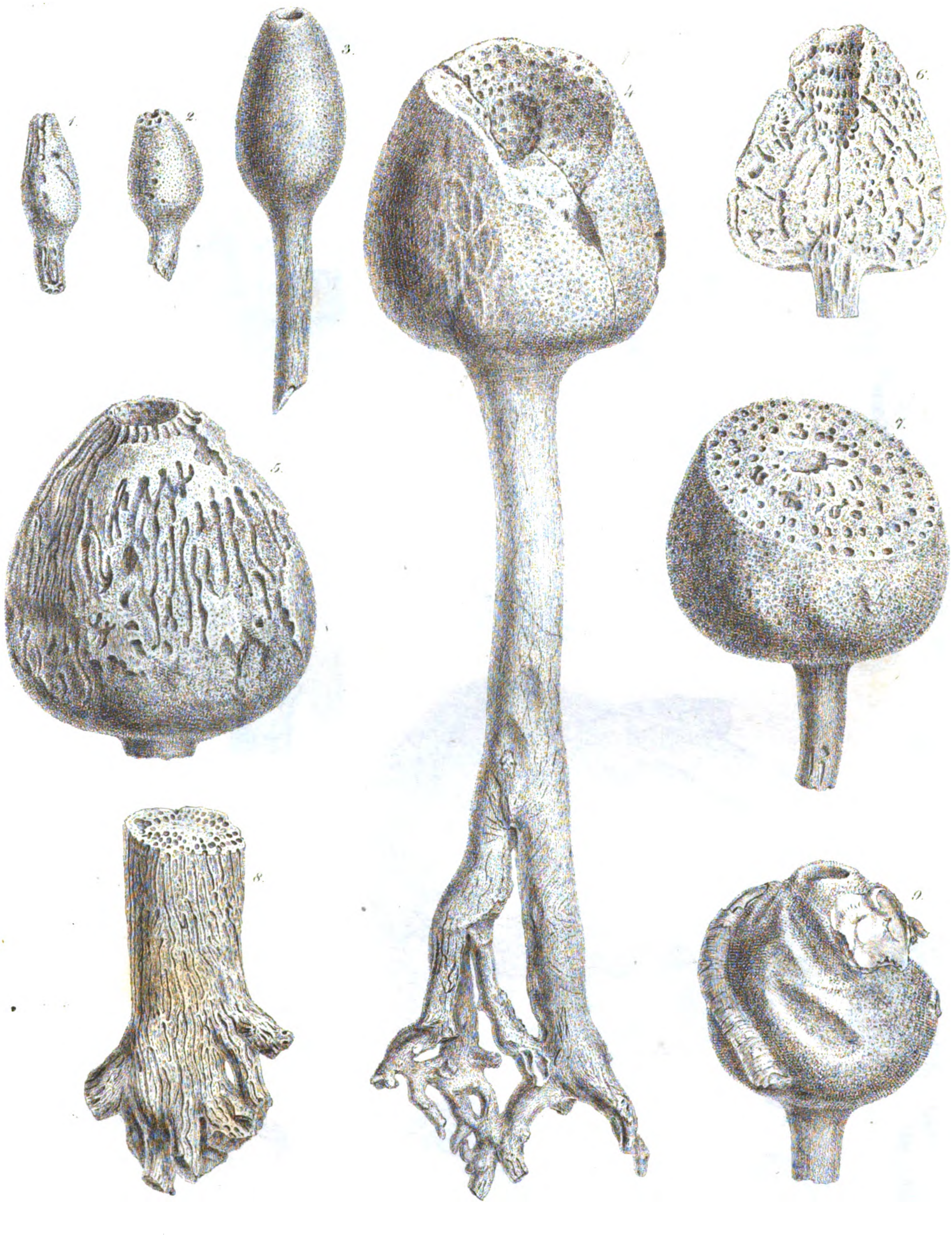
3.

2.



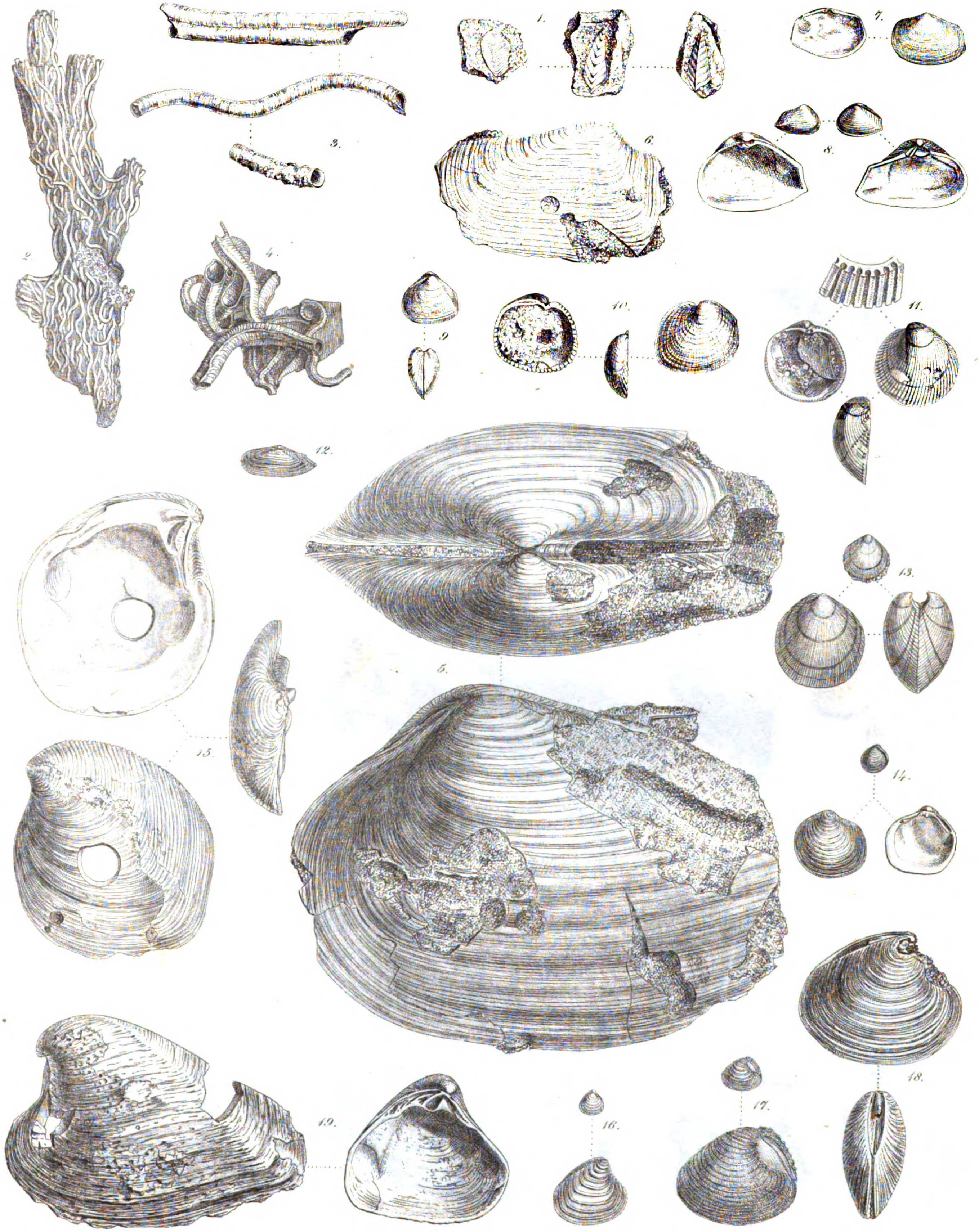
J. D. C. Sowerby

GREENSAND (of Blackdown, Devonshire)



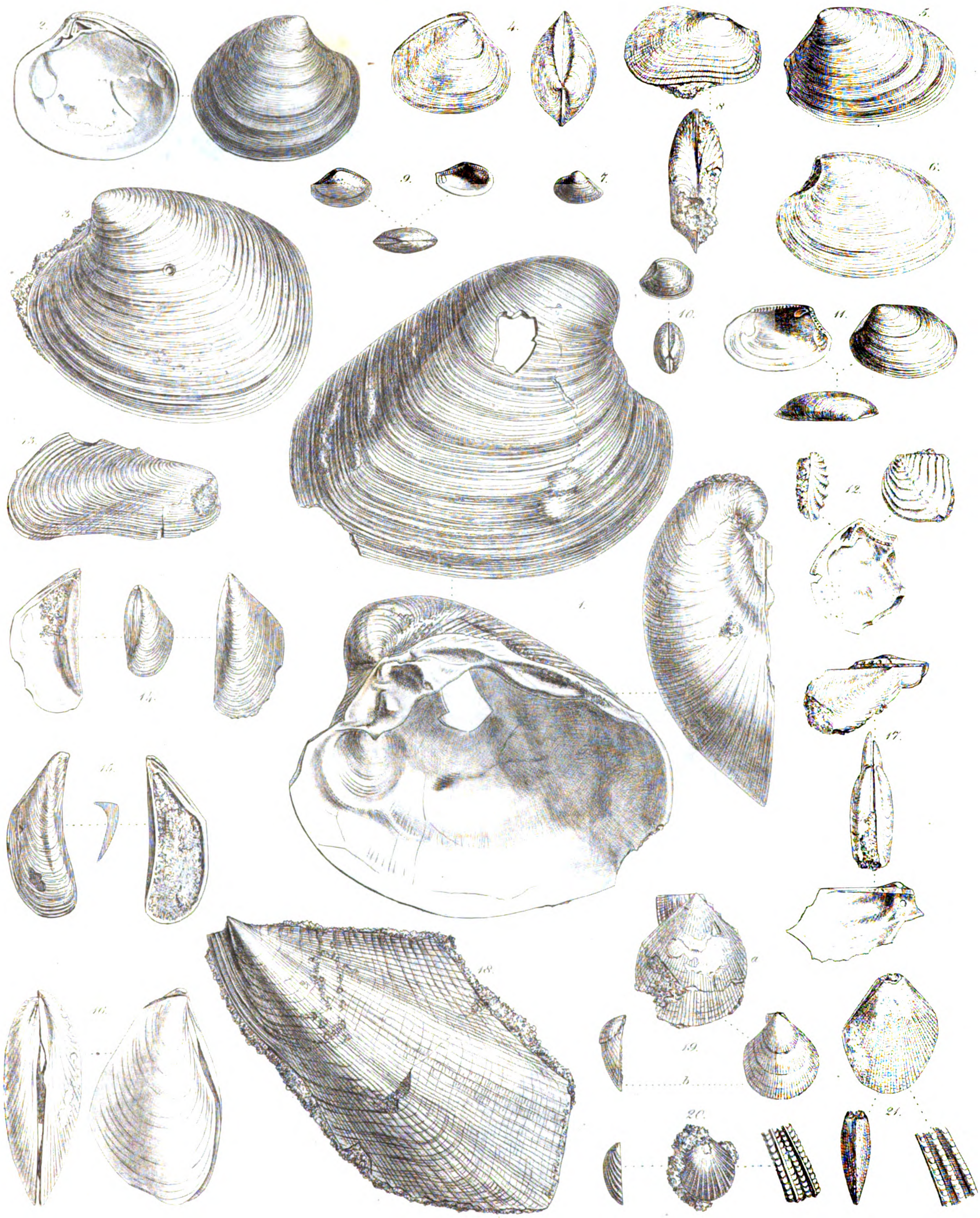
J. D. C. Sowerby

GREENSAND.–(of Blackdown.) continued



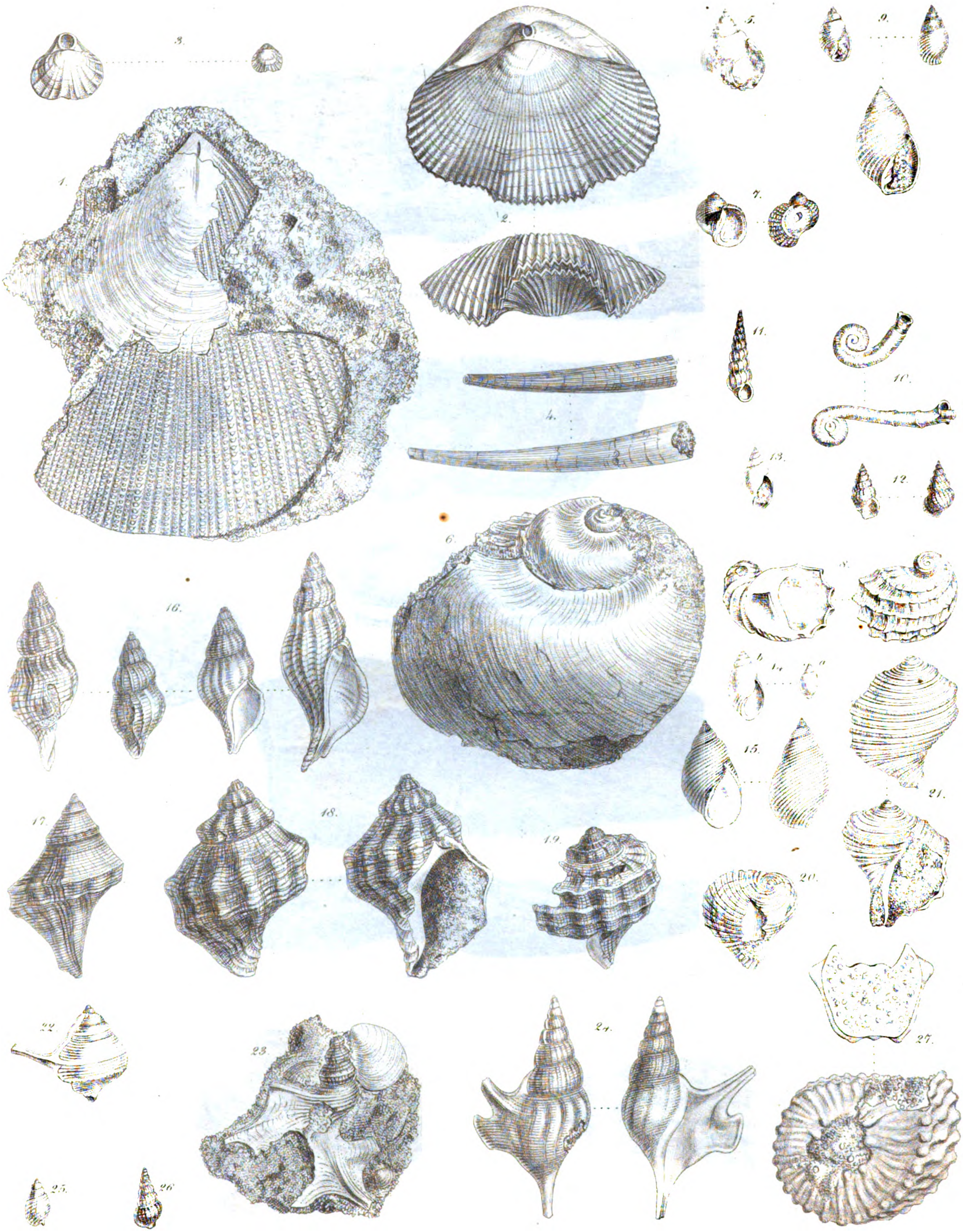
J.D.C. Sowerby fecit.

GREENSAND (of Blackdown,) continued.



J.D.C. Sowerby fc.

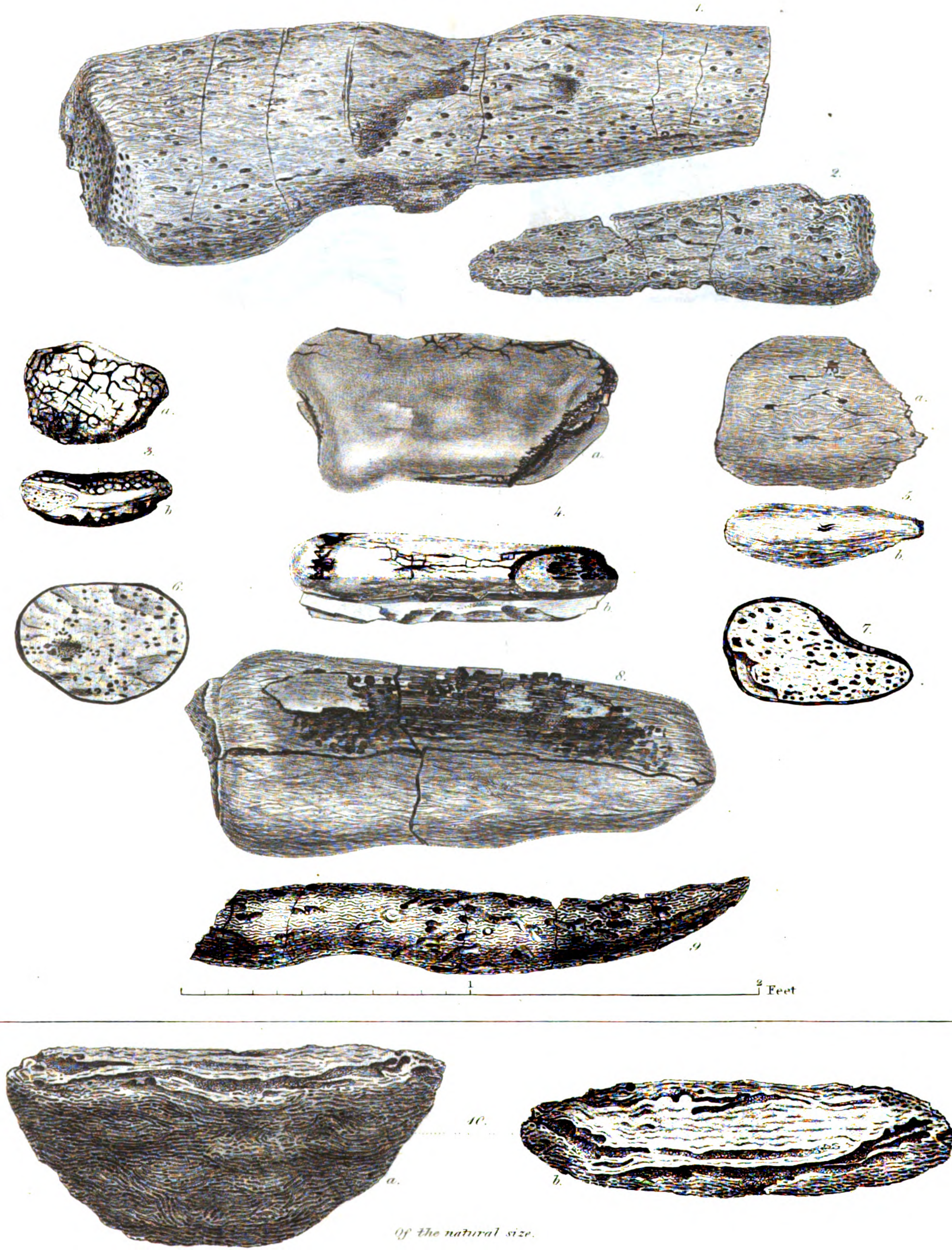
GREENSAND (of Blackdown) continued.



J. De C. Sowerby Sculp.

WEALDEN.

Endogenites erosa.



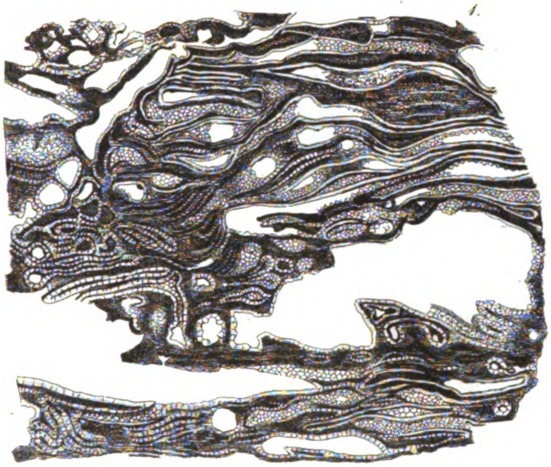
Of the natural size.

J. De C. Sowerby fecit.

WEALDEN.

Endogenites erosa.

1.



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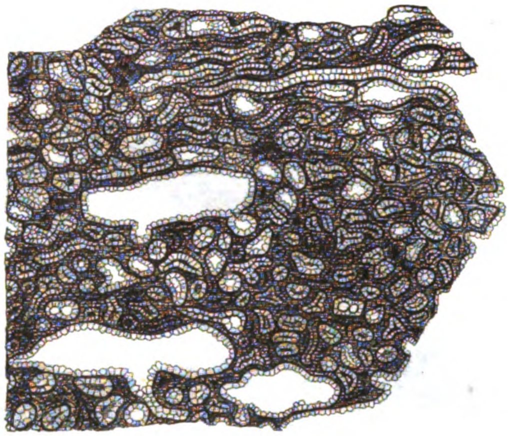
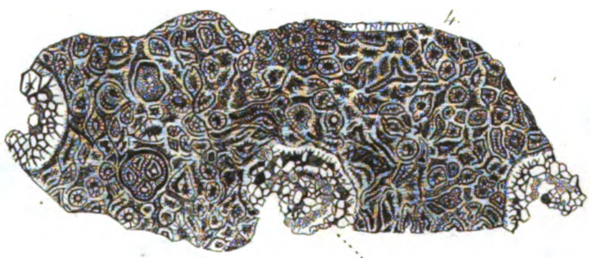


these two figures are magnified 4 times.

4.



magnified 4 times.

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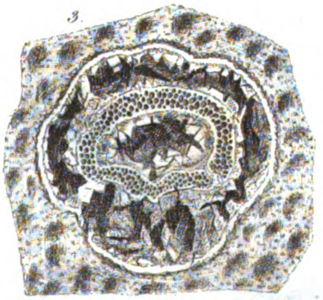
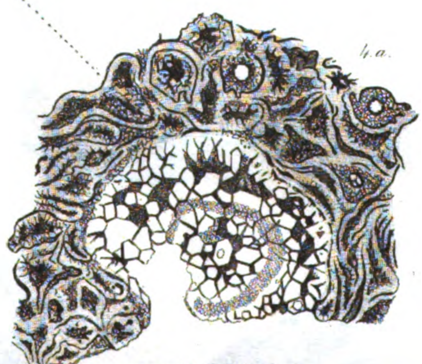


magnified 8 times.

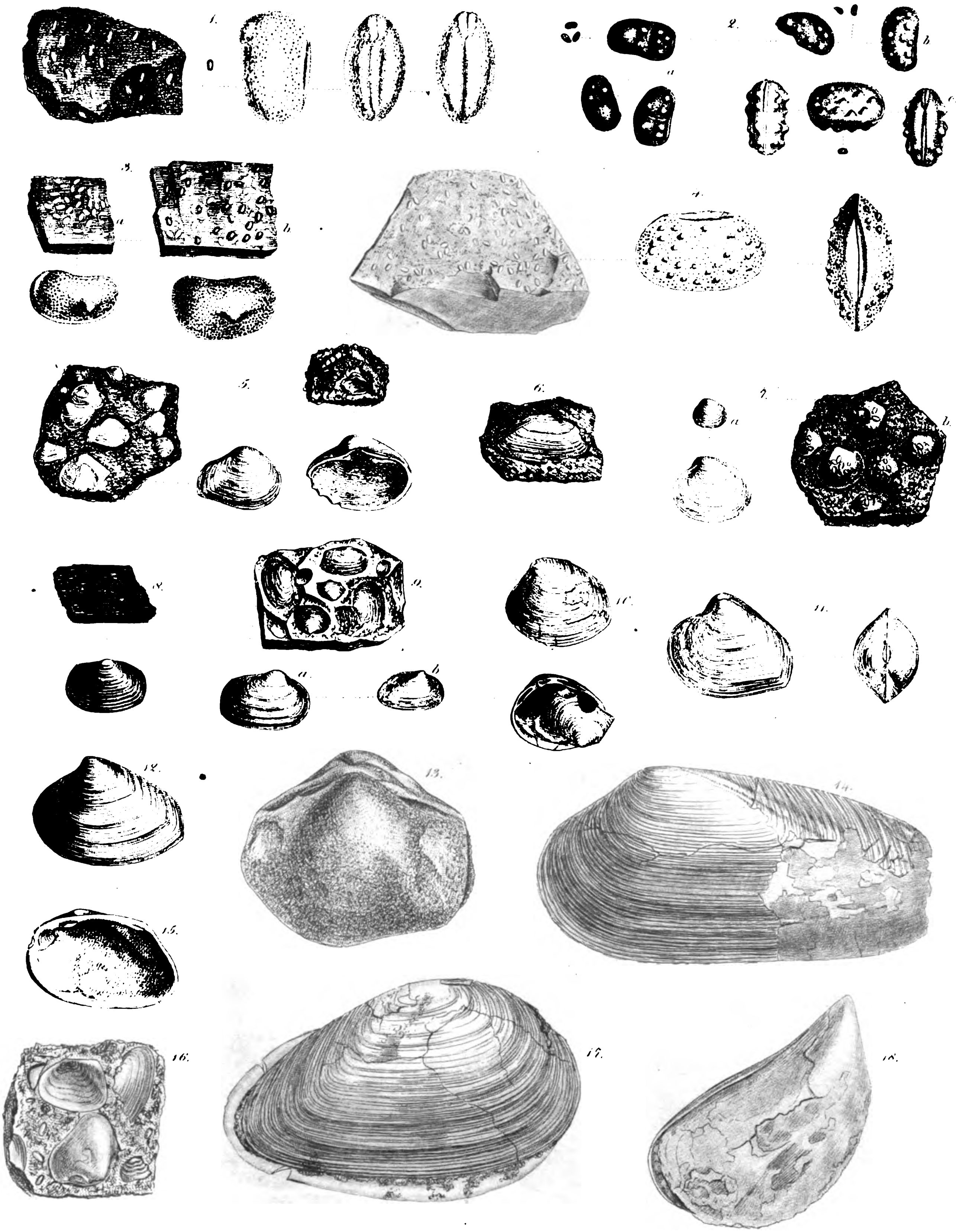
4.a.



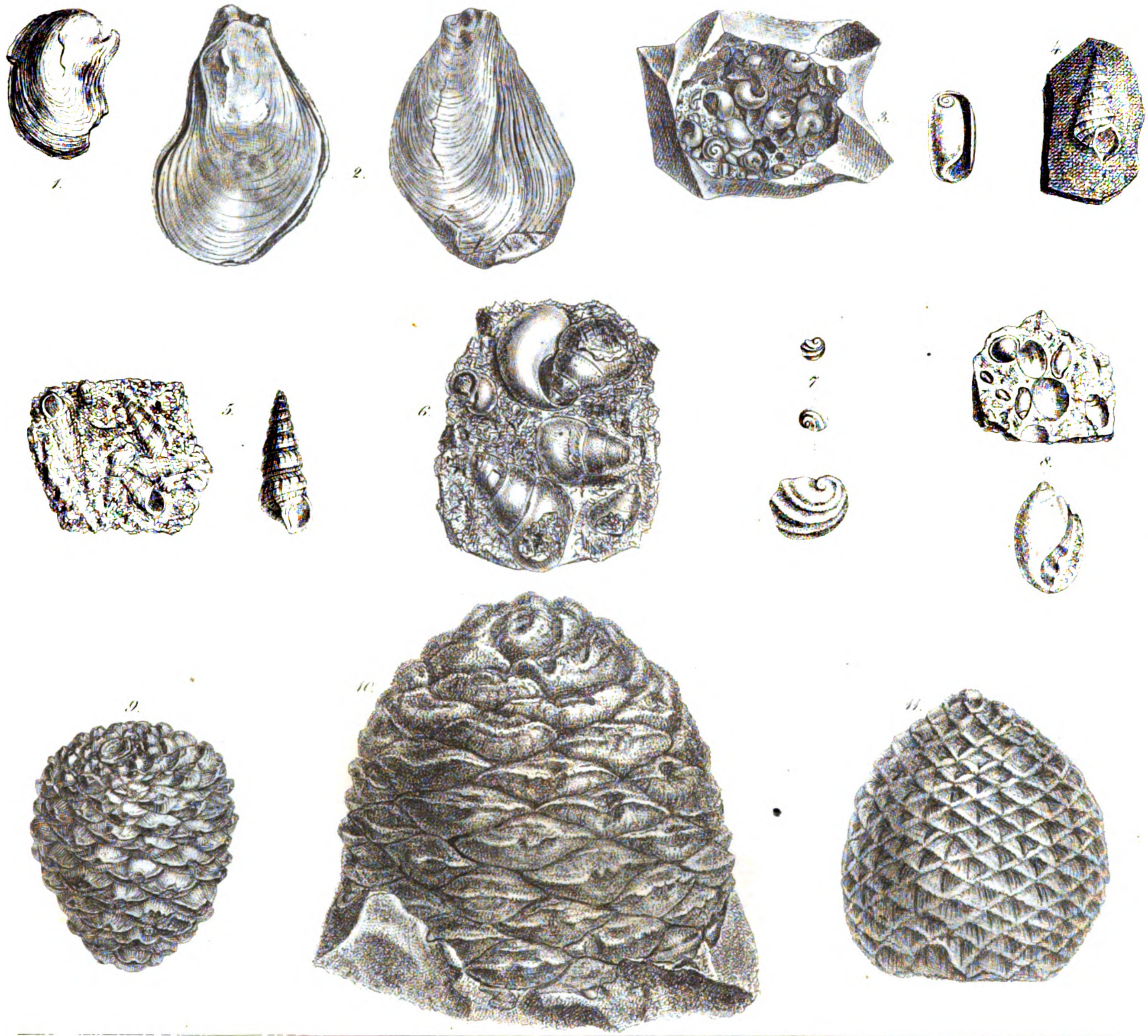
magnified 8 times.

J. D. C. Sowerby fecit.

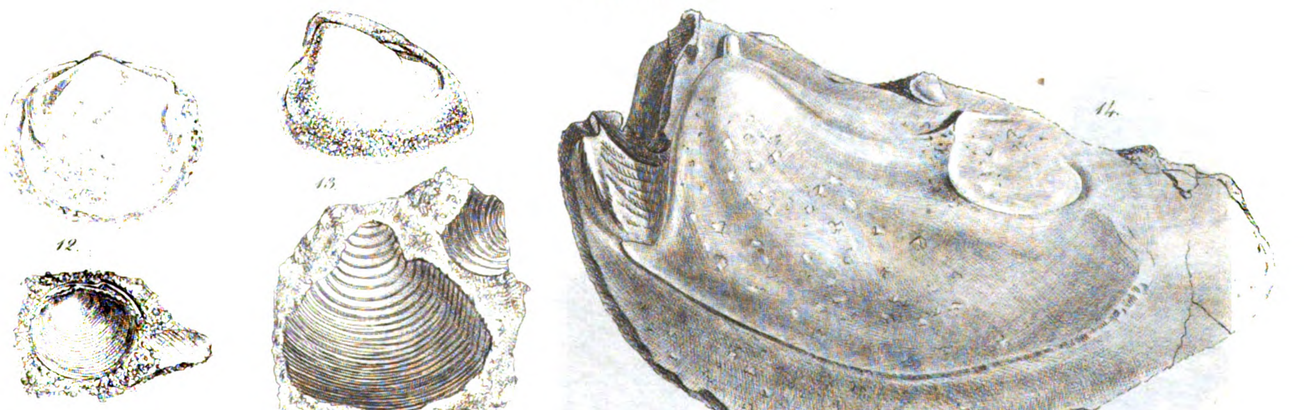
WEALDEN. (continued)



WEALDEN. (continued.)



PORTLAND.



PORTLAND (continued.)

J. D. C. Sowerby

APPENDIX.

APP. A.

Descriptive Notes respecting the Shells figured in Plates XI. to XXIII. *By* James de Carle Sowerby, F.L.S. &c.

PLATE XI.

Fig. 1. *Tornatella elongata.* Elliptical, elongated; surface furrowed; furrows crossed by short lines; whorls about four; lip slightly thickened. This resembles *Acteon* (*Tornatella*) *simulatus* (Min. Con. t. 163. f. 2.) of the London clay, even in the dotted furrows upon the surface of the shell, but it is much longer in proportion, and is only half the size.

Fig. 2. *Lucina? globosa.* A nearly globose smooth shell, with the lines of growth peculiarly waved near the posterior margin. I have not seen the interior.

Fig. 3. *Avicula Gryphæoides.* The convex valve nearly orbicular, with a projecting incurved beak, and two small unequal ears: when alone, it may easily be mistaken for *Inoceramus concentricus,* but the parts about the beak, especially the ears, show the difference. The other valve is nearly flat, orbicular, and has one small and one large ear. The convex valve *a.* is represented from specimens found at Nursted in Hampshire; the other valve, *b.* is from Cambridgeshire.

Fig. 4. *Pentacrinus.* The stem only has yet been found; it is various in size, the sides are concave, the angles rounded. Joints equal, the margins of their surfaces ornamented with short striæ. Some specimens show the bases of lateral arms. It strongly resembles a species found in the chalk;—(Mantell; Fossils of the South Downs, p. 183; Geol. of the S.E. of England, p. 112.); which is, however, much larger.

Fig. 5. *Pollicipes lævis.* The lateral valves are rhomboidal, smooth, thin, and nearly flat: in the partially decomposed state in which they are found, they appear to be composed of layers, of different degrees of transparency and depths of colour. This species also occurs in the green-sand at Blackdown: see Plate XVI. fig. 1.

Fig. 5*. *Pollicipes unguis.* Smooth, the valves are all remarkably curved, and broad in proportion to their length.

Fig. 6. *Pollicipes radiatus.* Valves wedge-shaped, flat, marked with sharp, elevated rays, diverging from their apices.

Fig. 6*. *Pollicipes rigidus* is distinguished by thin transverse elevations, which are very prominent upon the posterior valves: the lateral valves are elongated.

Fig. 7. *Venus? tenera.* Shell lenticular, rather transverse, neatly marked with concentric striæ; lunette lanceolate.

Fig. 7*. *Venericardia tenuicosta.* Transversely oblong, approaching to square. It varies much in convexity: and when old or interrupted in its growth, is nearly globose, rather heart-shaped. Specimens have been found twice the length of that represented in the figure, both of the oblong and globose form. The surface of the rays is rough, with slightly elevated obtuse scales. The interior of the margin is crenated. Lunette rather deep, heart-shaped.

Fig 8. *Nucula bivirgata.* Very convex; the surface ornamented with two sets of linear furrows, which meet towards the posterior slope, at acute angles directed towards the beak of each valve; the junction producing a regular line, without forming a ridge. Lunette broad.

Fig. 9. *Modiola bella.* Neatly striated, convex, with parallel edges, nearly equal sides, and obtuse beaks.

Fig. 10. *Lima semisulcata.* (*Plagiostoma semisulcatum,* Nilsson, Petrif. Suec. 25, t. ix. f. 3.) Ovate elongated, very convex, the beaks incurved, short; ears nearly equal, small. Where the lines of growth cross the ridges, which vary in number from 11 to 16, they form obtuse, short scales or grains.

Fig. 11. *Auricula inflata.* (Benett's Catalogue of Wiltshire Fossils, 4to, p. 2.) Shell ovate; spire small, pointed; the last whorl large; aperture at the lower part approaching to square, but with one of the upper angles elongated and acute; the lips united, thick, obtuse; the columella has two plaits, the lower sometimes divided by a groove along its middle. The surface of the shell is marked with numerous spiral lines of elongated punctures. The thick lip separates this from several species of Tornatella, to which in other respects it bears a strong resemblance. *Auricula incrassata* of Min. Conch. t. 163. is shorter and smaller, and has the lip more enlarged. *A. incrassata* of Mantell (Geol. Sussex, t. xix. figs. 2, 3, and 34.) also resembles it, but has a much shorter spire.

Fig. 12. *Natica canaliculata.* (*Ampullaria canaliculata,* Mantell, Geol. Suss. tab. xix. fig. 13.) Globose, depressed, smooth. Umbilicus large, circular, gradually expanded into the base. Around the upper edges of the whorls is a concave, transversely striated groove, best defined in the young shell,—as in *c.* The inferior specimen, *a b.* is filled with brownish phosphate of lime. See the figure of a much larger specimen, Plate XVIII. fig. 6.

Fig. 13. *Solarium ornatum.* Discoid, with a small portion of the spire elevated and acute; aperture rhomboidal. Surface, above ornamented with obtuse, radiating ribs,—and near the margin, both above and below, with granules in quincunx order.

Fig. 14. *Solarium conoideum.* (Min. Conch. t. 11.) A conical shell as high as it is wide; the umbilicus large and smooth. The outer coat of the shell is represented in this figure; and shows the upper part of each whorl to be concave, and elegantly marked with decussating striæ forming rows of granules; aperture rhomboidal, nearly square.

Fig. 15. *Pyrula Smithii.* Ovato-fusiform; two obscure keels and numerous striæ wind round its surface; spire rather elongated, acute. These two figures, perhaps, represent different species: fig. *a.* is more distinctly keeled than fig. *b.*, which, however, being considerably worn, has lost much of its external sculpture; but shows also longitudinal undulations, which can hardly be traced upon fig. *a.* Both the specimens are from Copt Point, near Folkstone. *Murex Smithii* (Min. Con. 578), lately removed to the genus Pyrula, is a different shell.

Fig. 16. *Rostellaria elongata.* Presumed to be a Rostellaria, from its resemblance to *R. marginata,* fig. 18.; from which it differs principally in its great length and the smaller number of ribs. Turrited, much elongated, ribbed, transversely striated; upper edge of the whorls smooth.

Fig. 17. *Rostellaria buccinoides.* A neat, subulate, costated shell, approaching to *R. rimosa*: it has but one varix upon each whorl: the lip is not lobed.

Fig. 18. *Rostellaria marginata.* Turrited, conical, transversely striated; ribs eight or ten upon each whorl, short and obtuse; last whorl keeled, without ribs. Named from a ridge or narrow band upon the upper edge of each whorl; which is more or less conspicuous in every specimen, and assists in distinguishing the species from *Rostellaria Parkinsoni.* See Pl. XVIII. fig. 24.

Fig. 19. *Rostellaria carinata.* (Mantell; Fossils of the South Downs, p. 86, Pl. XIX. figs. 10, 11, 12, and 14.) This figure, from a drawing by the Rev. G. E. Smith, exhibits the lip in an advanced stage of growth. The spire is nearly subulate, composed of eight or nine convex whorls; a row of small tubercles, or short ribs, winds round the middle of each whorl except the last,

which has two acute keels; the lip has a long forked projection arising from the upper keel; the beak is long and subulate; the whole surface striated.

Fig. 20. *Ammonites? circularis.* Aperture circular; whorls just touching each other: nearly close, acute, circular; sometimes forked ridges cover the surface. This specimen may, perhaps, be a portion of an Hamites or Scaphites?

Fig. 21. *Ammonites symmetricus.* Aperture nearly square; ribs blunt, slightly tumid as they approach the hollow in which the rounded keel is immersed, and though not equal in length, elegantly uniform in their elevation; the sides of the whorls flattened. The specimen here figured, though a fragment only, differs from every Ammonite known to me.

Fig. 22. *Ammonites crenatus.* Sides flattened; the inner whorls much exposed, their margins nearly smooth and rounded, those of the outer whorls crenated on each side of a narrow concave space over the siphuncle. Distinguished from *A. splendens* by the more exposed inner whorls.

Fig. 23. *Ammonites cristatus.* (De Luc, in Brongniart, Env. de Paris, pl. vii. 10.) Some of the ribs being acute and much more elevated than others, form the distinguishing character of this species. I believe *A. cristatus* and *A. subcristatus* of De Luc to be varieties of the same species: I have seen both from Folkstone: the specimen before us belongs rather to the latter variety.

PLATE XII.

Figs. 1, 2. *Hamites rotundus.* (Min. Conch. tab. lxi. fig. 2, 3.) The peculiar structure of the inner extremity in this species, is indicated, rather than distinctly seen, in these figures; which have been engraved from drawings by the Rev. G. E. Smith, taken from specimens collected by Lord Greenock, near Copt Point in Kent. Mr. Smith observes, in a note sent with the drawings, that the termination in a minute whorl, (imperfectly seen in the figures,) had been traced distinctly in more than one specimen; which proved that the coils of the spiral were nearly parallel to the straight part of the stem, and the axis at right angles to it. The spiral appears to have been open, as in many recent Serpulæ; so that its perfect preservation in the fossil could scarcely have been expected: and this would account for the defective state in which the Hamite is commonly found. Mr. Smith adds that the spiral portion appeared invariably to have been decayed, as if it had been filled up with soft matter, as in the case of Magilus. The figures show the remains of the spiral, in two different specimens; but in both much broken and displaced. The spiral part is round, with contiguous annular ribs, also round and regular.

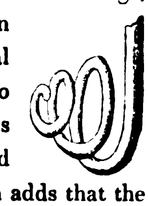


Fig. 3. *Hamites attenuatus.* (Min. Conch. t. lxi. fig. 4. and 5.) Both ends of this species, when complete, are similarly bent or folded in, not spirally, but so that the segments become parallel to each other. The larger parts are rather compressed, the smaller cylindrical; the ribs are annular and rounded.

Fig. 4. *Hamites spiniger.* The general form of this species is like that of *Scaphites Yvanii,* (Bull. de la Soc. Géol. de France, vol. ii. p. 355, pl. ii.); one portion being a flat volute, like an Ammonite, but with unconnected whorls; the other bent into the characteristic form of a Hamites: the sides are flattened. The spines form one of the chief specific characters: there are three rows of them on each side, placed upon the larger ribs on the involute part of the shell; they are gradually lost upon the other parts.

PLATE XIII.

Fig. 1. *Echinus? arenosus.* The underside is imperfect, and the genus therefore doubtful.

Fig. 2. *Panopæa rotundata.* Only a cast, which is nearly smooth. The ridge separating the posterior area, which is small, is strongly marked, and projects on the margin.

Fig. 3. *Trigonia spinosa*, var. Distinguished from *Trigonia spinosa* (Min. Conch. t. lxxxvi.), of which it is a variety, by the presence of longitudinal ridges continued from the bases of the spines, and by its more oblique form. It is often longer than the specimen here figured.

Fig. 4. *Diceras Lonsdalii.* The small portion hitherto examined of the external impression of this curious fossil, shows the shell to have been squamose, like an Oyster, and of considerable thickness. The two valves are less equal in size than is usual in the genus Diceras. The larger valve is an elongated cone, rather flattened and curved twice round; and it appears to have been attached to some foreign body, as in *Diceras arietinum.* The other valve has only an oblique conical umbo.

PLATE XIV.

Fig. 1. *Pholas giganteus.* In general aspect much resembles a Pholadomya; but the apparently squamose structure of the surface shows it to belong to the same section of the Pholades as *P. candidus.* Its valves are so convex as to form nearly a cylinder when closed. The reflected margin near the beak, so large in some Pholades, is probably broken away in this specimen.

Fig. 2. *Modiola lineata.* The depth of each valve is equal to its width; the beaks are obtuse; the margins are arched and nearly parallel; the surface longitudinally and finely striated.

Fig. 3. *Avicula pectinata.* A slightly convex shell, with large, square, depressed ears, and short acute linear ridges, alternately longer.

Fig. 4. *Ostrea retusa.* This, like most Oysters, is very variable in form, but generally much curved and nearly orbicular; the shell is moderately thick, plain in the middle, but strongly plicated at the margin with angular plaits. It occurs in massy groups. It is not so flat as *O. semiplana*, a fossil of the chalk; nor are its valves so equal, nor so thin, as in that species, which it otherwise much resembles.

Fig. 5. *Anomia radiata.* Irregularly orbicular, flat, finely radiated. The radii are coarser, and more distant, than the fine striæ which occur in the London clay species, *Anomia lineata*, (Min. Conch. t. 425.)

Fig. 6. *Anomia lævigata.* Much smoother, and more even, than any other known species: very thin, orbicular, and flat. The figures *a.* and *b.* are taken from different specimens; *a.* in Mr. Smith's collections; *b.* in Mr. Sowerby's.

Fig. 7. *Anomia convexa.* A remarkably convex species, with a large and prominent beak, and smooth surface. The furrows are produced by a Terebratula to which this specimen was attached, and to which it consequently bears a great resemblance.

[The name of this new species has been omitted, by mistake, in the list of Lower green-sand fossils of the Isle of Wight, p. 204. It was found there in the debris fallen from the cliff, on the shore east of Shanklin Chine.]

Fig. 8. *Terebratula Tamarindus.* Nearly orbicular, smooth; margin very obtuse. Disk rather flattened; beaks but little curved, with an angular, slightly prominent ridge on each side, passing down the sides of the valves.

Fig. 9. *Terebratula quadrata.* Ovate, gibbose; beak large; front broad, straight, with a few large plaits.

Fig. 10. *Terebratula Faba.* Elliptical, narrow, gibbose; front concave, but not elevated, very narrow; the perforated beak short, but prominent.

Fig. 11. *Terebratula elegans.* Transversely obovate; beak prominent, pointed, nearly straight; plaits numerous, sharp; front slightly elevated, straight.

Fig. 12. *Terebratula convexa.* Angles rounded; valves very regularly convex; beak large; plaits numerous, rounded; front slightly elevated.

Fig. 13. *Terebratula parvirostris.* Imperfectly tetrahedral, rounded; beak small, sharp; sides slightly produced and angular; plaits numerous, angular; eight or nine of them much elevated in the front.

Fig. 14. *Terebratula prælonga.* Ovate, much elongated, gibbose; front slightly elevated, with a depression in its middle; beak prominent, large; surface smooth. The figure *a.* is from a drawing by the Rev. G. E. Smith; *b.* from another specimen, also found near Sandgate.

Fig. 15. *Lingula? truncata.* Ovate, depressed, flattened most along the middle; front straight.

Fig. 16. *Pleurotomaria gigantea.* (Trochus; British Mineralogy, t. 403.) Conical, height and breadth equal; whorls slightly overlapping each other; sides straight; surface concentrically striated. The transversely striated band proceeding from the deep sinus in the lip, which marks the genus, is well preserved on a specimen seven inches in diameter, in the collection of Charles Manning, Esq., who obtained it from near Hythe, after this plate was engraved. Some specimens of this shell are so much changed by pressure as not to be above one inch high, while they are three or four inches in diameter, with a sharp margin.

Fig. 17. *Ammonites furcatus.* Discoid, sides and front flat; inner whorls partly exposed; aperture with a square front, oblong, deeply impressed with the preceding whorl, lateral angles truncated; ribs not very numerous, thick, curved, many of them forked, passing at right angles across the front.

PLATE XV.

*Scaphites Hillsii**. General form obovate, compressed; the inner whorls exposed, not touching each other, but still curved into a regular volute, compressed, bearing numerous small, close, rounded ribs: the outer whorl strikes off from the others, in nearly a straight line, to a considerable distance, and then bends back so that the aperture nearly touches the preceding whorl, furnished with ten or more distant, very prominent, sharp-edged ribs, which are most raised upon the sides. Aperture nearly square, thin-edged, preceded by a short rib over the front; Siphuncle small, close along the front, or outer margin of the whorls; septa much sinuated, not very close. The system of inner whorls occupies rather more than half the longest diameter of the entire shell, which is about fourteen inches.

Fig. 1. represents a specimen of the inner whorls, reduced to half the real diameter. A small Exogyra was found attached to the inner margin of one of the whorls of this individual, showing that there was always a space between it and the next whorl.

Fig. 2. is drawn from a portion of an outer whorl, also half the natural size. The specimen is irregularly flattened.

The above description has been made from several nearly entire specimens, obtained from the vicinity of Maidstone after this plate was engraved, and now in the possession of Sir Philip Grey Egerton, Mr. Bowerbank, and Mr. Sowerby. An outline, taken principally from Sir P. G. Egerton's specimen, on a scale of one fifth of the original dimensions, is inserted in the plate at fig. 3. Mr. Sowerby has also a specimen, from the same place, of a species nearly agreeing with this one, but probably distinct: it is much larger; and its system of inner whorls is free from radii and undulations.

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* In the list at p. 128, this fossil is erroneously called *Hamites*; perfect specimens not having been found, when that page was printed.

PLATE XV. a.

Siphonia pyriformis. (Goldfuss, Petrefactenkunde, tab. vi. fig. 7.) This plate represents several varieties in the form of this Siphonia, with some details of its structure; from which it may be inferred that the upper, enlarged part becomes broader in proportion, and more pear-shaped, as it increases in size. But although this may be stated as a general rule, the exceptions are numerous, and there seems to be as much variety in the form of the full-grown specimens of the fossil, as in that of the fruit from which this species has been named.

Figure 4, a specimen nearly entire, shows the root-shaped, lower, part of the stem, by which it was fixed to the rock on which it grew. The condition of the fossil does not enable us to speak decidedly as to the original state of the external surface in the living animal: we can perceive, however, that beneath the surface was a system of large tubular canals, placed in a circle, with some degree of regularity as to their distance from each other, and succeeded at intervals by other concentric circles of similar tubes. These are shown in the vertical and horizontal sections fig. 6. and 7., which had been very carefully ground down by the late Mr. Miller, for the purpose of showing the structure, and in the broken and abraded specimens, fig. 4. and 5. Fig. 8. is a specimen of a lower portion of the stem which belonged to the late Mr. Goodhall, F.G.S. Its external surface having been removed, the tubes which form the lower part of the stem are well displayed: and a similar observation may be applied to the head, fig. 5.

In fig. 9. a head is represented, the greater part of which is embraced by a Serpula. From this tube being at present nearly half immersed in the substance of the head, and from the groove-like impression visible in some places, it would appear that after the Serpula had attached itself, the head must have increased considerably in diameter; still, however, preserving its general form and proportions, where not covered by that tube.

PLATE XVI.

Fig. 1. *Pollicipes lævis*: from Blackdown, Devonshire. Supposed to be of the same species as Plate XI. fig. 5, found in the Gault near Folkstone.

Fig. 2. *Serpula filiformis.* The mode of grouping in this Serpula is remarkable. It consists of smooth, round tubes, slightly curved, and aggregated into elongated, often branching masses. The tubes are rather thick, nearly equal throughout their substance. This fossil may be the same with that which Goldfuss calls *S. socialis*, (Petrefactenkunde, tab. lxix. fig. 12.); but as he identifies the species from the oolite with that of the green-sand, I would retain his name for the former only. The substance of this shell in our green-sand fossil is thinner, and the tube generally more curved, than in the *S. socialis* of the oolite.

Fig. 3. *Serpula Tuba.* Simple, almost solitary tubes, of nearly uniform diameter throughout; shell thin.

Fig. 4. *Serpula Vermes.* The tube gradually increases in size, and has a carina along its upper surface. It is a larger, coarser species than Serpula *carinella*, (Min. Conch. t. 598. fig. 2.). *S. conformis* of Goldfuss (Petrefact. tab. lxvii. fig. 13.) is like it, but has subangular sides.

Fig. 5. *Panopæa ovalis.* The regularly oval form shown by the lines of growth, distinguish this from the species found either in the crag or recent: neither does the anterior side gape so much as in any of them. It is moderately convex and smooth; the beaks are nearest the anterior side, which is closed; the posterior extremity is rounded and gaping.

Fig. 6. *Mya læviuscula.* So perfect is this cast in calcedony, that even the asperities of the epidermis, such as occur in recent species, are preserved. The shell, which is nearly twice as

wide as it is long, is moderately gibbose, and has a characteristic depression along its middle. The sides gape slightly.

Fig. 7. *Amphidesma? tenuistriatum.* A transversely elongated, oblong, very flat shell, with numerous impressed striæ, the posterior extremity slightly truncated; the beaks nearly central, not produced. The genus is rather doubtful.

Fig. 8. *Corbula truncata.* Very similar to one, or two, species in the London clay. Its form is oblong-ovate; the posterior side is produced, obliquely truncated, and pointed towards the front. The surface is transversely striated.

Fig. 9. *Mactra? angulata.* Smooth, subtriangular; the posterior side defined by a ridge; beaks small, nearly close; hinge unknown.

Fig. 10. *Petricola nuciformis.* Suborbicular; striated longitudinally; the edge serrated; the beaks small, sunk into the shell.

Fig. 11. *Petricola canaliculata.* Orbicular, very convex, longitudinally furrowed; furrows nearly covered over edge granulated. The concealed furrows are represented in the magnified section; the edges of the costæ between them are sometimes connected across the furrows.

Fig. 12. *Psammobia? gracilis.* Much elongated transversely, nearly cylindrical; surface marked with many raised lines, which are most elevated at their extremities; posterior side defined, produced, and pointed.

Fig. 13. *Lucina? orbicularis.* Orbicular; convex; longitudinally striated; striæ numerous, often forked; beaks small, distant; edge entire.

Fig. 14. *Lucina Pisum.* Nearly globose; fifteen, or more, reflected ridges cross the surface.

Fig. 15. *Astarte concinna.* Oblong, convex, concentrically furrowed, thick; lunette elongated, deeply sunk; beaks oblique. In everything, except the elongated form, this resembles *Astarte striata*, (Min. Conch. t. 520. f. 1.), which is orbicular.

Fig. 16. *Astarte formosa.* Orbicular, approaching to triangular, rather flat, with thick edges; about ten prominent reflected ridges on the surface; lunette elongated, concave. Found in great numbers at Blackdown.

Fig. 17. *Astarte multistriata.* Very convex; rather wedge-shaped; with many concentric ridges, and numerous fine longitudinal striæ between them; lunette large and broad. A small, rare species.

Fig. 18. *Astarte impolita.* Obovate, convex, rather angular at the beaks: surface antiquated; ligament imbedded in a lanceolate groove.

Fig. 19. *Cyprina cuneata.* Cordato-cuneiform; surface even; posterior side straight, a little produced at its extremity; beaks prominent; valves deep; shell rather thin. The specimens found at Blackdown are seldom larger than the small figure: the large one was in the collection of the late Mr. Goodhall.

PLATE XVII.

Fig. 1. *Cyprina rostrata.* Distinguished by its general form from *Cyprina (Venus) angulata* (Min. Conch. t. 65.), which it nearly resembles. It is less convex, the posterior extremity is more produced, and the line thence to the beak straighter.

Fig. 2. *Cytheræa subrotunda.* Flat, lenticular, nearly orbicular, smooth; lunette elongated; fulcrum arched. One specimen has an Exogyra adhering to an eroded part of the surface.

Fig. 3. *Venus? truncata.* Rather less convex than *V. lineolata* (Min. Conch. t. 20.); strongly marked with lines of growth; the posterior side expanded and truncated; lunette obscure, lanceolate.

Fig. 4. *Venus? submersa.* Nearly orbicular; valves tumid; the posterior extremity truncated; lunette obscure; hinge-slope rather straight.

Fig. 5. *Venus? sublævis.* Very flat, elliptical, smooth; lunette undefined, not sunk.

Fig. 6. *Venus? immersa.* Very flat, ovate, smooth; lunette deeply sunk; its edge not defined.

Fig. 7. *Cucullæa formosa.* More deeply striated than *C. fibrosa*; and in form resembling *C. carinata* (Min. Conch. t. 207.). Very convex, transversely elongated; posterior extremity pointed.

Fig. 8. *Arca rotundata.* Surface longitudinally striated; the sides unequal; both rounded. There is no space between the beaks.

Fig. 9. *Nucula lineata.* Elliptical; posterior extremity slightly truncated, with a short point at its upper angle; surface transversely striated, with lines straighter than the lines of growth, which they consequently cross twice.

Fig. 10. *Nucula apiculata.* Convex, smooth, transversely obovate; posterior extremity pointed.

Fig. 11. *Nucula obtusa.* Convex, smooth, elliptical; lunette prominent, elongated.

Fig. 12. *Trigonia quadrata.* Nearly square, flat; anterior extremity rounded; concentrically ribbed; each rib bent at a right angle in the middle, where there is an obtuse knob.

Fig. 13. *Modiola reversa.* Transversely elongated, rather flattened; the posterior portion expanded; surface ornamented with thin concentric ridges, which are bent back or reversed upon the shell. In some individuals they are worn away.

Fig. 14. *Mytilus tridens.* The hinge is furnished with three unequal teeth; elongated, convex, carinated; beaks pointed; the surface very smooth. The teeth distinguish this species from *M. edentulus* (Min. Conch. t. 439. fig. 1.).

Fig. 15. *Mytilus prælongus.* Hinge without teeth; shell very thick, much elongated, keel-shaped. It approaches to *M. lanceolatus* (Min. Conch. t. 439. fig. 2.); but, independently of its remarkable thickness, the sides are nearly parallel, as far as the termination of the hinge-line, which is marked by an angle.

Fig. 16. *Mytilus inæquivalvis.* Shell broad; one valve much flatter than the other; both smooth.

Fig. 17. *Perna rostrata.* Ovate, nearly flat; the surface very smooth; the lesser wing produced; the shell thin, contracted at its base. Fragments of this species are very common at Blackdown, but perfect specimens rare.

Fig. 18. *Avicula anomala.* Obliquely elongated, imperfectly five-angled, flat along the middle; many longitudinal, narrow, elevated ridges extend over the surface, and are crossed by fine lines of growth. The valves are very deep, together measuring about $1\frac{1}{2}$ inch, with a square section; length three inches. This shell I believe to be an *Avicula*, although the hinge is not visible.

Fig. 19. *Pecten Millerii.* Oblong, rather convex; radii smooth, sharp, numerous, especially towards the edge; close together. The two smaller figures represent an unusually convex specimen.

Fig. 20. *Pecten compositus.* Oblong; with about 20 smooth, sharp, radii, and two rows of scales between each of them.

Fig. 21. *Lima? subovalis.* Rather quadrangular, elongated; radii very numerous, equal to the furrows between them, and ornamented with one row of rather obtuse distant scales.

PLATE XVIII.

Fig. 1. *Pecten Stutchburiensis.* Suborbicular, compressed; radii more than 60, alternately smaller, scaly; those towards one side large and distant, with oblique striæ between them.

Fig. 2. *Terebratula dilatata.* Wider than long, depressed, imperfectly three-lobed; plaited, plaits about 50, sharp; central lobe elevated; beak of the larger valve short and large. This resembles *Terebratula Vespertilio* of Brocchi, but is not so wide nor so distinctly three-lobed.

Fig. 3. *Terebratula megatrema?.* Moderately convex, transversely obovate; with a few distinct ribs. The beak is large and produced, with a very large perforation: whence the name.

Fig. 4. *Dentalium medium.* (An inferior figure is in Min. Conch. t. 79.) Subulate, very slightly curved, striated; striæ sharp, elevated, alternately smaller, gradually disappearing towards the aperture.

Fig. 5. *Litorina pungens.* Conical, acute, smooth; whorls five or six, the last inflated; aperture orbicular, with a projecting angle above; columella slightly compressed. This species, probably, belongs to a group of shells which Lamarck has called Ampullaria; and which in the Mineral Conchology is referred to Natica, but in the Index to that work is named Globulus. The columella is, however, rather different.

Fig. 6. *Natica canaliculata.* Species the same as Pl. XI. fig. 12, but a much larger specimen.

Fig. 7. *Natica granosa.* Subglobose; spire prominent, pointed, small; covered with spiral ridges which are divided by the lines of growth into rounded granules; whorls very convex; aperture oblong, expanded; umbilicus open.

Fig. 8. *Natica? carinata.* Oblong, with a small distinct spire; surface marked with five prominent rugged keels; aperture large. This shell appears to be umbilicated, but is not perfect; hence the genus is doubtful.

Fig. 9. *Tornatella affinis.* Ovate, pointed; base truncated; surface grooved, grooves crossed by lines; columella with one simple and one double fold. Very like *Acteon* (*Tornatella*) *simulatus* of the London clay, (Min. Conch. tab. 163. fig. 5. to 8.) but more elongated, more acute, and smaller; yet shorter than *Tornatella elongata*, (tab. 11. fig. 1.).

Fig. 10. *Vermetus concavus.* (Min. Conch. t. 57. fig. 1. to 5.) Tube rounded, curved into a depressed spiral, which is concave beneath; the whorls united by an expansion of the shell from the sides. These figures show the prolongation of the tube beyond the spiral part, which is not shown in the Mineral Conchology.

Fig. 11. *Scalaria pulchra.* An acute shell, with blunt costæ; whorls ten, close: a band connecting the costæ passes along the bases of the whorls.

Fig. 12. *Littorina gracilis.* A pretty, elongated, acute shell, with round whorls, bearing decussated furrows on their upper parts; aperture round, with an angle at the base.

Fig. 13. *Phasianella pusilla.* Elliptical, elongated, pointed, perfectly smooth; aperture elliptical, more than half as long as the shell.

Fig. 14. *Phasianella formosa.* Elliptical, elongated, rather blunt; smooth, except a few striæ at the base; aperture more than half the length of the shell.

Fig. 15. *Phasianella striata.* Elliptical, pointed, strongly striated; aperture oval, above half the length of the shell. This is like *Phasianella princeps* (Defrance), but more regularly oval.

Fig. 16. *Fusus rigidus.* Fusiform, costated, transversely striated; costæ rounded, roughened by the lines of growth; transverse striæ prominent, about 10 upon each whorl; whorls five or six, swelled in the middle, compressed at the upper part; aperture more than half as long as the shell, elliptical, pointed at both ends; beak variously elongated. The individuals of this species differ much in length and asperity; the edge of the aperture is frequently reflected.

Fig. 17. *Fusus quadratus.* (*Murex quadratus*, Min. Conch. t. 410, young.) Fusiform, rhomboidal, with a short conical spire, transversely striated and obscurely bicarinated; base produced, conical; whorls about five; aperture sub-rhomboidal. The form of the shell is fully developed in the specimen here represented.

Fig. 18. *Fusus rusticus*. A short, rugged, ovato-rhomboidal shell; with 10 or 12 ribs, each of which is formed into two knobs, so arranged as to give a squareness to the whorls; transversely striated; aperture ovate.

Fig. 19. *Fusus clathratus*. Sub-pyriform, costated and transversely striated; four carinæ crossing the costæ divide the surface of each whorl into three rows of cells; spire very short. The form is nearly that of a Pyrula.

Fig. 20. *Pyrula depressa*. Pyriform, with the spire sunk beneath the surface of the last whorl. Ornamented with many transverse, thread-shaped ridges.

Fig. 21. *Pyrula Brightii*. Ovate, sub-rhomboidal, ventricose, transversely bicarinated, and coarsely striated: aperture sub-rhomboidal; whorls four or five. Some specimens resemble *Fusus quadratus*, (fig. 17.); but they are shorter, have fewer and more thread-like striæ, and crenated carinæ.—Named after Richard Bright, Esq. of Ham Green, near Bristol.

Fig. 22. *Rostellaria retusa*. A short, ovate, striated shell; whorls rounded, with one distinct and one obscure carina on each. It has only one elongated, narrow branch to the lip. The surface between the striæ is particularly smooth.

Fig. 23. *Rostellaria macrostoma*. Turrited, with convex, carinated whorls; carinæ five, the middle one most prominent; aperture small, round, with a very much expanded and flattened lip, furnished with at least two branches besides the curved beak.

Fig. 24. *Rostellaria Parkinsoni*. (Mantell; Geol. of Sussex, t. 18. figs. 1, 2, 4, 5, 6, and 10. Min. Con. t. 558, upper fig. 3.) Turrited, transversely striated, costated; costæ numerous, oblique, long; aperture narrow; its broad lip furnished with one large subulate process directed upwards, and a broad angular expansion below it; beak long and subulate. The specimen, of which two views are here represented, is not perfect, but yet shows the form of the shell better than any before published, and proves that Mr. Parkinson's specimen from Faversham is a different species, although figured as the same in the Min. Conchology.

Fig. 25. *Nassa lineata*. Ovate, acute, wide at the base, transversely striated; whorls flattish, the upper edges sharp, distinct; aperture longer than the spire. Several species from the crag of Suffolk somewhat resemble this; but in them the body whorl is much smaller.

Fig. 26. *Nassa costellata*. Subulate, costated, and transversely striated; whorls about eight, ventricose, each bearing one varix; aperture nearly orbicular; lip thick.

Fig. 27. *Ammonites triserialis*. Discoid, with a flat margin, umbilicate, radiated. Three rows of protuberances, upon the marginal portions of the radii, and about ten tubercles around the umbilicus, distinguish this species. The aperture is nearly square. All its parts are elegantly rounded.

PLATE XXI.*

Fig. 1. *Cypris Valdensis*. (*C. Faba*?, Min. Conch. t. 485.—See the observations on the specific names; supra, p. 177.) Oblong-ovate, convex, punctated; front slightly concave; at one extremity of each valve is a small oval lobe; back hollow between the valves. It is very doubtful whether this be the *Cypris Faba* of Desmarest†, which is the inhabitant of a much newer fresh-water formation than the Wealden, and appears from the figure to be of a somewhat different form. When the figure in the Min. Conch. above referred to, was published, the author was not aware of there being more than one fossil species of Cypris, and supposed that the minute differences

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* Plates XIX. and XX, containing representations of *Endogenites erosa*, are described above, p. 172—176.: see also hereafter, p. 349.

† *Bull. de la Soc. Philom.* 1813, p. 259. Pl. IV. No. 8.; *Hist. Nat. des Crustacés Foss.* p. 141. Pl. XI. fig. 8.

which he himself had observed, might have escaped the notice of Desmarest's draughtsman; nor has he yet seen specimens from either of the localities given by that author. Besides the fossil species of Cypris engraved in this plate, we are now acquainted with five others; one in the freshwater formation at Hordwell, (see Lyell in Geol. Trans. vol. iii. p. 288.); one in the coal of Newcastle, (*Cypris arcuata*, Bean *MSS.*); and three found among tertiary marine shells of a modern period, in the island of Java;—though the last possibly may belong to the *Cytherina* of Müller, a genus so near to Cypris, that it may not be distinguishable in the fossil state, and the living species of which inhabit the sea.

Fig. 2. *Cypris tuberculata.* Discovered by the Rev. G. E. Smith at Seabrook near Hythe. Oblong-ovate, convex; with a narrow border to the margin, and from three to twelve tubercles upon the surface. The defined tubercles, and a distinct margin distinguish this species from *C. Faba*; it is also rather broader and flatter; but the general form and the number of the tubercles are variable, as well as the division across the middle of each valve, which in some specimens, as at letter *a.*, is so remarkable, as to indicate a distinct species, or even genus. More perfect specimens, however, shown at *b.* and *c.* are quite free from this division; and intermediate forms have been observed. The specimen represented in the upper figure at *a.* is from Swanage Bay; all the others are from the vicinity of Hythe.

Fig. 3. *Cypris spinigera.* Discovered by Mr. Lonsdale in the Weald-clay of the Isle of Wight. Oblong-ovate, broadest at one end, punctated; furnished with a single, short, conical spine on each valve; by which, and a shorter form, it is distinguished from the other species. It has a narrow lobe at one end of each valve of the same kind as in *C. Faba.* The specimens *a.* are from Sandown Bay; *b.* from Atherfield.

Fig. 4. *Cypris granulosa.* Oblong-ovate, punctated; with prominent granules upon its surface; the lobe at one end observable in *C. Faba* is wanting in this species.

Fig. 5. *Corbula alata.* A rather gibbose, smooth shell, with the posterior side produced and truncated.

Fig. 6. *Psammobia? Tellinoides.* (*Psammobia*, Mantell, Geol. S. E. of England, 251.) Shell transversely oblong-ovate; nearly flat, with conspicuous lines of growth. There are a few longitudinal furrows upon the posterior side.

Fig. 7. *Cyclas parva.* Rather thick, smooth, obovate, approaching lenticular; longer than *Cyclas media.* The larger figure, under letter *a.*, is magnified. The shell is found in great profusion in the Vale of Wardour. In the specimen represented at *b.*, from Dallard's Farm, (*suprà*, p. 259, and also from pits at Dashlet,) the shells are filled with the crusts of a small smooth Cypris.

Fig. 8. *Cyclas subquadrata.* Transversely oblong, with straight sides; strongly marked with lines of growth; flat (perhaps from pressure). Found at St. Leonard's, Sussex.

Fig. 9. *Cyclas elongata.* Transversely elongated, convex, nearly smooth; posterior extremity more or less obliquely truncated: the casts of the outside show that the surface is finely striated concentrically. There are two species of Cyclas in the specimen of slaty clay represented in the upper figure, *a.*, which was found at Etchingham near Robertsbridge in Sussex. The same forms occur also in the ferruginous sandstone of Langton Green, near Tunbridge Wells, with Unio, (see below Pl. XXI. fig. 16.); and in a bed of clay at the top of the cliffs on the west of St. Leonard's. It is probable that the rounder species is *Cyclas parva.* Fig. 9. *b.* is a variety of *C. elongata*, from Hollington near Hastings.

Fig. 10. *Cyclas media.* (Min. Conch. t. 527. fig. 2.) A large specimen; with another showing the hinge and its single tooth under the beak. Transversely obovate, depressed, thick, smooth; anterior side small; posterior rather pointed.

Fig. 11. *Cyclas media*: var. Gibbose; posterior side rather cuneiform and truncated. It has the appearance of being a little distorted by age.

Fig. 12. *Cyclas angulata*. Transversely ovate, convex; posterior side truncated, and separated by an angle and a point. A wider, thinner, more transverse, and larger shell than *C. media*.

Fig. 13. *Cyclas major*. (Cyrena, "larger species," Ann. of Phil. N.S. vol. viii. p. 376, *et passim*.) A convex, smooth shell:—the specimens are generally so imperfect, that their size is almost the only character to be observed.

Fig. 14. *Unio Mantellii*. Dorsal and ventral margins nearly parallel, straight; valves flattened, twice as wide as they are long; anterior side small, rounded.

Fig. 15. *Unio subtruncatus*. Ovate; valves flattish, thick, with obtuse edges: the posterior extremity obliquely wedge-shaped.

Fig. 16. *Unio Gualterii*. Nearly square, with the anterior side rounded; depressed; marked with twice bent parallel rugæ; posterior side somewhat eared. The only fossil species known that shows to any extent the waved rugæ so frequent in the recent species of this genus. The depression in the middle is not constant.

Fig. 17. *Unio Martinii*. Ovate, rather convex, nearly smooth, posterior side pointed; umbones not far from the middle, not prominent.

Fig. 18. *Mytilus Lyellii*. Oblong-ovate, somewhat flattened, especially towards the front; convex towards the pointed beaks.

PLATE XXII.

Fig. 1. *Exogyra bulla*. Oblong, convex, nearly smooth; beaks short, curved. The laterally curved beak distinguishes this shell from the Ostreæ of the same beds. Its shape, however, is very variable.

Fig. 2. *Ostrea distorta*. ("Ostrea; an undescribed species", Ann. of Phil. N.S. vol. viii. p. 376.) Elongated, narrow towards the hinge; one valve flat, both nearly smooth. This and the Exogyra, fig. 1. occur in masses, so closely grouped, that the form of the shells can seldom be traced.

Fig. 3. *Bulla Mantelliana*. (*Bulla*, Mantell, Geol. S.E. of England, 249.) A smooth cylindrical shell, nearly twice as long as wide, truncated at both ends: here accompanied by a small *Paludina*, supposed to be *P. elongata*, but which has a smaller spire than that shell generally has.

Fig. 4. *Melanopsis? tricarinata*. (*Melania tricarinata*, Ann. of Phil. N.S. vol. viii. p. 376.) Subulate, conical; whorls seven, carinated. Three carinæ occupy the exposed portions of the whorls, and are crossed by distinct lines of growth; the central one is the most prominent. More perfect specimens have induced me to remove this from the genus Melania to Melanopsis.

Fig. 5. *Melanopsis? attenuata*. Subulate, elongated; whorls about nine; with several carinæ crossed by undulations, strongest at the upper part of each whorl. The length is in proportion greater, and the whorls more numerous than in the last species, fig. 4.

Fig. 6. *Paludina Sussexiensis*. Spire an elongated cone, with nearly straight sides; whorls five, smooth, more numerous than in either *P. fluviorum*, *lenta*, or *carinifera* of Min. Conch. There are, probably, several other species of Paludina in the Wealden strata.

Fig. 7. *Neritina Fittonii*. (Mantell, Geol. S.E. of England, p. 248.) Convex; tricarinated; aperture large; spire very small. The specimens do not show the aperture, and are hardly sufficient to prove this shell to be a Neritina rather than a Nerita. The lowest figure is magnified.

Fig. 8. *Tornatella Popii*. Elliptical, pointed, smooth; spire small, of about three whorls. The cast shows two plaits upon the columella. Named from the Rev. W. L. Pope, of Tonbridge Wells.

Fig. 12. *Lucina Portlandica.* Orbicular, compressed; surface finely striated concentrically. Very like *Lucina concentrica,* (Annales du Mus. tome vii. p. 238, and tome xii. Pl. XLII. fig. 4. *a. b.*), but much more neatly striated; as shown by the cast of the outer surface, represented in the lower figure, which is from the Isle of Portland. The upper figure is from Swindon.

Fig. 13. *Cytherea rugosa.* Subtriangular; posterior extremity and beaks pointed; valves very convex near the beaks; outer surface concentrically furrowed, furrows most numerous on one side.

Fig. 14. *Trigonia incurva.* (*T. incurva,* Benett, Wiltsh. Fossils, tab. xviii. fig. 2.) Convex, flattened posteriorly, transversely much elongated; surface tuberculated; width more than twice the length. Since this Plate was finished, I have seen specimens from Brill, retaining the shell, which is tuberculated, as in *T. clavellata,* but the tubercles are smaller.

PLATE XXIII.

Fig. 1. *Ostrea falcata.* Elongated, curved towards the posterior side; one valve flat, thick; the other unknown.

Fig. 2. *Nerita angulata.* (*Nerita,* 2nd species; Benett's Catalogue, p. 4.) Subglobose?; with a single carina; spire rather small, obtuse; aperture oblong. This cast shows the muscular impression very distinctly.

Fig. 3. *Natica elegans.* Ovato-rhomboidal, smooth; spire small, pointed; whorls four or five, rather angular, their uppermost edges rounded; aperture more than two thirds of the length. The shell in this specimen, whose form is well preserved in silex, is very thin and smooth.

Fig. 4. *Buccinum naticoïde.* (*Ampullaria elongata,* Benett's Catalogue, p. 2.) Ovate, smooth, thick; spire produced; whorls four or five, their upper edges rounded, the last whorl ventricose; aperture ovate, two thirds the length of the shell; spire longer than in the last species; shell very thick.

Fig. 5. *Buccinum? angulatum.* Fusiform, short; sides of the spire straight; the last whorl has one keel in the middle; aperture rhomboidal, with a short rounded beak. In the produced beak, this specimen approaches to the genus Fusus, but the canal appears to be too broad. The external form has not been seen.

Fig. 6. *Terebra Portlandica.* (*Turritella,* Smith, Strat. Ident. Portland-plate, fig. 2.) Turrited, longitudinally striated; whorls rather concave near the upper edge, where they have also longitudinal furrows; aperture acutely elliptical; beak very short, curved. A very common species in the Portland stone; where, however, the form of the aperture is rarely seen. Here, it is preserved in chalcedony.

Fig. 7. *Serpula variabilis.* A cylindrical, rugose shell; with a considerable portion of the tube unattached, and an irregular suture on one or more sides. When young, the attached portion is triangular.

Fig. 8. *Serpula* triserrata*. A thick, externally triangular, attached tube; with three thin, serrated keels upon the upper angle. Attached to a portion of *Ostrea deltoidea.*

Fig. 9. *Mya depressa,* var. Oval, compressed, smooth, twice as wide as it is long. A much wider specimen than that figured in Min. Conch. t. 418. Intermediate forms are also met with.

Fig. 10. *Exogyra Virgula*; Goldfuss, tab. lxxxvi. fig. 3. (*Gryphæa Virgula,* Defrance.) Much elongated, arched; one valve convex, the other concave or flat; convex valve marked with elevated lines; by which the species is well distinguished.

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* This specific name is substituted for "tricristata," given to fig. 8, at p. 231; the latter having been appropriated by Goldfuss to a different species, from the lias near Bantz.—(See Goldfuss, p. 226. tab. lxvii. fig. 6.)

Fig. 11. *Trigonellites latus* Parkinson*. (—*Ichthyosiagones problematicus*, Dr. Rüppell†; *Aptychus lævis*, Von Meyer‡.) Oblong, triangular, compressed; one edge and one angle rounded; the longest edge flattened; one surface concave, striated; the other nearly flat, smooth, but marked with numerous minute circular pits; tissue cellular. I have just learnt from a specimen lent by Mr. Bean, that fig. 18. in Pl. V. of Phillips's Geology of Yorkshire, is a species like this. It is referred by Mr. Phillips to the Oxford clay; but Mr. Bean observes that he has had the same fossil from the Kimmeridge clay of Shotover Hill. A larger species is found at Scarborough, perhaps the same as that before us. (*suprà*, pp. 273, 292, and 316.)

Dr. Fitton, by whom the specimens here represented were found, in clay, near Whitchurch in Buckinghamshire, and at Southrey between Cambridge and Ely, (*suprà*, pp. 273, 292, and 316,) remarks: "When I found this fossil in 1827, I was unacquainted with the publications then "relating to it, and those of Dr. Rüppell and Mr. Von Meyer had not appeared;—but so far as "I can recollect, there was nothing in the circumstances attending these remains that could illus- "trate their origin and connexions. Along with them I found in Buckinghamshire *Gryphæa Vir- "gula*, but no Ammonites: in Cambridgeshire, *Ammonites Lamberti* is mentioned as occurring "at the same place (p. 316.). The valves of the fossil, like those of the Gryphæa, at both places "lay in the clay which contained them, as detached shells might be expected to do, if they had "been lodged confusedly in soft mud. Smaller and thinner valves, perhaps of a different species, "accompanied the larger specimens at Whitchurch, Bucks."

"Of the many names given to this fossil, I have, after some hesitation, retained that of *Tri- "gonellites*, which indicates no more than form; the relations of these singular bodies being still "obscure. As the valves are very often found detached, the term may be used provisionally, or "even ultimately remain, as a convenient denomination; in the same manner as *Belemnites* con- "tinues to be employed, although the bodies to which that appellation is given, are no more than "subordinate portions of some complex structure."

"If the fossils represented in Plate XXIII. be truly of the same species with those of Solen- "hofen, their identity is deserving of notice, geologically."

Fig. 12. *Nerinea Goodhallii*. Turrited, smooth; whorls numerous, half as long as they are wide, concave. There are three plaits in the interior, one upon the columella, one opposite to it, and one above it within the whorl; aperture rhomboidal. The section represented in the left hand figure shows the generic character. The same species but much larger, is found in the Bou-

* "Organic Remains &c.," vol. iii. Plate XIII. fig. 9. and 12.

† *Abbildung und beschreibung einiger neuen oder wenig gekannten Versteinerung, aus den Kalkschiefer Formation von Solenhofon*: von Dr. Ed. Rüppell,—4to, Frankfurt, 1829. Since this sheet has been at the press, (July 1836,) a short paper by Dr. Rüppell has appeared in the London and Edinburgh Philosophical Magazine, (July 1836, vol. ix. p. 32, &c.), to which I wish to refer the reader. Dr. Rüppell regards the two species of Parkinson's *Trigonellites*, as belonging to distinct genera: in one of which (*T. lamellosus*, P.) he supposes the valves to have formed the opercula of an animal somewhat resembling an Ammonite, but destitute of septa: this he proposes to denominate *Pseudammonites*. For the second genus, (to which the specimens represented in Plate XXIII. appear to belong,) Dr. Rüppell retains the name of *Ichthyosiagones*, originally used by Bourdet; and in this case the valves appear to have been internal shells, in large elliptic muscular masses, the structure of which has not yet been brought to light. Subsequently to the publication of Dr. Rüppell's first memoir, Mr. Von Meyer, in a paper referred to below[1], proposed a different view of the relations of these bodies; and gave the name of *Aptychus* to a genus comprehending all the different forms.

[1] *Acta Acad. Leop. Carol. Nat. Cur.* vol. xv. Part II. Read October, 1829; pp. 68—125. tab. lviii. fig. 1, 2, 4.

lonnois; where also other smaller species of this genus occur. This species is named after the late Mr. Goodhall, F.G.S., an indefatigable collector of fossils, and remarkably liberal in affording the use of them to inquirers.

The Wood-cut at p. 129. represents a portion of *Nautilus plicatus*, one third of the original size. The parallel linear furrows which pass over the whorls, are bent three times at acute angles, once on each side and once in the middle, the central angle being directed backwards. There is often some irregularity in the junction of the lines at the angles.

APP. A*.

FIGURES OF VEGETABLE REMAINS.

Sphenopteris gracilis.—The wood-cut at p. 181 represents the impression of a species of fern, discovered in the Hastings-sands, near Tonbridge Wells, by the Rev. W. L. Pope of that place. It has been referred to the genus *Sphenopteris* of Adolphe Brongniart*, notwithstanding its acuminate pinnulæ, and a certain degree of resemblance to *Odontopteris minor*, (Brongn. Veg. Foss. Pl. lxxvii.), on the ground of its apparent affinity to *Sphenopteris Mantelli* (Ibid., p. 170. Pl. xlv. fig. 3—7); its pinnulæ having a midrib, but no lateral veins. This specimen was accompanied by the impression of a species very nearly allied to, and perhaps no more than a variety of, *Sphenopteris Mantelli*.

PLATES XIX. AND XX.

Endogenites erosa.—The description of the plates representing the external form and internal structure of this singular fossil will be found above; (85.) to (89.), p. 172, 176. After those pages had been printed, two remarkable varieties of the form were discovered, in cutting down the cliffs near the White Rock at Hastings; in which the stony nucleus was not only very irregular in figure, but apparently divided into flat lobes, disjoined, or scarcely connected by very thin flakes of stony matter; the whole being externally coated with lignite, which occupied the entire thickness of the fossil in the intervals between the lobes. The form and mode of connexion, or apposition, of these stony nuclei, when divested of their covering, were such as to suggest a comparison with some varieties of Cactus.

PLATE XXII.

All that is known of the Cones and cone-shaped body, Figures 9, 10, and 11, of this plate, is mentioned in the list of fossils, at pages 181, 230, and 290. A section of that represented in fig. 11. on its longer diameter, did not exhibit any indication of vegetable structure: but the general resemblance in the outline and aspect of this specimen to part of the reduced figure of *Zamia horrida* given in Dr. Buckland's plate, (Geol. Trans. 2nd Series, vol. ii. Pl. xlviii. fig. 4.) is, perhaps, deserving of notice.

A *Cone* has recently been found on the shore of the Isle of Portland, not improbably derived from one of the beds of clay, or "Dirt", subordinate to the lower part of the Portland strata, the structure of which, according to Mr. Brown, approaches in some respects to that of *Araucaria*. I am indebted to the kindness of the Rev. David Williams, of Cross, near Bleadon in Somersetshire, to whom it belongs, for an opportunity of submitting this beautiful specimen to the examination of Mr. Brown, who will, I hope, describe its structure in the Transactions of the Linnæan Society.

* *Prodrome*, &c., p. 50.—*Hist. des Vég. Fossiles*, p. 169.

APP. B.

SYSTEMATIC AND STRATIGRAPHICAL LIST OF FOSSILS.

In the subjoined Tables, the *Genera* of the fossils mentioned in the lists given in the preceding pages, are arranged in systematic order; the *Species* are disposed alphabetically. The new species are in Roman letters; those previously figured, in Italics. The headings of the columns respectively explain their contents; and the following abridgements are employed:—

I.—*Synonyms and References to Authors.*

1. The Roman numerals, followed by Arabic numbers, refer to the Plates annexed to this paper: the small Roman letters refer to the volumes, or Plates, of other publications.
2. *M.C.*—refers to the "Mineral Conchology" of Sowerby; the numbers following those letters denoting the Plates and Figures.
3. *Ben.*—"A Catalogue of the Organic Remains of the County of Wilts". By Miss Ethelred Benett; 4to, Warminster, 1831.
4. *Brong.*—Cuvier and Brongniart's "*Environs de Paris*"; forming the 7th volume of Cuvier's "*Ossemens Fossiles*", 2nd edition.
5. *Ad. Brong.*—Adolphe Brongniart.
   ——— *Prod.*—"*Prodrome d'une Histoire des Végétaux Fossiles,*" 8vo.
   ——— *Hist.*—"*Histoire des Végétaux Fossiles,*" 4to.
6. *G.T.*—"Transactions of the Geological Society," 1st and 2nd Series.
7. *Gold.*—Goldfuss, "*Petrifacta Germaniæ, &c.* ("*Petrifacten Deutschlands, &c.*") Folio, Dusseldorf, 1826, &c.
8. *Mant.* or *M.*—refers to the publications of Mr. Mantell, distinguished as follows:—
   Mant. Suss.—"The Fossils of the South Downs"; or "Illustrations of the "Geology of Sussex," 4to, 1822.
   —— *Til.*—"Illustrations of the Geology of Sussex; with figures and "descriptions of the fossils of *Tilgate Forest*"; 4to, 1827.
   —— *Cat.*—"A Tabular Arrangement of the Organic Remains of Sussex," Geol. Trans. 2nd Series, vol. iii. p. 201, &c.; republished in the Geology of the South-east of England.
   —— *S.E. Eng.*—"The Geology of the South East of England," 8vo, 1833.
9. *Mar.*—"Geological Memoir on a part of Western Sussex," by P.I. Martin, London, 4to, 1828.
10. *Nil.*—Nilsson; "*Petrifacta Suecana,*" 1827.
11. *Par.*—denotes the works of Mr. Parkinson.
   —— *O.R.*—"Organic Remains," 3 vols. 4to. 1811.
   —— *Intr.*—"Outlines of Oryctology, or an Introduction to the study of "Organic Remains," 8vo, London, 1822.

II.—*Stratigraphical and Local Distribution.*

In this division of the Tables, the name of the formation is placed at the head of each column; "*Blackdown*" denoting the sands at that place and on the Devonshire coast, which seem to represent the whole of the Green-sand series.

The Lists of Fossils given in the preceding paper are referred to *by Counties*, the names of which are abridged as follows; the numbers after the abridged names denoting the pages where the species, respectively, are mentioned.

1. Kent *or* Kt.	*Kent*;—(14.) p. 112. 115.; (36.) p. 127, 131.	
2. Sur.	*Surrey*;—(68.) p. 152, 153.	
3. Ham. *or* Hnts.	*Hampshire*;—(75.) p. 156, 159.	
4. Suss. *or* Sss.	*Sussex*;—(90.) p. 176, 181.	
5. I. of W.	*Isle of Wight*;—(102.) p. 202, 206.	
6. Dor.	*Dorsetshire*;—(115.) p. 228, 232.	
7. Bl. *or* Dev.	*Blackdown*, and *Coast of Devonshire*;—(123.) p. 239, 242.	
8. S. Wilts, *or* S.W.	*South Wiltshire*;—(138.) p. 257, 261.	
9. N. Wilts, *or* N.W.	*North Wiltshire*;—(142.) p. 267, 269.	
10. Oxf. *or* Ox.	*Oxfordshire*;	—(155.) p. 296, 303.
11. Bucks, *or* Bcks.	*Buckinghamshire*;	
12. Bedf. *or* Bed.	*Bedfordshire*;	
13. Cam.	*Cambridgeshire*;	—(162.) p. 316, 317.
14. Nor.	*Norfolk*;	

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
VEGETABLE REMAINS.													
Fucoides	*Targionii*	Ad. Brong. *Hist.* iv. 6. Man. S.E. Eng. p. 166		I. of W. 203	I. of W. 204.								
Sphenopteris	*Mantellii*	Ad. Brong. *Hist.* xlv. 3-7. Mant. Tilg. p. 55, *note.*						Kent, 171, *note.*					
———	gracilis	Wood-cut, p. 181.						Suss. 181.					
Endogenites	*erosa*	XIX. & XX. G.T. 2nd Ser. i. 423. Mant. Tilg. p. 54.						Suss. 164, 167, 168, 172, 181.					
Mantellia	*nidiformis*	Ad. Brong. *Prod.* 96. *Cycadeoidea megalophylla,* Buckland, G.T. 2nd Ser. vol. ii. Pl. 47, 48.							Dor. 223, 230.				
———	microphylla	*Cycadeoidea microphylla,* Buckland, G.T. 2nd Ser. vol. ii. Pl. 49.							Dor. 230.				

Besides the foregoing, the following remains of Vegetables have been found; but too indistinct to admit of the determination of their Genera and Species.

Cone, species unknown; XXII. 10.; *Hastings-sand,* Suss. 181.
—— Another unknown species; XXII. 9.; *Purbeck,* Dor. 230.
—— Cone-like body, (*Quæ.* part of a Cycadeous plant); XXII. 11.; *Purbeck,* Bucks, 298.
Wood, coniferous silicified; *Lower green-sand,* Kent, 131, 153., Bedf. 297.; *Weald-clay,* Dor. 228.; *Hastings sand,* Dor. 229.; *Purbeck,* Dor. 221, 230., Oxf. 299.
—— dicotyledonous; *Gault,* Kent, 115.
—— bituminized, *Purbeck,* Oxf. 291.
—— large trunk of lignite; *Purbeck,* Bucks, 299.
Leaves of a Fern?; *Hastings-sand,* Isle of Wight, 203.
——— indistinct impressions of; *Upper green-sand,* Ham. 157.; *Purbeck,* Oxf. 299.

Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
ANIMAL REMAINS.													
POLYPARIA.													
Siphonia	*pyriformis*	XV. a. Gold. vi. 7.; & xxxv. 10. Park. O.R. ii. p. 96. Pl. 9. & 11.				Bl. 242.							
———	Websterii	G.T. 1 Ser. ii. pl. 27-30 Park. Intr. p. 51-2.	I of W 203										
———	Stems of uncertain species		Dor. 228. Bed. 296. Nor. 317†	Nor. 317.	Kent, 130. I. of W. 204. Bucks, 297.					Bucks, 300.			
Cyathophyllum		Gold. p. 54. & 244.		Kent, 113. S. Wilts 258.	Kent, 128								
Lithodendron?		Gold. vol. i. p. 44. *Caryophyllia* (Lam.)		Kent, 113.									
Astrea	*Tisburiensis*	*Madrepora Tisburiensis* (Miss Benett)								S. Wilts 260.			
———	species uncertain				Kent, 128. I. of W. 204.								Cam. 317

† In grey marl, at the bottom of the white chalk, Hunstanton.

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Madrepora	species uncertain	Goldfuss i. p. 22.			Kent, 129.								
Turbinolia	*Kœnigii*	Mant. Suss. xix. 22, 24.		Kent, 114. Surrey, 153									
Radiaria.													
Pentacrinites	*scalaris*??	XI. 2. (*Qu.* Gold. lii. 3. *e. f.*)		Kent, 114. S. Wilts, 259	Kent, 130								
Echinus?	arenosus	XIII. 1.			Kent, 128.								
———	species doubtful				Kent, 128.	Dev. 240.				S. Wilts, 260			Cam. 317.
Cidaris	*scutiger*	Gold. xlix. 4.			Kent 128.								
———	spines												Cam. 317.
Galerites	*subuculus*	Gold. xli. 2.			Kent, 128.								
Clypeus	*cunicularis*	Smith; Strata identified											Dor. 232.
Nucleolites	*carinatus*	Gold. xliii. 129. f. 11.			Kent, 129.								
Echino-spatangus	3 new species		Ham. 156.										
Spatangus	*argillaceus*	Phil. ii. 4.		Kent, 114.									
———	*Bucardium*?	Gold. xlix. 1.	S. Wilts, 258										
———	*Bufo*	Brong. *Env. de Paris*, Pl. V. f. 5. Gold. xlvii. 7.				Bl. 242.							
———	*granulosus*?	Gold. xlv. 3.	S. Wilts, 258										
———	*retusus*	Gold. xl. 2.			Kent, 130.								
———	three species, probably new				Kent, 130.								
———	species doubtful		I. of W. 203.		I. of W. 204.								
———	new?					Bl. 242.							
Crustacea.													
Cancer?		Martin, 34.			Suss. 157.					S. Wilts, 260			
Cypris	granulosa	XXI. 4.						Suss. 177	S. Wilts. 260 ?				
———	spinigera	XXI. 3.											
———	tuberculata	XXI. 2.					Kent, 177. I. of W. 205 Dor. 228.						
———	Valdensis	XXI. 1. (Olim *C. Faba*)					K. & Sss. 177 Sur. 177. I. of W. 205. Dor. 228.	K. & Sss. 177 Sur. & Ham. 177. I. of W. 204.	K. & Sss. 177 Sur. & Ham. 177. I. of W. 205. S. Wilts 260 Bucks, 297.				
———	species uncertain								Dor. 229. Bucks, 297.				
Astacus	claws			S. Wilts, 258	Kent, 128.					S. Wilts, 260			
———	(portions of)					Dev. 239.			Bucks? 297.				
———	species doubtful				I. of W. 204								

Corystes?		Mant. Sx. xxix. 13.		Kent, 113.									
——— ?					Kent, 128.								
———					Suss. 157.								
ANNULATA.													
Serpula	*ampullacea?*	M.C. 597, 1—5.				Bl. 242.							
———	*antiquata*	M.C. 598, 4.	Kent, 114. Dor. 228.		Kent, 130.	Bl. 242.							
———	*antiquata?*				I. of W. 204.								
———	*articulata*	M.C. 599, 4.		Kent, 114.									
———	*carinella*	M.C. 598, 2.				Bl. 242.							
———	filiformis	XVI. 2. (Qu. *S. socialis*, Gold. lxix. 12.?)				Bl. 242.							
———	*plexus?*	M.C. 598, 1.				Bl. 242.							
———	*rustica*	M.C. 599, 3.	Kent, 114.										
———	*tetragona*	M.C. 599, 1 and 2.										Bedf. 302.	
———	*tricarinata* †	M.C. 608, 3 and 4.										Bucks, 302.	
———	triserrata‡	XXIII. 8.									Dor. 231.	Dor. 231.	
———	tuba	XVI. 3.				Bl. 242.							
———	variabilis	XXIII § 7.			Kent, 130.						Dor. 231.		
———	Vermes	XVI. 4. (Qu. *S. conformis*, Gold. lvii. 13. *b.*)				Bl. 242.							
———	spec. uncertain			S. Wilts, 250	Kent, 153.					S. Wilts 261 Oxf., and Bucks, 300.	Oxf., and Bucks, 300.		
———	spec. uncertain				I. of W. 204			Bucks, 297.					
CIRRIPEDA.													
Pollicipes	lævis	XI. 5. XVI. 1.		Kent, 114.		Bl. 241.							
———	radiatus	XI. 6.			Kent, 130.								
———	rigidus	XI. 6*.		Kent, 114.									
——— ?	unguis	XI. 5*.		Kent, 114.									
CONCHIFERA.													
Teredo?				Kent, 114. Cam. 114.									
Fistulana					Kent, 152.								
Pholas?	gigantea	XIV. 1.		Kent, 115.	Kent, 130.								
———	*prisca*	M.C. 581.			Kent, 130.	Bl. 241.							
Gastrochæna					Kent, 128.					N. Wilts 268 Oxf. 299.	Bedf. and Bucks, 301.		Cam. 317
———					I. of W. 204								
Pholadomya	*deltoidea*	M.C. 197, 4.											Oxf. 303.
———		Martin, Mant. MSS.		Kent, 130.	Suss. 158.								
———	?				Kent, 152.								
Panopæa	*depressa*	XXIII. 9. (*Mya depressa*.) M.C.								Bucks 299	S. Wilts 261 Dor. 231.	Dor. 232. Oxf. 302.	
———	*gibbosa*	M.C. 42.								Bucks, 299.			
———	ovalis	XVI. 5.				Bl. 241.							
———	*plicata*	(*Mya plicata*) M.C. 419, 2, 3. Martin, MSS.	N. Wlts? 267	Kent, 114	Kent, 129. Suss. 158. I. of W. 204 Nor. 317.	Dev. 241.							
——— ?	rotundata	XIII. 2.			Kent, 129.								

† *S. tricarinata* of Goldfuss, Tab. lxviii. f. 6. is a different species. Sowerby's name and figure (608.) were published in July, 1829.
‡ This specific name is substituted for "tricristata", used at p. 231: see the description, *supra*, p. 347.
§ The Plate is erroneously stated to be XXI. at page 180.

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kim.-clay.	Oxford-oolite.
Panopæa	new?				I.of W. 204								
——?											Bucks 301.		
Mya	*depressa*	(See *Panopæa.*)											
——	læviuscula	XVI. 6.				Bl. 241.							
——	*mandibula*	M.C. 43.	N. Wilts267	I of W203 Dor. 228.	Suss. 158.	Dev. 241.							
——	plicata	(See *Panopæa.*)											
——	doubtful				Kent, 152.								
——	three species	Martin, p. 33.			Suss. 158.								
Lutraria?	*striata*	M.C. 534, 1.				Bl. 241.							
——?					Kent, 129.								
Mactra	angulata	XVI. 9.				Bl. 241.							
Amphidesma	tenuistriatum	XVI. 7.				Bl. 239.							
Corbula	alata	XXI. 5.						Suss. 176.	Dor. 229.				
——	*elegans*	M.C. 572, 1.				Bl. 240.							
——	*gigantea*	M.C. 209, 5, 6, & 7.			Ham. 157.	Bl. 240.							
——	*lævigata*	M.C. 209, 1 and 2.				Bl. 240.							
——	*striatula*	M.C. 572, 2. and 3.		Kent,113	Ham. 157. Suss. 157. I. of W.204								
——	truncata	XVI. 8.				Bl. 240.							
——?					N.Wilts268				S. Wilts 259				
——	(2 other species)					Bl. 240.							
——	new species	Martin, p. 32.			Suss. 157.								
Petricola	canaliculata	XVI. 11.				Bl. 241.							
——	nuciformis	XVI. 10.				Bl. 241.							
Psammobia?	gracilis	XVI. 12.				Bl. 242.							
——	Tellinoïdes	XXI. 6.						Suss. 178.					
——	spec. uncertain					Oxf. 298.							
Tellina	*inæqualis*	M.C. 456, 2.			Suss. 158	Dev. 242. Bl. 242.							
——	*æqualis*	G.T. 2 Ser. iii. p.211			Suss. 158.								
——	*striatula*	M.C. 456, 1.				Dev. 242. Bl. 242.							
——?	a new species				Suss. 158.								
Lucina?	orbicularis	XVI. 13.				Bl. 241.							
——	globosa	XI. 2.											
——	pisum	XVI. 14.				Bl. 241.							
——	Portlandica	XXII. 12.								S.Wilts 261. N.Wilts268 Bucks,299.			
——?	a new species				Ham. 158. Kent, 129. Suss. 158.								
——	two species?												
——	species doubtful										Bucks,301.		
Sphæra	*corrugata*	M.C. 335.			Kent, 130. Sur. 153. I.of W. 204								
Astarte	concinna	XVI. 15.				Bl. 239.							

——	*cuneata*	M.C. 137, 2.				Bl. 239.				S.Wilts 260 Oxf. 299. Bucks 299.		Dor. 232.	Dor. 232
——	*elegans*	M.C. 137, 3.											
——	formosa	XVI. 16.				Bl. 239.							
——	impolita	XVI. 18.				Bl. 239.							
——	*lineata*	M.C. 179, 1.				Bl. 239.							
——	multistriata	XVI. 17.				Bl. 240.							
——	*obovata*	M.C. 353.			Kent, 128.								
——	*striata*	M.C. 520, 1.				Bl. 240.							
——	fragments of 3 new species?				Kent, 128.								
Cyclas	angulata	XXI. 12.					Suss. 176.		Bucks, 297. Dor. 229. S.Wilts259				
——	elongata	XXI. 9.						Suss. 177.	S.Wilts259 Bucks, 297.				
——	major	XXI. 13.					Sus. 176, 177 I. of W. 205	I of W205	S.Wilts 259				
——	*media*	XXI. 10. M.C. 527, 2.					Suss. 176-7 I. of W. 205 Dor. 228.	Suss. 176. I. of W. 205 Dor. 229.	Sus. 176 Dor 229. S.W. 259 Bucks, 297.				
——	*media?*							Bucks, 297.					
——	*membranacea*	M.C. 527, 3.					Suss. 177 I. of W. 205 Dev. 228.	Sus. 177.	S.Wilts 259				
——	parva?	XXI. 7.							Bucks, 297. S.Wilts259.				
——	subquadrata	XXI. 8.						Suss. 177					
——	species probably new						I. of W. 205	Suss. 177. Bucks297	Bucks. and Oxf. 297.				
Cyprina	*angulata*	M.C. 65, Martin, MS.			Kt128,153? Suss. 157.	Bl. 240. Dev. 240							
——	cuneata	XVI. 19.				Bl. 240.							
——	rostrata	XVII. 1.				Bl. 240.							
Cytherea	*caperata*	M.C. 518, 1.				Dev. 240. Bl. 240.							
——	*lineolata*	M.C. 20, upper fig.				Bl. 240.							
——	rugosa	XXII. 13.								S.Wilt. 260 N.Wilt. 268 Bucks, 299	Bucks301		
——	subrotunda	XXII. 2.				Bl. 240.							
——	*parva*	M.C. 518, 46.		Kent, 113. S.Wilts, 258	Suss. 157. Ham. 157.	Bl. 240.				Dor. 230.			
——	*plana*	M.C. 20, lower fig.				Bl. 240. Dev. 240.							
Venus	*angulata*	(See *Cyprina.*)											
——	*caperata*	(See *Cytherea.*)											
—— ?	immersa	XVII. 6.				Bl. 242.							
——	*ovalis?*	M.C. 567, 1, 2.			Kent, 131 Suss. 159								
——	*Faba*	M.C. 567, 3.			Suss. 159 Nor. 317	Bl. 242.							
——	*lineolata*	(See *Cytherea.*)											
——	*parva*												
——	*plana*												
——	sublævis	XVII. 5.				Bl. 242.							
—— ?	submersa	XVII. 4.				Dev. 242.							

Fossils.			Stratigraphical and Local Distribution.											
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kim.-clay.	Oxford-oolite.
Venus?	tenera	XI. 7		Kent, 114									
——?	truncata	XVII. 3				Bl. 242.							
——	small spec. cast				Kent, 131								
——	two other casts	Martin, MSS.			Suss. 159								
——?			I. of W. 203										
——	two species, probably new)					Bl. 242.							
——												Oxf. 302.	Cam. 317
Venericardia	tenuicosta	XI. 7*.		Kent, 114. S. Wilts 259.									
Thetis	*major?*	M.C. 513, 1-4.	Ham. 157.		K. 131, 153? Suss. 159. I. of W. 205	Dev. 242. Bl. 242.							
——	*minor*	M.C. 513, 5, 6.			S.& H. 159. I. of W 205. N. Wilts 268	Dev. 242. Bl. 242.							
——	new	Martin, MSS.			Suss. 159.								
——	new					Dev. 242.							
Pullastra?										Oxf. and Bcks. 300	N. Wilts 269		Dor. 232
Cardium?	*decussatum*	M.C. 552, 1.		Kent, 113.					S. Wilts 259				
——	*dissimile*	M.C. 553, 2.			Kent, 128.					S. Wilts 260 N Wilts 268 Oxf. 301. Bucks 301.	Oxf. 301. Bucks 301		
——	*Hillanum*	M.C. 14, upper fig.				Bl. 240.							
——	*proboscideum*	M.C. 156, 1.				Bl. 240.							
——	*striatulum*	M.C. 553, 1.			N. Wilts, 268								
——	new species, delicately striated	Martin, MSS.			Suss. 157.								
——	species doubtful			Kent, 113.									
——		M.C.	I. of W. 203										
——?									S. Wilts 259				
Isocardia	*similis*	M.C. 516, 1.			Kent, 129.								
——?						Bl. 241.							
——													Cam. 317
Cucullæa	*carinata*	M.C. 207, 1.				Bl. 240.							
——	*costellata?*	M.C. 447, 2.			Kent, 128	Dev. 240.							
——	*decussata*	M.C. 206, 3 and 4.	I. of W. 203		Kent, 128 Suss. 157	Bl. 240.							
——	*fibrosa*	M.C. 207, 2.				Bl. 240. Dev. 240.							
——	formosa	XVII. 7.				Bl. 240.							
——	*glabra*	M.C. 67.	I. of W. 203		Kent, 128	Dev. 240.							
——	*glabra?*				Suss. 157.								
——	doubtful		Ham. 156.		Kent, 152.								
——	1 or 2 other spec.	Martin, MSS.			Suss. 157.								
——	new				Kent, 128. N. Wilts 268								Cam. 317
——	a small species										Dor. 231.		

Arca	*carinata*	M.C. 44. lower fig.	Ham. 156.										
——	rotundata	XVII. 8.				Bl. 239.							
——	spec. uncertain				N. Wilt268.					Oxf. 299.			Cam.317
Pectunculus	*sublævis*	M.C. 472, 4.				Bl. 241.							
——	*umbonatus*	M.C.472, 3; 156, 2-4		S. Wilts, 259	Kent, 130.	Bl. 241. Dev. 241.							
Nucula	*angulata*	M.C. 476, 5.				Bl. 241.							
——	*antiquata*	M.C. 475, 4.			Suss. 158.	Bl. 241.							
——	apiculata	XVII. 10.				Bl. 241.							
——	bivirgata	XI. 8.		Kent, 113									
——	*impressa*	M.C. 475, 3.			Suss. 158.	Bl. 241.							
——	lineata	XVII. 9.				Bl. 241.							
——	obtusa	XVII. 11.				Bl. 241.							
——	*ovata*	Mant. Sx. xix. 8.		Kent, 113.	Kent, 129.								
——	*pectinata*	M.C. 192, 6, 7.		Kent, 113. Cam. 113. Kent 152 S. Wilts 259		Dev. 241.							
——?	*undulata*	M.C. 554, 3.		Kent, 114. Bed. 296.									
Trigonia	*affinis*	M.C. 208, 3.				Bl. 242.							
——	*alæformis*	M.C. 215.		S. Wilts 259	Kt. 131 & 153 Ham. & Sus. 159 I of W. 205	Bl. 242. Dev. 242.							
——	*clavellata*	M.C.			Kent, 131.					Oxf. 300.	Dor. 231. N. Wilts 269 Bucks, 301.	Dor. 231.	Dor.232.
——	*clavellata?*				Ham. and Suss. 159.								Dor.232.
——	*costata*	M.C. 85.											Dor.232.
——	—— var.	(See *elongata.*)											
——	*dædalea*	M.C. 88.			Suss. 159.	Bl. 242.							
——	*eccentrica*	M.C. 208, 1-2.				Dev. 242.							
——	*elongata*	a variety of *T. costata* M.C. 431.			Kent, 131.								
——	*gibbosa*	M.C. 235-6.			N. Wilts268					Dor. 231. S. Wilts, 261 N. Wilts 268 Oxf. and Bucks, 300.	N.W. 269 Oxf. and Bucks302		
——	—— (var.)	approaching to *T. incurva*								Dor. 231.	Bucks. 302.		
——	incurva	XXII. 14. Benett 18, f. 2.								Dor. 231. S. Wilts, 261 N Wilts, 268 Bucks, 300	Bucks302		
——	*nodosa*	M.C. 507, 1.			Kent, 131.								
——	*pennata*	M.C. 237, 6.				Dev. 242.							
——	*Pullus*	M.C. 508, 2, 3.											Cam.317
——	quadrata	XVII. 12.				Bl. 242.							
——	*spectabilis*	M.C. 544.				Bl. 242.							
——	*spinosa*	M.C. 86. Martin, MS.			Kent, 131. Suss. 159.	Dev. 242.							
——	*spinosa* (var.)	XIII. 3.			Kent, 131.								
——	(new, cast)				Kent, 131.								
——	two or more species, indistinct.				Kent, 153.								

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Unio	*aduncus**	M.C. 595, 2.					Suss. 178.	Suss. 178.					
——	*antiquus*	M.C. 594, 3-5.					Suss. 178.	Suss. 178.					
——	*compressus*	M.C. 594, 2.					Suss. 178.	Suss. 178.	Dor. 230.				
——	*cordiformis*	M.C. 595. 1.					Suss. 178.	Suss. 178.					
——	Gualterii	XXI. 16.						Suss. 179.					
——	Mantellii	XXI. 14.					Suss. 179.	Suss. 179.					
——	Martini	XXI. 17.					Suss. 179.						
——	*porrectus*	M.C. 594, 1.					Suss. 179.	Suss. 179.					
——	subtruncatus	XXI. 15.						Suss. 178.					
——	species not distinct						Dor. 128.	Dor. 229.	Bucks, 298.				
——	large, new								Dor. 230.				
——	some other spec. probably new						Sur. and Suss. 179.						
Diceras	Lonsdalii	XIII. 4.			N. Wilts, 268								
Modiola	*æqualis*	M.C. 210, 2.			Suss. 158.								
——	*alæformis*	M.C. 251.			Kent, 129.								
——	*aspera?*	M.C. 212, 4.			Kent, 129.								
——	bella	XI. 9.		Kent, 113.	Suss. 158.								
——	*bipartita*	M.C. 210, 3-4.			Suss. 158.								Dor. 232
——	depressa?	M.C. 8. 3. upper fig.			I. of W. 204								
——	*imbricata*	M.C. 212. 1, 3.			Suss. 158.								
——	lineata	XIV. 2.			Kent, 129.								
——	parallela	M.C. 9.			Kent, 129, and 152.								
——	reversa	XVII. 13.				Bl. 241.							
——?	—— casts				Kent, 129.								
——	new				Suss. 158.								
——	new						I. of W. 205						
——	species doubtful				N Wilts. 268				S. Wilts, 260 Bucks, and Oxf. 297.	S. Wilts, 261 Oxf. and Bucks, 299			Cam. 317
Lithodomus	new species									Dor. 230.			
——	another species?									Dor. 230.			
Mytilus	*edentulus*	Mar. 32. M.C. 439. 1.			Suss. 158.								
——	inæquivalvis	XVII. 16.				Bl. 241.							
——	*lanceolatus*	M.C. 439, 2.			Suss. 158.	Bl. 241.							
——	Lyellii	XXI. 18.						Suss. 178.	Bucks, 298.				
——	prælongus	XVII. 15.				Bl. 241.							
——	tridens	XVII. 14.				Bl. 241.							
——	species not determined		Oxf. 296.		N. Wilts. 268				Bucks 298	S. Wilts, 261 Bucks, 299.	Bucks, and Oxf. 301.		
Pinna?	(crassa,) new species	not figured			Kent, 130.								
——	*tetragona*	M.C. 313, 1.			Kent, 130. Suss. 158. I. of W. 204	Bl. 241.							
——	a cast				Suss. 158.								
——	new?				I. of W. 204								

* Unio is, by Lamarck, connected with a feminine adjective; ?? but is considered as masculine by Sowerby; and in Mr. Lea's work "On the genus Unio";—4to, Philadelphia, 1832, pp. 6, 7.

Crenatula ...	speciesindistinct			Bed.? 296.						N Wilt, 268. Oxf. and Bucks, 300.	N Wilt, 269. Oxf. and Bucks, 301.		
Perna.	*quadrata?*	M.C. 490, 2.			I. of W. 204.								
——	rostrata	XVII. 17.				Bl. 241.							
Avicula	anomala	XVII. 18.				Bl. 240.							
——	gryphæöides	XI. 3.	Ham. 156.										
——	pectinata	XIV. 3.			Kent, 128.								
——	a smooth spec. probably new				Kent, 128.								
——?	species not determined	Martin, MS.		Bed. 296.	Suss. 157. Nor. 317.						Oxf. and Bucks, 301		
Gervillia	*acuta?*	M.C. 510, 5 *			Suss. 157.								
——	*aviculöides*	M.C. 511. 1—4. *Perna*, M.C. 66.			Kent, 128. Suss. 157. Ham. 157. I. of W. 204	Dev. 240.				Oxf. 299.		Dor. 132.	Dor. 232. Cam. 317.
——	*solenöides*	M.C. 510, 1-4.			Suss. 157. I. of W. 204.	Bl. 240.							
——	species not determined				Kt. 128, 152 Suss. 157.								
Inoceramus	*Cripsii*	Mant. Suss. 27, 11.		Kent, 113. Cam. 317.									
——	*concentricus*	M.C. 305.		Kent, 113. Kent, 152. S. Wilt. 258 Cam. 317. Nor. 317 †	I. of W 204. ...	Dev. 241.							
——	*gryphæöides*	M.C. 584, 1. Mar. 33.			Suss. 157.	Dev. 241.							
——	*latus*	M.C. 582, 1. Mant. Suss. xxvii. 10			Kent, 152.								
——	*sulcatus*	M.C. 306.		Kent, 113. S. Wilt. 259. Bed. 296.		Dev. 241.							
——	*tenuis*	Mant. Suss. p. 132.		I. of W. 191									
——	species not determined		S. Wilts 258 Oxf. 296.	Nor. 317†	Suss.? 157								
Lima	semisulcata	XI. 10. *Plagiostoma semisulcatum*, Nilsson, ix. 3.			Kent, 129. Suss. 158.	Bl. 241.							
——?	subovalis	XVII. 21.				Bl. 241.							
Plagiostoma	*cardiiforme*	M.C. 113, 3.											Cam.
——	*elongatum*	M.C. 559, 2. Mant. Suss. 19, 1. *Modiola parallela*. M.C. 9, upper r. hand fig.		Kent, 114. S. Wilt. 259	Kent, 130. I. of W. 204								
——	*Hoperi?*	M.C. 380.	I. of W. 203.										
——	*rigidum*	M.C. 314, 1.			N. Wilt, 268.								
——	obliquatum ‡	G.T. 2nd Ser. ii. p. 319.									Oxf. 301. Bucks, 301.		
——	*rusticum*	M.C. 381.								Oxf. 300.			
——	a small species				Kent, 152.								
Pecten	*annulatus*	M.C. 542, 1.											Dor. 232.
——	*arcuatus*	M.C. 205, 5, 7.										Bucks, 302.	
——	*asper*	M.C. 370, 1.	Ham. 156. Dor. 228.			Bl. 241.							
——	*Beaveri*	M.C. 158.	Ham. 157.	Nor. 317†									
——	compositus	XVII. 20.				Bl. 241.				Dor. 231. S. Wilt. 261. Oxf. 300. Bucks, 300.	Bcks. 301		
——	*lamellosus*	M.C. 239.											

* *Gervillia acuta*, of Min. Con. is stated to be "from calcareous sandstone at Collyweston," in the great Oolite.

‡ A new species, named by Mr. Sowerby,—"to be figured in Min. Conch."; from the highest beds of the Brora district.

† In the *red* stratum, (chalk?), at Hunstanton.

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Pecten	*Lens*	M.C. 205, 2.										Bedf. 302.	
———	Millerii	XVII. 19.				Bl. 241.							
———	*nitidus*	M.C. 394, 1.	Ham. 157.										
———	*obliquus*	M.C. 370, 2.			Kent, 129. Suss. 158. I. of W. 204 N. Wilt, 268								
———	*orbicularis*	M.C. 186.	Ham. 157. I. of W. 203. Dor. 228. S. Wilt, 258	I of W203 S.W. 259.	Kent, 130. Suss. 158.	Bl. 241.				Oxf. 300. Bucks, 300.			
———	*quadricostatus*	M.C. 56, 1, 2.	I. of W. 203. Dor. 228. S. Wilt, 258		Suss. 158.	Dev. 241.							
———	*quinquecostatus*	M.C. 56, 3-8.	Ham. 157. Dor. 228.	I of W203	Kent, 130 and 152. N.W. 268	Dev. 241.							
———	———var.	very convex, young?	Dor. 228.										
———	Stutchburianus*	XVIII. 1.				Bl. 241.							
———	*vimineus*	M.C. 543. 1. 2.											Cam. 317
———	species indistinct		Ham. 157.			Dev. 241.				N.W. 268.	Dor. 231. Oxf. 301. N.W. 269.		
———	new?	Martin; not figured			Suss. 158.								
Plicatula	*inflata*	M.C. 409, 2.	Ham. 157. I. of W. 203.										
———	*pectinöides*	M.C. 409, 1.		Kent, 114.	Kent, 130 and 153.								
———	spec. uncertain									Dor. 231. Bucks, 300.			Cam. 317
Podopsis	*striatus*	Defrance. *Dianchora striata.* M.C. 80. 1				Bl. 241.							
Gryphæa	*bullata*	M.C. 368.										Bedf. 302.	
———	*canaliculata*	*Chama*, M.C. 26, 1, p. 68	I. of W. 203.			Bl. 240.							
———	——— var.	(a broad variety)				Bl. 241.							
———	*Columba*	M.C. 383, 1, 2.	Ham. 156.										
———	*dilatata*	M.C. 149. 1.								Oxf. 299. (Port. sand?)		Bedf. 302. Bucks? 302.	
———	*globosa*	M.C. 392.		Cam. 317. Nor. 317†.									
———	*sinuata*	M.C. 336.	Ham. 156.		Kent, 128 and 152. I. of W. 204.								
———	*vesiculosa*	M.C. 369.	Ham. 156. I. of W. 203 Dor. 228. S. Wilt, 258.			Dev. 241.							
———	*vesiculosa?*				I. of W. 204.								
———	*Virgula*	(see *Exogyra*.)											
———	spec. uncertain			I. of W. 203									

* Named after Mr. Samuel Stutchbury of the Bristol Institution.

† In the *red* stratum, (chalk?), at Hunstanton.

Exogyra	bulla	XXII. 1.							Dor. 229.				
——	*conica*	*Chama conica, recurvata,* and *plicata,* M.C. 26, 2, 3, and 4. *Exogyra* M.C. 605, 1–3	Dor. 228. S.W. 258	Kent, 113 and 115. Bed. 296. Cam. 317.	Kent. 152 I of W. 204	Dev. 240.							
——	—— (var.)	ridge high and sharp.				Dev. 240.							
——	new	near to *Conica*			I of W. 204								
——	*halyotöidea?*	*Chama*, M.C. 25				Bl. 240.							
——	*lævigata*	M.C. 605, 4.	Dor. 228.		Kent, 128. Kent, 152.	Dev. 240.							
——	*nana*	M.C. 383, 3.								Bucks, 299.	Dor. 231.	Bucks, 302.	Dor. 232.
——	*undata*	M.C. 605, 5-7	I. of W. 203.			Bl. 240.							
——	*Virgula*	XXIII. 10. *Gryphæa*, Defrance										Bucks, 302.	
——	species indistinct						Dor. 228			S. Wilt. 260. Bucks, 229.			
Ostrea	*carinata*	M.C. 365			Kent, 129. I. of W. 204	Dev. 241.							
——	*deltöidea*	M.C. 148.									Dor. 232.	Dor. 232. Oxf. 302. Bcks 302.	
——	—— var.	near to *deltoidea*										Bedf. 302.	
——	distorta	XXII. 2.							Dor. 229. S. Wilts, 259	Bucks 299			
——	*expansa*	M.C. 238, 1.							Bucks, 298. (Portland stone?)	S.W. 261. Oxf. and Bcks. 299.			
——	falcata	XXIII. 1.								S. Wilts, 261			
——	*gregaria*	M.C. 111, 1-3.								N. Wilts 268			Cam. 317.
——?	*lævigata*	*Exogyra*? M.C. 605, 4.									Dor. 231.	Oxf. 302. Bucks, 302.	
——	*læviuscula*	M.C. 488. 1.										Bucks, 302. Bedf. 302.	
——	*macroptera*	M.C. 468, 2, 3.		Kent, 114.	Kt. 129. I of W 204	Dev. 241.							
——	retusa *	XIV. 4.			I. of W. 204.								
——	*solitaria*	M.C. 468, 1.									Bucks, 301.		
——	*undulata*	M.C. 238, 2.								S. Wilts, 261			
——	a new species	thick-shelled								Oxf. 299. Bucks, 299.			Dor. 232.
——	(plicated)						Dor. 228.						
——	(smooth)						Dor. 228.						
——	(deeply concave)											Cam. 317.	
——	different spec. probably new, but indistinct		Dor. 228. S. Wilt, 258		Kent, 129. Dor. 228		I. of W. 205 Dor. 228	Suss. 178.	Dor. 229. Oxf. Bks. 297-8.		Bucks. Oxf. 301.	Oxf. 303.	
Anomia	lævigata	XIV. 6.			Kent, 127.								
——	radiata	XIV. 5.			Kent, 128								
——	convexa *?	XIV. 7.			I. of W. 338.								
Orbicula	a new species	Martin; not figured			Suss. 158.								
Terebratula	*biplicata*	M.C. 90, & 437, 2-3.		Kent, 114. Nor. 317 †	Kent, 130. I. of W. 205	Bl. 242.							
——	convexa	XIV. 12.			Kent, 130.								
——	*depressa*	M.C. 502, 2. Mar. MS.	I. of W. 203		Suss. 159.	Bl. 242.							
——	dilatata	XVIII. 2.				Bl. 242.							
——	*dimidiata*	M.C. 277, 5.				Dev. 242.							
——	elegans	XIV. 11			Kent, 130.								
——	*elongata*	M.C. 435, 1, 2.			Kent, 130.								
——	Faba	XIV. 10.			Kent, 130.								

* The two species thus marked *, have been omitted by mistake in the list at p. 204. *O. retusa* is from Atherfield, I. of Wight:—See p. 338. note.
† In the *red* stratum, (chalk?), at Hunstanton.

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Terebratula	*Gibbsiana*	M.C. 537, 4.			Kent, 130, and 153. I. of W. 205.								
—	*inconstans*	M.C. 277, 3, 4.											Dor. 232
—	*lata*	*T. lata*, M.C. 100: lower fig. (smooth)			Suss. 158.								
—	*latissima*	*latissima*, M.C. Index. *lata*, M.C. 502, 1. (plicated)			Kent, 130. I. of W. 205 N. Wilt 268.	Bl. 242.							
—	*Lyra*	M.C. 138, 2.				Bl. 242.							
—	megatrema	XVIII. 3.				Bl. 242.							
—	*nuciformis*	M.C. 502, 3.	N. Wilt, 268?		Suss. 159. I. of W. 205 N. Wilts 268								
—	*oblonga*	M.C. 535, 4-6.			Kent, 130, and 153. N. Wilts 268								
—	*ovata**	M.C. 15, 3.		S Wilt? 259	Knt. 130† Suss. 158.								
—	parvirostris	XIV. 13.			I. of W 205.								
—	*pectita*	M.C. 138, 1.	Dor. 228.										
—	*Pisum*	M.C. 536, 6, 7.	I. of W. 203			Bl. 242.							
—	prælonga	XIV. 14.			Kent, 130.								
—	quadrata	XIV. 9.			Kent, 130.								
—	*Sella*	M.C. 437, 1.		Kent, 114	Kent, 130. I. of W. 205.								
—	*semiglobosa*	M.C. 15, 9.	Oxf. 296.										
—	*striatula*	M.C. 536, 3-5.				Bl. 242.							
—	*sulcata*	Parkinson. G.T. 1st Ser. v. p. 59.		Kent, 114. Cam. 114.									
—	*subundata*	M.C. 15, 7.		Nor. 317†.									
—	Tamarindus	XIV. 8.			Kent, 130.								
—	*tetrahedra*	M.C. 83, 5.											Oxf. 303
—	two or three spec. probably new		I. of W. 203.	S. Wilt, 259	Kent, 134. Suss. 159.								Dor. 232
Lingula	*ovalis*	M.C. 19, 4.			Kent, 129.								
— ?	truncata	XIV. 15.			Kent, 129.								
—	spec. indistinct				I. of W. 204.								
Mollusca.													
Dentalium	*cylindricum*	M.C. 79, 2.				Dev. 240.							
—	*decussatum*	M.C. 70, 5.		Kent, 152. S. Wilt, 258.									
—	*ellipticum*	M.C. 70, 6. and 7.		Kent, 113. S. Wilt, 258.		Bl. 240.							
—	*medium*	XVIII. 4. M.C. 79, 5				Bl. 240.							
—	spec. uncertain			Cam. 317									
Patella	spec. indistinct				Suss. 158.								

* Called *ovalis*, at p. 130.

† In the *red* stratum, at Hunstanton, Norfolk.

Bulla	Mantelliana	XXII. 3.						Suss. 176.					
Planorbis	spec. indistinct								Oxf. and Bucks, 298.				
Limnæa?									Oxf. 298.				
Auricula?	*incrassata*	M.C. 163, 1-3.			Nor. 317.	Bl. 240.							
——	inflata	XI. 11.		Kent, 113. S. Wilts 258									
——	two species probably new	Martin, MSS.			Suss. 157.	Bl. 240.							
Melania	*Hedingtonensis*	M.C. 39, outer fig.											Dor. 232 Oxf. 303.
Melanopsis?	attenuata	XXII. 5. *Melania*, Ann. Phil. (1824) viii. 376.					Dor. 228.	Suss. 178.					
——?	tricarinata	XXII. 4. *Melania*, ibid.					Dor. 228.	Suss. 178.					
——?									Bucks, 297.				
Paludina	*carinifera*	M.C. 509, 3.						Suss. 178.	Dor. 230.				
——	*elongata*	M.C. 509, 2.					Kent, 161. Sx. 167, 178 I. of W. 205 Dor. 228.	Suss. 178. I. of W. 205–6 Dor. 229. Bcks? 297	Dor. 230. S. Wilt, 260. Bucks, 298.				
——	*fluviorum*	*P. vivipara*, M.C. 31, 1					Suss. 178. I. of W. 191, 201, 206.						
——	*Sussexiensis*	XXII. 6. Mant.						Suss. 178.	Dor. 230.				
——	two or more spe. probably new*							Suss. 178	Bucks, 298. S. Wilt. 260. Oxf. 199.				
Neritina	*Fittonii*	XXII. 7. Mant. S.E. Eng. 243.						Suss. 178					
Nerita?	angulata	XXIII. 2.								N. Wilts 268			
——	*sinuosa*	M.C. 217, 2.								S. Wilts, 261			
Natica	canaliculata	XI. 12. XVIII. 6. *Ampullaria*, Mant. Suss. xviii. 11.		Kent 113. Suss. 152.†		Bl. 241.							
——?	carinata	XVIII. 8.				Bl. 241.							
——	elegans	XXIII. 3.								S. Wilts 261 Oxf. 299			
——	granosa	XVIII. 7.				Bl. 241.							
——	species uncertain		S. Wilts 258	S.W. 259	Suss. 158.‡ Ham. 158. I. of W. 204 Nor. 317.	Bl. 241.							
Tornatella?	affinis	XVIII. 9.		Kent, 114.		Bl. 242.							
——	elongata	XI. 1.	Kent, 106§.										
——	Popii	XXII. 8.						Suss. 178.					
Vermetus	*concavus*	XVIII. 10. M.C. 57, 1-5.	Dor. 228.		I. of W. 205 Suss. 159	Dev. 242.							
——	*polygonalis*	M.C. 596, 6.	I. of W. 203	I. of W. 203	Kent, 131.	Dev. 242.							
——	*radiatus*	*Planorbis*, M.C. 140, 5				Bl. 242.							
——	*umbonatus*	*Vermicularia*, M.C. 57, 6, 7.	I. of W. 203 S. Wilts 258 N Wilts 268										
——	—— large?		I. of W. 203										
——	spec. uncertain		Oxf. 296.										
Scalaria	pulchra	XVIII. 11.				Bl. 242.							

* *Paludina* acuminata, in the list of Isle of Wight fossils, p. 205, and Dorsetshire, p. 228, was intended for a species, supposed to be new, but too indistinct for figuring.

† Inserted as an *Ampullaria*, at p. 152.

‡ Parkinson; Org. Rem. iii. pl. vi. f. 2.

§ In chalk-marl; p. 106. note.

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Solarium	conoïdeum	XI.14.M.C.11. *Cirrus plicatus.* M.C.141,3.	I.of W. 203.	Kent, 114. S.Wilt259.		Bl. 242.							
——	ornatum	XI. 13.	I.of W. 203	Kent,114 S.W.259.									
——	granulatum	*Cirrus granulatus,* Mant.Suss. p. 195.	Ham. 157.										
Cirrus	*depressus*	M.C. 428, 3.	Dor. 228.										
Trochus (see	*Pleurotomaria.*)												
Pleurotomaria	*Gibsii*	*Trochus,* M.C. 278,1.		Kent, 114.									
——	*reticulata*	*Trochus,* M.C.272,2.										Oxf. 303.	
——	gigantea*	XIV. 16.			Kent, 131, 153.								
——	spec. uncertain									N.Wilt266. Oxf. 300. Bucks,300.			
Trochus	*Sedgwickii*	M.C. Index *T. reticulatus,* M.C. 272, 2.	I of W. 203										Dor.232
——	spec. uncertain		Ham.157.										Dor.232
Litorina	*conica*	*Turbo,* M.C. 433, 1.			I.of W. 205	Bl. 242.							
——	gracilis	XVIII. 12.				Bl. 241.							
——	*monilifera*	*Turbo,* M.C.395, 1.			N.Wilt.268	Bl. 242.							
——	*muricata*	*Turbo,* M.C. 240, 4.											Cam. 317
——	pungens	XVIII. 5.				Bl. 241.							
——	*rotundata*	*Turbo,* M.C. 433, 2. Martin, MSS.			Suss. 159 I.of W205.	Bl. 242.							
——	spec. uncertain	*Turbo ?*			Suss. 159					S.Wilt.261.			
Turbo	(see *Litorina*).												
Monodonta	new species?									Dor. 231.			
Phasianella	formosa	XVIII. 14.				Bl. 241.							
——	pusilla	XVIII. 13.				Bl. 241.							
——	striata	XVIII. 15.				Bl. 241.							
Turritella	costata	M.C. 565, 4.				Bl. 242.							
——	*excavata*	*T. concava,* M.C.565. *Cerithium excavatum* Brong., p.399, ix. 10.				Bl . 242.				S.Wilt 260.			
——	*granulata*	M.C.565,1.Mar.M.S.	S. Wilts258?		Suss. 159. Nor. 317.	Bl. 242.							
——	*muricata ?*	M.C. 499, 1, 2.											Cam.317
——	spec. uncertain	Martin, MSS.		Kent, 114.	Suss. 159.					Dor. 230. S.Wilt 261.			
Potamides?	a new species	Mantell, MSS.					Suss. 178. I.of W.?206	Suss.178.	Bucks.298.				
Fusus	clathratus	XVIII. 19.				Bl. 240.							
——	*quadratus*	XVIII. 17. *Murex,* M.C. 410. 1.				Bl. 240.							
——	rigidus	XVIII. 16.				Bl. 240.							
——	rusticus	XVIII. 18.				Bl. 240.							
——	spec. indistinct					Bl. 240.							Cam.317
Pyrula	Brightii	XVIII. 21.				Bl. 242.							
——	depressa	XVIII. 20.				Bl. 242.							
——?	Smithii	XI. 15.		Kent, 114.									

* Called *Trochus* striatus at page 131.—*Pleurotomaria striata,* M.C. 171. f.1. is a fossil of the mountain limestone.

Murex	*Calcar*	M.C. 410, 2.		Kent, 113.		Bl. 241.							
Rostellaria	buccinöides	XI. 17.		Kent, 114.									
——	*calcarata*	M.C. 349, 6-7.		Kent, 114	Suss. 158. I. of W. 204 Nor. 317.	Bl. 242.							
——	*carinata*	XI. 19. Mant. Sx. xix. 10-14.		Kent, 114. Sur. 153. S. Wilts 259									
——	elongata	XI. 16.		Kent, 114.									
——	marginata	XI. 18.		Kent, 114.									
——	macrostoma	XVIII. 23.				Bl. 242.							
——	*Parkinsonii* *	XVIII. 24. M.C. 558, 3. (upper figure.)		Kent, 114.	Suss. 158. I of W 204	Bl. 242.							
——	retusa	XVIII. 22.				Bl. 242.							
——	*doubtful*				Kent, 130.								
——	very like *Pes pelicani*	Mant. MSS.			Suss. 158.								
——	new species					Bl. 242.							
Buccinum	angulatum	XXIII. 5.								N. Wilt 268. Bucks, 299.			
——	Naticöide	XXIII. 4.								S. Wilt, 260. N. Wilt, 268. Bucks, 299.	Bcks. 301.		
Nassa	costellata	XVIII. 26.				Bl. 241.							
——	lineata	XVIII. 25.				Bl. 241.							
Terebra	Portlandica	XXIII. 6.								Dor. 231. S. Wilt, 261 N. Wilt, 268 Oxf. and Bucks, 300.			
Nerinea	Goodhallii	XXIII. 12.											Dor. 232.
Belemnites	*attenuatus*	M.C. 589, 2.		Kent, 113. S. Wilt, 258. Nor. 317.									
——	*fusiformis*	Park. Org. Rem. iii. t. 8, 13.											Dor. 232.
——	*minimus* †	M.C. 589, 1.		Kent, 113. Sus. 152. Nor. 317.									
——	a large species				Kent, 152.								
——	spec. doubtful		I. of W. 203.		Kent, 128.								
Trigonellites	latus	Park. O.R. iii. xiii. 9 & 12 *Ichthyosiagones*, Dr. Rüppell ‡. *Aptychus*, Von Meyer §.									Bucks, 302. Cam. 316, 317.		
——	a smaller spec.	*Qu.* young of *T. latus*									Bucks, 302.		
Ammonites	*auritus*	M.C. 134.		Kent, 112. S. Wilt, 258.		Bl. 239.							
——	*Benettiæ*	M.C. 539.		Kent, 112. S. Wilt, 258.									
——	*Beudantii*	M.C. 549. Brong. 7, 2. 112.		Kent, 112. S. Wilt. 258.									
——	*biplex*	M. C. 293, 1, 2.								Dor. 230. S. Wilt, 260. N. Wilt, 268. Bucks 299.	S. Wilt, 261. N. Wilt, 269 Oxf. 300. Bucks, 300.	Dor. 231. Bucks, 302. Nor. 317.	
——	*Brodiæi*	M.C. 351.								S. Wilt, 260			
——	*Catillus*	M.C. 564, 2.	Ham. 156.										
——	*cinctus ?*	M.C. 564. 1.	I. of W. 202										
——	circularis	XI. 20.		Kent, 112.									Dor. 232.
——	crenatus	XI. 22.		Kent, 112.									

* *R. Parksonii*, of Min. Con. 349, fig. 1 to 5, (since named *R. Sowerbeyi*, in the General Index, at the end of vol. vi.) is a fossil of the London clay.

† This species, according to Mr. J. Phillips, is distinct from *B. Listeri*: the latter being found only in the *red chalk* of the cliffs at Scarborough.—Geol. of Yorkshire Coast, p. 75. (1st Edit.)

‡ Suprà, p. 348:—See also Edinb. and Lond. Phil. Mag. vol. ix. p. 32.

§ *Act. Acad. Cæs. Leop. Carol. Nat. Cur.* vol. xv. Part ii. tab. lviii. et lix.

Fossils.			*Stratigraphical and Local Distribution.*										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Ammonites...	*cristatus* * ...	XI. 23. Brong. 7. 10.		Kent. 112. and 337.									
—— ...	*decipiens*	M.C. 294.		Bedf. 296.									
—— ...	*denarius*	M.C. 540, 1.				Bl. 239.							
—— ...	*dentatus*	M.C. 308,	N. Wilts, 267.	Kent, 112. Kent, 152. Nor. 316. S. Wilt, 258.	Suss. 157.	Bl. 239.							
—— ...	new	*serratus*, Park. G.T. 1st series, v. 58. Allied to *dentatus*, M.C. 308.		S. Wilt, 258.		Bl. 239.							
—— ...	*falcatus*	M.C. 579, 1.				Bl. 239.							
—— ...	furcatus	XIV. 17.			Kent, 127. I. of W. 204								
—— ...	*giganteus*	M.C. 126.								S. Wilt, 260. N. Wilt, 268. Bucks, 299.	Dor. 231. Oxf. 301. Bucks, 301.	Bcks. 302.	
—— ...	*Goodhallii*	M.C. 255.				Bl. 239. Dev. 239							
—— ...	*Gulielmi*	M.C. 311.										Bucks, 302.	
—— ...	*hippocastanum*	M.C. 514, 2.				Dev. 239.							
—— ...	*inflatus*	M.C. 178.		Kent, 112. Cam. 316.									
—— ...	*Lamberti*	M.C. 242, 1-3.											Cam. 317
—— ...	*lautus*	M.C. 309.	Oxf. 296 †.	Kent, 112 and 152. Cam. 316. S.W. 258.		Bl. 239.							
—— ...	*Mantellii*	M.C. 55.	I. of W. 202										
—— ...	—— (var.)	without tubercles	I. of W. 203										
—— ...	*minutus*	M.C. 53, 3.		Kent, 112.									
—— ...	*Monile*	M.C. 117.	S. Wilts 257	S. Wilt 258.	Kent, 127.								
—— ...	*mutabilis*	M.C. 405.										Dor. 232.	
—— ...	*Nutfieldiensis*	M.C. 108.			Kent, 127.								
—— ...	*ornatus*	Park. G.T. 1st ser. v. 57.		Kent, 112.									
—— ...	*pansus*	Park. G.T. 1st ser. v. 57. p. 57. 58.		Kent, 112.	Lower 2. 1.								
—— ...	*planus*	Mant. Suss. xxi. 3.		S. Wilts 258									
—— ...	*proboscideus*	M.C. 310, 4-5.		Kent, 112.									
—— ...	*Rhotomagensis*	M.C. 515. Park. G.T. 1st ser. v. p. 58		Kent, 112. I. of W. 191 S. Wilt 258.								Bed. 302.	
—— ...	*Selliguinus*	M.C. Gen. Ind. vol. vi. *lævigatus*, M.C. 549. *Selliguinus*‡, Brong. p. 394. vii. 1.	I of W. 203.	Kent, 112, I. of W. 203 S.W.? 258.									
—— ...	*splendens*	M.C. 103.	Ham. 156.	Kent, 112 Sur. 152		Dev. 239.							
—— ...	*subcristatus*	(see *A. cristatus.*)											
—— ...	symmetricus	XI. 21.		Kent, 112.									
—— ...	triserialis	XVIII. 27.				Bl. 239.							

* Inserted in the list at p. 112, as *A. subcristatus*; which Mr. Sowerby considers as no more than a variety of the same species.—see p. 337.
† In chalk marl.
‡ At p. 203, the synonym of *A. Selliguinus* is erroneously stated to be *A. Beudantii*.—See Min. Conch. vol. vi.; list of corrections.

——— ...	tuberculatus ...	M.C. 310, 1-3. ...	...	Kt.112,152. S. Wilts.	...	Bl. 239.						
——— ...	*varians* ...	M.C. 176. ...	I.of W. 203 S Wilts,257 N. Wilts267									
——— ...	——— var. ...	gibbose ...	...	...	...	Dev. 239.						
——— ...	*varicosus* ...	M.C. 451, 4, 5. ...	...	Kent, 112. S.Wilts 258 Cam. 316.	...	Bl. 239.						
———	species not determined ...	...	...	Kent, 152.	Kent, 127 Suss. 157.	Bl.239.	I.of W.205 a fragment.	...	...	Dor. 230. Oxf. 299. Bcks, 299	Dor. 231. S.Wilt.261 Bcks, 301.	**N.Wilt269. Bucks, 302.**
——— ...	fragment of a very large species	perhaps *Hamites*? ...	...	...	Kent127. Kent152.							
Scaphites ...	Hillsii ...	XV. 1. and 2. ...	...	...	Kent, 128.							
Hamites ...	*armatus* ...	M.C. 168. ...	...	Kent, 113.								
——— ...	*attenuatus* ...	XII.1-3. M.C.61,4,5.	...	Kent, 113. Kent, 113.								
——— ...	*compressus* ...	M.C. 61, 7, 8. ...	...	S.Wilt,258.								
——— ...	*elegans* ...	Park. G.T. 1st Series v. p.558. ...	...	Kent, 113.								
——— ...	*gibbosus* ...	M.C. 62, 4, (right hand figure) ...	...	Kent, 113.								
——— ...	*Gigas* ...	M.C. 593, 2. ...	...	...	Kent, 128.							
——— ...	*grandis* ...	M.C. 593, 1. ...	...									
——— ...	*intermedius* ...	M.C. 62, 2-4. ...	...	Kent, 113.								
——— ...	*maximus* ...	M.C. 62, 1. ...	...	Kent, 113.								
——— ...	*nodosus* ...	M.C. 216, 3. ...	...	Kent, 113.	Kent, 128.							
——— ...	*rotundus*? ...	XII. 1. and 2. M.C. 61, 2, 3. ...	...	Kent, 113.								
——— ...	spiniger* ...	XII. 4. ...	...	Kent, 113.								
——— ...	*spinulosus* ...	M.C. 216, 1. ...	...	...	...							
——— ...	*tenuis* ...	M.C. 61, 1. ...	...	Kent, 113.		Bl. 241.						
Turrilites ...	*costatus* ...	M.C. 36. ...	...	...	...							
——— ...	*tuberculatus* ...	M.C. 74. ...	I.of W. 203			Bl. 242.						
——— ...	spec. uncertain .	...	...	...	I.of W. 205							
Nautilus ...	*elegans* ...	M.C. 116. ...	Ham. 156.	...	Kt.129,152.							
——— ...	*inæqualis* ...	M.C. 40, lower figure	...	...	Kent, 129.	Bl. 241.						
——— ...	plicatus ...	Wood-cut, p. 129. ...	...	...	Kent, 129.							
——— ...	*radiatus* ...	M.C. 356. ...	...	...	I.of W. 204							
——— ...	*simplex* ...	M.C. 122. ...	...	...	Kent, 129.							
——— ...	*undulatus* ...	M.C. 40, upper figure	...	...	Kent, 129.							
——— ...	spec. uncertain †	Martin, MSS. ...	...	...	Suss. 178.							

REMAINS OF VERTEBRATED ANIMALS.

Fishes.												
Asteracanthus	*ornatissimus* ...	Agassiz, MSS.‡ ...	...	...	...	...	...	...	...	...	...	**Oxf.‡**
Chimæra ...	*Egertoni* ...	Dr. Buckland, Geol. Soc. Proceed. ii. 206.	...	...	...	...	...	...	...	...	...	**Oxf. 303.**
——— ...	*Townsendii* ...	Ibid.	...	...	...	...	...	...	...	Oxf. 300.		
Hybodus ...	grossiconus ...	Agassiz, MSS.‡ ... Mant. Tilg. pl. v. 14. and xv. 2. ...	...	...	...	...	...	Suss. 180.				
——— ..	acutus ...	Agassiz, MSS. ...	...	...	...	...	...	...	...	...	...	**Oxf.‡**
——— ...	spec.uncertain	Agassiz, MSS. *Silurus*, Mant. Tilg. pl. x. 4. and 6. ...	...	...	...	...	...	Suss. 180.	Dor.‡			

* Erroneously named *H. aculeatus*, at p. 113.

† Besides the foregoing species, an imperfect cast of another *Nautilus* was found in the upper green-sand of the Isle of Wight, at Western Lines, which, at p. 203, has been erroneously called *compressus*. The *N. compressus*, of Min. Con., tab. 38, is a fossil of the mountain limestone.

‡ Egerton:—"Catalogue of Fossil Fish in the collections of Lord Cole and Sir Philip Grey Egerton:" 8vo, 1836.

Fossils.			Stratigraphical and Local Distribution.										
Genera.	Species.	References to Plates and Authorities.	Upper Green-sand.	Gault.	Lower Green-sand.	Blackdown.	Weald-clay.	Hastings-sand.	Purbeck.	Portland-stone.	Portland-sand.	Kimmerid. clay.	Oxford-oolite.
Lepidotus ...	*Fittoni*	Agas.ii. 30, *a.* and *b.* *Lepisosteus*, Man.Til. v. 4, 15.; x. 2, 3, 4, 15, and 16.					I. of W. 206.	Suss. 169. Suss. 180.					
——— ...	Mantellii	Agass.ii.xxx f.10-15, and xxx. c. *Lepisosteus*, Man.Til						Suss.180*.					
——— ...	*minor*	Agass. vol. ii. xxxiv.							S.Wilt 260.				
Pholidophorus	*ornatus*	Agass.MSS.†, & i.pl.G							S.Wilt 260.				
———	another species	Agass. Feuilleton, Mars, 1836, p.79.										Oxf. 303.	
Psammodus	*reticulatus*	Agassiz, MSS.†										Oxf.†	
Pycnodus ...	*microdon*	Agass. vol. ii. xxxiv. Mant. Tilg. xviii. 26, 27; tab.xxiii.e. 3,4,5.					Suss. 180.	Suss. 180.					
Tetragonolepis	*mastodonteus*	Agassiz, vol.ii. p.216. t.23.e,3-5. Web.G.T. 2d Ser.ii. pl. vi. 5-7.						Suss.‡	Dor.‡				
Indistinct remains of Fishes.§	Teeth, palatal bones, scales, and vertebræ	Agass. Geol. Soc. Proc. ii. 101.	Ham.156 I. of W. 203.	S.Wilt.259.			I.of W. 206	I.of W.206	Dor.230. Bcks,298.	S.Wilt361. Bucks, 300.	Dor.?301	Dor. 231.	
Reptiles.													
Trionyx	Bakewellii	Mant. S.E. Eng. 225.						Suss. 179.					
Emys	spec. uncertain	ibid.						Suss. 179.					
Chelonia	spec. uncertain	ibid.						Suss. 179.					
Turtles	spec. uncertain	ibid.											
Crocodile	remains of two or more species	Mant.S.E. Eng.261—394.						Suss. 179.	Dor. 230.				
——— ...	teeth						I.of W. 206 Dor. 128.	I. of W. 206					
Megalosaurus		Dr.Buckland, G.T.2d Ser.i. 394, pl.41-44... Mant. S.E. Eng. 260						Suss. 179.					
Phytosaurus	cylindricodon	Mant. ibid. 292						Suss. 179.					
Hylæosaurus	(new genus)	Mant. ibid. 316, pl.v.						Suss. 179.					
Plesiosaurus	species uncertain	Mant. ibid. 281-394.						Suss. 179.				Oxf. 303.	
Pterodactylus		Man.Tilg. pl.viii. f.1, 3, 10, 11, 18. S.E. Eng. p.283						Suss.					
Iguanodon		Mant. Phil. Tr. 1825, p. 177. S.E. Eng. 268-281; 304-316			Kent, 153‖		Suss. 169, 170,179-80. I.of W.206.	Suss. 179. I.of W.206. Dor. 229.					
Saurians	spec.uncertain	fragments of bones, and teeth					Dor. 228.	I.of W.206.	Oxf.298.	N.Wilt269. Oxf.301-3 Bucks,303.		Oxf. 303.	
Birds.													
Ardea	Bones	Mant. S.E. Eng.283. Geol.Soc.Proc.(1835) ii. p. 203.						Suss. 180.					
Quadrupeds.													
Hyæna	remains of		Kent, 153¶										

* Agassiz vii. and Mantell. † Egerton's "Catalogue", &c. 1836. ‡ Fragments, in Mr. Cumberland's Collection at Bristol, from Hastings,—Agassiz: also figured by Mr. Webster.

§ Besides the remains above enumerated, M. Agassiz mentions a fish of the *Gault*, presented by Mr. Hailstone to the Geological Society, which is different from any he had previously seen; and new fishes of the *Chalk* and *Green-sand*, communicated by Mrs. Murchison; (*Feuilleton, Mars*, 1836; pp. 79—80.) *Copröid masses*, consisting principally of phosphate of lime, are found, in the *Gault*, at several places;—as at Folkstone, p. 111; Ridge, in the Vale of Wardour, p. 247; West Norfolk, p. 312; in the Lower Boulonnois, p. 111, *note*: in the *Lower green-sand*, near Pulborough, p. 181; Isle of Wight, p. 206: and in the *Kimmeridge-clay*, in Buckinghamshire, p. 303.

‖ *Supra*, p. 132, *note*; and Text, p. 180.

¶ In sandy loam, at the top of the quarries, Boughton, near Maidstone.

APPENDIX C.

LIST OF HEIGHTS.*

THE following list may be useful to those who examine the country described in the preceding paper, by furnishing some points of known elevation, from which it will be more easy to estimate the surrounding altitudes, than if the entire heights above the sea were to be conjectured.

The height of the tides upon the English coast is influenced by so many variable circumstances, that in selecting a zero for a list of heights, some permanent natural or artificial mark, of easy access, is very much to be preferred to the level of the sea, either at high or at low water; the latter, especially, being objectionable, from the greater difficulty of ascertaining it, and from its being frequently concealed. On this point, I am supported by the opinion of Mr. Lubbock, whose publications on Tides give great weight to his authority. In the subjoined lists, therefore, I should have adopted, as the common point of reference, one of the standard marks hereafter mentioned, had not the heights obtained during the Ordnance Survey, and some others mentioned below, been all referred to the level of the sea at low water; while, as the mode in which that point was determined is unknown to me, I have thought it best not to make any change in the original measures, by conjectural reduction.

The Tide-marks on the Thames, in London and its vicinity, which are referred to in legal proceedings, and which form the base line, or " datum ", of many of the railroad sections, have been derived from a long series of observations on the depth of water, first made, I believe, at the East India Docks, by Capt. Huddart, and subsequently at the London Docks; from which latter place, marks, corresponding to the average spring tide high-water mark, have been transferred by levelling, to most of the bridges, and to the lock on the Thames, at Teddington above Richmond, which is, at present, the farthest range of the tide. The *time* of high water varies a little, at different points along this interval, but the ultimate heights are supposed to be the same throughout.

In the year 1830, Mr. Lloyd having fixed a standard mark at the Sheerness dockyards, found the mean rise and fall of the spring tides at that place to be 17·6150 feet; and of neap tides

* The exact determination of heights is, by geologists, regarded as of small importance; but the judgment upon this subject is, perhaps, unconsciously influenced by the difficulty which attends it; since if we could measure heights as easily as horizontal distances, it cannot be doubted that the former would be recorded and reasoned upon more frequently. As geology advances, it becomes more and more necessary that none of the elements which enter into the physical history of the globe should be neglected; and it is probable that many important inferences, not at present foreseen, might result from a correct acquaintance with the levels throughout large portions of the earth's surface. Already it has been ascertained in Sweden, that the land has been gradually raised within a few years, by a small but very perceptible quantity; and in all countries, especially those subject to earthquakes, it is a point of great interest to determine whether the relative levels of the sea and land, are truly as permanent as they are supposed to be. In the Survey now in progress in Ireland, and in the operations for a new map of France, the heights are carefully ascertained and inserted on the maps: perhaps it may still be hoped, that some general system will be adopted for connecting the measurement of heights in England with the Ordnance Survey. In the mean time it is satisfactory to find that at the late meeting of the British Association for the Advancement of Science, (August, 1836), a committee was appointed, and a portion of the funds placed at their disposal, (small, it is true, with reference to the object), for the purpose of devising and conducting observations on the relative level of the land and sea upon our coasts.

11·320 feet; his *mark* (called the "*North Standard*"), being 4·0661 feet above the mean level of high water, and 21·6811 feet above that of low water at spring tides. He then ascertained by very careful levelling, the heights above the standard, of several points in the vicinity of the Thames, between Sheerness and London *: whence it appears that what is called the "*Trinity* "*high-water mark*," at the *London Docks*, TRINITY H.W. 1800. ^ (" answering to XXIII. of the indices " marked on the south-west side of the entrance",) is 2·0112 feet below his "North standard," and consequently 19·6699 feet above low-water mark at Sheerness. The last-mentioned quantity, therefore, must be added to the height of any station above the Trinity mark, at the London Docks, in order to obtain the height of the same station above the sea at low-water at Sheerness.

The places in the South-East of England mentioned in the subjoined lists, are grouped in the order of the counties referred to in the preceding pages, beginning on the north. The names are disposed alphabetically. The heights are expressed in feet and decimals of a foot. The authorities and references to them are the following:

1. "*O.*"—An alphabetical list of all the heights ascertained during the progress of the Ordnance Survey, given in the official account of that operation, published in 1811 †, calculated from the level of the sea at low water. The places of the stations are mentioned in the Phil. Trans. for 1800, pp. 576 to 583; and in the " Account," above mentioned, pp. 70 to 81.

2. "*C.*"—Bradshaw's maps of the canals and navigable rivers in the midland counties of England, in three parts. The heights are taken from *low water* at Liverpool, (at a point 6 feet 10 inches below the sill of the Old Dock); which point is stated to be 21 feet below the Trinity House *high-water* mark at the London Docks, and consequently 1·331 feet beneath low-water mark, mean spring tides, at Sheerness, according to Mr. Lloyd.

3. "*M.*"—A manuscript list of heights, principally in Cambridgeshire, ascertained by Mr. M'Lauchlan, of the Ordnance Survey, and Mr. Glaisher of Cambridge, and for which I am indebted to the former gentleman. In this list (which is *not* an official document,) the heights are counted from the level of the sea at low water, in Lynn Deeps.

4. "*B.*"—A MS. list of heights above the sea at low water, ascertained by the late Mr. Bevan of Leighton, for which I am indebted to his son, Mr. Bevan of Wellingborough, and to Mr. Matthews of Leighton.

5. "*W.*"—A short list of heights in the Isle of Wight, subjoined to Mr. Webster's letter to Sir H. Englefield. These are chiefly barometrical, and from their being connected with some of the measurements of the Ordnance survey, it is probable that the zero was low-water mark.

* Phil. Trans. 1831; p. 167 *et seq.* Mr. Lloyd (p. 190,) "concluded his levellings at a "standard mark at the landing-place on the north-east side of the *New London Bridge*;" which "mark was 2·3967 feet below the North Standard mark at Sheerness;" and consequently 0·3855 foot, (= 4·626 inches), below the Trinity mark at the London *Docks*. The mark here referred to is a flat piece of brass, let into a cavity in one of the two large flags or slabs of granite, which form the landing-place at the bottom of the second flight of steps, descending from the footway on the north-east side of the bridge. The upper flight consists of 29 steps; the second, at the foot of which is the mark, of 26; the lowest flight is commonly more or less concealed by the water. The cavity in which the mark is lodged, is about 3 inches square, with rounded angles; and is two feet from the eastern wall or side of the bridge, and 2 feet 8 inches from the southern edge of the stone. The surface of the brass is about half an inch beneath that of the stone, which is itself a few inches below the level of the water at high spring tides.

† "An account of the Trigonometrical Survey, &c. 1800, to 1809; by Lieut.-Col. Mudge, and "Capt. (now Lieut.-Col.) Thomas Colby, R.E."; 4to, 1811, vol. i. p. 299—311. This work refers to the previous publications in the Phil. Trans. for 1795, 1797, 1800, and 1803, and carries on the account of the operations to the end of 1811.

6. "*F.*"—A small number of heights upon the coast of Kent and Sussex ascertained by myself, from observations with excellent barometers and thermometers by the late Mr. Carey. The lower station in these observations was either the shore itself, (the height of the barometer, below or above the spring-tide high or low water marks, being estimated),—or the drawing-room floors of the houses at Sandgate and Hastings, in which I resided, the height of which above the sea was ascertained by a mean of several observations, sometimes checked by comparison with more elevated stations measured directly from the shore, and again from the houses. The variation of the tides at Sandgate was assumed to be the same as at Dover, = 18·30 feet, and at Hastings, = 21·50 feet; which Capt. Beaufort, by whom I have been favoured with these numbers, states to be respectively the mean derived from a series of observations at those places, in 1834 and 1835.

Stations.	Above the sea at Low Water.
NORFOLK.	Feet.
Denver Sluice, near Downham Market, above the Deeps at *Lynn*	1
CAMBRIDGESHIRE.	
Aldreth station, between *HaddenhamMills* and *Aldreth* O.	122
Balsham Ord. Station O.	380
——— Steeple, (top) M.	410
Barton Hill, between Madingley and Barton M.	175
Brandon Station (Suffolk) M.	190
Burwell Steeple, bottom M.	96
CAMBRIDGE, level of the Cam M.	24·50
——— South Chimney of *St. John's College* M.	71·25
——— *Observatory*, top of the Dome. M.	123·50
Chapel Bush, Hazlingfield M.	220
Cherry Hinton, Chalk-pits M.	150
Cottenham Steeple, top M.	116
Duxford-Pen, Duxford :—(Dux*worth*, Ord. map) M.	372
Ely, Water at the Bridge M	14
——, ground at Cathedral M.	75
——, Top of the Tower M.	290
Fulbourn Windmill M.	140
Gog Magog clump M.	250
———, Telegraph Station O.	260
Haddenham Steeple, (bottom) M.	133
Hardwick Spire (bottom) M.	225
King's Hedges, cross roads in the Roman Way M.	55
Linton, Rivey Wood, (top) O.	387
Madingley Station O.	188
Maggots Mount, obelisk M.	152
Newmarket, Four-mile Stable M.	180
———, Ordnance Station O.	267
Orwell Station O.	255

Stations.	Above the sea at Low Water.
	Feet.
Quy-cum-Stow Steeple, (bottom) M.	84
Swaffham Bulbeck, Mills M.	130
——— *Prior*, Mills M.	140
Soham Steeple, (bottom) M.	62
Stuntney, near Ely M.	60
Sutton Steeple (top). The tower is said to be 108 feet high M.	174
Thorney Hill, near Ely M.	50
Wicken Steeple, (bottom) M.	58
Wilburton Steeple, (bottom) M.	122
Witcham Steeple, (bottom) M.	55
BEDFORDSHIRE.	
Brogborough House (chimney), near Ledlington B.	395
Dunstable; hill above Zouche's farm, east of the town O.	850
Grange Mill, Leighton Heath B.	386
Hockliffe Church, battlements B.	468
Ivinghoe Church, top of spire B.	503
Leighton Buzzard churchyard B.	300
———, Grand Junction Canal ¼ mile south of the town B.	281·75
———, Turnpike between the town and *Wing* B.	465
——— *Mile Bush*, between *Leighton* and *Soulbury* B.	453
———, Canal level from *Stoke-Hammond* Lock, to the three Locks at *Soulbury* C.	256·75
Lidlington Mill Hill B.	450
Mentmore, ground near the church B.	425
Overend Green, east of *Reach* B.	482
Ridgmont Castle, hill B.	420
Shire Ash, on the road between *Hockliffe* and *Woburn* B.	544
Toddington, ground near the Church B.	515
Totternhoe-Castle hill B.	540
Woburn Church, (battlements) B.	479

* It will be found that some of the heights mentioned in the text of the preceding paper, differ from those of the lists here subjoined, having been calculated froman estimated *mean level of the sea*, instead of the level at low water. The difference is one half the mean variation of the spring-tides at the respective places mentioned.

Stations.	Above the sea at Low Water.
	Feet.
Northamptonshire.	
Arbury Hill, near Daventry ....O.	804
Hertfordshire.	
Barkway Windmill: top.....................O.	513
Berkhampstead, general level of the Vale...B.	350
————, adjacent hills, general level ....B.	600
Bridgewater Monument, (gallery) ....B.	811
Burley Hill, near Royston ....O.	342
Great Chishall, (steeple) ....M.	470?
Heydon Hill, Chishall Down ....M.	480?
Kensworth, hill near Dunstable ....O.	904
Lilley hoe, Ord. Station ....O.	664
Rickmansworth, current ....B.	159·75
Royston, Ord. Station ....O.	481
Tharfield Windmill, (Downs)...............O.	570
Two-waters, Grand Junction Canal.........B.	275·08
Buckinghamshire	
Aylesbury, Grand Junction Canal ....C.	359·17
————, church, top of spire ....B.	425
Great *Billington,* hill near church ....B.	428
Bow Brickhill, Ordnance Station ....O.	683
————, Church battlements ......B.	600
Brill; *Redshill,* north-east of the town, (lower than the church) ....O.	555
Buckingham; level of Canal ....C.	265
Cheddington, church, top of tower ....B.	429
Crawley, North, church battlements...... B.	437
Fenny Stratford, level of canal ....B.	240
————, (to Stoke Hammond lock).C.	249·25
Muswell Hill, Ordnance Station............O.	744
Newport Pagnell, (canal) ....C.	196·25
————, canal near, from *Wolverton* to *Woolston,* by Great Linford...C.	247·75
Quainton, Ordnance Station ....O.	754
Stewkley, ground near the church ....B.	508
Stony Stratford, canal level, from *Thornton Park* ....C.	252·25
Tring, (canal to *Wendover,* summit level) . C.	404·50
Wendover Hill, Ordnance Station ....O.	905
Wingrave, Church, top of tower ....B.	530
Oxfordshire.	
Abington; canal, above the lock at *Horseferry* ....C.	177·59
Banbury, Canal, North of the town ......C.	312·17
————, South of the town ......C.	305·50
Barnwell, canal to *East Chatton* ....C.	288·75
————, at *Uffington Wharf* ......C.	283·75
Caversham Mill, canal ....C.	125·25

Stations.	Above the sea at Low Water.
	Feet.
Clifton Hampden, Canal, W. of Oxford ...C.	159·08
Culham, canal south of ....C.	161·25
Junction of the *Thame* and *Isis,* below *Wittenham Wood* ....C.	154·25
River at *Bensington* Ferry ....C.	153·25
River *Isis,* south-west of *Ensham* village...C.	205·25
Evenlode river, west of Oxford .... C.	194·83
Heyford, upper, canal north of the village..C.	254·83
———— south of the village..C.	250
Iffley, canal below the village ....C.	185·69
Lechlade, (Gloucestershire?) ....C.	243·08
Nettlebed, Windmill ....O.	820
Old Nan's Wear, on the *Isis,* south of *Bampton* ....C.	224·34
Oxford, Canal Lock on the south-west of the city ....C.	190
Purley, on the Thames, below *Maple Durham* Lock ....C.	128·34
Sandford, by Nuneham ....C.	177·59
Shotover Hill, top..............................O.	599
River *Isis,* east of *Stanton-Harcourt* ......C.	206·25
Streatley, (within the course of the Thames across the Chalk), at the Ferry...C.	138·50
Wallingford, canal level, by *North Stoke,* to *Moulsford*.................................C.	149·34
Wantage, canal at..............................C.	288·75
Middlesex.	
Cranford, junction of the Paddington and Grand Junction Canals ....C.	251
Hanger Hill.......................................O.	251
King's arbour ....O.	132
Thames river, north of *Wargrave* ....C.	108·75
————, above *Great Marlow* C	94·17
————, near *Maidenhead* ....C.	79·08
————, at *Eton* ....C.	65·59
————, near *Egham* ....C.	52·08
————, at *Laleham*...........................C.	48·17
————, at *Shepperton*........................C.	40·59
————, at *Teddington,* above the Lock ...C.	23·75
————, at *Limehouse* entrance of Regent's Canal (high-water) ....C.	21
Hunton Bridge ....C.	225·59
London; reservoir of the *Royal Society's Standard Barometer* at Somerset House, above "a fixed mark" on Waterloo Bridge*	83·21
Rickmansworth, canal near to mill ....C.	170·17
Mole River, opposite *Hampton Court*......C.	28·25
Weybridge, Basingstoke Canal ....C.	50
St. Pancras, Regent's Canal ....C.	79·59
Uxbridge, Grand Junction Canal, south of the town ....C.	113·08

* It is very desirable that the "mark" here referred to (from the Register of the Barometer, &c. published periodically in the Phil. Trans.), should be connected with the standard marks on the Thames: its height above the mean level of the sea, is "presumed about 95 feet." Observations of the barometer and thermometer, are taken by one of the officers of the Royal Society twice every day; at 9 A.M. and 3 P.M.

Stations.	Above the sea at Low Water.
	Feet.
BERKSHIRE.	
Kennet and *Avon* canal, above *Hungerford* ....C.	326.50
——— at *Kintbury* ...C.	300·17
——— west of *Newbury* ....C.	257·58
——— south of *Reading* ....C.	124·75
Nettlebed Windmill ....O	820
Nuffield Common ....O.	757
Scutchhamfly Beacon (chalk) ....O.	850
The River *Thames*, at *Sonning*, north-west of the village ....C.	115·75
Wytham Hill (north-west of Oxford)......O.	576
Whitehorse Hill ....O.	893
WILTSHIRE.	
Beacon Hill ....O.	690
Great Bedwin, canal below the village ...C.	385·69
Calne, level of canal ....C.	227·92
Chippenham ....C.	190·08
Clack, canal west of the village ....C.	233·08
River *Isis*, north of *Cricklade* ....C.	276·58
———, canal near, at *Kempsford*......C.	261·25
———, near *Inglesham* above *Lechlade* C.	245·42
———, near *Buscot*, below *Lechlade*...C.	233·34
Melksham, junction of the Wilts and Berks with the Kennet and Avon canal ....C.	135·42
Vale of Pewsey, canal from *Devizes* to *Wooton Rivers* ....C.	429·5
(The canal falls towards Melksham from this level, by 29 locks, 239 feet.)	
——— canal level at *Burbage Wharf* ....C.	462·5
Seend, canal north of, (Kimmeridge clay)...C.	190·50
Stanley Abbey, levels of canal ....C. {	206·25 191·08
Thames and Severn Canal, north-east of *Cricklade* ....C.	268·5
Wilts and Berks Canal, at *Swindon* Wharf, summit level ....C.	333·75
———, level near *Shrivenham* ....C.	302·34
Westbury Down, Ord. Station, (chalk) ...O.	775
Wootton Basset, canal, south of ....C.	301·5
HAMPSHIRE.	
Butser Hill, near Petersfield ....O.	917
Dean Hill ....O.	539
Highclere Beacon ....O.	900
Inkpen Beacon ....O.	1011
Portsdown Hill (top of Nelson's Monument) ....O.	447
Itching Navigation, at *S. Stoneham* ....C.	16·17
——— at *Bishopstoke* ....C.	56·42
——— west of *Twyford* ......C.	101·50

Stations.	Above the sea at Low Water.
	Feet.
Itching Navigation, south-west of *Winchester* ....C.	129·58
Stockbridge Hill ....O.	620
Andover canal, at *Red-Bridge* ....C.	5·83
——— at *Romsey* ....C.	61·42
——— at *Stockbridge*	120
——— at *Andover*	184·83
SURREY.	
St. Ann's Hill ....O.	240
Bagshot heath ....O.	463
Banstead Down, near *Banstead* ....O.	576
———, hundred acres (chalk) ...O.	443
Botley Hill ....O.	880
Croydon Canal, at *Sydenham* ....C.	173·17
———, junction with Surrey Canal, *Deptford* ....C.	17·42
Hindhead ....O.	923
Leith Hill, Tower, (base?) ....O.	993
Norwood ....O.	389
Surrey and Sussex Canal passing *Wonersh* C.	128·42
——— *summit level*, from *Rushwood* to *Sidney Wood* ....C.	162·75
River *Wey*, at *Godalming* ....C.	128·58
——— below Catherine Lock ....C.	111·92
KENT.	
St. Alban's Court, near Wingham ....F.	119·4
Allington Knoll ....O.	329
Copt Point, Gault Cliff ....F.	144
Dover, Castle ....O.	469
—— mean range of spring tides 1834. ......*	18·25
——— 1835 ......*	18 25
——— by report of Harbour-Master 1828 ....F.	20·00
——— mean of neap tides do. ....F.	13·00
———, *extreme* variation of spring tides...F.	24·00
Folkstone, hill, Ordnance Station ....F.	575
———, Turnpike ....O.	585
Folkstone, mean difference of spring tides by report of experienced boatmen ......F.	18·0
——— of neap tides...F.	11·0
———, top of the *Chalk* cliff, nearest to the town ....F.	566
———, *Martello Tower*, No. 1. Base...F.	261
———, Ditto No. 2. Base...F.	193
———, Ditto No. 3. Base...F.	172
———, cliff near the town, on the east F.	117·60
———, cliff at the Church ....F.	145·50
Goudhurst, Kent ....O.	497
Greenwich, Observatory ....O.	214
High nook, near Dymchurch ....O.	28
Hollingburn hill ....O.	616
Nail Down, west of Sandgate ....F.	334
Paddlesworth, hill ....O.	642
Ramsgate, mean range of spring tides; 1834.*	15·25
——— 1835.*	14·75

* Capt. Beaufort, R.N. MSS. from the Reports of the Coast Guard Preventive Service Officers.

Stations.	Above the sea at Low Water.
	Feet.
Kent, (*continued.*)	
River Medway, at *Tunbridge* ....C.	79·69
——— at *Brand Bridge*............C.	47·08
——— west of *Yalding* ....C.	41.69
——— south of *Teston*, above the Lock ....C.	33·69
——— south of *Maidstone*, (Lower green-sand) ....C.	21·58
——— north-west of *Allington* Castle ....C.	20·08
Ruckinge church, west of *Aldington* ......O.	37
Saltwood Castle, near Hythe, in the court...F.	217·50
Sandgate, drawing-room floor of a house in Prospect Place ....F.	57·50
———, hill top over Prospect Place ...F.	263·50
Shakspeare's Cliff, top........................F.	350
Shooter's Hill ....O.	446
South Foreland, Upper Light-House, base..F.	355·20
———, Lower Light-House, base..F.	276·42
Swingfield, steeple-top........................O.	530
Tenterden, (steeple)...........................O.	322
Tolsford Hill ....O.	572
Sussex.	
Arun river, at Thorndell, before it enters the Chalk range ....C.	17·58
Beachy Head, highest cliff ....F.	543
———, old signal ....O.	564
———, base of the house.F.	559
———, *Holywell* chalk pit, cliff top.F.	244
Bell-Tout; cliff edge ....F.	297
———, *First Sister*, or "First of the Sevens," (cliff top) ....F.	266·50
Brightling-Down near Battle ....O.	646
Brighton, site of a former signal-house on the race-course.............................F.	406
Canal, west of *Loxwood*, 11 Locks below the summit level ....C.	75·58
——— near *Spurland* farm, below Mallam Lock ....C.	44·42
——— near *Rowner*, farm ....C.	36·58
——— near *Snape*, below Middle Lock ...C.	25·34
——— near *Neville Wood*, and thence to *Pulborough* ....C.	14·58
Chanctonbury ring, South Downs, (Chalk), Ordnance Station...........................O.	814
Clayton, range of the chalk on the south, about 200 feet lower than the general height of the ridge ....O.	462
Crowborough-Beacon ....O.	804
Ditchling-Beacon ....O.	858
Fairlight Down, top, Ordnance Station ...O.	599
———, same place..................F.	593·6
———, floor of the octagon room in Dr. Batty's house........................F.	555·7
Firle Beacon, South Downs ....O.	820
Frant, near Tunbridge Wells, (top of steeple)...O.	659
Hastings; *Castle hill*, highest point ......F.	271
———, *East cliff*, average level ....F.	257
———, the *Lovers' Seat*..................F.	350
———, average range of spring tides 1834... *	22·00
———, Ditto...........at a point about 3 miles west of the town; 1835.......... *	21·00
——— mean of two years...................................... *	21·50
Newhaven, highest point of the Castle hill..F.	208
Ouse River, at *Ryeland Bridge* ....C.	136·69
———, north-west of *Lindfield* ......C.	110·25
———, west of *Sheffield Park* ....C.	67
———, north of *Goldbridge* Lock......C.	54·17
———, *Sharp's lock*, 2 miles west of Uckfield...C.	48·90
———, *Barcombe Mill*, above the locks.C.	26
———, *Hamsey Place*, north of Lewes C.	18.50
Portobello, top of cliff; about the average level of the cliff from *Rottingdean* to *Newhaven*	96·60 100
Rooks Hill Beech, near Goodwood; Ordnance Station ....O.	702
Rother River, west of *Midhurst* ....C.	68·58
———, near *Pulborough* ....C.	19·08
Rottingdean, cliff top beneath the Windmill ....F.	128
Seaford Cliff, top, N.E. of the Signal ...F.	309
Isle of Wight.	
Bembridge Down ....W.	355
Black-gang Chine, guardhouse on the headland ....W.	400
St. Boniface Down ....W.	355
St. Catherine's Lighthouse ....O.	830
——— *Down*, cliff top under the hill ....W.	591
Culver-cliff top... ....W.	259
Mottestone Down.............................O.	698
Shanklin Down, (*Dunnose* of the Ordnance Survey) ....O.	792
Dorsetshire.	
Blackdown hill, (north-east of Abbotsbury).O.	817
Bull-barrow (south of Sturminster) ......O.	927
Charlton, Common (north of Wincanton).O.	582
Corfe Castle hill ....O.	207
Downs over *Handfast Cliff* ....O.	584
Height of the *Cliff* itself ....O	352
Nine Barrow Down (Isle of Purbeck) ...O.	642
Pillesdon hill (west of Beaminster).........O.	934
Wingreen hill (south-west of Berwick St. John) ....O.	941

* Capt. Beaufort, R.N.; MSS. from the Reports of the Coast-Guard Preventive Officers.

7. *Railroad Sections.*—From the uncertainty of the tide levels, and the inherent defects of the methods, both trigonometric and barometrical, by which most of the heights above mentioned were obtained, they cannot be absolutely depended on within a few feet. Those given in the sections of the numerous railroads through England, having been ascertained by levelling, are much more to be relied upon: they are, probably, as accurate as any that ever have been obtained in undertakings not expressly directed to scientific purposes; and are the more valuable, as the two other modes of measurement are most erroneous when the elevations are small. In the course of a few years the entire surface of this country, wherever the introduction of railroads is practicable, will thus be covered with a network of intersecting lines, along every one of which the heights will have been determined to within a few inches of the truth. A well-arranged collection of the levels will then form a very useful compilation to inquirers in various departments of physical science; and it is to be hoped that some person properly qualified, who has leisure for such a purpose, may be induced to enter upon the undertaking*.

The following Lists contain only the approximate height of a small number of points, along the principal lines of railroad in that part of the South-East of England which is represented in the map, Pl. IX. The first two cut through the chalk range of the midland counties, in passing from London;—1. North-westward, as far as Stony Stratford;—2. By Reading, through the defile of the Thames, towards Abington; and thence, westward, to the vicinity of Chippenham. 3. The South-eastern line, after passing the chalk near Godstone, descends the Valley of Kent, by Tonbridge and Ashford, to Folkstone and Dover. 4. and 5. The Brighton lines traverse the chalk downs and the Wealden denudation, southwards, between London and the Sussex coast. 6. The Southampton railroad crosses the continuation of the anticlinal line of the Wealden towards the Vale of Wardour, and connects the basins of London and the Isle of Wight.

I.—HEIGHTS ON PART OF THE LONDON AND BIRMINGHAM RAILWAY†.

Stations.	Height above the Datum.	Stations.	Height above the Datum.
	Feet.		Feet.
The Datum in the Section of this Railroad, is the same with that of Bradshaw's map of canals; viz. *Low-water* mark at the *Old* Docks, *Liverpool*, (6 Ft. 10 In. under the Dock sill.)		Highest point of the ground over the *Tunnel* near *Primrose Hill*, about 0·1 mile north-west of letter *P*	189·50
		Road from London to Edgware, at *Kilburn* .	130
Datum below the Trinity *high* water mark, at the *London Docks*: (Bradshaw)...21 feet.		South-east bank of the *Brent*, about a mile east of *Apperton*	87·6
[The datum at Liverpool, therefore, is *beneath* low-water mark at Sheerness, (21 — 16·6699 =) 1·330 feet.]		Road from *Harrow* to *Harrow Weald*, about ½ mile beyond *Greenhill*............	190
		——— *Stanmore* to *Pinner*, near Dovehouse farm	218·08
Height of railway above the datum at the *Regent's Canal* near *Camden Town*	118·75	Highest point of ground over the *Tunnel* at *Oxhey-lane*: north of the *e* in *lane*.........	287

* In the present unfinished state of the works, the attempt would be premature; but when the railroads have been completed, the several lines will furnish admirable facilities for accurate levelling along them, and for connecting the heights in the interior of England, with fixed and durable standards at well-chosen places on the coast, the height of which above the sea, may be afterwards ascertained by long-continued observation. From the first of these operations, we should obtain the *relative* height of a number of points, any one of which might be taken as a standard, and all of which are, probably, themselves in motion, and may be expected to differ in elevation after the lapse of years. On this account, the multiplication of standard marks, both inland and on the shore, is very desirable; while the latter should be compared, from time to time, with the supposed invariable mean level of the sea. The height of the tides themselves, however, is in some degree affected by the features of the coast, which it is well known to geologists, are in a state of constant and even rapid alteration.

† Where roads, canals, and streams are mentioned in these lists, the points referred to are those of their intersection by the railway. The names of the places are in the Ordnance Maps; and the precise points are indicated by reference to adjacent words, letters, or objects on the map.

Stations.	Height above the Datum.
	Feet.
Birmingham Railroad (*continued*).	
Railroad at south-east end of Tunnel	236
Bend of the *Brook*, east of *Oxhey-lodge*	214·83
Turnpike road from London, near the entrance of *Watford*	200·50
Valley, or flat, of the *Colne*, north-east of *Watford*	189·25
Road from *Watford* to *St. Alban's*, midway between *Callow-land* and *Nascot-farms*	251·83
Highest point over the Tunnel at *Russel-farm*, near the top of *R* in *Russel*	342
Railroad at entrance of the Tunnel	250
Grand Junction Canal, about ¼ mile south-east of *Nash Mill*	219
Canal, about 3 miles from the last place, between *Boxmoor* and *Bourn-end*	297·83
Road to *Berkhampstead Place*, between the Canal and the *Castle*	352
Highest point over the Tunnel, near the *road* from *N. Church* to *Ashridge*; bottom of letter *N* in *Northchurch*	442·42
Highest ground over the railway at *Three-score-acres lane*; east of *a* in *Grand*	461·83
Road from *Tring* to *Dunstable* (boundary between Herts and Bucks); about midway between *Folly* and *Bulborne*	446·17
Grand Junction Canal, south-east of *Seabrook*	347·75
Road from *Ivinghoe* to *Leighton-Buzzard*; on the south-west of *Horton*; (a continuation of the Vale of Aylesbury)	332·58
Road from *Leighton* to *Wing*, at an elbow east of *Southcot*	318
Railroad at entrance of the Tunnel *Linslade Wood*, north-west of *Leighton*	306
Highest point of ground over the Tunnel, about letter *l* in *Linslade*	391
Road from *Great Brickhill* to *Soulbury*, near Rislip farm; north of *R* in *Rislip*	302·75
——————— to *Newton Longville*	317·69
Stream under the railroad between *Water Eaton* and *Bletchley*, about ¼ mile west of the word *Water*, and south-west of *Stony Stratford*	247
Brook under the main road to *Stony Stratford*, near *Denbigh Hall*; about 46¼ miles from London	264·42
Average height of railroad, from the Tunnel at *Linslade Wood*, to the road last mentioned ... about	300
Grand Junction Canal, about ¾ mile east of *Wolverton*, north of letter *l* in *Canal*	247·75
Bottom of the *Valley* of the *Ouse* and *Tove Rivers*; about 2½ miles north-east of *Stony Stratford*; near *r* in the words *River Ouse*	213

II.—PART OF THE SOUTH-WESTERN RAILROAD; LONDON TO BRISTOL.

The former terminus, or starting point, of this road, was on the Birmingham railway, about a mile west of Kensal Green. The present terminus is at *Westbourn Green*, about ¾ mile north of *Bayswater*, on the Uxbridge road from London.	
The Datum, or base, of the Section is supposed to be about 7 feet above the Trinity high-water mark, at the *London Docks*.	
[Therefore, (approximate) height of the datum, above low-water mark at Sheerness is (19·6699 + 7) = 25·6699 feet.]	
Paddington Canal, at the north-west angle of *Old-oak* Common	85
Brent River at *Hanwell*, south of letter *H*	14
Road from London to *Uxbridge*, near the cross road from *Greenford* to *Norwood* and *Osterley Park*	65
Paddington Canal, east of letter *Y* in *Yedding Brook*	84
Grand Junction Canal, near *Botwell*	84
River *Colne*, near W. Drayton; west of the words *Colham Mill*	68
General level of the surface, on the line from near *Southall*, to the heights over the *Valley of the Thames*, east of Maidenhead Bridge ... about	86
Road from *Slough* to *Stoke Poges*; about ¼ mile from the cross roads	90
Cross road from *Amerton Bank* to *Taplow*, about 24½ miles from London, on the road to *Maidenhead*	69
River *Thames*, about ¼ mile south of *Maidenhead Bridge*	56
Highest point of ground over the railroad; north-east of the road from *Shottesbrook* to *Knowle Hill*; about ¼ mile north of the letters *ot*	142
River *Lodden*, about a mile south-west of *Ruscombe* church	95
Road from London to *Reading*, about 36½ miles; near letter *k* in *Holme Park* (over the Tunnel)	180
Railroad at the entrance of the Tunnel on the east; south-east of the 36th milestone	126
Highest ground over the Tunnel near its western extremity	193
River *Kennet*, near *Broken-brow*, north-west of letter *B*; about ½ mile east of *Reading*	98
General level of the Valley of the Thames, from *Broken-brow* to near *Kentwood*, about	100
Highest point of *ground* over the *Tunnel* near Purley; south of east of the words *Purley Hall*	253
Road about 4½ miles from Reading to *Pangbourn*, north of *y* in *Purley Hall*	147
Thames River, about ¼ mile north by east from *Moulsford* Church, Berks	117
Highest ground over the line of railroad, between the Thames and *West End*, on the south-west of *Cholsey Field*	195
Paper mill stream, north-east of *South Moreton*; and north-west of *P* in *Paper*	134

Stations.	Height above the Datum.
	Feet.
General level of surface, from the *Thames* near *Moulsford* to *East Hagborne*	152
Road from *Dudcot* to *Appleford*; west of the word *Vauxhall*	173
Road to *Abingdon* and *Oxford*, at the entrance of *Steventon* on the south-east	195
Berks and *Wilts Canal*, about 0·4 mile north-east of *Pinmarsh farm*	191
Brook north of *Grove-Wick*	206
Brook near *Circourt*; east of the word *farm*, between *Denchworth* and *Challow Marsh* farm	205
Road from *Wantage* to *Stanford*, south-west of *W* in *Westmead*	240
Highest ground on the north-west of *Collier's farm*, towards *Baulking*	280
Canal about a mile south-east of *Longcott*	258
Highest point over the railroad, on the slope north of *Bourton*, 0·9 mile east of *Hackron Bridges*	319

Stations.	Height above the Datum.
	Feet.
River *Cole*, about ¼ furlong west of canal at *Hackron Bridges*; (county boundary entering Wilts from Berks)	263
Roman *Ermine* Way; about ¼ mile south-east of *Stratton-St. Margaret's*	324
North Wilts Canal, west of *Lower Eastcott*, near the bottom of *E*	308
Brook at *Westcot*, about ½ mile from *Okus*	284
Brook under the turnpike and railroad at *Hunts-Mill*, about ¾ mile south-west of *Wotton Basset*	238
River *Avon*, about ¼ mile north-west of *Avon*; near the final *e* in *Newhouse* farm, 3⅛ miles north by east from *Chippenham* church	130
Level of the railroad at that place	170

III.—ON THE SOUTH-EASTERN RAILWAY, FROM LONDON, BY TONBRIDGE AND ASHFORD, TO DOVER.

This line was originally intended to join the Southampton railroad. The starting point has since been altered, and is not yet determined.	
The datum, or base of the section, is the Trinity high-water mark at *Vauxhall Bridge*.	
Height of datum above low-water at *Sheerness* ....19·67 feet.	
Level of *Mitcham Common* near the Workhouse	90
Entrance of a proposed Tunnel through the chalk, at *Woldingham*	365
Road to *Woldingham Church*, about ¼ mile south of the Church	790
Highest point of ground over the Tunnel, at the meeting of two roads, south of letter *W* in *Woldingham*	793
Oxtead Bridge, at the east end of the village:—(*Stream*, about 270 feet)	277
Brook south-east of the farm-house, about ⅛ mile south of *W* in *Willwood* Farm	188
Road to *Edenbridge*, about a furlong north of the cross roads at *Holdfast*	224
Brook east of *Bowbeach* farm, where crossed by road to Tonbridge	106
River *Medway*, south-west of Powder Mills, and 1¼ mile from *Tonbridge*; west of the *y* in *Medway*	60
General level of surface, from the road east of *Tudely* church (70 feet), to a road west of *Hoghill Green* (53)	60
Main road from Tonbridge to *Tonbridge Wells*; about ⅛ mile from the separation	79
———— to *Hastings*	67
Road at *Rat's Castle*, on the eastern verge of *Paddock Wood*	35
River *Teise*, south-west of the final *e*, near Bockenford	30
Road to Maidstone, immediately on the north of *Marden*; west of letter *M*	83
River *Beult*, about 0·4 mile south by east of *Hockenbury Bridge*	30
Road from *Cranbrook* to *Charing*, at Hoghill Green	97
Stream about ½ mile east of *Ninhouse*, about two miles south-west of Ashford	135
Road about ⅛ mile south-west from *Mersham* Church	162
Road from *Sellinge* to *Hythe*, about ⅛ mile from *Grove Bridge* over the Stour	193
River *Stour*, south of *Stanford* Church, about 1¼ mile from its source near *Postling*	230
Summit of the sand heights cut by railroad near *Stone Farm*	325
Stream at *Beachborough*, nearly south of the summer-house, 0·3 mile west of the word *Mill*	166
Ground at *Cheriton Tile-pits*	155
Streamlet (valley of the gault), about ½ mile from *Inbrook*, south of St. Thames's Well	83
Ground at base of *Martello Tower*, No. 1	241
[The same place above *low*-water, barometrically ....F. 261 Deduct diff. of tides, (at Folkstone)... 21	240]
Height of the *chalk cliff*, at the beginning of the undercliff east of *Copt Point*	465
Height of proposed termination of the railroad, near the *Arch-cliff fort*, Dover; 58 miles 7 furlongs from London	107

A change

Stations.	Height above the Datum.
	Feet.
South-eastern Railroad (*continued*).	
A change in the beginning of this line has been since proposed, which will carry it through *Godstone* and *Tandridge*. The following are some points on the new section :—	
Road from *Croydon* to *Addiscombe*, north of N in Croydon	209
Park hill; top of ridge, south of letter *a* ...	263
Combe lane, bottom of *C*	210
Road from *Croydon*, near *Purley House*, bottom of letter *H*..............................	254
Hill on which is the *old London road*, south of *l* in *Riddles' Down*	407
Opposite to the road to *Cattersham*	413·69
Beginning of the proposed Tunnel, west of *Tillingdown* farm	473
Highest ground above the Tunnel	573
Road at the Dog-kennel (Marden Park ?)...	460·05
Road, or lane, from the *Oxtead* road to *Godstone* Church	383
Road to *Tandridge* Church; near *k* in *Old Park Wood*	382
Road from *Oxtead* to *Crowhurst*, south of the turn to *Whitehall*; about 0·05 mile from *S* in *Stockhurst*	235
Brook, between *Jincock's* and *Stookhouse* farms...	213
Road from *Crowhurst* to *Limpsfield*, at *Milston Wood*, about 0·1 mile south of letter *t* in *Milston*	292
Road at *Willwood* farm	236
Brook about ⅛ mile south-west of *Willwood Farm*...	187
[The new line hereabouts joins that first projected.]	
Road to *Edenbridge*, immediately on the south of road from *Hole Farm*	224

IV.—SIR JOHN RENNIE'S LINE OF RAILROAD, FROM LONDON TO BRIGHTON.

The beginning of this line, in the section laid before Parliament, is at *Kennington*.	
The datum, or base of the section, is the Trinity *high-water mark* in London.	
North-eastern angle of *Mitcham Common* {	107 97·25
Smithham Bottom, near the road from Croydon to Merstham; letter P. of T.P..........	200
Same road, south-west of buildings called *Old brewhouse* in the Ord. map	225
Road to *Coulsdon*, at the place where it strikes off from the main, about ½ mile south of the *Red Lion*........................	297
Above *Hooley House*, on a line through the second *o* in the former word..................	323
Turnpike-road, where crossed by a line drawn through the words *Cottage*—(*Stoney Cottage*), and *Downs*—(*Farthing Downs*) ...	303
Ground above the railroad, opposite to the *Star Inn* near Chipstead; between the letters *t* and in *a Star*	358
Road (above the proposed Tunnel) from the *Turnpike* to *Dean's Farm*; about three fourths of the distance from the Turnpike road	397
Highest point of ground over the proposed Tunnel at *Merstham Hill;* about 4½ furlongs south of the point last mentioned...	498
Turnpike-road north of Merstham, at the *Joliffe Arms*, north of the letters *ge* in *Parsge*..	363
Ground near the *Windmill*, *Merstham*, on the ridge of the Upper green-sand (firestone)	362
Millstream, west of the bottom of letter *M* in *Mill*	285
Stream, where cut by a line from the top of the letters in the word *Linkfield*............	232
Road from *Nutfield* to *Reigate*; immediately on the south of the second *a* in *Tanyard*.	238
Earl's Wood Common; on a line with the lower part of the word *Common*, on the east	190
Height east of *Pertridge Common*; at the first *o* in the word *Wood*	233
Stream, a tributary of the *Mole*; immediately above, and north-east of the letter P. in T.P.	167 156??
Stream tributary to *the Mole*, between the two letters *B* in *Bonehurst Bridge*	152
[From the brook at *Bonehurst Bridge*, to that north of *Hazlick Mill* (more than 4 miles), the surface is nearly flat; on the Weald-clay.]	
Brook, about 2 miles south of the place last mentioned; above the second letter *e* in *Horley-lane* Farm	165
Lane dividing Surrey and Sussex; south-west of the second *a* in *Oakland*	145
Stream at *Hazlick* Mill; where crossed by the road from Jordan's Farm to Wakeham's Green	154
River *Mole*, near the road from *Crawley* to the Workhouse, south of the letter *g* in *Three Bridges*	217
[Near this place, the ground begins to rise into the Forest ridge, (Hastings-sand).]	
The *Mole* river, in *Tilgate Forest*; on a line with the word *Tilgate*, and north-west of letter *C* in *Cinder Banks*	254
Ground in *Tilgate Forest*, about half a furlong north of *re* in *Green Trees*	304
Ground over a proposed Tunnel through the summit of *Balcombe Down*; (about a furlong east of the letter *B* in *Balcombe*) ...	439
Road from *Cooper's Corner* to *Balcombe Church*; at the letter *e* in *Cooper's*.........	293
[A rapid descent of very irregular ground succeeds.]	

Stations.	Height above the Datum.
	Feet.
Stream of the *Ouse* River; immediately on the south of the letters *l* and *s* in *Pil-sty*	54
Highest point of ground over a proposed Tunnel through the heights north of *Cuckfield*; about half a mile south of letter *a* in *Taylor's Barn*........	371
[Irregular ground, rapidly declining, succeeds for about 2 miles.]	
Stream of a large branch of the *Adur*; about 2·1 miles directly south of the bottom of letter E in the word CUCKFIELD, and about 2 miles west of *Wivelsfield*	49
[The surface here for about 4 miles is very irregular; the greatest height, about 250 feet; the average, 80 to 100.]	
Stream, south of the letters *Oa* in *Friar's Oak*	98
Road from *Hurster Point* to *Keymer*; where cut by a line drawn from *r* in *Friar's*, through *a* in *Wickham*, north of Clayton .	165
Road, from the London road to Brighton, towards the Windmill on *Clayton Hill*; south of *D*, and north-west of *G*, in the words *Duncton's Gate*	382
Highest point of ground, over a proposed Tunnel through the chalk; about half a furlong south of the point last mentioned	458
[*Ditchling Beacon*, 2½ miles eastward,—(the highest point of the chalk range in this neighbourhood,) is, according to the Ordnance Survey, 858· feet above *low* water.]	
Exit of the proposed Tunnel, about ¼ mile north of *Pangdean*	204
[The ground thence descends rapidly and uniformly towards Brighton, along a valley of the chalk.]	
Lane to the church at *Patcham*, about 0·1 mile from the turnpike road	164
Termination of the proposed railroad, on the *Lewes road to Brighton*, near the *Royal Garden*........	82

V.—MR. STEPHENSON'S LINE OF RAILROAD, FROM LONDON TO BRIGHTON.

This line is intended to strike off from the Southampton railroad. The datum or base of the section is consequently the same as of that line; viz. the Trinity high-water mark at *Vauxhall Bridge*.	
Road from *Wimbledon to Merton*, ¼ mile south of *ed* in *Wimbledon*........	54
Road on *Merton Common*, to Cannon Hill; west of the top of letter *C* in *Common* ...	39
Stream from *Pylford Bridge*, crossed by railroad about 0·2 mile north-east of letter *P* in *Park Farm*	54·4
Height at *Sparrow Farm*........	141
Road from *Kingston* to *Ewell*, over a small ridge; between the end of the word *Ewell* and *Court*........	104
Stream of the *Hog's mill* river; at a point due south of letter *C* in the word *Court*	72
Road on the northern verge of *Epsom Common*; at a point due north of letter *o* in *Epsom Wells*	172
Highest point of ground over a Tunnel through the ridge on *Epsom Common*; 0·1 mile due south of the second *m* in the word *Common*	244
Height of the railroad at the exit of the Tunnel........	153
General level of the ground, on the south-west of the ridge, by Duke's Hill, to the north-west of *Ashstead*	156
Road from London to *Leatherhead*, north of the first letter *e* in *Leather*........	169
Road from *Leatherhead* to *Dorking*, east of letter *M* in the words *R. Mole*	125
River Mole, due south of the letter *e* in *Mole*; nearly on a line joining the words *Fetcham* and *Mickleham*........	93
Highest point of ground over an intended Archway in *Norbury Park*; north of the letter *r* in *Norbury*	225·5
Level of railroad at bottom of Archway ...	134
River *Mole*; immediately south of the Archway, and of letter *y* in *Norbury*	98
River *Mole*; about 0·8 mile south of the last place, north of letter *e* in the word *West-humble*	108
Millstream, ¼ mile north of letter *P* in *Punch-bowl*	128
Road from *Dorking* to *Reigate*, at the cross-roads south-east of the words *Punch Bowl*	184
Highest ground over a proposed Tunnel, about 0·35 mile from the cross roads last mentioned; south-east of G in DORKING...	345
Height of the bottom of Tunnel at its exit...	82
Lane or road, west of letter P in Park Farm	218
Stream between two lanes north of letter *S* in *Scammet's Farm*	165
Stream (another tributary of the Mole, springing on Holmwood Common); at a point south of the second *m* in (*Brockham*) *Common*	207
Stream which runs to *Ewood Pond*; on the north-west margin of a wood, about ¼ mile from the edge of the pond	205
Height, in the wood, between the words *Henfold* and *Park Gate*	285
Streamlet on the south of the wood, due east of the word *Knole* Farm	221
[The highest point of the railroad hereabouts, is between the streamlet last mentioned and the village of *Newdigate*, and is 247 feet above the datum. The road then declines rapidly to Warnham, and thence to the seaside.]	

Stations.	Height above the Datum.	Stations.	Height above the Datum.
	Feet.		Feet.
Mr. Stephenson's Brighton (*continued*).		Heights cut through by the railroad, on the south-east of *Cobb's Hill*; about 0·1 mile south of letter *s* in *Tuckman's*...............	123
Brook between *Green's Farm* and *Rushet*, where crossed by a line joining letters *n* and *t* in those words..........................	213	Two streamlets, south-east of the point last mentioned, where cut by the line passing from *a* in *Tuckman's* to *ha* in *Smallham*: the level in both is, about	40
Highest point of ground cut by the railroad, on the east of *Plaistow Farm*, 1 mile from the point last mentioned	297	Heights on the north of *Joulsfield Common*, east of West Grinstead; about 0·1 mile north-west of a Windmill	90
Boundary of the counties of *Surrey* and *Sussex*; immediately above letter *M* in *Muggeridge Farm*	213	Road north of letter *a* in *Partridge Green*, about ¼ mile east of the main road to *Steyning*	25·5
Brook on the east of the London Road, about 1·7 mile south of *Kingsfold*; and 1·15 mile from *Warnham*	153	Principal branch of *the Adur*, on the north-west of Henfield,—(called in the section *Henfield Cut*);—where crossed by a line connecting letter *e* in *Bine Farm*, with *L* in *Lashmer's*: nearly on a level with the Datum	0·0
Brook south-east of *Slaughter's Bridge*, under the letter *B*	155	[Thence to the seaside, the railroad follows the valley of the *Adur*; passing through the chalk range, by the defile of that river, to *Shoreham*.]	
Height, east of the main road, on the west of a small wood above the words *Lake Barn*.	229	Part of a hill cut through by a projected Tunnel north of Brighton, on the road to *Preston*, about 0·1 mile north of a windmill on its summit, is about.................	198
Stream, a tributary of the *Arun*, on the south-west of *Horsham*; north of the letters *ar* in *Farthings*, and a little south of west from the words Tower Hill.................	83		
Railroad at the same point	140		
Road from *Horsham* to *Worthing*; about 2¾ miles from the former, between the word *Prior's*, and a short lane leading to that farm-house	136		

VI.—LONDON AND SOUTHAMPTON RAILROAD, BY BASINGSTOKE AND WINCHESTER.

This road begins on the bank of the Thames, near *Nine-Elms*, about ¼ mile south-west of *Vauxhall Bridge*.		Ground above the railroad, outside of *Oatland's Park*; directly south of the second *a* in *Oatlands*	103
The datum or base of the section is the *Trinity high-water mark* at that bridge. The levels were ascertained under the didirection of Mr. Giles, engineer to the Company.		*Old River Wey*, north-east of the letter *k* in *Hollick's* Farm................................	29
The height of the datum above low-water mark at Sheerness, is ....19·67 feet		*Wey navigation*, at the commencement of the Basingstoke canal; south-east of letter *w* in *Ham Haw*	42
[The natural surface for about 2 miles from the point of commencement, across *Battersea Fields*, is 1 to 5 feet *below* high-water mark.]		*Road* on *Woking Heath*, from Horsell to Heathside; under letter *W*, and immediately west of letter *H* in *Heath*	90
Road from *Battersea Rise* to *Wandsworth*, immediately on the west of the cross-road to Battersea	40	Summit of a *ridge of sand* (called *Gouldsworth* in the section); south of letters *Gr* in *Royal Oak Green*, and west of the word *Crossland*	185
Highest point of ground on *Wandsworth Common*, about the letter *i* in the words *Half Farthing*	80	*Stream* on the north-east of *Pirbright Common*, south of letter *m* in *Hermitage*	103
River Wandle, where crossed by the railroad, near letter *t* in *Garret Mill*.................	10	Height on *Pirbright Common*, north of letters *ir* in *Pirbright*	173
[From the foot of the height near *Kingston*, south-east of Surbiton, to *Walton Common*, is a continuous flat.]		Ground at the eastern angle of *Furzehill Pond*...	168
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Stations.	Height above the Datum.
	Feet.
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Height cut through by the railroad, $\frac{1}{6}$ of a mile from *Newnham Church*	301
Stream on the south-west of *Newnham*, and 0·08 mile north of the *io* in the words *Red Lion*	198
Highest point of ground cut through by the railroad between *Newnham* and *Old Basing*; 0·35 mile south of letter *M* in *Basing Mill*	292
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Mill Head, *River Loddon*; $\frac{1}{2}$ mile west of bottom of the word *Old*	224
Main road from *Basingstoke* to *Reading*; on a line with the bottom of the word *Penton's*, in *Penton's Mill*	307
Road from Basingstoke to Whitchurch, at *Worting*, about midway from the cross roads to the church	318·75
Railroad at the same point	341
Height south of the word *Worting*	362
Road from *Church Oakley* to *Fairdown Copse*; about 0·63 mile from the church, on the south-east	404
High ground about $\frac{1}{8}$ mile south of the place last mentioned	420
[This point is a little higher than the general range of the heights between *Worting* and *Steventon*.]	
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Stations.	Height above the Datum.
	Feet.
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Depression on the south-west of the height last mentioned; northern extremity of *Cobley Wood*....................................	374
Height at the angle of an inclosure, west of the words *Popham Beacon*	454
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Depression 0·7 mile south-west by south of *Warren's Farm*; north of *S* in *Sheep Ho.*	268
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Stream and road near *Weston*, about 0·86 east of the church at *Stoke Charity*...............	208·5
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Railroad at the same point	130
[From this place to the shore, *east of Southampton*, the railroad follows the line of the *River Itching*, with a nearly uniform descent.]	
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Railroad at the same place.....................	52·5
Road from *Southampton* to *Twyford* and Winchester, about $\frac{1}{2}$ mile north of *Swathling*	23
[The railroad reaches the level of the London high water-mark, within the grounds of *Portswood House*.]	

D.—ADDITIONS AND CORRECTIONS.

Coast west of Hastings.—The alterations and improvements on the coast west of Hastings were so rapid, soon after the preceding pages 163. to 171. were written, that, within a few weeks, an entirely new face of the cliffs was brought to light; a great part of the original surface having been cut away, so as to throw back the vertical section to a much greater distance from the sea, while the debris were employed in raising a quay, by which the shore is now concealed. The Rev. Granville Vernon Harcourt, who had examined the new features thus disclosed, was so good as to point out to me several appearances, which proved that the structure of the shore was not quite so simple as I had supposed it to be, though the sections above described, and that represented in Plate X. b. fig. 3., are in the main correct. Several intermediate though slight derangements occur between the principal fault at the White Rock and the site of the church west of St. Leonard's; and the whole of the phenomena show that the original stratification hereabouts has been fractured and dislocated throughout, although the disjointed portions are seldom widely separated.

It would be impossible, without the aid of a map on a very large scale, to represent these derangements, nor have they more than a local interest. The place of one of the principal interruptions between the White Rock and Warriors' Gate is represented in Pl. X. b. fig. 3.; and the beds composing the group thus divided, which, on the east of that point, dip slightly towards the sea (or to the west of south), could be detected in several places within (or north of) the *Marina* at St. Leonard's, in the sides of the new roads and streets then in progress, inclining, generally, to the *north*. Their identity could be traced by the aid of two thin beds of greenish Fuller's earth, frequently concurrent, but sometimes about 4 or 5 feet apart, and separated by about 8 feet of grey sand and sandrock, from a bed of dark grey clay, much charged with portions of lignite, in which indications of vegetable structure were perceptible, but none so distinct as to indicate the species. These beds are all superior to the Endogenite group of the White Rock; and their distance above that group, on the north-east of St. Leonard's church, was clearly seen to be nearly the same as at the White Rock. At the roadside, on the east of St. Leonard's church, I myself found a specimen of Endogenites, at the place mentioned by Mr. Parish from report.

The greater part of the ground formerly above the White Rock had been removed by the operations above mentioned, and the fault there was distinctly uncovered to the extent of several yards. The strata which form the cliff at the brewery descend gradually to the sea, without apparent disturbance, but the ruins of the superior strata, including numerous fragments of the lignite bed, were mixed in great confusion on the western and upper side of the fault; which rising gradually towards the north-east, seemed to cross the valley there separating the cliffs from those of Hastings Castle Hill, in a direction from about south 35° west to the east of north. On that line a wide but not deep fissure, or ravine, could be discerned passing towards the place called *Bohemia*; and on the opposite side of the valley, a detached portion of confused matter, including, as at the White Rock, masses of clay iron ore, was visible in a highly inclined position, at the corner of one of the lanes descending from the Castle Rock to the marsh. It is not improbable that the fault may be continued further up the valley on the north-west of Hastings.

Bones of Birds in the Wealden.—Mr. Mantell, in a short paper read before the Geological Society, June, 1835*, has shown by anatomical evidence that the bones found at Tilgate Forest, and

* "Proceedings," vol. ii. p. 203.

suspected to belong to Pterodactyles, were correctly referred to birds. On placing some of the questionable fragments before Mr. Owen, of the College of Surgeons, that gentleman found, in a tarso-metatarsal bone, the articular surface and place of attachment of the posterior, or opposite toe, distinctly indicated; and on a comparison of these fragments with the foot of a recent *Ardea*, no doubt remained as to the similarity of their structure. This short paper beautifully illustrates the bearing of exact comparative anatomy upon Geology.

Supposed Wealden in Northamptonshire.—Mr. Lonsdale having, during the last summer, resumed his examination of the oolitic system, and followed out the series from the north of Oxfordshire to the Humber, informs me, that he did not observe any traces of the Wealden in the vicinity of Wansford; which is mentioned at p. 309. as the place where a beautiful specimen of *Lonchopteris Mantellii* was supposed to have been found. The tract belongs to the great oolite, which is the highest formation, and is extensively quarried in every direction around Wansford: on the west of Peterborough, the highest formation is the cornbrash. Mr. Lonsdale, therefore, thinks that the occurrence of any portion of the Wealden group in such a situation, is extremely improbable, and that the specimen above referred to may have been ascribed to that place by mistake.

Supposed Chalk in Rutlandshire.—The existence of Chalk, *in situ*, at *Ridlington*, in Rutlandshire, Mr. Lonsdale considers also as being very improbable. The village stands on the ferruginous sand of the inferior oolite; about half a mile west of it, is a small pit of the bottom beds of the great oolite, now a subsided mass: and great oolite is quarried near Brooke Hall, two miles north of Ridlington; but with the exception first mentioned, there is no trace of any stratum superior to the inferior oolite, in the immediate neighbourhood of that village.

Inoceramus intermedius.—This fossil, which is mentioned at p. 317, as from Hunstanton cliff in West Norfolk, is a new species, ascertained by Mr. Sowerby; by whom a drawing of it was made, for a Wood-cut, published in Loudon's "Magazine of Natural History," for 1829, vol. ii. p. 296. Mr. Sowerby informs me that its occurrence is not unfrequent in the flinty chalk of Norfolk and Kent; and that it is found occasionally, in flint, in the gravel around London.

CONTENTS.

APPENDIX.

ERRATA ET CORRIGENDA.

Page 106, line 5, *for* No. 1.) illustrates *read* No. 1. and X. b. fig. 1. illustrate

—— 107, — 17, *after* No. 1. *insert* and Plate X. b. fig. 1.

—— 108, Note *, *for* Section, Plate X. a. No. 1. *read* Sections, Plate X. a. No. 1. and X. b. fig. 1.

—— 111, line 3 from bottom, *for* at *read* from

—— 112, — 23, *for subcristatus* read *cristatus*; *and add* Plate XI. fig. 23.—See Appendix A. p. 337.

—— 113, — 15, *for Hamites* aculeatus *read Hamites* spiniger

—— — — 9 from bottom, *add the words* also at Blackdown, Devon, Plate XVIII. p. 242.

—— 119, — 9 from bottom, *for* Siphonaria, *read* Siphonia

—— 130, — 20, *for* XXI. f. 7. *read* XXIII. fig. 7.

—— 131, — 14, for *Trochus*, read *Pleurotomaria*

—— 138, The thickness of the beds represented in the *Wood-cut* differs in some respects from those of the *List*, p. 139; the latter are the more correct.

—— 143, line 22, *dele* is

—— 153, — 3, *for* striata *read* gigantea

—— 164, — 3, *for* fig. 2. *read* fig. 3.

—— — — 4, *for* No. 5. *read* No. 6.

—— 167, — 11 from bottom, *for* (b.) *read* (β.)

—— — — 9 from bottom, *for* (b.) *read* (β.)

—— — — 9 from bottom, for *fluviorum* read *vivipara*

—— 168, — 1, *for* (2. b. and 2. e.) *read* 2. β. and 2. ε.

—— — — 8, *for* 12 *read* 10?

—— — — 11, *for* 2. a. *read* 2. α.

—— — last line, *add* p. 186, *read* (95.) p. 186.

—— 181, line 15, *for* Pippingford *read* Peppingford-Park

—— — — 21, for *Odontopteris* read *Sphenopteris*

—— 182, — 13 from bottom, *for* No. 6. *read* No. 7.

—— 195, — 14, 15, 17, from bottom, for *Gryphæa* read *Exogyra*

—— 203, — 3, for *Seligrimus* read *Selliguinus*

—— 204, — 2, *insert* "*Anomia* convexa. Plate XIV. fig. 7. Shore East of Shanklin Chine. See p. 338."

—— — — 25, after *Ostrea* carinata *insert* "Ostrea retusa, Plate XIV. fig. 4.; from Atherfield, in the Lower greensand."

—— 214, last line, for VIII. *read* IX.

—— 225, line 14, *dele* and

—— 230, — 9, *for* XX. *read* XXII.

Page 231, line 24, *for* tricristata *read* triserrata

—— 234, — 6, *after* thus: *insert* "(see Plate X. a. No. 11, and X. b. fig. 9.)"

—— 241, — 19, 2nd column,
—— 342, — 2, from bottom,
and Descript. of Pl. XVIII. fig. 1. } *for* Stutchburiensis *read* Stutchburianus

—— 242, — 9, first column, *for* megastrema *read* megatrema

—— — — 5, second column, *add the words* "also from Eastware Bay, in Kent; see p. 114, line 32."

—— 252, — 15, *for* 4 feet to 7 feet *read* 4 to 7

—— 259, — 19, *for* in *read* or

—— 260, — 8, *for* Berston *read* Benston

—— 262, — 26, *for* South *read* North

—— — — 32, *for* between Gin Cross *read* from Gore Cross

—— 273, — 6 from bottom, *for* Aptychus *read Trigonellites*

—— 292, — 23 and 30, *for* Aptychus *read Trigonellites*

—— 297, — 10 from bottom, *dele the semicolon after* suboolitic

—— 298, — 20, for *Potamides carinatum* read *Potamides?* (a new species.)

—— 300, — 5 from bottom, *for* 286 *read* 206

—— 302, — 19, for *Aptychus* (Von Meyer),—read "*Trigonellites*, (Parkinson); *Ichthyosiagones*, (Rüppell); *Aptychus*, (Von Meyer.)"

—— 303, — 5, *for* 206. *read* 286.

—— 304, — 16 from bottom, *for* masses *read* matter

—— — — 24, *for* masses *read* matter

—— 305, — 9, *dele the word* "chalk"

—— 309, — 4, *note* †, *for* R. C. *read* C. B.

—— 316, — 6 from bottom, for *Aptychus* read *Trigonellites*

—— 324, — 8, *for* (168.) p. 326. *read* (167.) and (168.) pp. 326. and 329.

—— 339, — 9, for *gigantea read* striata

—— 352, In the reference connected with *Pentacrinites scalaris*, for fig. 2. *read* fig. 4.

Tables 353, After *Gastrochæna*, insert "sp. doubtful.—In perforations in dicotyledonous (silicified) wood;—*Gault*, east of Folkstone."

—— 355, In the reference *Cytherea* subrotunda, *for* Pl. XXII. 2. *read* Plate XVII. 2.

—— 355, After *Cyclas media* insert "C—— *media*, a gibbose variety, Pl. XXI. fig. 11. (*Hastings-sand*; Sussex, 177.—*Purbeck strata*; S. Wilts, 259.)"

—— 358, *note, dele ?? after the word* adjective

IX.—*Geological Sketch of the North-western Extremity of Sussex, and the adjoining Parts of Hants and Surrey.*

By Roderick Impey MURCHISON, Esq. Sec. G.S., F.R.S., &c. &c.

[Read December 16th, 1825.]

I PROPOSE to illustrate in this memoir the order of superposition of the strata in that north-western part of Sussex which is bounded on the south by the chalk escarpment of the South-downs, and in those adjoining parts of Hampshire and Surrey which are bounded severally, on the west by the Alton chalk-hills, and on the north by the North-downs.

Having examined a portion of this country with my friend Dr. Fitton, I was encouraged by him to attempt an exact delineation of the whole, by colouring the Ordnance map according to geological formations *. This task being now accomplished, I beg to lay the result before the Geological Society, together with such illustrative specimens of the strata and their fossils as I have been able to collect in the course of last summer.

The formations of which this district is composed, begin to emerge from the superior strata at the northern extremity of the parish of Bentley in Hants, 6 miles north-east of Alton; and they range from thence to the south and east, until their escarpments are cut through by the Arun, which river I have chosen to make the limit of my present observations.

The chalk escarpments of the Alton hills and of the South-downs, converging towards Petersfield, are united at an acute angle in the parish of East Meon, 4 miles west of the former place; and within that angle the inferior strata are disposed conformably. Hence by assuming the Weald clay in the little valley of Harting Combe as the *nucleus* of the district, a regular succession is developed up to either chalk-range, and the breadth of each intermediate formation which mantles round the Weald clay, is shown by the map and section annexed.

The same order of superposition having been clearly established in the

* Pl. XIV. is a sketch taken from the coloured copy of the Ordnance map alluded to in the text.

sections of the coast of the Isle of Wight*, my object is to point out the identity of this extensive inland tract, in which all the members of the series, from the chalk to the beds below the Weald clay, appear to be more largely and uninterruptedly displayed than in any other part of England. It is the more necessary to define accurately all the strata of this district, inasmuch as three of the formations have been hitherto described to be one range of green-sand; whereas the upper green-sand is divided from the lower, throughout the whole of this country, by a distinct and important breadth of *Gault clay*, of which the royal forest of Alice Holt forms the north-eastern portion.

The strata, therefore, the relations of which it is my object briefly to describe, commencing below the chalk in a descending series; are,

1st. Firestone, or Upper Green-sand.
2nd. Gault.
3rd. Lower Green-sand.
4th. Weald Clay.
5th. Hastings or Iron Sand.

I. *Firestone, or Upper Green-sand.*

This formation, which lies immediately below the chalk, is provincially termed Malm-rock, and is known by that name alone in the counties of Hants and Sussex, throughout a range of 40 miles. Its geognostic position and the fossils it contains, prove it to be geologically identical with the upper green-sand or firestone of Merstham. The beds are nearly horizontal, or they dip at only a slight angle towards the chalk. The whole formation is peculiarly characterized by constituting *terraces*, which vary in breadth from a quarter of a mile to two and three miles, and which generally correspond to the sinuosities of the chalk hills. These terraces are covered by a tenacious grayish-white soil, celebrated for its abundant production of wheat. Quarries are to be seen in all the lanes which intersect this country; and in many places the sides of the roads, which by the rapid decomposition of the rock are worn into deep hollows, present sections from 20 to 30 feet deep. The harder beds are used for building; and though the occurrence of firestone is not frequent, still that variety is seen in some places, at Selborne for instance, where it is employed in the construction of ovens.

The upper beds are the most cretaceous; but these sometimes pass into a grayish-blue compact limestone, which is of great thickness at Binsted and

* See Annals of Philosophy, 1824, New Series, vol. viii.

Froyle in Hants, and at Sutton in Sussex:—occasionally a blue chert may be observed.

The inferior beds have a softer and more sandy character, particularly near their junction with the Gault.—The depth of the wells sunk in this stratum varies from 60 to 100 feet.

The fossil shells, though belonging to few species, are extremely numerous: they are usually much compressed; and the beds in which they abound being of a perishable quality, they are very fragile.

Those which I have collected are chiefly from Nursted and Buriton, Hants. —The following names were obligingly afforded me by Mr. Sowerby, who examined the specimens.

Ammonites rostratus.
Ammonites varians.
Pecten orbicularis.
Gryphæa vesiculosa.
Avicula. New species not yet figured.
Echino-spatagus. New species figured and named in the Icon. Sect. Foss. cent. 2da of König.
Fish:—fin of the Balistes?

Circular impressions and highly indurated cylindrical bodies, probably portions of stems of Alcyonia, are very frequent.—Of the above fossils, the *Ammonites rostratus* and the *Pecten orbicularis* are the most abundant and characteristic, the latter especially being often well preserved; and it is to be remarked that these two fossils occur in the same geological position in the Undercliff of the Isle of Wight.

The relations of the Malm-rock are no where better exhibited than in the vicinity of Binsted, Hants. The peninsular terrace upon which that village stands, is composed exclusively of this formation, which projecting nearly 3 miles beyond the Alton chalk-range from south-west to north-east, is surrounded at its base on three sides by the subjacent Gault. The Malm-rock is cut through by the river Wey, which thus separates the promontories of Binsted from those of Froyle and Bentley *.

There exists a remarkable analogy between this inland range, and that laid open in the coast-section of the Undercliff in the Isle of Wight. The Malm-rock at Hawkley, like that of the Undercliff, forms a terrace terminated by a

* The Malm *Rock* of Sussex and Hants must be distinguished from the Malm *Land* of Surrey at the base of the North-downs, east of Box Hill; the latter being an agricultural term for the black clay belonging to the Gault.

mural escarpment, having its crest and base fringed with foliage, and resting upon a green talus of Gault. This base of clay after the wet winter of 1774 (see White's Hist. of Selborne, letter 45) gave way under the superincumbent pressure, occasioning the well-known Hawkley Slip, by which houses and barns were displaced or thrown down. The surface of the Gault was rent into fissures, and a large portion of the debris of the Malm-rock was ingulfed. The subsidence of the Gault between Luccombe and Bonchurch, in the Isle of Wight, has more recently occasioned a similar fall of the Undercliff.—It may be stated, as an inducement to the traveller to diverge from the high road into this district, that the deep and woody glens which intersect the escarpment of the Malm-rock, offer the most picturesque varieties of landscape.

II. *Gault.*

Below the range of the Malm-rock is seen a continuous breadth of Gault. This stratum is most clearly developed at the north-eastern angle of the district; where it forms the valley under Bentley and Binsted, and then rises into eminences which compose the forest of Alice Holt. The superior bed is commonly a brown or yellowish clay; but on penetrating a few feet, blue harsh clay is reached, which generally effervesces with acids, and appears to be of uniform character throughout, in the deepest sections. On the surface of Alice Holt there is frequently a diluvial covering of red and yellow flints, which in some places is from 12 to 14 feet thick; and where this occurs, water has been procured by sinking merely through this gravel; whilst in other parts, the subjacent blue clay has been penetrated to the depth of 40 feet unsuccessfully. Of the fossils of this formation I have met most frequently with the *Ammonites dentatus*, at 6 or 8 feet below the surface. The junction of the Gault with the Lower Green-sand is clearly exposed at the south end of the village of Wracklesham, where the superior beds of the latter formation are similar to those, of which specimens have been brought up by boring through the Gault near Cambridge, and which are now in the museum of the Society.

The agricultural character of this clay is unvaried in its whole extent from Wracklesham near Guildford to the river Arun in Sussex. Its line is marked by the most fertile water meadows and the finest forest timber; thus presenting a *green* belt, which clearly defines and distinguishes it from the rich wheat land of the Malm-rock above, and the arid expanse of the Lower Green-sand below.

III. *Lower Green-sand.*

The Lower Green-sand is the most extensive formation in this district, and presents an undulating and unequal surface. It rises from the valleys of Gault, and swells into hills, which increase in elevation as they recede from the incumbent strata, and finally attain a height equal to the most lofty points of chalk in the range of the South-downs.

The beds dip every where towards the chalk, but in the south-eastern part of the district more rapidly than in the north-western. They are inclined towards the Alton chalk-hills at an angle which is scarcely perceptible, and accordingly in that quarter are expanded over a more considerable extent of surface than towards the South-downs, where the dip frequently amounts to 10 or 15 degrees.

Woolmer Forest, Petersfield, Haslemere, Midhurst, and Petworth are in this formation.

The superior beds consist of quartzose grains combined with oxide of iron; and they abound in veins of iron-stone, which are occasionally hollow and of large dimensions, at other times compact. The colour of the sands in this part of the formation is very varied: in some places, as near Rogate, deep sections occur of a pure white sand; whilst in Woolmer Forest and at Frensham the mass is dark red, with many veins of contorted and cellular iron-stone.

A bed of calcareous grit appears to occur uniformly along the centre of this formation, and may be traced from Godalming through Headley, Lyss, Rogate, Stedham to Dean Farm near Petworth. At the latter place it is a compact blue limestone, and is extensively quarried for the roads; but in the former situations, the grit is a conglomerate of quartz grains and pebbles, bound together by a strong calcareous cement, and is called *Bargate Stone* *;—it is hard and durable, and has recently been burnt for lime.

Towards the lower part of the sands, gray and blue chert occurs, particularly at Iping Hammer-ponds, Brinksole Heath, &c. &c.

The lowest beds are marked by a great change of appearance;—green particles are now intimately mixed throughout the mass, and all the hills which immediately adjoin the valley of the Weald clay, afford a yellowish sandstone filled with green particles, which is used for building, and is the only bed of this formation west of the river Arun, which I have observed to contain fossils, or rather the casts of them †. These casts appear to be of Ammonites and Terebratulæ, but were not sufficiently perfect for Mr. Sowerby to distinguish the species.

* Mr. Greenough informs me that this calcareous grit extends eastward thoughout the same formation in Surrey and Kent, where also it is known by the name of *Bargate Stone.*

† Parham Park is in this formation; but being west of the river Arun, the consideration of the fossils found there is not now entered upon.—Those however which I have seen from that place, are very unlike the casts to which I now allude.

The best quarries of this rock are north of Midhurst, as at Dunner Hill, Pit's Hill, &c. &c.

It is worthy of remark that this formation, though not retentive of water, supports a vast number of small lakes or ponds. Those of Frensham, Woolmer Forest, Petersfield, Iping and Burton are examples.

The river Wey (the principal branch of which rises in the chalk at Alton from numerous and perennial springs), after flowing through the chalk, the Malm-rock and the Gault successively, has its course exclusively in this stratum for about 20 miles, until it turns to intersect the chalk-escarpment at Guildford. In like manner the Rother, or western branch of the river Arun, which rises in the chalk and flows over the intermediate formations, is in its subsequent course confined to these sands; passing near Lyss, Petersfield, and Midhurst, to its junction with the main branch at Pulborough.

The depth of the wells in this formation increases with the rise of the hills. At Petersfield water is reached in 20 or 30 feet; at Rake common, in 200 feet; and in boring for water this summer at Petworth-house, near 400 feet of sand were passed through, when a blue clay was brought up which effervesced with acids.

Diluvial accumulations of chalk flints sometimes occur on the surface of these sands, as at Rogate Common, &c. and several beds of such debris were cut through last summer near Trotton, in making the new road from Petersfield to Midhurst. Their presence on this stratum is worthy of remark, as I have never met with them on the subjacent formation of Weald clay.

IV. *Weald Clay.*

The Weald clay, which is next in the series, forms at Harting Combe the nucleus of the western part of this district.—The line A B on the map, drawn from this point west-by-north and south-south-east, shows a section complete in all its members up to the chalk escarpment on either side.

The passage from the lower green-sand to the clay is well observed along the base of the hills which bound the valley on the south, where very thin beds of various-coloured clays alternate with soft dark green-sand. These striæ seem to mark the dip, which is at an angle of from 10 to 12 degrees.

The surface clay in the bottom of the valley is yellowish-brown in colour; but changes below to a deep red, and is then highly impregnated with oxide of iron.

The general form of the valley in this part of the Weald is peculiar, and the great inequality of its width is a striking feature in the geological map.

From its western angle and commencement at Harting Combe, little more of it is seen to the east, for 7 or 8 miles, than a narrow gorge, which is flanked, on the north, by the lofty hills of Blackdown, and on the south, by the corresponding ridge extending from Holder and Bexley hills to near Petworth. The valley is then suddenly expanded to three times its former breadth by the retirement at a right angle of the sand-escarpment of Blackdown and Haslemere.

In the extensive vale thus laid open the best specimens of the Sussex or Petworth marble are found. The disintegrated beds near the surface afford the characteristic Viviparæ in abundance, whilst in the more compact masses the *Cypris Faba* may also be discovered. The different localities of this marble are given in the annexed table of the order of superposition : but it may be remarked that the parish of Kirdford contains some of the largest and finest slabs.

Iron-ore is much disseminated through this formation, as well as through the inferior formation of Hastings or Iron Sand.—The Weald clay abounds in ancient iron-works, and their sites are still to be traced from near the junction of the lowest beds with the Hastings sand, up to the highest beds at the base of the lower green-sand. In the gorge of Harting Combe, at Lynch, Redford, &c. &c., the slag of the extinct furnaces is yet used as a material for repairing roads. These places are situated from 10 to 12 miles west of the outcrop of the iron-sand.

V. *Hastings or Iron Sand.*

This lowest formation of the vale of Sussex rises in gentle undulations immediately to the east of Kirdford in the parish of Wisborough Green, where, at Headfold-wood Common near Loxwood, its outline makes an angle, corresponding to that formed by the Weald clay and the superior strata.

Although these beds at their first emergence consist chiefly of clay, yet they differ essentially from the Weald clay in containing near the surface small flags of a slightly *calcareous sand-stone,* and beneath these, large tabular masses of a calcareous grit, which is very similar to certain beds of the Stammerham and Slinfold quarries west of Horsham. Unlike, however, to the latter, the calcareous grit-stone of Wisborough Green is based upon a deep mass of red ferruginous marly clay, and is only found in detached portions.

The Horsham beds have already been well described by Mr. Lyell, in a letter addressed to Mr. Mantell and read at the Geological Society, and have been examined by Mr. L. at Stammerham; but their extension to Skiff Common and Loxwood, from 9 to 10 miles west of that place, has not previously been noticed.

I have now the satisfaction of laying before the Society numerous fossil remains of large vertebrated animals from two localities at the extreme western angle of this formation, where the inhabitants have occasionally found similar remains for many years. Their occurrence to the eastward, however, appears to be very partial. In the extensive quarries of Stammerham I could only discover that one vertebra had been seen (apparently that of a tortoise); whilst in the intervening tract of 9 or 10 miles between that place and Loxwood, no analogous remains have been met with, although numerous quarries of the same tabular grit-stone are worked at Slinfold, Billingshurst, &c. &c.

The greater number of the bones now presented, were found at Headfoldwood Common, in 1824; they were situated about 5 feet below the surface: above them the mass was yellowish-brown clay, with micaceous sandstone occurring occasionally; and below the clay were large tabular masses of the calcareous grit. Immediately beneath this stone the bones were impacted in ferruginous and marly clay; under this were veins of blue clay, containing selenite.

The largest specimen proves to be a femur*. It measured, when entire, 3 feet 7 inches in length. (See Pl. XV. fig. 9.) One vertebra (No. 8) and many large fragments of bones were also found here.

Recently J. King, Esq. of Loxwood, has met with many more osseous remains imbedded in the clay north of his house, and about 3 feet from the surface. By his kindness I am now enabled to present a series of vertebræ and other specimens to the Society. (See Pl. XV. fig. 1 to 7.)

Mr. Clift, of the College of Surgeons, obligingly examined these remains. He finds that they possess the striated texture of surface which characterizes the bones of fishes, crocodiles, and aquatic saurians; and that the thin wall or exterior crust, which covers an interior cancellated structure, further establishes his conclusion, that they have belonged to some great aquatic animal.

Having submitted the drawings and some of the specimens to Baron Cuvier for inspection, I have been favoured by him with the following remarks. "I am inclined to believe," he observes, "that they are the remains of a *new* species of large saurian; since I am not acquainted with any thing similar to them amongst either recent or fossil reptiles: nevertheless, as Mr. Mantell has not yet found (that I am aware) the different parts of the skeleton of the Iguanodon, and since the formation in which these new bones occur, appears, from your account of it, to be a continuation of that of Tilgate Forest, I think it not impossible that some of these bones may have belonged to that animal. I can safely affirm that the vertebræ now submitted to me are not those of Plesiosaurus; but whether any of these remains did or did not belong to the

* This femur is in the possession of I. Napper, Esq., of Ifold, who politely sent it to the Geological Society for inspection.

Megalosaurus, the specimens of that animal in my possession are too few to enable me to decide. All that I can state is as follows. The vertebra No. 8, found near the great femur, does not appear to be of the same species with the others. No. 2 is probably a lumbar vertebra. No. 4 may be a sacrum. Nos. 1, 3, and 6, are certainly caudal vertebræ. No. 6, which (as you will observe) consists of two united into one, is remarkable for presenting an anchylosis of two caudal vertebræ: and No. 6 was disposed to become anchylosed to No. 3. I have just examined all my skeletons of reptiles, and have not found any analogous case, except when the tail has been broken; and then the bones become united by exostosis, which is not the case with these specimens. Hence it would seem, that this must have been an animal making such feeble use of the tail, that the caudal vertebræ were occasionally anchylosed together. No. 3 is one of the first caudal vertebræ, *viz.* of those which support the largest chevron-shaped bones; for the articular tubercles of these bones are very strongly marked upon it. No. 11 (not here figured) is the articular apophysis of a vertebra. Nos. 5 and 10 (not figured) are probably portions of ribs. As to No. 7, the rugosities of its two extremities, which evidently terminated upon cartilage, indicate that it did not belong to a limb; and it can therefore only have been either a false rib or a branch of the os hyoides."

Before receiving the preceding communication from Baron Cuvier, through the kind assistance of Mr. Mantell I had compared these remains with the bones from Tilgate Forest found in the same formation; but as no teeth or specimens sufficiently marked and *peculiar* have yet been met with at Loxwood, I was not able to establish any case of identity between the bones from these two localities.

The vertebræ are of a very uncommon form, being highly contracted in the middle with sharp angular sides; and of their two extremities, the one is nearly *flat*, the other concave: hence it appears probable that they are not referrible to the Iguanodon of Mr. Mantell, nor to any of the hitherto discovered saurians of Tilgate Forest.

In concluding the geological view of this district, I beg to observe, that if Loxwood be taken as a centre, a section to the south presents a similar succession of strata to that which is developed on either side of Harting Combe, with the addition in the former case of the iron-sand. The river Arun, in its course from the Weald, passes through the lower green-sand, the gault, the malm-rock, and the chalk of the South-downs; whilst a section to the north, exposes principally the green-sand, between which and the chalk of the Hog's Back the intervening formations are reduced almost to imaginary lines.

Appendix I.

Order of Superposition.

Formations.	*Subdivisions and Varieties.*	*Localities.*
Chalk	. . . .	South-downs, Alton Range, &c.
A. Fire-stone or Upper Green-sand, provincially termed *Malm-rock*	Malm-rock	In all the terraces under the chalk.
	Compact blueish building-stone .	Froyle and Binsted, Hants. Sutton in Sussex.
	Fire-stone	Selborne, &c.
	Fossils abundant at	Nursted, Harting, Hawkley, &c.
B. Gault	Upper beds stiff brown clay . . Lower beds dark blue harsh clay containing Ammonites, &c. .	Alice Holt Forest, Steep, Down Park, Elstead and Minsted Marshes, &c.
C. Lower green-sand, Car-stone, or Shanklin Sand	Quartz grains with oxide of iron .	Petersfield, Turwick, &c.
	Pure white sand with delicate ferruginous veins.	Sand-pits south of Rogate.
	Iron-stone, cellular, in large tubes	Road east of Cowdry Park.
	Compact iron-stone	Woolmer Forest, &c.
	Calcareo-siliceous grit: Bargate-stone	Hedley, Lyss, Trotton, Stedham, and Half-way Bridge between Midhurst and Petworth.
	Blue fine limestone grit	Dean Farm, Petworth.
	Sand-rock passing into chert . .	Iping Ponds, Brinksole Heath, &c.
	Siliceous yellow building-stone with green particles; . . .	Dunner Hill, Pit's Hill, and
	And containing casts of Ammonites, Terebratulæ, &c. . . .	Range north of Midhurst.
D. Weald Clay . . .	Yellowish brown clay, red below with argillaceous iron-ore . .	Harting Combe, Redford, &c. Extinct Iron furnaces, &c.
	Yellowish brown clay, containing compact Petworth marble . .	Kirdford, Palfreys, Battlehurst Glass-house, Spar Wood, &c.
E. Hastings or Iron-sand	Calcareous sand-stone in clay, with disintegrated Viviparæ: tabular calcareous grit with *bones of large vertebrated animals* . Deep red clay below with argillaceous iron-ore . . . . . Lowest bed: courses of blue clay with Selenite	Headfold-wood Common, Loxwood, Wisborough Green, Skiff Common, &c.

Appendix II.

Quantity of Calcareous Matter in some of the Rocks mentioned in the preceding Paper.

Malm-rock	from Hawkley Slip,	yellowish	20 per cent.
	.. Nursted	grayish	21
	.. Ditto	brown	19
	.. Bentley	blue, compact	34
Bargate Stone	from Lyss		66
	.. Godalming		68
Iron Sand	Grit from Slinfold		34
	.... Cuckfield, road-stone		24
	.... Loxwood, above the bones		29

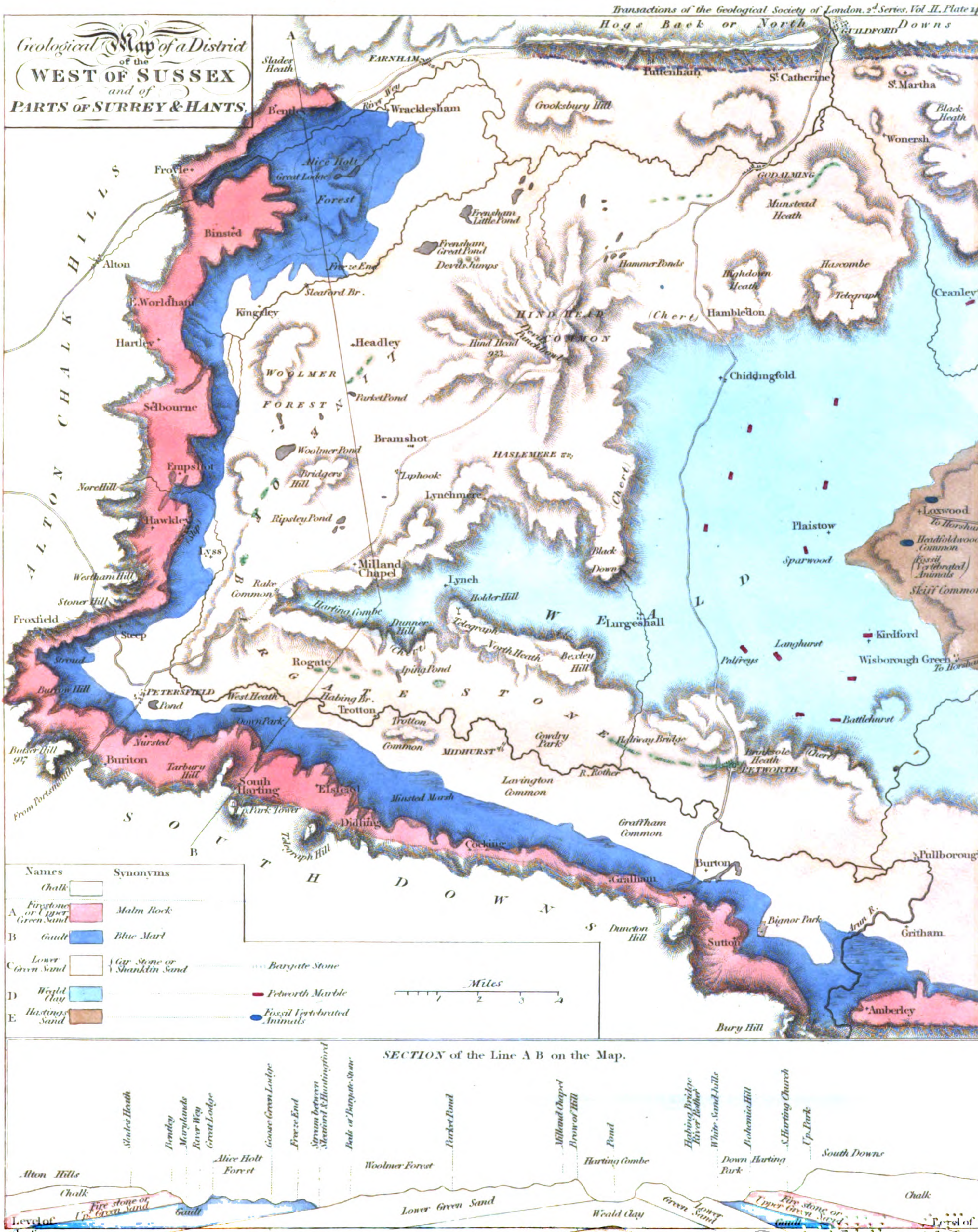

Geological Map of a District of the WEST OF SUSSEX and of PARTS OF SURREY & HANTS.
Names
Synonyms
Chalk
A Firestone or Upper Green Sand
Malm Rock
B Gault
Blue Marl
C Lower Green Sand
Car Stone or Shanklin Sand
Bargate Stone
D Weald Clay
Petworth Marble
E Hastings Sand
Fossil Vertebrated Animals
Miles
1
2
3
4
Hogs Back or North Downs
ALTON CHALK HILLS
SOUTH DOWNS
WEALD
HIND HEAD COMMON
WOOLMER FOREST
BARGATE STONE
GUILDFORD
FARNHAM
Puttenham
St. Catherine
St. Martha
Slades Heath
Bentley
River Wey
Wrecklesham
Crooksbury Hill
Black Heath
Wonersh
Frovle
Alice Holt
Great Lodge
Forest
GODALMING
Frensham Little Pond
Frensham Great Pond
Devils Jumps
Munstead Heath
Binsted
Alton
Hammer Ponds
Hascombe
Highdown Heath
Freeze End
Sleaford Br.
E. Worldham
Kingsley
Hambledon
Telegraph
Cranley
(Chert)
Hind Head 923
Devils Punchbowl
Headley
Hartley
Chiddingfold
Parket Pond
Selbourne
Bramshot
Woolmer Pond
HASLEMERE
Empshot
Bridgers Hill
Liphook
Norehill
Lynchmere
Hawkley
Ripsley Pond
Loxwood
To Horsham
Plaistow
Headfoldwood Common
Fossil (Vertebrated) Animals
Skiff Common
Sparwood
Lyss
Black Down
Westham Hill
Milland Chapel
Rake Common
Lynch
Holder Hill
Stoner Hill
Harting Combe
Froxfield
Dunner Hill
Telegraph
Lurgeshall
Steep
North Heath
Bexley Hill
Kirdford
Stroud
Langhurst
Rogate
Iping Pond
Palfreys
Wisborough Green
To Horsham
Meon
Burrow Hill
PETERSFIELD
Pond
West Heath
Habing Br.
Trotton
Battlehurst
Down Park
Trotton Common
Cowdry Park
Halfway Bridge
Butser Hill 917
Nursted
Buriton
Tarbury Hill
MIDHURST
Byworth
Brinksole Heath
PETWORTH
Chert
R. Rother
From Portsmouth
South Harting
Elstead
Lavington Common
Up Park Tower
Minsted Marsh
Didling
Graffham Common
Telegraph Hill
Cocking
Burton
Pullborough
Graffham
Duncton Hill
Bignor Park
Arun R.
Gritham
Sutton
Amberley
Bury Hill
A
B
SECTION of the Line A B on the Map.
Slades Heath
Bentley
Marylands
River Wey
Great Lodge
Alice Holt Forest
Goose Green Lodge
Freeze End
Stream between Sleaford & Huntingford
Beds of Bargate Stone
Woolmer Forest
Parket Pond
Milland Chapel
Brow of Hill
Pond
Harting Combe
Habing Bridge River Rother
White Sand-hills
Bohemia Hill
Down Park
S. Harting Church
Harting
Up Park
South Downs
Alton Hills
Chalk
Fire stone or Up. Green Sand
Gault
Lower Green Sand
Weald Clay
Lower Green Sand
Fire stone or Upper Green Sand
Gault
Chalk
Level of the Sea
Level of the Sea
Hastings Sand

Plate XV.

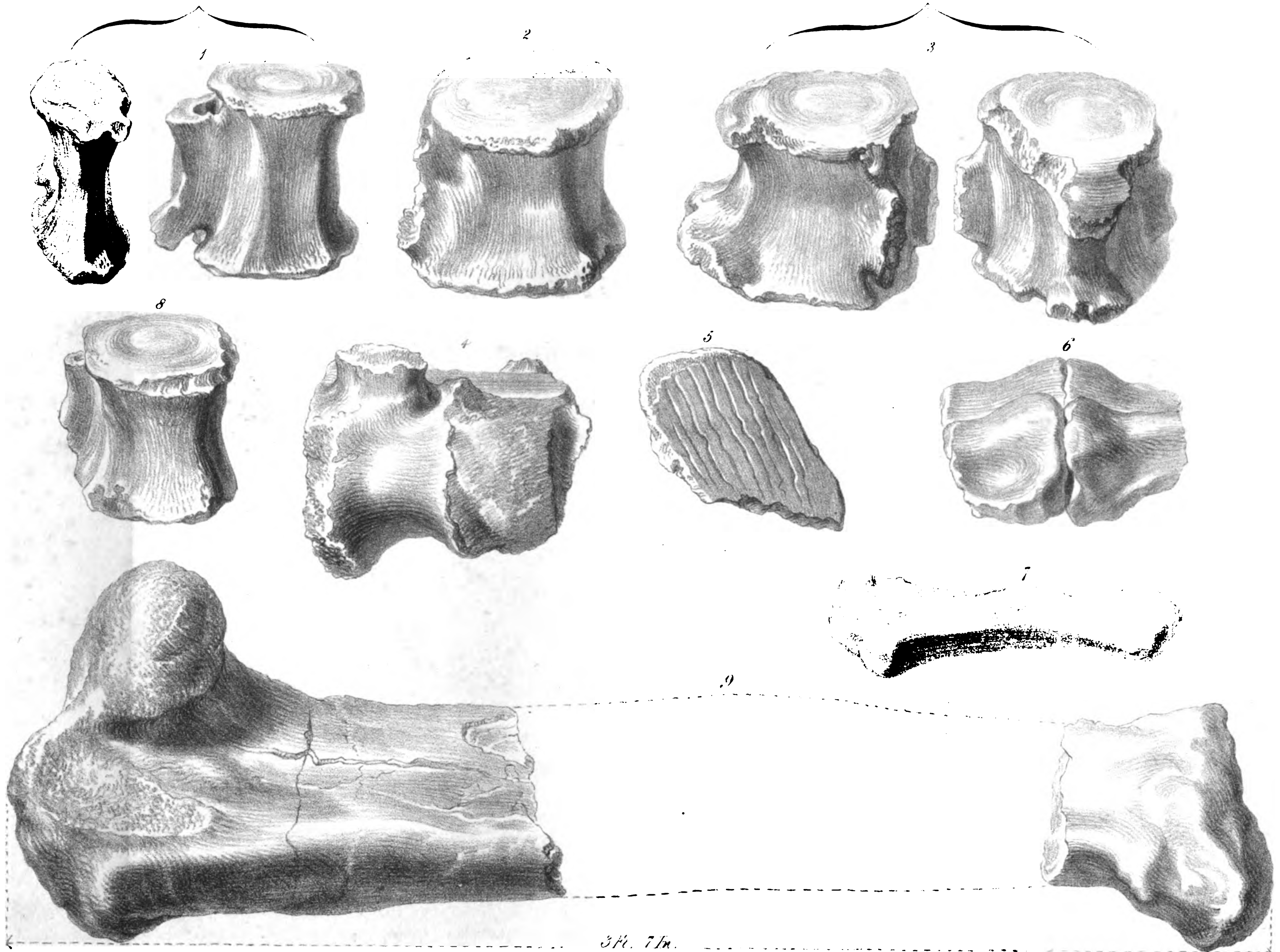
Bones of saurian animals from the Iron-sand.

Figs. 1 to 7, from the N.E. of Loxwood: see pp. 104, 105.

Figs. 8 and 9, from Headfoldwood-common.

Fig. 1. A caudal vertebra.

2. A lumbar vertebra.
3. One of the *first* caudal vertebræ.
4. Sacrum.
5. Portion of a rib.
6. Two caudal vertebræ anchylosed together.
7. False rib; or branch of the os hyoides.
8. Vertebra found with the great femur.
9. The great femur: see p. 104.



G. Scharf del et lithog.

Printed by C. Hullmandel.

FOSSIL SAURIAN BONES FOUND AT LOXWOOD

N.º 1. 2. 3. 4. 5. 6 & 7. found N. of Loxwood N.º 8 & 9 at Headfieldwood Common The Vertebræ and Number 7 are drawn half the natural Size.

I.—*On the Geological Structure of the Wealden District and of the Bas Boulonnais.*

By WILLIAM HOPKINS, Esq., M.A., F.R.S., F.G.S. &c. &c.

[Read February 3rd, 1841.]

INTRODUCTION.

GEOLOGISTS have long recognized the fact of the approximate parallelism of lines of dislocation in those districts in which systems of such lines are found to exist; and in my memoir on Physical Geology, published in vol. vi. part 1. of the Transactions of the Cambridge Philosophical Society, I have shown that such parallelism would, in many cases and under the most simple and probable conditions, be the necessary consequence of the simultaneous action of an elevating force acting beneath extensive portions of the crust of the globe. I also demonstrated that two systems of parallel dislocations might be produced by the same elevating force, the direction of the one system being perpendicular to that of the other. I also pointed out the circumstances under which, according to theory, there would be a necessary deviation from parallelism in these systems, and I indicated the relations which such deviations would bear, in certain general cases, to the boundary of the disturbed district, and to the particular configuration of its surface. On these points I proceeded farther, in theory, than geologists had gone in observation. There are still few districts, even in those countries with which we are geologically best acquainted, where observations have been made in sufficient detail to bring this subject, as a branch of descriptive geology, to the point to which I have carried it in theory.

Under these circumstances my attention was directed to the district of the Weald in Kent, Surrey and Sussex, as one in which the phænomena of elevation might be expected to accord with correct theoretical results in a greater degree than in many other cases, on account of the regularity of its boundary, and the apparent absence of the effects of that more violent, local, or irregular action of the elevating force, which it must ever be impossible to reduce to calculation.

When I came, however, to examine the descriptions which we already possessed of the geological structure of the district, I found them too imperfect and fragmentary to enable me to detect with certainty the accurate laws of the phænomena, or to allow me to appeal to them as tests of the accuracy of my theoretical views.

The general anticlinal structure of this tract has been long known. Dr. Mantell and Mr. Lyell recognized also the existence of several longitudinal anticlinal lines, running generally in an east and west direction. Dr. Mantell had also made several insulated observations on the dip of the strata in different localities; but I am not aware that either of these gentlemen so far directed his attention to observations of this kind, as to determine accurately the position or extent of any one of the lines of elevation, the existence of which they had recognized, much less to detect the true law by which (as we shall see hereafter) these lines are related. Dr. Fitton has also made several observations on the structure of the Weald, and has given some valuable sections in his memoir "On the Formations below the Chalk," a work to which I have constantly referred in my own investigations. Only one part of the Wealden district, however (the south-western), has been hitherto examined, with reference to its structure, in much detail. This portion, lying more especially in the neighbourhood of Pulborough, was carefully investigated by Mr. Martin, and described by him in a memoir published some years ago. The author in this memoir enters into some speculations concerning the general character of the whole tract comprised within the limits of the Wealden denudation, and especially directs attention to its transverse drainage. Almost every one of its rivers, in some parts of its course, passes nearly perpendicularly through one or more of the longitudinal ridges of the district, and finally escapes from it by passing transversely through the bounding chalk escarpment. It seems almost impossible to render any account of this frequent transverse direction of the river-courses, without referring it to the original existence of transverse fissures, as Mr. Martin has done. He appears to have been the first to recognize distinctly what I conceive to be the real structure of the district in this respect, but his views were for the most part conjectural, except so far as they were applied to the neighbourhood of Pulborough. With respect to other parts of the district, they appeared to rest principally on analogy, and not on facts furnished in detail by direct observation. I determined therefore to attempt to supply the deficiency of evidence in that large portion of the Wealden district which had not been examined in sufficient detail; and since the analogy which the denudation of the Bas Boulonnais bears to that of the Weald, and the relative positions of the two districts, indicate the great probability of their elevations having been contemporaneous, I considered it necessary, in order to render the investigation complete, to examine also the Bas Boulonnais, for the purpose of ascertaining whether its structure bears any definite relation to that of the Weald. The first part of the communication which I have now to make to the Society contains the results of these investigations; the second part will contain a discussion of theoretical notions, founded on a general view of the phænomena of the Wealden districts, together with those of the adjoining country as described by other observers.

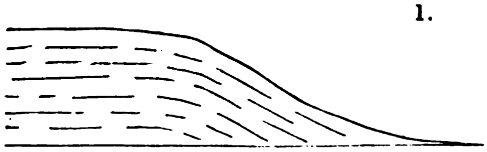
In stating what has hitherto been done with respect to the geological structure of this district, I may notice a section made by the late Mr. Farey from the North to the South Downs, across the centre of the Weald. In the lines of elevation which it recognizes, this section accords with my own observations; but many of its details are evidently so entirely hypothetical, that I should not venture to appeal to it on any of the minuter points of structure which it professes to exhibit. It is also impossible, in noticing the labours of previous observers, to omit those of Dr. Mantell, whose name has long been so closely associated with the geology of the south-east of England. If I have been able to make but little use of his observations, it is that our objects have been entirely different; so that his work, abounding as it does with interesting matter in the department of the science to which it is especially devoted, contains but few observations bearing immediately on the objects of my own researches.

§ 1. The Wealden District.

It would be useless to enter here into any detailed description of a tract of country of which the general geological features are so well known as those of the district comprised within the bounds of the Wealden denudation. It will only be necessary to state, that the tract to which my researches have been principally confined is bounded on the English side of the Channel by the clearly-defined escarpment of the chalk, extending from the coast near Folkstone, in a north-westerly direction, by the north-east of Ashford and of Maidstone and north of Seven Oaks, and thence in a westerly direction by Reigate, Dorking, Guildford and Farnham, after which it passes to the east of Alton and round Petersfield, whence it proceeds in a nearly easterly, and finally, in a nearly south-easterly direction by Lewes, to the coast at Beachy Head. The Bas Boulonnais is bounded by an exactly similar escarpment of chalk, commencing on the north at Wissant, proceeding by Desvres and Samer, till it again meets the coast seven or eight miles south of Boulogne; its extent from north to south, parallel with the coast, being about twenty, and that from east to west, along the road from Boulogne to St. Omer, about twelve miles. It requires but little effort of the imagination to connect the two extremities of these escarpments at Folkstone and Wissant, as well as those at Beachy Head and the southern point of the Bas Boulonnais. Thus connected, the English and the French districts, with the intervening portion of the Channel, would form a tract which may be described generally as an elongated oval, but having a curvilinear instead of a rectilinear axis. Its length is about 150 miles, and its greatest breadth about 40 miles.

Before I proceed to the particular description of phænomena, it may be desirable to explain the precise sense in which I have used certain expressions in this paper. There are frequent instances in the Wealden district in which the section of a longitudinal elevation is such as represented in the annexed diagram, the beds dipping (and in many cases with great rapidity) in one direction, but preserving a

1.



sensible horizontality in the opposite one. This is obviously not an *anticlinal* arrangement, nor can the line from which the descending dip commences be termed with propriety an *anticlinal line*. I have called it a *line of flexure*, finding it almost essential to employ some distinctive term to denote it. All anticlinal and synclinal lines, lines of flexure, of fault, &c., I have frequently designated by the general term of *lines of elevation*.

I shall now commence my description with an account of the central range of the Wealden district, consisting almost entirely of Hastings Sand.

Hastings Anticlinal Line.—A well-defined ridge, forming the most striking feature in this part of the district, runs from Battle to the north of Hastings. The Hastings anticlinal line may be traced with great precision from within a mile of Battle to the coast. It appears to lie just on the northern side of the summit of the ridge, and runs in a straight line to meet the coast at a point south-east of Fairlight church. The northern side is the best defined, owing to the rapid dip of the beds on that side, which in some places is not less than 50° or 60° in a direction perpendicular to that of the ridge. On the southern side the average dip, though considerable, is not nearly so great. The point where this line meets the coast is well defined in the splendid natural section which the cliffs afford. It should be observed, however, that the general direction of the coast makes an angle of about 45° with that of the anticlinal line, and therefore makes about the same angle with the line of greatest dip, so that the apparent dip of the beds in the cliff is much less than their real dip. It is not however very great, and is much more regular than in the neighbourhood of Battle. I could not trace the anticlinal line quite up to that place, to the north of which a distinct system of lines commences.

Brightling and Battle Lines.—Brightling Down is one of the highest points in this part of the country, its height being stated to be 646 feet. The anticlinal line passes through its summit, where it is extremely well defined, the dip both on the north and south being very considerable. It extends westward through the northern extremity of Heathfield Park, beyond which I could detect no distinct evidence of its continuation. To the eastward it does not appear to be distinctly continued beyond the village of Brightling, which is situated on the extremity of that part of the range of hill. Immediately on the south of Brightling Hill is another on which Dallington is situated, and which is continued more or less distinctly to Battle. This line however is not anticlinal immediately to the south of Brightling Down, nor is the Brightling line transferred to it, where this subordinate range passes farther east than the Brightling one; for I distinctly ascertained the general dip to be to the south, on the north side of the Dallington range, about Darvel Beach and in Limekiln Wood.

Further to the east, we obtain an instructive section along the new road from Battle to St. John's Cross, which runs nearly in a straight line between those places. Immediately to the north of Battle, the hill on which the windmills stand is shown by the new cuttings to be strongly anticlinal. The direction of the anticlinal line appeared to coincide with that of the hill, and to be two points to the south of east (E.S.E.). It is not continued far to the east, nor to the west. I conceive it to be independent both of the Hastings and Brightling lines. Proceeding northward towards St. John's Cross, we recognize a synclinal line in crossing the valley and small stream about a mile and a half from Battle; and another at a point of the road east of Mountfield. The exact position of the anticlinal between them is not very distinctly marked, but must be very nearly as indicated on the map. North of the last-mentioned synclinal line the beds rise rapidly up to St. John's Cross, on the north of which they appear to descend very gradually to the river at Robertsbridge, thus forming a third anticlinal line between Battle and that place. Of the two northernmost I had no means of determining the exact directions.

On the west of the new road above mentioned, the dip is said to be very irregular, and the country much dislocated. The irregularity is probably more apparent than real, as far as regards the positions of the lines of elevation. There is scarcely any irregularity in the dip along the new road, which affords an almost continuous section from Battle to St. John's Cross, though the existence of great irregularity might have been inferred from merely insulated observations along that section. Still we might reasonably expect some irregularity about the point where the Brightling line terminates, and the three lines above described commence. It is certain also that there has been more than ordinary disturbance along the whole of the Brightling and Hastings lines. In the neighbourhood of Battle, particular beds of limestone have been worked to a considerable extent, and can be easily identified. By means of these beds a fault has been detected in Archer's Wood of sixty fathoms, as stated by Dr. Mantell*. Indications of great dislocation are observable also in many other places.

On the east of the new road from Battle to St. John's Cross, it would seem impossible to identify the three lines above mentioned to any considerable distance. The valley which passes down to Winchelsea (at least the upper part of it) may, possibly, have originated in a dislocation connected with the central line. At Brede (on the northern side) one of the beds of hard limestone above mentioned is worked for repairing the roads, and I was informed that the same bed was found at the level of the river, a point lower by several hundred feet than the village. Supposing this to be the case, there must be an enormous fault running along this part of the valley. The dip on both sides of the valley is to the east of north. On the north of the valley also, half-way between Sedlescomb and the Udymer great road, a new cut showed the strata rising southward at an angle of about 25° to a ridge running south of east, with a parallel valley on the north. Along this ridge I have no doubt of the existence of a line of elevation.

I have been the more particular in the description of the phænomena between Battle and Brightling, because the line terminating at one of those places has been represented as a continuation of the one terminating at the other, the whole line having thus been made to assume a somewhat irregular and anomalous form. This is, in fact, one of those localities in which insulated observations are sure to lead to erroneous conclusions respecting true geological structure, the discovery of which can frequently be effected only by the most careful and laborious research†.

Bexhill Line.—In proceeding westerly along the coast from Hastings, the natural

* Geology of the South-east of England, p. 221.

† Dr. Mantell has remarked, "The dip of the strata around Pounceford, as in all the surrounding district, is as various as possible, the disruption of the beds being so great, that faults, and *horses*, as the risings of the strata are called in Sussex, are observable in almost every quarry."—*Geology of the South-east of England,* p. 225. I think it necessary to notice this passage as coming from the eminent geologist from whose work it is quoted, lest it should be thought to militate against my own conclusions in which I assert the existence of so much regularity and law in the phænomena of elevation of the district of the Weald. There are probably few very disturbed districts in which insulated observations might not appear to justify such a remark as that just quoted; but it is equally certain that patient research, with a clear geometrical conception of the subject, will rarely fail to evolve from such seeming confusion, the most unequivocal laws of geological structure. Pounceford is situated a little to the north of Brightling anticlinal line. The variations of dip in that neighbourhood are much more in *degree* than in *direc-*

section formed by the cliff exhibits the beds of Hastings sand dipping apparently towards the west, their real mean dip being about two points west of south. This dip is continued to St. Leonards, where it takes the opposite direction. In a newly-cut road in the direction of greatest dip, about a mile west of that place, the inclination of the beds was far more distinctly exhibited than in the face of the cliff, the direction of which is not far from that of the strike. This reverse dip is distinctly continued to a point south-east of Bexhill, where the south-westerly dip is again resumed, and a little farther to the west the beds are brought for a short space into nearly a vertical position. The disturbance has produced a fault, the magnitude of which is too great to be determined by the section of the cliff, which does not exceed 20 or 30 feet in height. At some distance beyond the fault, the gentle dip of the beds (in a direction about S.S.W.) is again resumed. I did not extend the examination further.

A range of low hill is represented on the Ordnance Map, running from Bexhill to Ninfield. It was difficult to detect distinct evidence of structure along this ridge; but I obtained what I considered to be a satisfactory observation, which gave the north-easterly dip about a mile and a half north-west of Bexhill. I was thus led to conclude that the line of elevation, which doubtless accompanies this range for at least two or three miles from the sea, passes along its southern side after passing to the north of Bexhill. I could detect no trace of it near Ninfield.

Hurstmonceaux Line.—A low range of hill similar to that last mentioned, and in a direction parallel to it, passes to the north of Hurstmonceaux Park. The part called Windmill Hill is distinctly anticlinal. There can be no doubt that a line of elevation coincides with the general direction of the hill.

Transverse Fractures of the Hastings Line.—About half-way between Battle and Hastings the new road has been cut through High Beach Hill, and exhibits a fine section of a great disturbance, produced by a transverse fracture which has given a local anticlinal arrangement to the beds, and formed a short transverse anticlinal line. The hill and transverse valley on the north of it, by the top of which the road passes, have evidently originated in this cross dislocation.

The new road above mentioned runs, nearly in a direct line, from High Beach Hill to Hastings, and affords the evidence of another transverse fracture along the valley immediately on the west of Silver Hill. There appears to be an enormous fault, as indicated by the two portions of what is I think unquestionably the same

tion. The existence of such variations is not more certain than that the general dip is somewhat to the east of north, as stated by Dr. Mantell himself to be the case, at the place just mentioned. The structure of the Brightling ridge is in fact remarkably distinct.

stratum, and belonging to Dr. Mantell's Ashburnham beds. The fault is probably several hundred feet. The valley along which it appears to run is marked in the Ordnance Map by the course of a rivulet south-east and south of the village of Hallington.

Another great fault is also exhibited by the cutting of the same road at its entrance into the western extremity of Hastings. Dark, shaly, argillaceous beds there abut directly against the massive beds of white sandstone. The direction of the fault is very nearly perpendicular to the Hastings line. I could find no distinct evidence of it at other points more remote from the coast, though I think it probable, from external indications, that it is continued across the central ridge, on the east of the village of Ore.

Wadhurst and Hawkshurst Line.—About seven miles north of the westerly portion of the Brightling line is a range of hill, distinctly marked on the Ordnance Map, passing through Wadhurst. About three-quarters of a mile north of Wadhurst, I observed a rapid dip to the north. At Best Beech Hill the beds are much disturbed, and somewhat irregularly; and a little north of Mark Cross (near the western extremity of the ridge), in a large quarry near the road to Tunbridge Wells, the dip is observed to be rapid and to the north. At Mark Cross and south of it the dip is very small, but tends towards the south. Likewise in a large pit on the great road near to and south of Wadhurst, the dip, though not large, is distinctly to the south. These observations prove the existence of an anticlinal line along the ridge above mentioned. Its continuation to Hawkshurst is distinctly proved by observations immediately on the north and south of the line, the dip being generally from 5° to 10°*. I was unable to trace it with any distinctness farther than Meagrane Hill. The hills of Sandhurst and Bonhurst appear to have been the result of surrounding denudation rather than of elevation.

About three miles to the north-east of these latter places is a range of hill through Rolvenden and Bennenden, which does not appear however to be connected with any continuous line of curvature of the strata. On the contrary, in returning from Bennenden to Hawkshurst I obtained a series of observations which gave the dip uniformly east of north, proving the continuity of the nearly north-easterly dip as far as the axis of the Bennenden range. From Rolvenden to Bennenden I could find no evidence of any sensible inclination of the beds. This range does not in fact form a very decided feature, and is probably due to denudation.

* The dips on the north of the line were clearly observed on the road from Ticehurst to Newhenden, near Flimwell; also about Hawkshurst. To the N.E. of Ticehurst near Pillory Farm, and in some large quarries near Piles Heath (Ordnance Map) and Bedgbury Park, the dip was nearly 20°. The position of this line is determined very accurately.

The western portions of this line and of the Brightling line comprise between them an extensive valley, the formation of which would probably in the first instance be the necessary consequence of the elevation of these lines. Its drainage is somewhat remarkable, the only outlet for its waters being at Robertsbridge, whence they are discharged into the Rother. A comparatively small depression would convert the lower part of this valley into a small bay communicating with the sea by the valley of the Rother. It would seem probable that in the gradual rise of the land it had formerly existed under that form, and that a great part of the denudation, to which its actual form is probably in a great measure due, was thus effected. Its western extremity is bounded by the high land which is continued southward from Frant by Rotherfield to the west of Heathfield Park, the point to which I traced the Brightling anticlinal line. This transverse high land forms a watershed, from the highest points of which the water descends on the one side through the valley just described to be discharged into the sea by the Rother, and on the other to the Ouse, which passes by Lewes and discharges itself at Newhaven. It does not however assume the character of a transverse *ridge,* its general elevation being much the same as the western extremities of the Brightling, Wadhurst, and Frant Hills on the one hand, and considerably less than that of Crowborough on the other. The Brightling anticlinal line seems to lose all its distinctness when it meets this high land.

Crowborough Anticlinal Line.—The elevated range including Ashdown Forest on the east and St. Leonards Forest on the west manifestly constitutes the central ridge of the middle portion of the Wealden district. It is clearly an anticlinal elevation, though it seems difficult to determine with perfect accuracy the position of the anticlinal line. On the northern side of Ashdown Forest there is a gradual but small continuous rise of the beds towards the summit; and on the south side I traced a much more rapid and continuous dip to the south from near Crowborough Gate to High Hurst Wood, two miles south of the former place. In considerable quarries at the latter place the dip was about 15°. The surface nearer the summit of the Forest is occupied by loose sand, which affords no means of observing the dip. There cannot however be much error in concluding that the anticlinal line passes near to Crowborough Beacon.

The above observations were made in an excursion from Tunbridge Wells to Crowborough. I also crossed this central elevation from Cuckfield to East Grinsted by Balcombe. The dip at the cutting of the Brighton railroad near the last-mentioned place was considerable, and to the north, nor could I detect any indications of southerly dip in crossing Tilgate Forest. From this it appeared probable that the position of the anticlinal line was not north of Balcombe, nor can it certainly be far south of that place, as shown by evidence which I shall speak of shortly.

Of the position of this line between Crowborough Beacon and Balcombe, I have no evidence, but the general continuity of the line between these points is rendered almost certain by the general structure of this part of the district. We may conclude therefore that it here runs almost exactly east and west, and we observe that if it be continued easterly, it precisely coincides with the Wadhurst line. These two lines may therefore be regarded as continuations of one and the same line.

When I thus speak of the unity and continuity of the line between Crowborough and Balcombe, and to the west of the latter place, I am tacitly referring the formation of the Ashdown and St. Leonards ridge to the existence of a single anticlinal line, or (speaking with reference to my theoretical views) of a single longitudinal fissure. It is very possible however that this characteristic ridge may be due to the original and simultaneous formation of several longitudinal fissures, so near to each other, that we are unable to distinguish their separate effects by the outward structure of the elevation. Still such a system of lines, occupying but a small transversal space (as in the present instance), may in descriptive language be spoken of as a single line, and we may still assert the probable identity of this system and the Wadhurst line as in the preceding paragraph.

On the south of Balcombe and between that place and Cuckfield is an east and west valley which forms a distinct feature in that neighbourhood, and of which the length and direction are marked on the Ordnance Map by the course of a small stream, one of those which, by their confluence, ultimately form the river Ouse. In descending into this valley on the northern side, by Slaugham Park, the beds are observed to dip southward with the hill, which shows that the Crowborough line must pass to the north of the Park, agreeing with the direction previously assigned to it. This direction, continued westward, would pass very near Horsham, but that neighbourhood presents no external indications of disturbance, the strata being very nearly horizontal. I examined the quarries near Warnham, at Theall near Slinfold, three miles west of Horsham, at Stammerham, two miles south-west of it, and at Tower Hill near Horsham. In all these places there was scarcely a sensible deviation from perfect horizontality*. There was no evidence of the continuation of any distinct anticlinal line west of St. Leonards Forest.

Cuckfield Line.—On the south of the valley just mentioned as passing between Balcombe and Cuckfield is a small elevated range, sufficiently determinate to give to the valley which it bounds a perfectly distinct character. It is a subordinate

* Dr. Mantell has remarked, that "the dip of the strata around Horsham and Tilgate Forest is exceedingly variable; the general inclination is towards the S.E." He also states that the beds in the Forest are nearly horizontal. The fact is, that all around Horsham the beds are so nearly horizontal, that I think it impossible to assign to them any prevailing dip. In such a case the slightest local cause might determine the existing small dip in each locality.

anticlinal ridge. I found distinct evidence of a northerly dip in descending into the valley along the London road from Cuckfield. Similar evidence is found in the quarries near Cuckfield. On the south side of this hill the general southerly dip of the district commences. I obtained also the most decisive evidence of the continuation of this line between two and three miles east of Cuckfield, at the cutting for the Brighton railroad, which being there transverse to the anticlinal line, exhibited it with great distinctness. The dip to the north at this point could not be much less than 15°. The line appeared to run exactly east and west. It is probably co-extensive at least with the valley to the north of it, extending three miles west of Cuckfield. How far it may extend to the east beyond the railroad, I had not the means of determining. I detected no evidence of it in crossing the general central ridge from Uckfield to East Grinsted.

I may here remark, that in passing along the London and Lewes road, I observed distinct evidence of anticlinal arrangement of the beds close to Uckfield on the south of the town, the strike being east and west. If the Brightling line were continued, it would pass very near this point. I am far from insisting on this as any evidence of the continuation of that line westward of Heathfield Park. It is perhaps more probable that the position of the beds near Uckfield is due to one of those undulations which, although of comparatively small extent, still follow the general law of those which, on a larger scale, are designated as anticlinal elevations. A more detailed examination of the district would probably detect many such minor anticlinals; nor would such an investigation be without its interest and importance, because the greater the number of minor phænomena which can be comprised in our generalizations, the stronger becomes the proof of the truth of the laws established by observation, and of the theories which distinctly deduce such laws from the operation of physical causes. Such detailed research however belongs peculiarly to the province of the local geologist, by whom alone we can hope to see it carried to the extent which the actual state of theory demands.

Before we proceed with the description of other anticlinal lines, it may be well to direct attention to the relations existing between the external configuration of that portion of the district already considered, and its internal structure. The Battle and Brightling ridges, two of the most characteristic, have manifestly originated, as we have seen, in the formation of the anticlinal lines with which they coincide; and it is equally evident that the valley between the Brightling and the Wadhurst line has owed its origin to the formation of the intermediate synclinal line. This arrangement of the beds would necessarily guide more or less the action of the denuding causes to which the complete formation of the valley must be referred. This valley, as I have shown, is bounded on the west by the high land in the neighbourhood of Rotherfield, where there appears to be no considerable inclination of the strata; while farther westward the elevation of Ashdown Forest has given a considerable and continuous declination of the strata to the south, with which the surface of the country is there in accordance. The actual drainage of the south side of the central ridge from Rotherfield to St. Leonards Forest appears to have originated in this continuous descent of the beds from Ashdown, by which an opening was afforded to the water from the western part of the range, while the Cuckfield anticlinal ridge presented a barrier to their southerly progress. Finally, the configuration of the surface between the ridge just mentioned and the central one is manifestly due to the internal structure, with which also the general descent of the surface to the south from the Cuckfield ridge is in perfect accordance.

Frant Line.—About three miles north of the Wadhurst anticlinal line is a range of hill, extending from Etheridge Park on the west, by Frant, nearly to Lamberhurst on the east. In ascending the hill from Tunbridge Wells by Frant, the dip is small but distinctly to the south, and therefore opposite to the general dip on this side the central range. A new cut in the great road also immediately south of Lamberhurst exhibits the section of an anticlinal line with rapid dips. These observations have convinced me that this range (which forms a marked feature in the country) originated in a curvature of the strata, but such that the deviation from horizontality had not been very considerable, except near Lamberhurst. The prominent feature which the range presents to the north, is probably more due to the denudation of the valley below than to the elevation of the hill. Still both analogy and direct evidence (as far as it extends) indicate the origin I have assigned to it. It will be observed that it preserves an exact parallelism with the Wadhurst line. All traces of it appear to be lost in the transverse high land already mentioned as passing by Frant and Rotherfield.

Bidborough Hill.—This hill is about three miles south of Tunbridge. The road from that place to Tunbridge Wells affords a good section, exhibiting the upper beds of the Hastings sand rising rapidly from beneath the Weald clay, which approaches the foot of the hill on the north side. There must necessarily be an exactly similar rise of the beds along the north side of the hill further to the west, since the beds of the Hastings sand on the side and summit of the ridge rise much above the level of the upper surface of the Weald clay in the valley. On the south side of the hill I could make no good observations of the dip except near Southborough, where the beds are nearly horizontal. More westward there were indications of a considerable dip to the south, which seems probable also from the external form of the hill. I cannot however assert such to be the case from good observations. The western extremity of the hill is bounded by the transverse valley of the Medway; the Tunbridge road passes over its eastern extremity. This may be considered as a line of flexure rather than an anticlinal line.

Brenchley Hill.—This hill is situated about five miles nearly east of Bidborough Hill, to which it is exactly similar, except that it affords more distinct evidence of its being strictly an anticlinal ridge. East of the castle I found opposite dips of nearly 20° to the east of north and about 16° to the south, and so near to each other as to determine accurately the position of the anticlinal line. It there lies a little south of the summit of the ridge.

Brenchley and Bidborough Line.—Bidborough and Brenchley Hills are connected by a range which overlooks the valley occupied by the Weald clay, and is formed by the comparatively rapid rise of the beds of the Hastings sand from beneath the clay. It diminishes in height (probably by denudation) as it approaches the eastern extremity of Bidborough Hill, from which it is separated by an ill-defined transverse valley. A distinct line of flexure thus connects the two hills above mentioned, though the evidence may be somewhat less forcible than it is in those two striking localities. The line of curvature is continued in an exactly similar manner to the west of Bidborough, but becomes less distinct as we proceed westward, and loses all determinate character north of East Grinsted. It dies away also in the same manner at the other extremity east of Brenchley Hill.

Transverse Valleys and Fractures of the Central Ridge.—It will be observed that the continuity of the range just described is broken in three places, at Penshurst by the valley of the Medway, between Bidborough and Brenchley, and again east of Brenchley Hill by the valley before mentioned, along which a small stream rising at the foot of Frant Hill and passing by Lamberhurst finds its way to the Medway. The first is the most remarkable of these transverse valleys.

I have already spoken of the watershed formed by the transverse high land which passes by Rotherfield and Frant; and if we proceed northward from the latter place along the Tunbridge road, we find (as shown by the map) that the streams which rise along that line on the right run to the east, and those on the left run westward, so that the watershed is continued northward as far as the valley of the Weald clay, notwithstanding the great alteration in the external surface produced by denudation to the north of Frant Hill. The Medway is formed by the confluence, about Ashurst, of the streams which thus flow westward, with others running principally from west to east along longitudinal valleys. From this point it takes its course by Penshurst directly through the longitudinal range above described. If this transverse break in the range were now filled up, a lake of considerable area would be formed in the valley of the Medway, with branches ramifying along the different valleys which communicate with it. Supposing such a barrier to have once existed, in this and similar cases which may hereafter be considered, the point to which I would immediately direct attention is the evidence which may enable us to judge how far the destruction of the barrier may have been facilitated by the previous existence of a transverse fracture.

It is probable that such a fracture, when of considerable magnitude, would frequently be attended with considerable irregularity in the position of the beds immediately contiguous to it. Such however would not necessarily be the case; and we may doubtless assert the converse proposition as far more generally true; viz. that great irregularity of elevation will be attended with transverse fracture. Consequently, while a great and irregular inclination of the beds at any transverse section of a longitudinal range almost necessarily affords evidence of transverse fracture, the absence of such irregularity will be no proof of the non-existence of such dislocation. This conclusion is abundantly corroborated by the phænomena of the mining districts, where the evidence on such points is so much more determinate than in those in which the observations are merely superficial.

This irregular disturbance of the strata is remarkable along the sides of the transverse valley of the Medway. Near a spot termed Nashes on the Ordnance Map, the dip was between 40° and 50° to the north; and at a point on the opposite side of the river, and about equidistant from it, I estimated the dip at about 30° south-east. At other points the disturbance was equally great and irregular. It is well seen in the large quarries south of Ashour, where the dip is nearly 20° to the north-east, which is perfectly anomalous considered with reference to that of the general elevation. These facts leave no doubt, in my opinion, of the original existence of a large transverse fracture which has determined the position of the present transverse valley, and facilitated its formation by aqueous agency.

I found similar evidence, though not perhaps equally conclusive, near the transverse valley marked by the course of the river from Lamberhurst to the east of Brenchley Hill. I have already noticed the evidence of an anticlinal line at Lamberhurst. The disturbance there is very considerable, as it is likewise at a point on the opposite side of the valley and nearly equidistant from it, in the large quarries west of Bedgbury Park, as already noticed, where the dip is between 20° and 30°. Goudhurst is situated on a hill which borders the valley on the east, and forms a prominent feature in this neighbourhood. In ascending it from the south by the road which enters the town, we recognise its origin in a great disturbance, which has given a dip to the beds of about 40° to the south. The disturbance appears to be local and irregular; for on the north-east side of the hill the dip appeared (though not very distinctly) to be considerable and to the north-east; and about Iden Green (a mile and a half to the east) no indications of disturbance were visible, the beds being there sensibly horizontal, as well as about Cranbrook, a fact already noticed. Hence I conclude Goudhurst Hill to have been due to one of those irregular disturbances which indicate transverse fracture. Also about Winchet Hill, the point on the east side of the valley exactly opposite to the eastern extremity of Brenchley Hill, I observed considerable irregularity of disturbance.

These circumstances combined afford strong evidence of the valley in question having originated in a transverse fissure.

I shall now proceed to the western and south-western parts of the district.

I have already described the general horizontality of the beds near Horsham, and the consequent absence of any determinate anticlinal *line*. Still the general configuration of the district shows distinctly the continuation of the anticlinal *elevation*. The greensand of Hind Head for instance is much higher than the same beds at those points north and south of that hill where they pass under the chalk escarpments; but this greater elevation being principally acquired soon after emergence from beneath the chalk, the central portion is left nearly horizontal. This relative elevation is also in great measure lost still further to the west by the gradual westward declination of the beds; and therefore, when we arrive at the chalk on the west of the general denudation, it becomes still more difficult to assign any determinate position to a distinct anticlinal line. Mr. Martin however appears to have recognized, in an east and west valley near Haslemere, some evidence of its continuance along that valley, a position which very well accords with the general elevation, and also with the westerly prolongation of the Hastings sands.

Greenhurst Anticlinal Line.—This line, running near and parallel to the South Downs, is one of the most important geological features in the south-western portion of the district. It has already been described in detail by Mr. Martin. The evidence of this line, as pointed out to me by that gentleman, is perfectly clear from the chalk at Piecomb on the east to Coldwaltham Park (south-west of Pulborough) on the west. It will be immediately recognized on the map.

Pulborough Line of Flexure.—About two miles to the north of this line and parallel to it, we recognize a well-marked line of flexure passing close above the village of Pulborough. The annexed diagram represents the section from the chalk escarpment to the Weald clay, in a direction nearly north and south, and passing by Wiggonholt Common and Pulborough.

2.

4. Chalk and Upper Greensand.
3. Gault.
2′. Lower Greensand, lower beds.
2. Lower Greensand, upper beds.
1. Weald Clay.

The Greenhurst line meets the section at A, and the line of flexure at B.

This line of flexure does not extend far to the east of Pulborough. On the west of that place it is well defined near Stopham and Fittleworth.

Midhurst Line of Flexure.—A line exactly similar to the one just described, and sufficiently well defined, passes by Sellham and Midhurst to Trotton Common. A north and south section, however, across this line differs from the above section in the absence of the anticlinal disposition of the beds there represented at (A). The beds rise to the line of flexure (B) directly from the chalk.

This line ranges exactly with the Pulborough line. They both appear to me to belong in fact to the same line, as represented in the map. Mr. Martin however appears to think, that what I have termed the Midhurst line is a continuation of the Greenhurst anticlinal line, which he supposes to take a north-westerly direction from the point where I have considered it to terminate, nearly in the direction of the river, to Sellham. There cannot, I conceive, be any very positive evidence of the junction of these two lines, and therefore I have preferred the view above given respecting them. The difference however between this view and Mr. Martin's is of no importance whatever.

Lewes Anticlinal Line.—In the cliffs and chalk-pits north-west of Lewes, and in those north-east of it on the opposite side of the river, the upper chalk with flints dips with a rapidity which would, at a comparatively short distance to the south, carry the upper beds of the chalk down to the level of the bed of the river, whereas the chalk hills in that direction, on the opposite side of the chalk valley in which Kingston and Falmer are situated, are nearly as high as the escarpment north-west of Lewes. There must necessarily therefore be either a fault, or a rise of the beds to the north from a synclinal line, by which the chalk about Kingston is brought up to its actual elevation. The complete explanation is given by the natural section on the opposite side of the river near Southerham. The rapid ascent of the beds to the south is there beautifully exhibited. The synclinal line passes into the cliff just about the coombe-like valley (marked in the Ordnance Map) immediately north of Southerham, in the insulated chalk hill east of Lewes. It is doubtless connected with the formation of that valley. The southerly ascent of the beds is seen very distinctly till they meet the valley between the hill just mentioned and the general chalk escarpment on the south of it, where the regular dip to the south is again resumed. The anticlinal line must therefore run along this valley. Mr. Martin has detected farther indications of its continuation to the east, and, for the reason above stated, it is certain that it strikes into the chalk on the west of Lewes. The exact coincidence of the direction of this line with that of the Greenhurst line renders it highly probable that the one is a prolongation of the other*.

* Dr. Mantell observed these phænomena in the immediate neighbourhood of Lewes, and has given a section of the chalk cliffs on the east side of the river opposite to the town, in his 'Geology of the South-east of England,' p. 352.

At Piecomb and south-east of Lewes, (the points at which the Greenhurst and Lewes lines of elevation respectively strike into the projecting chalk mass,) there are two large coombe-like valleys which are worthy of remark, as indicating in the most unequivocal manner, the influence of a line of dislocation in aiding and guiding the operation of denuding causes. Had the action of these causes continued, it is easy to see how, as far as the dislocations may proceed, the projecting chalk between Lewes and Piecomb would have gradually disappeared as much by the process thus indicated on its flanks as by the effect produced on the general front escarpment. From Piecomb to a point directly south of Petworth, as well as to the east of the insulated chalk hill at Lewes, this operation has been completed, which has probably been owing to the more decided character of the dislocation along those portions of the anticlinal lines than between Lewes and Piecomb. I have stated my reasons for doubting the actual prolongation of the Greenhurst line west of the projecting chalk escarpment directly south of Petworth. This projection is probably due to the feébler influence of the dislocation as it approached that point. The two coombe-like valleys above mentioned may afford a useful analogy in forming our conclusions in some other cases to be hereafter described.

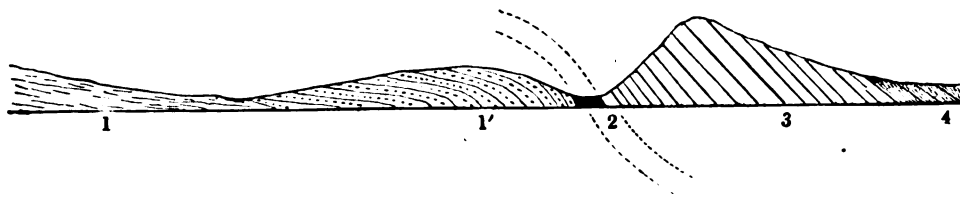
Transverse Valleys near the Greenhurst Line.—On the north-west of Pulborough the river Arun makes its way through the lofty escarpment of the greensand, as described some years ago by Mr. Martin, who also pointed out to me a remarkable and anomalous dislocation at the point immediately east of the transverse valley where the river first penetrates the escarpment. The beds dip north-west at an angle of about 30°, whereas in the vicinity there is a very regular dip to the south. This has been justly attributed I think by Mr. Martin to the transverse fracture in which we conceive the valley to have originated. The evidence is precisely similar to that already adduced with respect to the transverse breaks in the Bidborough range. It will be remarked too, that at Lodsworth, west of Petworth, one of the tributary streams to the Arun penetrates the greensand escarpment, in the manner above described. A small stream also descends down a deep valley east of Petworth from the upper part of the greensand range, and Mr. Martin informed me that there exists evidence of this valley having in like manner originated in a cross fracture.

I would also here direct attention to the manner in which the chalk ridge is traversed by the Arun, the Adur, the Ouse and the Cuckmare, circumstances to which I shall again allude in the sequel.

I shall now proceed to the north-western part of the district.

The Farnham, Guildford, Dorking and Godstone Line of Flexure.—The most remarkable part of this line is the chalk hill called the Hog's Back, extending from Guildford to a point within about two miles of Farnham, where it ceases somewhat abruptly. The dip at Guildford is considerable, but increases as we proceed westerly till, about Seal, it amounts to 70° or 80°, being everywhere exactly north. This dip carries the chalk rapidly down under the tertiary beds, leaving a narrow and lofty ridge of chalk. The basseting edge of the gault occupies a narrow strip at the foot of the escarpment, but the upper beds of the lower greensand occupy a far larger proportionate surface. This is owing to the fact of their inclination being very much less than that of the chalk, as represented in the annexed diagram.

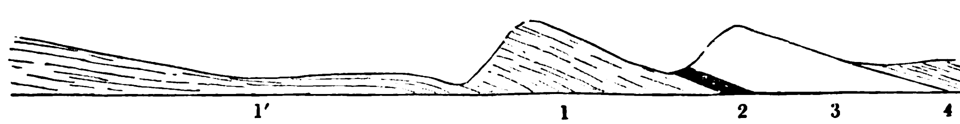
3.



4. Tertiaries.
3. Chalk.
2. Gault.
1, 1′. Lower Greensand.

The section through Crookbury Hill is similar to the one here given, except that the lower greensand rises to a greater height than in the instance before us. This elevation shows that the beds of that formation must have a considerable dip from thence to the Hog's Back; and this dip, though much less than that of the chalk, is considerably greater than that of the greensand beds further south, which would otherwise have occupied a very much smaller space in that direction than they actually occupy. This change in the magnitude of the dip probably takes place near the hill, but I saw no distinct reason to suppose that the hill is anticlinal, as Mr. Martin appears to think it. The same observation will apply I think to the whole of his Pease Marsh anticlinal line, east of the hill in question. The proper line of flexure (as previously defined) from the western extremity of the Hog's Back to the east of Puttenham is unquestionably very near the foot of the escarpment; and by Guildford, it runs not far south of St. Catherine's Hill, and close under the hill above Shalford, and the prominent point on which Margaret's Chapel is situated. At Guildford the inclination of the chalk, though still very considerable, is much less than it is farther to the west; but here it is continued without diminution to the first escarpment of greensand, constituting the hills just mentioned. That of Margaret's Chapel attains a higher elevation than the chalk escarpment, as represented in the annexed section, though it is not much more than a quarter of a

SECTION THROUGH MARGARET'S CHAPEL HILL, NEAR GUILDFORD. 4.

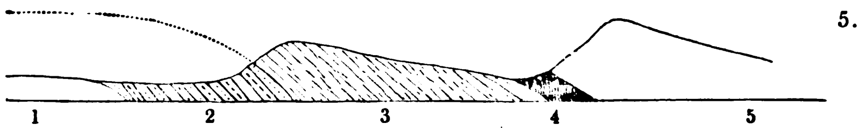


4. Tertiaries.
3. Chalk.
2. Gault.
1, 1.′ Lower Greensand.

mile from its foot. The sand emerges from beneath the chalk in the same manner by Albury, Shiere and Wotton, though, as we proceed easterly, the first escarpment of greensand (at the foot of which the river runs by Albury) becomes less determinate. On the south of this line I could find no distinct indications of southerly dip; on the contrary, all my observations indicated a gradual rise of the beds from the foot of the first to the summit of the second escarpment of greensand along Leith Hill and Hurtwood Common. I therefore concluded that this was, throughout the whole of the range above mentioned, an extremely well-defined line of flexure, without being anticlinal. Mr. Martin regards the part of the line east of Guildford as a continuation of his Pease Marsh line*.

As we proceed westward of Gomshall, this line is perhaps somewhat less distinct. Immediately south of Dorking, however, it is well marked in Berry Hill, on the south side of which the Weald clay is brought to the surface, dipping rapidly to

SECTION THROUGH DORKING.



5. Chalk.
4. Gault.
3. Lower Greensand.
2. Weald Clay.
1. Hastings Sand.

the north. Still I found no indications of an anticlinal arrangement. In proceeding across the small valley in which Berry Hill Park is situated, and thence up the hill on the road to Leith Hill, we find the junction of the lower greensand and Weald clay at a considerably greater elevation than at Berry Hill. From the latter to the former point, the Weald clay would probably rise by its general inclination in Leith Hill, which is much smaller than that with which it rises up to Berry Hill.

The continuation of this line is also recognized along the range of hill extending from Park Hill, Reigate, by Bletchingley to Tilburstow Hill, south of Godalming. The Weald clay appears at a considerable elevation on the south side of the latter hill. If the inclination with which it rises to that point were continued south of it, the width of the surface occupied by this formation would probably not exceed three times its thickness. The actual width is however about four miles. There must consequently be a great change of inclination immediately to the south of

* The difference between my representation of these phænomena and Mr. Martin's arises merely from my recognizing the *line of flexure* as that which ought to be especially noted, rather than that which he considers as marked by a small degree of anticlinal arrangement.

Tilburstow Hill, which distinctly proves the continuation of the line of elevation up to that point*.

Evidence of Transverse Fractures between Farnham and Godstone.—Leith Hill is the highest hill in the whole district, being 993 feet above the level of the sea. The Weald clay in its south escarpment rises to the height of 200 or 300 feet above the valley at its foot. The dip appears to be generally regular from the summit to the first escarpment of greensand already described. It presents to us some important indications of transverse fracture.

At the south-east corner of the hill, near the small hamlet of Cold Harbour, a great local disturbance has evidently taken place, and is shown by the position of the beds in the side of the hill south-west of the hamlet and in the quarries near it. The direction of the fracture is also indicated by the deep-cut valley running northward from the village. The whole of this picturesque spot, as we descend from the summit of the hill by Kittlands, is strongly indicative of local disturbance. I attribute these appearances to a transverse fracture running north and south along the above-mentioned valley. The indentation in the face of the escarpment on the south, exactly opposite the deep-cut valley on the north, indicates the manner in which the denuding agents have been guided and aided in their work by the fracture; and we easily conceive how, if their operation had been continued for a comparatively short time longer, the eastern extremity of this hill would have become an insulated mass, like the chalk hill on the east side of Lewes.

Immediately to the west of Leith Hill, we also observe a deep indentation in the face of the hill (distinctly marked on the Ordnance Map), which forms one of those coombe-like valleys before noticed at Piecomb and Lewes, the origin of which I refer to the existence of a cross fracture operating precisely as the longitudinal one has undoubtedly operated at those places. There is likewise another indentation of the same kind a little further to the west, as shown also by the map; and an exactly similar case also presents itself at Hascombe in the escarpment of the greensand south of Godalming. In all these instances there is not merely an indentation in the face of the hill, but a narrow valley has been formed, of greater or less depth, through the top of the ridge, and is continued down the regular slope of the hill on the opposite side. In each of these transverse valleys, and in others of the same kind, there exists a perennial spring a little below the highest point of the valley on the sloping side of the hill, and in general also a correspond-

* Dr. Mantell recognizes a *fault* in this hill, and I have no doubt that such is the case, and that it probably extends some distance westward. It is very possible that this long *line of flexure* may in several places become a *line of fault*, but the distinction is immaterial as regards my own theoretical views in this district. They are equally *lines of elevation.*

ing one in the escarpment. I have observed the temperature of a considerable number of springs of this description, and have found it, at different times of the year, to be uniformly about 51° or 52° Fahr. These springs seem strongly confirmative of the existence of transverse dislocations, of which they would be almost the necessary consequences.

Transverse River-courses through the Greensand Escarpment.—In the transverse valleys just described, we may probably recognise the earliest stage in the formation of those large transverse valleys which have resulted from the removal in such places of the whole escarpment of the greensand, and through which the transverse drainage of the district takes place. One of these is opposite Guildford, and another near Dorking. The wider these valleys are, the less likely are they to afford present indications of any transverse dislocations in which they may have originated. In neither of these cases have I been able to recognise direct proofs of such origin. Our conclusions respecting them can only, therefore, rest on analogy.

There is also another curious case of a transverse river-course, opposite the western extremity of the Hog's Back, where the western branch of the Wey, instead of pursuing what might appear its natural course at the foot of that hill, cuts directly through the greensand ridge west of Cooksbury Hill. It seems to have an obvious connexion with the change of structure which is observable between the chalk ridge just mentioned and Farnham. I have already stated that the dip towards the western end of that ridge is not less than 70° or 80°, whereas at Farnham it is not more perhaps than about 10°. This change accounts for the sudden termination of the ridge, and indicates moreover a transverse curvature, such as must almost necessarily be accompanied by a transverse fracture, which, continued in a direction exactly south from thence, would account for the actual and apparently anomalous direction of the river-course as above described.

West of the supposed transverse fracture just mentioned, the Guildford line loses its distinct character. I doubt its continuance much to the west of Farnham. Near that place I believe considerable disturbance is indicated by subterranean water-courses, but I could detect no conclusive external evidence of a line of curvature or anticlinal line beyond that place. Mr. Martin's Pease Marsh line, however, somewhat south of the former, seems, as it approaches the chalk westward, to assume a more determinate character than I conceive it to have nearer Guildford. Towards the east I have shown that the Guildford line extends to Tilburstow Hill. Immediately east of that hill is another break through the greensand escarpment, to the east of which we find a line of elevation, which I shall now proceed to describe.

Seven Oaks Line.—This line was first noticed by Dr. Fitton in his memoir "On the Strata below the Chalk." He traced it from Montreal Park to a point between

Westerham and Limpsfield. I also found indications of it nearly as far to the east as Seal. In some places (as at Dry Hill Farm, west of Sundridge) it assumes a distinct anticlinal character; at other places it appears to be a line of curvature, the beds rising rapidly from the north, and being continued with a gradual ascent to the greensand escarpment. I did not examine the country in the immediate vicinity of Limpsfield, to ascertain whether this line was a continuation of the Guildford and Godstone line or not. On that account, as well as from the circumstances of its assuming a somewhat different character and deviating in some degree from the direction of that line, I have given it a distinct appellation. They both probably belong strictly to the same continuous line of dislocation.

From the eastern extremity of this line to the coast at Folkstone, I believe there is no distinct analogous line of elevation, either along the greensand escarpment, or between it and the escarpment of the chalk. The beds rise with a gradual and easy inclination from beneath the chalk, and present no distinct evidence, so far as I have been able to detect, of any determinate line of elevation.

Transverse Valleys of the Seven Oaks Range of Greensand.—In this range are several transverse valleys similar to those already described in the Leith Hill range. One of the best-defined is that which descends from the escarpment by French Street and through Hill Park east of Westerham. It is marked by a strong spring in the escarpment, and from French Street a rivulet descends to the north along the valley. I can feel no doubt of the origin of this valley having been due to a transverse fracture. We have a similar case again at Ide Hill, (about two miles to the east of the former,) though the valley is not so well-marked a feature as in the former instance. We have, however, the strong spring in the escarpment, with decided evidence of considerable local disturbance about the hill. A third case is found in a narrow valley which descends from Whitley Mill (about two miles south-west of Seven Oaks) immediately to the east of Riverhead. The disturbances along this valley demonstrate its origin to have been in a dislocation. The stream which works the mill originates almost entirely in the copious spring just above it, and in the escarpment at Everlands we find the corresponding spring. This has evidently been a strong fracture, and we may observe that its direction exactly ranges with that of the valley along which the river Darent penetrates the chalk.

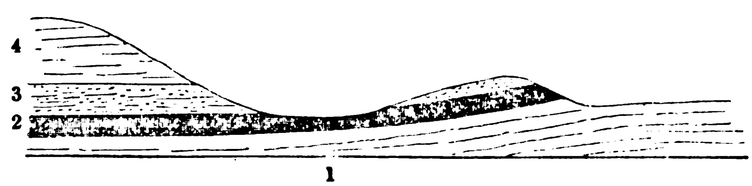
Maidstone, Ashford and Folkstone Range of Greensand.—On the east of Seven Oaks there is a break in the greensand escarpment, beyond which that formation occupies a considerably wider space opposite the entrance of the Medway into the chalk hills. The smallness of the general dip corresponds to this increase of width, and the phænomena of elevation appear to be less marked and interesting here than in the greater part of the area occupied by the greensand. East of the Medway the escarpment becomes extremely bold and abrupt till we come beyond Pluckley, a village five or six miles from Ashford. About Sutton and Ulcomb it begins to approximate to the chalk escarpment, and its general dip must be somewhat greater. Opposite Ashford we find another great break in the range, which, further south, no longer preserves by its elevation the distinct character which it generally possesses.

The springs along this escarpment are not nearly so frequent as in those of Leith Hill and Seven Oaks, where the indications of disturbance are much greater; and we may particularly remark, that between the Medway and Sutton Valence, the Ordnance Map does not indicate the existence of a single rivulet flowing from the escarpment, and resembling those always formed elsewhere by the springs I have described. Now this part of the escarpment, from its altitude and verticality, would be particularly favourable to the formation of springs in cases where the water, arrested in its descent from the upper surface by some impervious stratum, would be compelled to seek a horizontal outlet, probably that which the nearest valley or escarpment would afford. Such springs however seldom occur in escarpments *from* which there is any considerable dip; and on this account the escarpments previously mentioned would be less favourable to the production of springs than that now spoken of. The comparative absence of springs in this escarpment is probably due to an absence of those dislocations in which perennial springs so frequently originate. This conclusion is in perfect harmony with the undisturbed character of this portion of the district. In the escarpment east of Sutton there are two or three large springs which I attribute to fractures; there is also reason to believe that the disturbance has there been somewhat greater.

River-courses through the Chalk Escarpment.—One of the most curious circumstances connected with the geological structure of the Wealden district is its transverse drainage through the apparently insurmountable barrier of the surrounding chalk hills. The river-courses through these hills are far more striking than similar instances already mentioned in the interior of the district, because, in the first place, the barrier broken through is of far greater strength and massiveness, and secondly, the continuous lateral longitudinal valleys seem to present scarcely the smallest impediment to a totally different drainage, by which the whole water of the district might have been carried along those valleys under the chalk escarpment, or that of the greensand, and discharged into the channel by Folkstone or Beachy Head. The most obvious solution of the difficulty which the existence of the transverse river-courses under such circumstances presents to us, is in the hypothesis of their having originated, as in other cases, in transverse dislocation, and I have been desirous of verifying the truth of this hypothesis by the discovery of indications of disruption along the transverse valleys through the chalk. I have not, however, in these instances been very successful. The amount of the positive evidence of facts is not great. The point at which the river at Dorking breaks through the chalk escarpment is directly opposite the extremity of Leith Hill, which has obviously been a point of considerable disturbance, and it is highly probable that any transverse fracture there might also pass through the chalk. Near Seven Oaks, I have already shown that a well-defined line of fracture in the greensand would, if produced, pass along the river-course through the chalk. The course of the Arun through the chalk is along the direction of the valley by which it cuts through the greensand, and which affords direct evidence of dislocation. The course of the Ouse at Lewes seems also evidently connected with the great disturbance which has there taken place. But one of the best indications perhaps of the connexion between transverse valleys and dislocation in the chalk is afforded by the well-marked valley along which the road from Godstone to London passes. The state of internal dislocation of the chalk is shown by the occasional bursting forth of a copious stream which takes its course northward down the valley. This does not occur, I believe, more than once in two or three years, and after a more than usually rainy period. I am told that the water possesses some property which renders it very destructive to vegetation.

Another case also, though not comprised within the district with which I am immediately occupied, deserves notice. I allude to the transverse course of the river Medina through the middle of the central ridge of the Isle of Wight. The two parts of the ridge on the east and west respectively of the north and south transverse valley are not in the same line, but are so situated that their anticlinal lines are parallel and about two miles apart. The western portion of the ridge swells out to the north on the west of the cross valley to meet the extremity of the other portion, the dip of this connecting portion of the range being generally about north-west and south-east, or in some parts more easterly and westerly. The annexed diagram represents an east and west section of the valley of the Medina near Rookley, and very nearly in the direction of the more southerly anticlinal line. It presents a north and south line of flexure which must almost necessarily be ac-

6.



4. Chalk.
3. Upper Greensand.
2. Gault.
1. Lower Greensand.

companied by a corresponding north and south fracture, in which I conceive the valley to have originated.

Independently of such evidence as the above, the opinion that river-courses through the chalk escarpment have originated in transverse fissures must rest on analogy, or more especially on the degree in which the hypothesis harmonizes with that general theory which may be recognised as best accounting for the general phænomena of elevation. I shall again refer to the same point in the concluding section of this memoir.

The Bas Boulonnais.

The denudation of the Bas Boulonnais has laid bare certain portions of the oolitic series, which, together with the cretaceous beds, were first described by Dr. Fitton and subsequently in greater detail by M. Roget, to whose work I am indebted for much information. I shall find it necessary to repeat in some measure what had been previously observed by these gentlemen respecting the superficial range of the different beds of the district, in order to convey a more distinct conception of its *geological structure.*

At Wissant the gault is observed to emerge at a slight inclination, but is again immediately lost under the accumulations of sand (*les dunes*), extending nearly two miles along the coast. To the south of these dunes the Kimmeridge clay commences and occupies the whole range of coast, with the exception of some other dunes at the mouths of the rivers, till we arrive at those which extend along the coast from the southern part of this district for many miles. In proceeding eastward from the coast, we find the coral rag and Oxford clay brought to the surface by a very small rise of the strata in that direction. On the south of the river which falls into the sea at Ambleteuse, the Oxford clay is the lowest bed which is thus exhibited (Diagram No. 26.)*. On the north of that river the same clay is brought up in like manner, but by a rather greater inclination of the strata, and consequently at a smaller distance from the coast (Diagram No. 25.). An inferior portion of the oolites also here emerges from beneath the Oxford clay, and reposes immediately and unconformably on a portion of the carboniferous series consisting of mountain limestone and interpolated beds of coal.

This last circumstance exhibits that great discontinuity in the process of deposition, so generally recognised in this part of the world, which took place after the formation of the carboniferous series. Another important instance of a similar kind is also not less clearly shown in this district than in the southern coast of England, in the entire unconformity of the chalk, gault, and greensand with the beds on which they repose. To the west of the Calais road through Marquise, the lower of these beds appear to come in contact with the Oxford clay. Immediately to the east of that road the mountain limestone presents itself, and to the north of

* These diagrams of the Bas Boulonnais are appended to the memoir, and will be found in pages 47, 48.

it the highly inclined beds of still lower formations, on which the chalk itself seems immediately to repose. In the north-east corner of the district, the cretaceous system overlies the upturned edges of the mountain limestone with its beds of coal; till we come to the south of the river which bounds the older formations, where the lower greensand is found to repose on the Oxford clay along the whole boundary of the district by Boursin, Colemberg, Henneveux, Brunembert, Lottinghen, and Desvres. To the south-west of the latter place, and at Samer, the greensand lies immediately on the coral rag; and along the southern boundary it reposes also on that formation or on the Kimmeridge clay.

Oxford Clay.—The hill north-west of Marquise, on which the village of Basinghen is situated, presents to the east an escarpment of considerable elevation, the upper part of which is occupied by the Oxford clay, and the lower part by the oolitic beds immediately beneath it (Diagram No. 26.). These latter beds extend a little to the west of the Marquise and Calais road, where they form a thin and unconformable covering to the lower part of the platform formed by the surface of the mountain limestone.

At some distance north of the village, the Basinghen Hill takes a north-westerly direction; and from that point the Oxford clay descends and passes under the upper formations nearer the coast. On the south of Basinghen it likewise descends towards the south and passes beneath the valley of the Ambleteuse river. The coral rag also bassets out on the high ground west of Basinghen, passing down to the above-mentioned valley, and under the Kimmeridge clay which occupies the coast from Ambleteuse to the dunes at Wissant.

On the south of the Ambleteuse river the Oxford clay forms an escarpment similar to that at Basinghen, but is at a greater distance from the coast (Diagram No. 26.). It passes from the east of Wievre Effroy to meet the valley of the Wimereux near Belle. On the south of that valley the high ground is projected eastward beyond Alinctun, where the Oxford clay still rises to the brow of the hill by Henneveux and Brunembert, as far as the Liane. The same formation also occupies the whole of the district east of this line of hill, till it is concealed beneath the unconformable covering of the cretaceous system as previously described. On the south of Brunembert the escarpment takes the westerly direction of the Liane, the upper part being formed of the coral rag and the lower of Oxford clay, the lower part of which probably stretches over the surface of the greater part of the valley comprised between the above escarpment on the north, the forest of Desvres on the west, and the boundary hills on the east and south. Thence it passes under the eminence on which the forest just mentioned is situated, and rises in the hill which still follows the course of the Liane in the south-westerly direction which that river suddenly assumes, till it meets the road from Boulogne to Desvres, near which after a gradual southerly declination the clay passes entirely under the coral rag.

Coral Rag.—This formation is found to basset regularly in a band of greater or less width on the west of each of the hills above described as having its escarpment formed principally by the Oxford clay. From the point at which that formation entirely disappears (as just stated) beneath the coral rag, the latter occupies the valley of the Liane to a considerable elevation on both sides of the river, till it arrives within about two miles of Boulogne. It passes also under the eminence on which Samer, on the Paris road, is situated, beyond which it is covered up by the lower greensand.

Kimmeridge Clay.—This formation succeeds in ascending order. North of Ambleteuse it occupies a narrow tract along the coast. On the south of the river it extends from the coast by Maninghen to the east of Hesdres, over the high ground which intervenes between the Ambleteuse and the Wimereux rivers. And on the south of the latter it extends in like manner from the coast into the Forêt de Boulogne, and occupies the heights immediately to the north of that part of the valley of the Liane along which runs the Paris road, the sides of the valley itself being occupied by the coral rag, as before stated. The most eastern point to which it proceeds is Samer. The insulated hill on which that place is situated is capped by some of its lower beds, distinctly characterized by the *Gryphæa virgula*, and resting on the coral rag which forms the base of the hill (as already mentioned), and extends to the valley of the Liane. On the south of the Liane it extends from the coast in a similar manner, till the coral rag emerges from beneath it, or it becomes concealed by the unconformable covering of lower greensand.

This formation is best exhibited in the coast section immediately to the north of Boulogne. The lower division consists of a species of blue marl, with not unfrequent hard stony bands, and is for the most part filled with the remains of the *Gryphæa virgula*. The upper portion consists of a similar blue marl, frequently somewhat shaly, and containing the *Gryphæa virgula* in much smaller quantity. It contains however in considerable numbers a *Gryphæa* which appears to me a distinct species, and has not, I think, been yet named. This portion is also characterized by the *Ostrea deltoidea*, of which I never observed a specimen in the lower portion of the formation. These two parts are separated by thick continuous bands of sandstone frequently characterized by large *Trigoniæ* (Diagrams Nos. 27, 28, 30.). They descend to the level of the sea at La Crêche (Diagram No. 28.), and furnish the enormous blocks on the beach at that point. It is by means of these distinct divisions of this formation that we are enabled to make out the geological structure, where most complicated, with a degree of accuracy which would otherwise be unattainable.

Structure of the District near the Coast.—Commencing with the coast section from Boulogne (Diagram No. 28.) and proceeding northward, we observe that the stony bands which separate the two portions of the Kimmeridge clay are brought down from the top of the cliff to the beach, by a rapid curvature of the beds, at La Crêche. These beds then dip beneath the level of the sea, and the cliff, from that place to the mouth of the Wimereux, is composed, in its lower part, of the upper division of the Kimmeridge clay, the higher portion of the cliff consisting of the superincumbent sandstone beds above described. In this part of the cliff there is a considerable dip to the north which carries the upper surface of the Kimmeridge clay below the level of the sea at the dunes at the mouth of the Wimereux. On the north of the dunes, however, the upper division of that formation is found at a considerable altitude. It afterwards descends again with a gentle dip to the north beneath the Ambleteuse dunes. It ranges also to the eastward along the north side of the valley of the Wimereux, where it may be distinctly traced nearly as far as the Calais road, ascending by the gentle eastward rise of the beds nearly to the top of the hill. I identified it at the mouth of the Wimereux and also near the Calais road by the deltoid oyster; and moreover, near to the village of Wimille, the lower bed of Kimmeridge clay is distinctly recognised in the lower part of the valley by the abundance of the *Gryphæa virgula*. Returning to the top of the cliff at La Crêche, we find distinct evidence of the continuance, in a direction parallel to the Wimereux, of the line of flexure of which the section is so beautifully exhibited in the cliff. The junction of the upper sand on the north with the lower Kimmeridge clay on the south, which marks the course of the line, may be distinctly traced close by the fort near La Crêche, to the north of the column of Napoleon, into the upper part of the valley of the little river Denacq. In some part of this range it probably becomes a *line of fault*.

On the north of this line it is easy to trace the upper division of the Kimmeridge clay with the superincumbent upper sand down to the valley of the Wimereux (to which it descends in the same manner as in the cliff) and also to the Denacq. The windmill about three-quarters of a mile from Wimereux, on the Boulogne road, stands on the clay (Diagram No. 29.), which also appears at the little hamlet north of the column, whence it passes northward under the quarries in the upper sand near that spot. In a quarry also near to Wimille, and between the great road and the Denacq, the beds of that formation are found to dip rapidly into the valley. Hence then the upper division of the Kimmeridge clay passes into the bottom of the valley of the Wimereux on its southern side, while on the northern side, as already shown, it occupies nearly the top of the hill. Consequently there must be a very large fault ranging along that valley from the coast to the village of Wimille (Diagram No. 29.).

The top of Mont Lambert is the highest point within a considerable distance of Boulogne. The extensive quarries near its summit are easily recognised as belonging to the upper sand. In descending in any direction we soon arrive at the upper division of the Kimmeridge clay, and along the road to Boulogne the siliceous beds beneath it are distinctly seen. These descend the hill on the north side across the St. Omer road down to the upper part of the valley of the Denacq, already noticed as ranging with the La Crêche line of elevation, where I found them near the upper extremity of the valley abutting directly against the upper division of the Kimmeridge clay (Diagram No. 30.). This distinctly proves the continuation of the La Crêche line up to this point. It probably dies away somewhat east of it.

At the point just mentioned the clay was identified by the oyster shells; and, moreover, I traced it along the brow of the hill on the east of the valley of the Denacq, which shows that a great fault also ranges along the lower part of that valley down to Wimille, since it has been shown that the upper division of the Kimmeridge clay passes down to the bottom of the valley on its western side.

When the clay on the east side of the valley of the Denacq meets the valley of the Wimereux, it ranges along its south side at the same elevation. It also constitutes the hill on the north side of the valley nearly to the summit immediately east of the Calais road; consequently we have no longer the same evidence of a great fault ranging along this valley east of Wimille, as on the west of that place. There are evidences of disturbance, however, on the north side of the valley. South of Maninghen I found the beds in a newly-opened pit dipping very rapidly to the north. About Souvremoulin there were indications of cross fractures, by which the lower beds of the Kimmeridge clay are brought nearer the bottom of the valley than either to the east or west of that place. I have no doubt therefore that the dislocation, in which the valley west of Wimille undoubtedly originated, was continued to the east of that place. It probably dies away towards the upper part of the valley in the same manner as in the La Crêche line.

From the high ground north of the Wimereux, and between the coast and the Calais road, the upper division of the Kimmeridge clay may be traced, gradually descending towards the Ambleteuse valley as in the coast section, the declination of the strata in that direction however being less, as far as I could judge, at points more remote from the coast. At Auxdresselles, the northern extremity of the Ambleteuse dunes, we find some hard siliceous beds rising from beneath the valley, and apparently also from beneath the upper division of the Kimmeridge clay. The portion at the level of the beach being disintegrated by the waves, leaves the shore strewed with enormous blocks, exactly similar to those which are found also on the beach at La Crêche, and they belong, I conceive, to the same bed. North of Auxdresselles, the dip, as seen in the cliff, is to the south, which shows the valley to be here formed by a synclinal arrangement of the beds, since on the south of the valley the dip is northerly. The same arrangement is also maintained more to the east, as shown by the section (Diagram No. 30.) of the hill at Basinghen already described. On the east of Marquise the valley is bounded by the older formations, and a transverse section of it is altogether different.

I have already mentioned the general structure of Mont Lambert near Boulogne. The hill appears to have originated in a local disturbance. On the side towards Bainctun, the beds dip very rapidly into the hill, an arrangement of the strata which brings up the coral rag at the foot of the hill, and the Oxford clay in the valley at Bainctun as shown in Diagram No. 27. The general dip of the hill on the western side is small and towards the coast. On the north it has already been stated that the dip is with the general declination of the surface in that direction.

On the south of the Liane there are no indications of distinct lines of elevation.

In the portion of the Bas Boulonnais more remote from the sea, and occupied by the oolites, the indications of elevatory movements are much less sensible than in the tract already described. I was not able there to trace the lines of elevation above described to points more remote from the coast than those above indicated. There is, however, some evidence of a transverse dislocation close to the borders of the chalk near Henneveux, which is perhaps deserving of mention. It has been stated in a former part of this paper, in tracing the course of the Oxford clay, that the hill on which Alinctun is situated projects its eastern escarpment as far east as Henneveux and Brunembert, very near to the opposite chalk escarpment. It appeared to me probable that the Oxford clay dipped with some rapidity to pass under the chalk. This must necessarily be the case if the present difference of elevation between the top of the Oxford clay escarpment and the bottom of that of the chalk was produced by the elevatory movement which took place after the deposition of the oolites. Assuming this to be true, there must here be a transverse line of flexure, such as would almost necessarily be attended by a corresponding dislocation. Such a fracture is indicated by a deep valley which cuts directly across the high plateau of Oxford clay near its eastern extremity. The course of the valley is marked by a small stream which falls into the Liane near the village of Bournonville. It would be extremely difficult to account for it, I conceive, in any other manner. Still, it is possible, though I think improbable, that the surface of the Oxford clay might have been approximately the same as at present before the unconformable deposition of the cretaceous system, in which case its actual configuration may have been due to denudation, and not to elevation.

Structure of the North-eastern Portion of the District.—This is the tract occupied by the carboniferous and older formations. An account of its structure is in some measure foreign to my present object, since it must be almost entirely independent of the elevatory movement which led to the denudation of the district. I shall only offer one or two remarks on the subject. The surface of this portion of the district forms a rather elevated plateau bounded by the chalk hills on the north, and by the river which runs by Marquise on the south. On the north side the beds dip very rapidly to the south. The surface of the southern boundary is covered up by a thin covering of the unconformable oolites, but in one part I found a clear section of the inferior beds, which showed them dipping very rapidly and regularly to the north. If such be the case along the whole southern boundary (as I think extremely probable), the central portion of these older formations must lie in a synclinal trough. The dip is there very irregular, and generally much less than on the northern boundary, or at the point where I observed it on the southern limit. These facts are easily accounted for by the structure now described.

§ 2. Theory of the Elevation of the District.

The special object of this second section of my memoir is the comparison of the phænomena above described with the conclusions drawn from the theory of elevation as given in the Transactions of the Cambridge Philosophical Society; but I shall also avail myself of this opportunity of developing several points of that theory more in detail, and of offering such elucidations of the whole subject as the example before us may afford. In doing this I shall add somewhat to the mechanical reasoning hitherto employed; but, generally, those parts of the memoir in which we are not engaged in the immediate application of one theory to the district before us, will consist rather of more detailed explanations of fundamental hypotheses and final results, than of the mechanical reasoning, for which I must refer the reader to the memoir just alluded to.

1. In any accurate researches on this subject, based on mechanical principles, some hypotheses must necessarily be made respecting the *constitution of the elevated mass and the action of the elevatory force*. In the memoir above referred to, I have obtained the general results, assuming, for the greater simplicity, the cohesive power of the mass to be uniform throughout, and have then shown in what other cases those results would still be accurately or approximately true. The cohesion may have varied *continuously* according to any law and in any degree, in passing from one point of the mass to another; or it may have varied *discontinuously* along any vertical line within the mass, as for instance, in passing from one hori-

zontal bed to the contiguous one. In these cases the general results will still be accurately true, so far at least as we are now concerned with them. I have also shown what modifications would be produced in the phænomena by the existence of planes or surfaces within the mass, irregular in position and of partial extent, along which the cohesive power may be much smaller than in the immediately contiguous portions of the mass. They may be termed *surfaces of discontinuity*, and consist of irregular joints and cracks formed in the process of solidification, or by partial disturbance previous to the general action of the elevatory force, the effects of which are to be investigated. In such cases the lines of elevation (the phænomena with which we are here principally concerned), instead of being straight or regularly curved, will be broken or zigzag lines or curves; but their general directions will be approximately the same as if the mass were uniform. Such will also be the case if the mass be *regularly* jointed in several directions. If it be jointed in two directions only, the mean line of fracture will be made to deviate more or less from the direction it would take if the mass were homogeneous, towards that of the system of joints with which the fracture makes the least angle, but still always tending to resume the direction it would have in the homogeneous mass, whenever the continuity of the joints is interrupted.

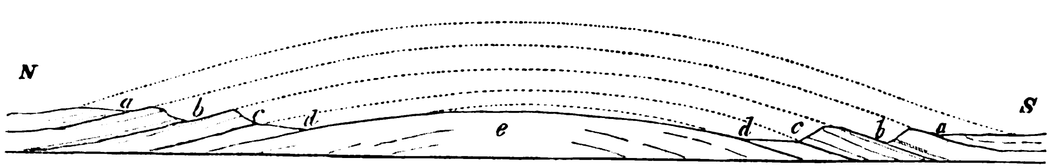
With respect to the elevatory force, it is assumed that it acted *simultaneously* throughout the disturbed area, with an *intensity* which might approximate to uniformity for large portions of that area, while it might be greater at particular points of it.

2. I have called the force *elevatory*, because the general character of most disturbed districts seems to indicate that the subterranean force, tending to elevate the earth's crust, has predominated over its weight tending to depress it; but if we suppose the contrary to have been the case, and the effect to have been a depression of the mass acted on, the phænomena with which we are principally concerned, the lines of dislocation, will follow the same law as if the mass had been elevated. It is only necessary that the resultant force at each point should generally be nearly vertical, *i. e.* nearly perpendicular to the upper and lower surfaces of the mass in its undisturbed position. I shall always speak of it, however, as *elevatory*.

3. We are not directly concerned in this theory with the physical cause to which the existence of an elevatory force may be due. Our object is to account for the varied phænomena of elevation, by referring them to some simple and general mechanical action; and, in so doing, to consider how far we may be able to define the nature of that action; whether it may have been general or local; and whether the resulting effects may be attributable to many repeated efforts, or to few. To give the greater definiteness, however, to our conception of the mechanical

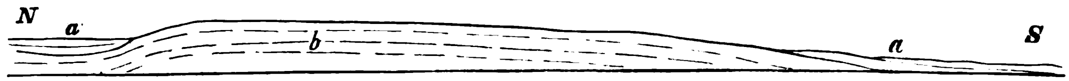
action here assumed, we may observe that it is exactly that which would be produced on a nearly horizontal surface by the pressure of a fluid, the action of which, being perpendicular to the surface, would be nearly vertical.

4. In applying this theory to any proposed district, we have first to consider whether the elevatory force (which, according to our fundamental hypothesis, has acted simultaneously at every point of the lower surface of the uplifted mass,) has acted with the same or with a different intensity on different portions of that surface. If the force acted under any continuous portion of the mass with a greater intensity than under another such portion, the former would, *cæteris paribus*, be more elevated and disturbed than the latter; and assuming the undisturbed positions of the component strata and the external surface to have been originally horizontal, the position of any stratum, or that of the surface immediately posterior to its elevation, and anterior to any subsequent subsidence, would indicate these two portions of the elevated mass. In determining them by observation, we must necessarily assume the external configuration of the proposed district, (independently of subsequent denudation), and the disturbed forms of the strata, to retain in a certain degree the characters impressed on them by that decisive movement to which our theory may refer the more characteristic phænomena of elevation. As an elucidation, let us take the tract of country with which we are here concerned, including the Bas Boulonnais and nearly the whole of that portion of England lying south of the Thames, and extending to the west of the Wiltshire Downs; and let us assume, for the moment, that every part of this tract was elevated simultaneously; and for the greater simplicity of the elucidation, we may also suppose it to have received its whole elevation at a single movement. To judge of the relative elevations of different portions of it immediately after this movement, we must consider what would be the form of the external surface at the present time if no denudation had taken place. For this purpose we must conceive the tertiary beds to extend over the whole of this tract (since the elevation took place posterior to their deposition), as represented in the accompanying diagrams. The



7.

first (No. 7) represents a general section across the Weald, from north to south; the second (No. 8) a similar section west of the Wealden denudation; and the third (No. 9) a longitudinal section along the axis of the whole district from the Bas Boulonnais to the west of the Wiltshire Downs*.



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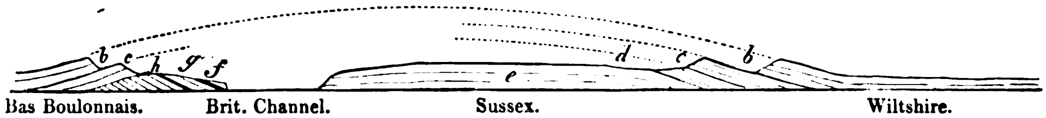


It thus appears that if there had been no denudation, we should have had an elevated range, the base of which would have occupied the whole of the tract defined above. The height of different portions of this range would have been very different. Within the boundary of the Wealden denudation, the greatest elevation above the sea would have been equal to the actual height of the central portion of the district together with the thickness of all the beds superior to the Hastings sand up to the tertiaries inclusive. This would probably have amounted to not less than 4000 feet, while the elevation of the western part of the range would perhaps not have exceeded 2000 feet, being its present height together with the thickness of the tertiaries.

For the purpose of presenting more distinctly to the mind the actual amount of elevation in this tract, I have supposed the tertiaries and the inferior formations now wanting to have been once continuous over the whole surface of the district. It would manifestly, however, answer our purpose equally well, if, instead of comparing the elevation of this imaginary surface of the tertiaries with their actual surface in the surrounding country, we should take the surface of any continuous stratum, and compare its elevation within the disturbed district with its depression beneath the actual surface of the surrounding district. The relative elevation of each stratum, real or imaginary, taken with reference to its undisturbed position beyond the bounds of the disturbed district, will be the same, and may be termed the *geological elevation* of the district, in contradistinction to the actual elevation of its existing surface.

Taking, then, the whole disturbed tract as above defined, since the geological elevation of the Wealden portion of it, with the Bas Boulonnais, is so much greater than that of the remaining portion generally, it is concluded, in the application of

* The following are the references to these diagrams:

a. Tertiaries. *e.* Hastings sand.
b. Chalk, Upper greensand and Gault. *f.* Kimmeridge clay.
c. Lower greensand. *g.* Coral rag.
d. Weald clay. *h.* Oxford clay.

In the Bas Boulonnais the chalk and greensand repose unconformably on the Kimmeridge clay and lower beds.

our theory, that the elevatory force acted with greater general intensity in the former than in the latter part of the district. It is also concluded, that the intensity of the elevatory force, throughout the district of greater geological elevation, so far at least approximated to uniformity, that its variation was generally much less rapid in passing from one point to another within the boundary of this portion of the whole tract, than in passing from a point within to another without that boundary.

The hypothesis of a single elevatory movement introduced, as above stated, for the greater distinctness of elucidation, is not essential to this reasoning. If we suppose the whole elevation to have been produced by successive movements, we must then apply the conclusion of the preceding paragraph more especially to that particular decisive effort of the elevatory force to which we refer the characteristic phænomena of the district.

5. The next point in the application of this theory is the determination of the boundary of the district which may have been simultaneously disturbed. This must be effected by ascertaining the area throughout which the phænomena of elevation are distinctly characterized by the same laws. Thus in the case with which we are immediately concerned, we observe that, in the western portion of the Wealden district, the longitudinal lines of elevation run approximately east and west; and such is also known to be the case in the Vale of Pewsey, and again in the Vale of Wardour. The great dislocation likewise of the Isle of Wight and the Isle of Purbeck preserves a parallel direction; and, although the evidence may not be so determinate as in the Weald, Mr. Martin has lately shown that intermediate lines, some of which may be regarded as continuations of those from the Weald into the great Wiltshire plateau of chalk, approximate to the same general law of parallelism. Hence I conclude that the boundary of the tract subjected to the simultaneous action of the elevatory forces is exterior to, and not remote from, the chalk escarpment of the Bas Boulonnais; and, after passing across the Channel from the north of Wisant to the east of Folkstone, that it is continued in like manner exterior to the chalk escarpment of Kent and Surrey, till it comes to the north of the Hog's Back and Farnham, whence I conceive it to be continued westward parallel to the general direction of the valley of the Thames, and probably not far from it (as shown by the discontinuous line in the map), as far at least as the Vale of Pewsey. On the south I consider this tract to be bounded by a line south of the southern coast of this country (see map), the exact position of which we have not the means of ascertaining; and on the west there is also some indeterminateness, arising partly from the absence of more detailed observations, and partly from the interference of other systems of dislocation which may have originated in independent elevatory movements in the south-western portion of this country. If all the strata removed by denudation were replaced, the above

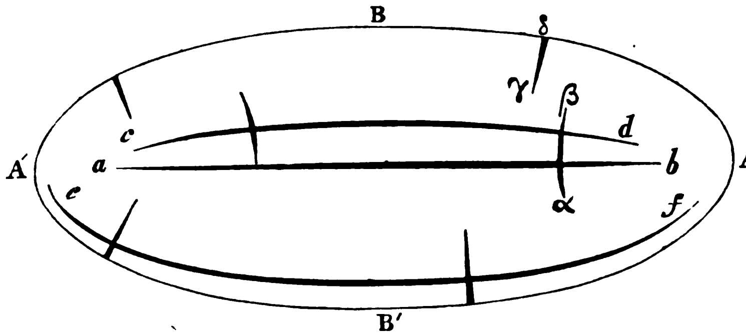
boundary, with the exception of the western extremity, would be distinctly indicated by the resulting mountain range.

6. To define the boundary of that portion of the district which is conceived to have been subjected to a more intense action of the elevatory force than the other portions, we must suppose the boundary line to turn southward at Farnham, and to preserve the same relation to the chalk escarpment from thence by Petersfield to Beachy Head, as that above described with reference to the other portions of that escarpment, and to pass across the Channel from that point to the southern boundary of the Bas Boulonnais. The boundary of the portion of the district now referred to is indicated in the map by a discontinuous line, which will be easily recognised.

Having established these preliminary points respecting the action of the elevatory force and the boundaries of the disturbed district, we must determine the general directions of lines of dislocation which would be formed in the elevated mass, assuming its approximate homogeneity. If it be not homogeneous, the lines of fracture may be modified as previously explained (page 31), but the results will still be approximately true.

7. It has been shown in the memoir already referred to, in the Transactions of the Cambridge Philosophical Society, that if the elevatory force be uniform, and the boundary of the elevated area be circular, a system of fissures might be formed, concentric about the centre, or diverging as radii from it. If the force acted with much greater intensity at the centre than elsewhere, the latter system would generally be formed, and not the former. It would then become a case of what I have termed *conical elevation*. If the circle be of large extent, and the force approximately uniform and of sufficient intensity, both these systems might be formed in a mass constituted like that we have to consider. If, on the contrary, the elevated area were a parallelogram of finite breadth, but of indefinite length, one system of fissures only could be formed. Its direction would be parallel to the axis of the parallelogram.

Now the circle, and the parallelogram of indefinite length, may be regarded as the two extreme or limiting cases of the ellipse, or, more generally, of any regular *oval*. For conceive an oval always preserving its shorter axis the same in magnitude and position, to change its form by a change in the magnitude of its greater axis. When this variable axis is equal to the constant one, the oval will become circular; and when the variable axis becomes indefinitely great, the oval will approximate more and more nearly to two straight lines parallel to the greater axis and passing through the extremities of the minor one. And as the general form of the oval is intermediate to these two extreme or limiting cases, it is not difficult to see, that the curve along which a longitudinal fissure would be formed under our assumed conditions, when the boundary of the elevated mass is oval, will be generally intermediate to the straight line and circle, in the sense in which the oval is so. In the particular case in which the fissure should be *central*, it would be a straight line along the axis; if *lateral*, it would deviate more from the straight line and approximate more to the form of the external oval boundary, according as the position of the fissure should be more remote from the axis, as represented in the following diagram (No. 10). The conditions of symmetry are sufficient to

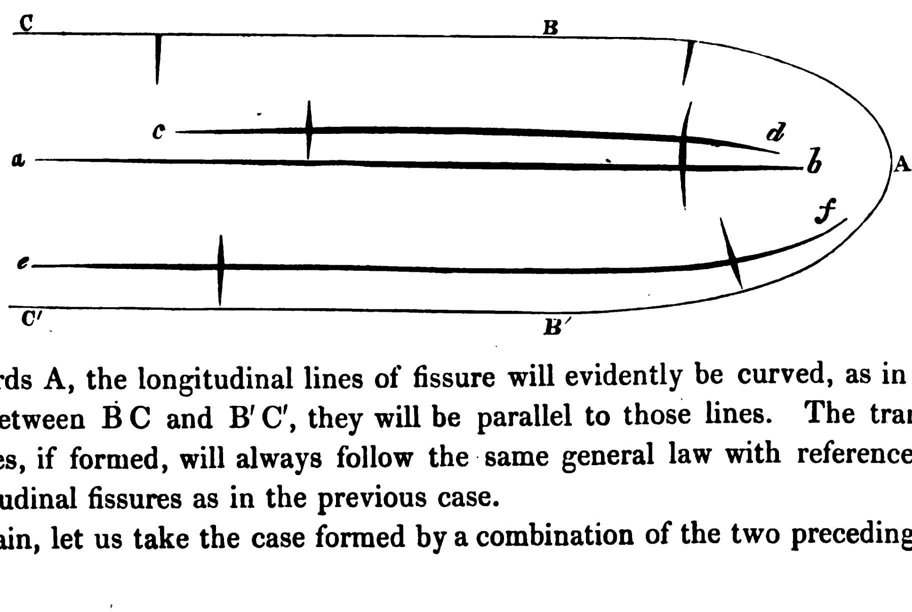


10.

establish these results, without entering into the mechanical reasoning on which they really depend.

A system of transverse fissures (α β, γ δ, &c.) might also be formed, the law of which, as theoretically determined, would be, that every such fissure should be perpendicular to each longitudinal fissure at the point of intersection.

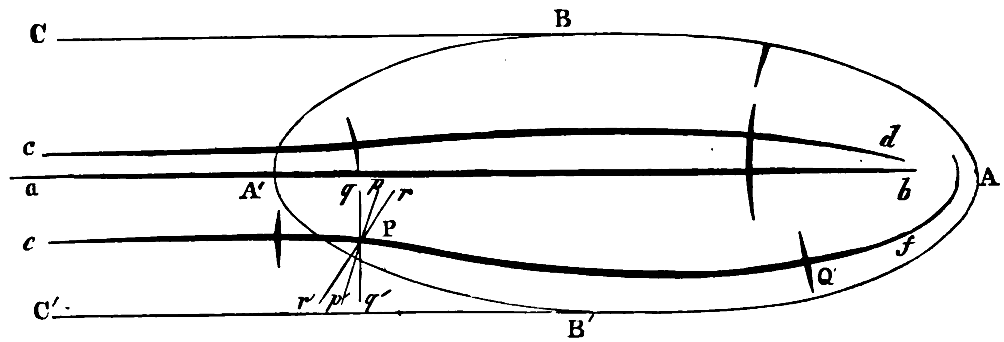
Let us now take the case represented in No. 11, in which the extremity, A, of the disturbed district has the same form as in the previous case, while the portions B C and B′C′ of the boundary are continued indefinitely and parallel to each other.



11.

Towards A, the longitudinal lines of fissure will evidently be curved, as in fig. 4; but between B C and B′ C′, they will be parallel to those lines. The transverse fissures, if formed, will always follow the same general law with reference to the longitudinal fissures as in the previous case.

Again, let us take the case formed by a combination of the two preceding cases, the portion A B A′ B′ (No. 12) being supposed to be acted on by an elevatory force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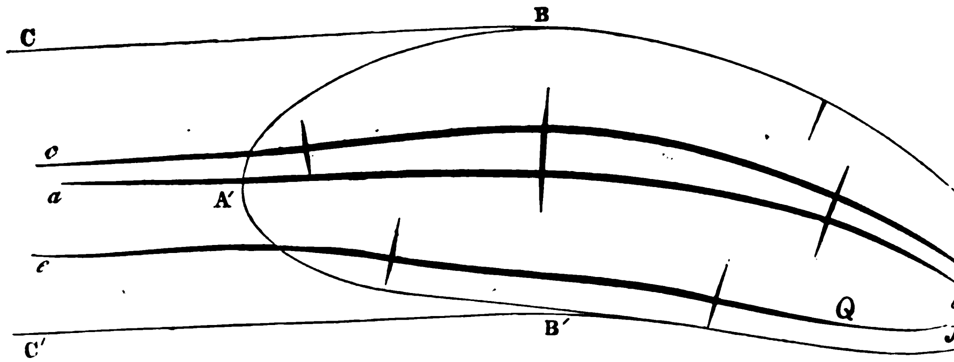
of greater intensity than the remaining portion. Let F denote the force acting on this latter portion, and let that on the former be equal to the sum of F and an additional force (f). If F alone acted on the whole area, we should have the case of fig. 11; and the question is, how would the fissures of that case be modified by the contemporaneous action of f, in addition to F, on the oval A B A′ B′? Now if f acted alone on that portion, and F did not act at all, either in that or the other part of the district, we should have the case of fig. 10, and therefore it is obvious that the modification produced by it would be such as to make the lines of fig. 11 approximate more or less to those of fig. 10, in the manner represented in fig. 12, the direction of a fissure through any point situated like P being intermediate to those in which it would proceed through that point in the two preceding cases respectively.

This conclusion follows immediately also from the consideration that the direction of the longitudinal fissures at any point will be perpendicular to the direction of greatest tension at that point*. Thus, if the force acted uniformly throughout the whole space A C C′, the direction of greatest tension at the point P would be $q\,q'$ perpendicular to the axis A A′; and if the force acted on the oval alone, the direction of greatest tension would be in some such direction as $r\,r'$. Consequently, in the actual case proposed, it is obvious that the greatest tension will have a direction $p\,p'$, intermediate to the two former directions, and therefore also, the direction of the fissure will be intermediate to those which would be formed in the previous cases respectively.

* This may admit of exceptions, but will be true whenever there is a greater tendency to form longitudinal than transverse fissures. At certain points, not remote from the extremities of an elongated oval, the tension along $r\,r'$ may be a minimum; in which case the direction of maximum tension will be perpendicular to $r\,r'$, and the transverse would probably be formed first; but in such case the longitudinal one, if formed at all, must be perpendicular to the transverse one, and the conclusion of the text would still hold true.

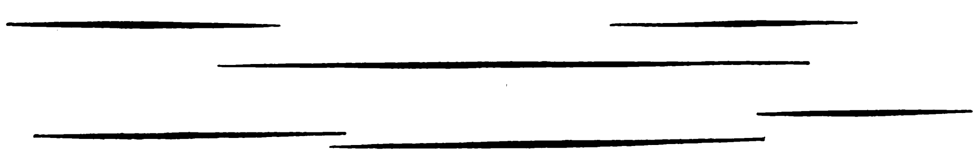
We may now pass to the case represented in fig. 13, which differs from fig. 12



13.

in having for the axis of the oval a curved instead of a straight line. To estimate the effect produced by this change of form on the direction of the longitudinal fissures, conceive the area A B A′ B′ uplifted and thus placed in that state of tension which it can just support without dislocation. If we take a point Q in the portion B A B′ of the oval, it is not difficult to see that the line of greatest tension through Q must (to a degree of approximation sufficient for our present purpose) bear the same relation to the curved axis of the oval, as the corresponding line through Q′ in fig. 12 bears to the rectilinear axis in that case. Consequently the directions of longitudinal fissures through Q and Q′ (which must be perpendicular to the lines of greatest tension) must also bear similar relations to the two axes respectively. Consequently the line of fissure through Q, instead of curving upwards as in fig. 12, may curve downwards, as represented in fig. 13, provided the curvature of the axis be sufficiently great. The curvature of the lines of dislocation on the side of the axis opposite to Q will evidently be increased by that of the axis. A fissure near the axis will obviously be approximately parallel to it.

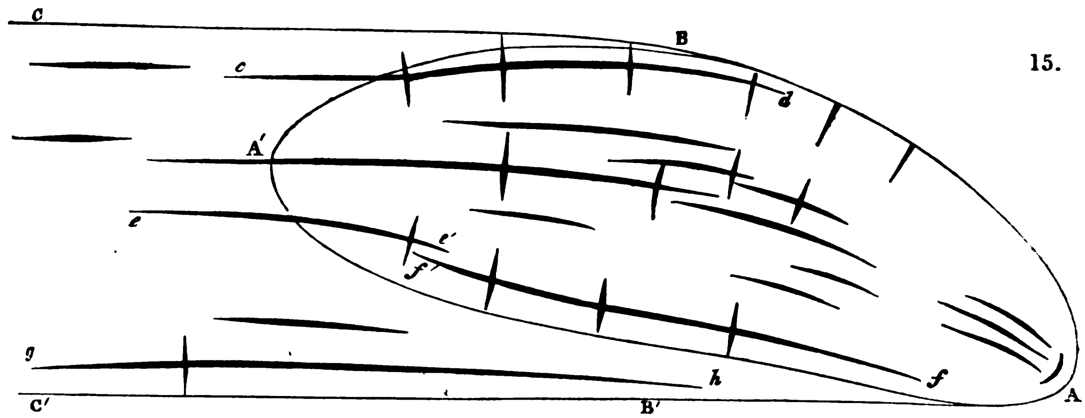
In the preceding diagrams, I have represented, for the sake of simplicity, only one central and two lateral longitudinal fissures; but I have shown in the memoir so often referred to, that under very probable conditions, instead of a single continuous fissure, we should have several parallel fissures; so that if, for instance, we take the simple case of a uniform mass, of which the surface is a parallelogram of indefinite length, elevated by a uniform force, we should have a system of fissures such as represented in the annexed diagram (14). It should be observed,



14.

that we cannot possibly know sufficiently the exact conditions of the problem to determine the precise position of each individual fissure; but we know that every longitudinal fissure must, in this case, be parallel to the sides of the parallelogram, and that thus the whole system must possess the distinctive character of parallelism.

In like manner we may replace the longitudinal fissures of fig. 13 by any other system in which the direction of each fissure, or rather the curve line in which it meets the surface, shall be in accordance with the law distinctly indicated by that diagram. Thus we may take the system represented in fig. 15, where, instead of a single central longitudinal fissure, we have several, and where the lateral fissure *e f*



15.

(fig. 13) is replaced by two, *e e′* and *f′ f*. The law of this system is no longer that of strict parallelism, nor can it be simply described. It is one, however, which is obvious to the eye, and must characterize the whole system formed under the conditions contemplated in this case, whatever may be the position of the individual fissures with respect to their distances from the sides or extremities of the district. Of the different systems which might be thus formed and characterized by this law, I have selected one in fig. 15 bearing a close resemblance with the actual district under consideration, to facilitate the comparison between this theoretical diagram and the observed phænomena. The boundary A B′ C′ has also been varied from fig. 13 for the same purpose. The system of transverse fissures is represented by the transverse lines.

8. To bring the results of our theoretical investigation to an actual comparison with those of observation, I have further to remark, that, according to our theory, all the *secondary* phænomena of elevation, such as faults, anticlinal lines, lines of curvature, &c., are the immediate consequences of the *primary* phænomena of fissures, and must, therefore, follow corresponding laws. Hence the lines, representing fissures in fig. 15, may represent the corresponding lines of elevation, such as constitute the objects of direct observation. To test the accuracy of our theory,

then, as applied to the Wealden district, we have only to compare our theoretical diagram (15) with the map on which the observed lines of elevation are delineated.

In doing this, we may, in the first place, direct attention to the central system of observed longitudinal lines. We have not one line, but many, all of which have the same curvature as the geometrical axis of the district; and we may remark that the three lines of the Bas Boulonnais have exactly the directions they ought to have, if considered as the prolongation of the central system across the Channel. All this is in accurate accordance with our theoretical diagram. Nor is the Greenhurst line less curiously accordant with the line ef (fig. 15)*. The line by Seven Oaks and Farnham agrees with the theoretical line cd and the line gh also becomes almost the exact representative of the well-known line of the Isle of Purbeck and the Isle of Wight. The central transverse system of fractures follows the theoretical law, as do the fractures also of the chalk escarpment, assuming its transverse river-courses to have originated in such fractures, and the directions of dislocation to coincide with the direction in which the actual rivers penetrate the chalk. It will be observed that the courses of the Wey and the Mole through the northern escarpment are very nearly north and south, while those of the Darent, the Medway and the Stour incline successively more to the north-east as the general axis of the district, and the central longitudinal lines incline to the south-east. This is exactly in accordance with our theoretical deductions; and though we have no right to cite this harmony as one of the proofs of the theory, in the same manner as if the origin of each river-course in a dislocation had been established by more positive evidence, we may insist upon it as affording strong corroboration of this view of their origin, and of the theory by which we are accounting for it.

The only sensible deviations from the directions which our calculations assign to the lines of elevation are found in a few of the transverse fractures, more especially in the Seven Oaks ridge, which appear to bear somewhat more to the north-east than the corresponding lines in the theoretical diagram (15). These latter lines, it will be recollected, are determined on the supposition that the structure of the elevated mass has been such as to exercise no sensible influence on the directions of the lines of elevation. It is not, however, contended that the hypothesis is necessarily true. The extent to which it must be received in any particular district, is to be determined by the degree of accordance between the observed and calculated results. The almost perfect accordance in the case before us affords the most conclusive proof that can be offered, of the general truth of the supposi-

* It is easily seen from our observations, at the close of the last article, that this accordance may be regarded as equally perfect, whether the Greenhurst line be one continuous line towards Petersfield, or be formed of two lines, as represented in the map. (See Greenhurst line, p. 15.)

tion in this particular instance; but in those localities where we observe a want of this perfect accordance, we must necessarily recognise the operation of some modifying cause. The transverse fissures just mentioned present an instance of the kind; and the modifying cause was probably the jointed structure of the mass in the locality in which they exist; for it appeared to me that the predominant joints in the neighbourhood were such as would be likely to produce exactly the kind of modification recognised in the directions of the transverse dislocations.

And here we may remark, that the great tendency of an approximately uniform elevatory force, in a tract of which the length is much greater than the breadth, would be to produce *longitudinal* fissures, since the directions of greatest tension would manifestly be perpendicular to the longer axis of the district, except at its extremities. The formation of *transverse* fissures might, in such cases, be due, in a considerable degree, to local irregularities in the action of the elevatory force, or in the constitution of the mass. The longitudinal fissures would be formed *first*, and their prior existence would, in a great measure, determine the directions of the transverse fissures, whether the latter were formed at the next instant during the same elevatory movement, or at any subsequent movement. This cause, however, as respects its influence in fixing the directions of the transverse fissures, would frequently be less determinate than the general action of the elevatory force, in fixing those of the longitudinal fissures; and, therefore, while the latter might remain sensibly unaffected, the former might be materially modified by the irregularities above mentioned in the action of the force, or in the constitution of the mass. Such modifying causes must necessarily exist in all cases; but we can have no means of calculating their effects. In some instances they might be sufficient to destroy all symmetry and apparent law in the resulting phænomena; but in the instance before us, the accordance between observed and calculated results assures us that the influence of merely local causes has been extremely small.

In this harmony between facts and theory we observe something more than a *first approximation* to accuracy. If nothing more had been established by observation than that there were certain lines of elevation of which the general directions approximated to east and west, and others which were directed nearly to the north and south, and a theory had been offered assigning some probable cause for *this law of parallelism*, such theory might have been deserving of attention as a first and rough approximation to a more accurate one. But the theory which I have been applying to the Wealden district does not stop at this point. It not only assigns a physical cause for the general law of parallelism, but, wherever the data of the problem are sufficiently determinate, it shows the manner in which the lines of elevation will deviate from this parallelism in each particular district. In the case before us, the deviations of the longitudinal lines from rectilinearity and from accurate parallelism with each other, according to theory, have been distinctly pointed out, as well as the manner in which the transverse lines are related to the longitudinal ones, and their consequent deviation also from accurate parallelism. The exact accordance of these deviations with those which I have established by observation in the Wealden district constitutes the most complete proof which a theory of elevation can admit of in its application to any district in which we can observe little more than the lines of elevation, and have no means of examining those more minute details of geological structure which the operations of the miner alone can lay open to us.

9. One conclusion from this theory is, that the whole tract previously defined as extending from the Bas Boulonnais to the south-western part of England was raised by a force acting contemporaneously at every point of the lower surface of the elevated mass, for that hypothesis has been proved *sufficient* to account for the observed phænomena. Moreover, it is *necessary*; for if this were not the case, conceive this area divided into separate portions, each of which was elevated separately. Then, since it has been shown that the form of the area simultaneously elevated is one of the most essential circumstances on which the directions of dislocation depend, it is manifest that those directions would follow different laws in the different portions successively elevated, which is contrary to the observed phænomena.

10. There is another point of interest on which our theory does not enable us to arrive at an equally demonstrative conclusion: I allude to the question respecting the manner in which the district may have attained its actual geological elevation; whether by one great upheaval, or by many successive minor ones. The only demonstrative inference to which our theory leads us is this,—that there must have been one considerable decisive and simultaneous movement by which the dislocations of the elevated mass were produced; and I should further regard it as highly probable that this movement was sufficient to impress upon the district its most distinctive and characteristic features, as far as they depend on its geological elevation. I shall not here, however, enter into a discussion of the mere probabilities of the question, for which, in fact, a theory of the denudation of the district is scarcely less essential than that of its elevation. I will only observe, that while we are compelled, as I conceive, to recognise the decisive movement above described, considerations connected with the denudation of the district equally constrain us to recognise in it the slow process of continental elevation.

11. Our theory also leads us to the inference, that extensive cavities formerly existed within the solid portion of the earth's crust, and, if not always, were at least sometimes filled with fluid or gaseous matter, to the expansion of which the elevation and fracture of the superincumbent solid crust is to be attributed. Eleva-

tion and fracture might undoubtedly be produced by the expansion of a *solid* mass immediately beneath the superficial crust, but the phænomena of *faults*, in which the beds on one side of a dislocation are frequently raised to so considerable a height above the corresponding beds on the other, would manifestly not result from this kind of expansion; and therefore it is concluded that the elevation must have been owing to the expansion of a *fluid* or *gaseous* mass, since there appears to be no other conceivable mode of producing the elevatory force. I shall now endeavour to explain how we may distinctly conceive the requisite mechanical action to have resulted from this agency.

It will be recollected, that in the investigations by which the effects of elevatory forces have been determined, the elevated mass has been assumed to be *fixed* at each point of its boundary,—a condition which is manifestly satisfied by the hypothesis of an internal cavity, co-extensive with the surface of the elevated district. If the observed phænomena be such as are referable to an approximately uniform action of the elevatory force, they will only require the hypothesis of a continuous and uninterrupted cavity, occupied by matter possessing the property of fluidity in a very considerable, though not necessarily in a perfect degree. In general, however, the phænomena indicate a more energetic action in particular portions of the disturbed district, and in such cases some additional considerations become necessary. For the greater simplicity, I have usually considered these phænomena as due to a more intense action of the elevatory force, the resistance of the uplifted mass being uniform. This resistance, however, may be different in different portions of the mass, and the resulting effect will then depend not merely on the intensity of the elevatory force, but on the ratio which that intensity bears to the resistance opposed to it; so that the effects will be the same, whether the force be variable and the resistance uniform, or the converse. Thus, for instance, the greater geological elevation of the Wealden district as compared with that of the other portion generally of the whole disturbed tract, might be referred to a smaller resistance of the uplifted mass; to account for which, we have only to suppose a certain portion of the superior beds which are now wanting in that district, not to have existed there at the epoch of its elevation. The absence of this superincumbent weight, conjoined with a uniform force throughout the whole disturbed tract, would manifestly be equivalent to the action of a greater force beneath that portion of the district, conjoined with a uniform mass; and the phænomena of elevation would in either case be sensibly the same.

If we would refer a greater relative geological elevation to a greater intensity of the elevatory force, it may be desirable (though not essential to our immediate object, as stated in Art. 3.) to explain how that intensity might be greater in one part of the internal cavity than in another, notwithstanding the tendency of a fluid to exert an equal pressure in all directions. For this purpose we may first suppose the fluidity of the matter contained in the cavity to have been *imperfect*, like that, for example, of newly ejected lava; or, secondly, we may suppose the communication between one continuous portion of the cavity and the contiguous portions not to have been perfectly free, but partially impeded by solid masses, capable of resisting fusion at the temperature of the surrounding matter. The whole general cavity might thus consist of several portions, with obstructed communications, like a number of lakes connected by comparatively narrow or shallow channels. Under such conditions, if any cause of expansion were to act with greater intensity on the fluid contained within one of these internal lakes, the fluid pressure throughout it might be approximately uniform, and much greater than that transmitted by the imperfect fluid through impeded channels to the surrounding lakes. We should thus obtain that kind of action of the elevatory force which, as above shown, the phænomena of the Weald require for their explanation*.

12. Other suppositions respecting the structure of internal cavities might also enable us to account for the existence of a fluid pressure, acting with different intensities on different portions of the elevated mass. It is not, however, my object at present to enter further into speculations of this nature; nor is it here necessary for us to consider to which of these hypotheses the greatest probability of truth may attach, or whether the greater observed elevation of such a district as the Weald may have been due to the more intense action of the elevatory force, or the greater weakness of that portion of the elevated crust. It is enough to have shown that the hypothesis of internal cavities does enable us to assign a distinct and simple cause for the mechanical action necessary to account for such phænomena of elevation as we find in the Weald and in other analogous districts.

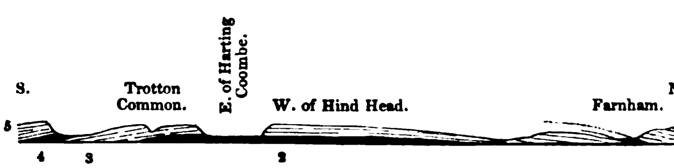
I shall not, by here touching upon other points of our theory, lengthen a communication which has already exceeded the limits I had intended to prescribe to it. This has arisen from an anxiety to avail myself of the occasion afforded by the admirable example before us, to elucidate the fundamental points and some of the more important results of the theory in its application to the Weald and all similar districts. I have thus hoped also to correct some imperfect, if not erroneous conceptions which have been entertained on this subject, whether they may have arisen from an imperfect development of my own views, on my part, or an imperfect comprehension of the conventional meaning of the language I have used, on the part of the reader. Such conventional language must necessarily appertain to every branch of science, nor can it be perfectly understood without a clear knowledge of, at least, the fundamental principles and simpler applications of the science to which

* It appears to me that the existence of internal lakes *with obstructed communications* affords the best explanation of the phænomena connected with earthquakes and volcanic action in South America.

it belongs. Thus it may happen that expressions which are strictly calculated to convey perfectly accurate notions of the reasoning employed or the results arrived at, may, when addressed to persons imperfectly acquainted with the language of the subject, convey conceptions either positively erroneous, or at least devoid of that distinctness and precision without which they become comparatively valueless. Such, perhaps, is especially the case in the application of mechanical science to the problems which geology presents to us. In these problems, approximate solutions only can be sought for; and the sense in which the language of mechanics, as an accurate science, is constantly used, can only be completely understood by those who can understand, from the nature of the problem proposed, the degree of approximation which may be attainable in its solution. In some instances it must be impossible to obviate this difficulty on the part of the reader; in others it could only be done by a verbal prolixity, which might justly be deemed intolerable in a communication to a scientific body. Under the impression however, that many geologists who have not devoted their attention to mechanical science might feel an interest in these theoretical views on geological elevation, I have ventured, in this memoir, to give such repetitions of former statements and such detailed explanations as may tend to render the subject more generally intelligible. Should this object be accomplished, it will be deemed, I trust, a sufficient apology for the want of that greater brevity which it is generally desirable to maintain in original communications on scientific subjects.

TRANSVERSE SECTIONS ACROSS THE WEALDEN DISTRICT.

16.



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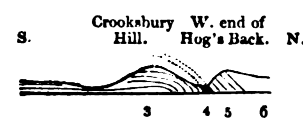

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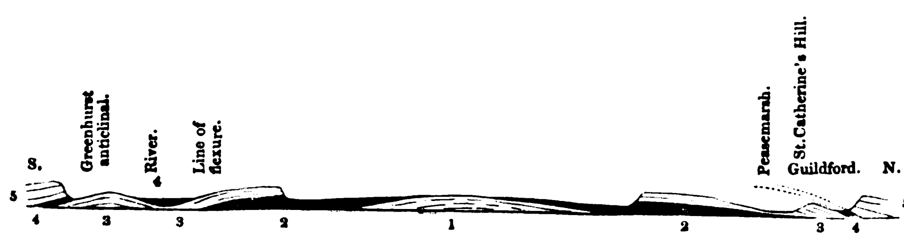

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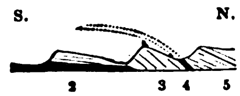

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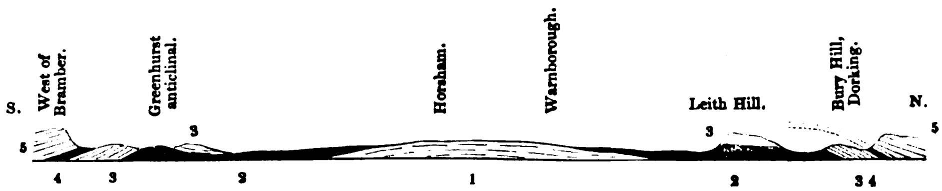

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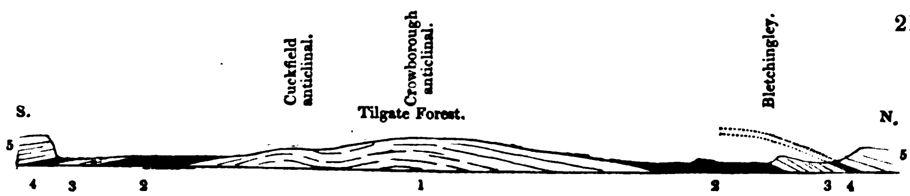

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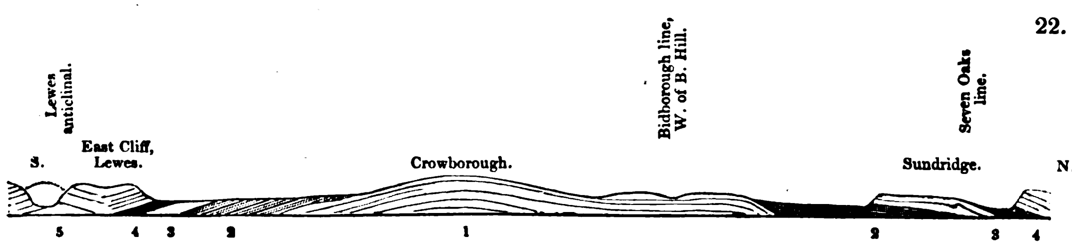

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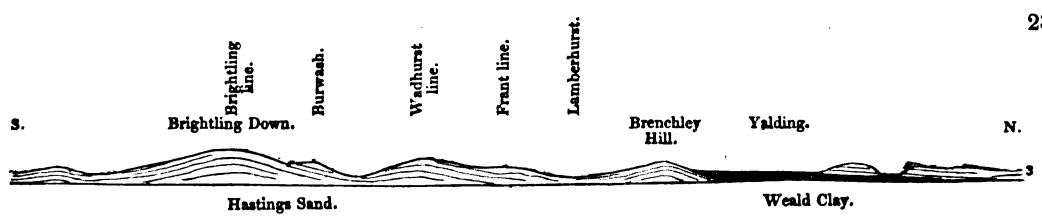


24.

25.

References.

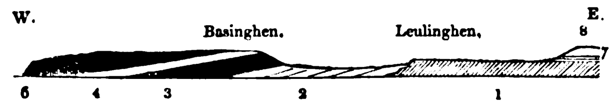
6. Tertiary strata.
5. Chalk and Upper Greensand.
4. Gault.
3. Lower Greensand.
2. Weald Clay.
1. Hastings Sand.

Description of the preceding Sections.

Of these sections the first (16) exhibits, near its southern extremity, the line of flexure which Mr. Martin is disposed to consider as the continuation of the Greenhurst anticlinal line. At its northern extremity it is intended, in conjunction with (17), to show the great change which takes place in the dip of the chalk after we pass the western extremity of the Hog's Back, as mentioned in the description of this part of the district. Section 18, at its northern end, exhibits the Weald clay just appearing at the surface in Peasemarsh, as described by Dr. Fitton and Mr. Martin. The latter gentleman considers his Peasemarsh line as running from thence through Crooksbury Hill. The southern end of this section exhibits the Greenhurst line, with the patch of gault to the north of it, as well as the line of flexure which I have described as passing from Pulborough to Trotton Common. Section 19 shows the manner in which the rapid dip is continued to the top of Margaret's Chapel Hill, and, together with (20) and (21), shows the continuation of the great line of flexure near the chalk escarpment of the North Downs. Section 20 also exhibits the Greenhurst anticlinal at the point where it brings up the Weald clay in a valley of elevation. Section 21 exhibits the Crowborough and Cuckfield anticlinals. Section 22, at its northern end, shows the Seven Oaks line, and at its southern end the Lewes anticlinal, supposed to be a continuation of the Greenhurst line. This section and (23) also exhibit the Bidborough and Brenchley line, which is generally a line of flexure, but assumes the anticlinal arrangement at Brenchley Hill. In the latter section we also recognise the Frant, Wadhurst and Brightling lines. Section 24 exhibits the two distinct anticlinals through Battle and St. John's Cross, into which the Brightling appears to be divided to the east of Brightling. Section 25 is perpendicular to the Battle and Bexhill lines, exhibiting the fault in the low sea-cliffs near Bexhill.

In the *lengths* of these sections the scale of the Ordnance Map, one inch to the mile, has been reduced to $\frac{1}{24}$th of an inch to the mile. In the *heights* no topographical accuracy has been aimed at. The object has been to give a clear conception of the character of the phænomena of elevation which the district presents.

SECTIONS OF THE BAS BOULONNAIS.



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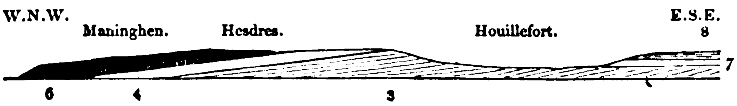

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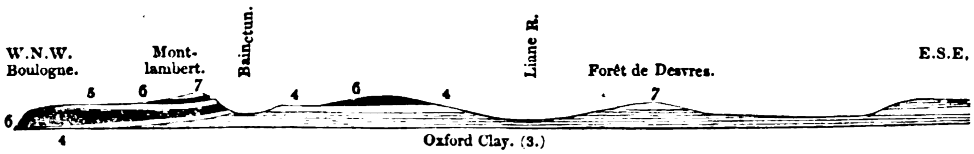

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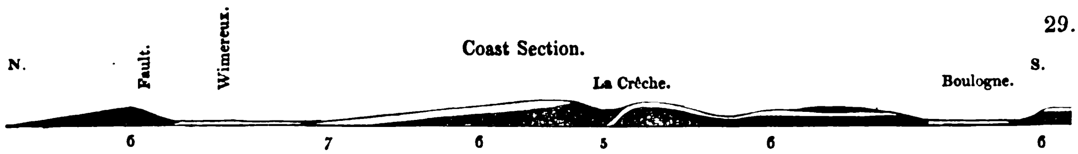

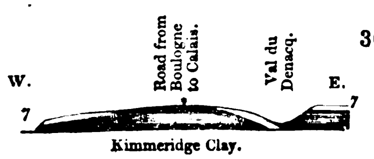

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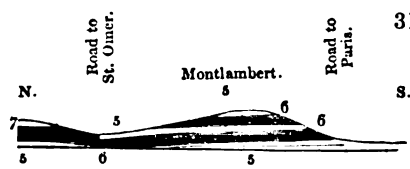
31.



References.

8. Chalk, Upper Greensand and Gault.
7. Beds between the Gault and Kimmeridge Clay.
6. Kimmeridge Clay.
5. Sand beds in the Kimmeridge Clay.
4. Coral Rag.
3. Oxford Clay.
2. Oolite.
1. Mountain Limestone.

Description of the Sections of the Bas Boulonnais.

The preceding group represent sections of the Bas Boulonnais. The first three (26), (27), (28), are nearly parallel to each other, and nearly perpendicular to the direction of the coast north and south of Boulogne. The first shows the unconformable position of the lower oolite on the mountain limestone about Marquise and Leulinghen, and of the cretaceous system in the north-eastern corner of the district. The second section shows the superposition of that system on the Oxford clay. The third (28) exhibits the structure of Montlambert, the highest hill within the chalk boundary. The rapid rise of the beds on its east side brings up the Oxford clay in the valley at Bainctun. At the eastern end of the section, the cretaceous system is again observed to rest immediately on that clay, as does the lower part of it also in the Forêt de Desvres. These sections are on a scale about twice as great in length as those of the Wealden district; section (29) is on a scale about eight times as great. It is a section of the coast north from Boulogne. The line of La Crêche is finely exhibited in the cliff. The section also shows the fault at Wimereux; the beds continued from La Crêche to *a* beneath the surface of the sea, would on the north side of the fault be found at *a'*, if they still existed there, as they do within less than a mile of the beach. From the fault the beds are observed to descend towards the north into the next valley; from which they rise again on the north of Auxdresselles, forming the third line represented on the map, in proceeding northward from Boulogne. Section 30 shows the fault by which the valley of the Denacq is formed, and section 31 represents that of Montlambert in a direction perpendicular to that given in (28); it also shows the continuation of the line of La Crêche near the St. Omer road, where it assumes the character of a fault. The valley of the Denacq on meeting this fault assumes its direction.

In these sections, the beds between the gault and Kimmeridge clay are not distinguished from each other. The upper portion of these beds is undoubtedly the lower greensand of our own country. The lower portion is considered to belong to the Portland formation. The former portion consists almost entirely of ferruginous sand; the latter contains huge calcareous blocks, sometimes forming irregular beds, which are worked, in many places, for building and other purposes. There are large quarries of this kind on Montlambert, where the beds are immediately above the Kimmeridge clay; and also near the column of Napoleon, immediately on the *north* side of the fault of La Crêche, by which, on the *south* side, the lower beds of the Kimmeridge clay are brought up to the level of the quarries.

Description of the Map.

Plate I.

The map contains the Bas Boulonnais on the east, and the disturbed district, mentioned in the memoir, as far west as Southampton. The greater part of the great Wiltshire plateau of chalk lies still further to the west, and is too extensive to be included.

The *boundary of the disturbed district*, denoted by a black dotted line, comprises that extent of country (as far as the map extends) which I conceive to have been *simultaneously* disturbed. The interior dotted black line indicates that part of the district in which the elevatory force is conceived to have acted generally with greater intensity than in the remaining portion. It comprises the whole district of the Weald (as defined by the great Wealden denudation) and that of the Bas Boulonnais. These boundaries are, of course, to be considered as only approximate, and independent of local irregularities.

The red lines are *lines of elevation*, whether they be faults, anticlinal lines, or lines of curvature. The continuous red lines denote lines of elevation clearly established by observation; the dotted lines denote those the existence of which rests on less positive evidence. Synclinal lines are not marked.

The map has been engraved on a reduced scale from that of the Ordnance Survey.