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THE INFERIOR OOLITE AND CONTIGUOUS DEPOSITS OF THE SOUTH COTTESWOLDS*

BY

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[Plates XV.-XXI.]

CONTENTS

I.—INTRODUCTION.

In previous papers I have described in detail the Inferior-Oolite and contiguous deposits of the Bath-Doulting[1] and Rissington-Burford districts.[2] Between these two, however, is an upland tract of considerable extent where Inferior-Oolite rocks occur. It embraces the South, the greater part of the Mid, and the North Cotteswolds.

The Inferior Oolite of the northern portion of the South Cotteswolds, and of certain sections still further south, has

* This paper was communicated on November 13th, 1906, but some additions have since been made.

1 Quart. Journ. Geol. Soc., vol. lxiii. (1907), pp. 383-436.

2 *Ibid.*, pp. 437-443. The Burford-Rissington district is in the Mid Cotteswolds, but it has been already described.

received considerable attention at the hands of several geologists: that of the Mid Cotteswolds is fairly well known; but that of the North—excepting of the Cleeve-Hill plateau—still requires a considerable amount of attention.

It is proposed, therefore, to deal with the Inferior Oolite and contiguous deposits of the Cotteswold Hills in two papers. The first and present one describes the stratigraphy of the beds in the South Cotteswolds, and shows the connection between these beds and those in the Bath-Doulting district, and through them with those in Dorset and Normandy. The second will deal with the beds of the same Series in the Mid (*pars:* see footnote on page 63) and North Cotteswolds, and on the one hand will show their connection with the South-Cotteswold rocks, and on the other with the beds in the Rissington-Burford district.

(i.) *Geographical Extent of the Inferior Oolite in the South Cotteswolds.*—The South Cotteswolds are twenty-four miles long, and extend from Lansdown, near Bath, to Rodborough-Hill, near Stroud.

In the neighbourhood of Bath, deep ramifying valleys run far northwards into the hill-country; but from Tog Hill, near Doynton, as far north as Hillsley, the escarpment is free from noticeable combs. Between this latter locality and Uley Bury, however, the upland is again greatly incised, and long straggling hills alternate with deep sinuous valleys. Thence northwards, as Lycett wrote, "the heights are much more wall-like, affording on their summit a pleasing variety of bare ground, of oolite quarries and of beech woods," and terminate in Selsley Hill, which overlooks the populous vale of Stonehouse. To the east is the Nailsworth Valley, which is separated from the deep, canal-like Chalford Valley by Rodborough Hill and Minchinhampton Common.

In the South Cotteswolds, in the southern portion, the Inferior-Oolite rocks do not give rise to any very striking features. This is due, partly to the fact that they occur at a comparatively low altitude; partly to their thinness; and partly again to the thick succeeding deposits of Fullers' Earth and Great Oolite diverting the eye from any small feature they might make. As the hills are followed to the north, however, the altitude at which the Inferior-Oolite beds crop out

rises; the outcrops of the Fullers' Earth and Great Oolite recede, and, as a result, the superficial extent of the Inferior Oolite broadens.

(ii.) *Historical Retrospect.*[1]—When correlations of the South-Cotteswold Inferior-Oolite rocks have been attempted, and this remark particularly applies to the "Top-Beds," they have been none too successful; but this is not altogether to be wondered at, for the stratigraphy is by no means easy to make out—the rocks at the southern end approximating to those of the Bath-Doulting district, and those at the northern end to those in the Mid Cotteswolds, while in the intervening area the transition between the two takes place.

The first definite reference to the geology of the South Cotteswolds is contained in Conybeare and Phillips' "Outline of the Geology of England and Wales" (1822), but they do nothing more than simply describe the trend of the hills between Stroud and Bath, and remark that they "appear to be generally capped by the Great Oolite, and to exhibit the strata we are now describing [that is, the Inferior Oolite] in their escarpment." (*loc. cit.*, p. 251).

Between 1822 and 1850 there appeared Murchison's "Outline of the Geology of Cheltenham" (1834); his "Silurian System" (1839); and a second edition of the former work "augmented and revised by H. E. Strickland and James Buckman" (1844, Cheltenham; 1845, London). All these works contain remarks on the Inferior Oolite, but are confined to the Cheltenham district.

Their influence on South-Cotteswold geology, however, is clearly indicated in the Rev. P. B. Brodie's paper of 1850, "On Certain Beds in the Inferior Oolite, near Cheltenham,[2] in which reference is made to Selsley Hill. It shows that considerable subdivision of the Inferior Oolite had been accomplished. Brodie was unable to decide if what are now called the *Scissum*-Beds, Lower Limestone and Pea-Grit were represented at Selsley; but observed the Oolite Marl, "somewhat reduced in bulk" and full of *Nerinæa* and other shells, overlaid by "flaggy bastard freestone"—the Upper Freestone of present nomenclature. Between the Upper Freestone and

1 The section on Plate XXI. should be studied before reading the Historical Retrospect.
2 Quart. Journ. Geol. Soc., vol. vi. (1850), pp. 239-249.

Upper *Trigonia*-Grit, Brodie thought there came "a coarse kind of freestone about 50 feet thick, which took the place of the Gryphite-Grit and rubbly oolite [*Buckmani*- and Lower *Trigonia*-Grits] " of such places as Leckhampton Hill; but judging from some remarks made later by Lycett, it was the Lower Limestone to which Brodie was referring, having wrongly interpreted its stratigraphical position.

To Brodie's paper were appended "Notes on a Section of Leckhampton Hill," by H. E. Strickland.[1] In this appendix Strickland recorded seven subdivisions of the Inferior Oolite at Leckhampton Hill: those enumerated in the left-hand column below:

Subdivisions at Leckhampton Hill	Lycett's three main subdivisions
1. *Trigonia*-Grit	Upper Ragstone
2. Gryphite-Grit	
3. Rubbly Oolite, with many fossils	
4. Fragmentary oolitic freestone ..	Freestone
5. Oolite Marl	
6. Freestone	
7. Pea-Grit and Belemnite-Bed ..	Lower Rag[stone] and Sands

Brodie's paper was communicated on January 9th, 1850. On July 30th of the same year, Lycett read one entitled "A Tabular View of Fossil Shells from the middle divisions of the Inferior Oolite in Gloucestershire."[2] In connection with the present subject, the chief point of interest is that he made three main subdivisions of the Inferior-Oolite Series—those stated in the right-hand column above.

He also made a very laudable attempt to indicate the changes that these three subdivisions underwent from north to south. According to him, the lowest subdivision, the Lower Ragstone and Sands, increases in thickness from two feet at Leckhampton Hill to 40 feet at Stroud, and 70 feet at Bath. The median or Freestone subdivision, he writes, "is somewhat diminished at Stroud, and loses the greater portion of its volume, including the Oolite Marl and all the upper beds before it reaches Bath, where it is represented by 60 feet of freestone" (*loc. cit.*, p. 65). The Oolite Marl, it is true, dies out a short distance to the south of Selsley Hill, and the Pea-Grit disappears as an easily-recognizable horizon after Coaley

1 Quart. Journ. Geol. Soc. vol. vi. (1850), pp. 249-251.
2 Proc. Cotteswold Nat. F. C., vol. i. (1849-53), pp. 62-86.

Wood; but the "disappearance" of the Freestone subdivision is more complete than this. In the neighbourhood of Bath the *whole* of it has gone, and the Upper *Trigonia*-Grit rests directly upon the Upper-Lias sands. The freestone of the Bath district, referred to by Lycett, is a supra-Upper *Trigonia*-Grit Inferior-Oolite deposit—not an inferior one. Lycett also wrote that the Upper Ragstone disappeared *altogether* to the south of Wotton-under-Edge. This is not quite correct: all except the Upper *Trigonia*-Grit do; but this subdivision is continuous from Stroud to the immediate neighbourhood of the Mendips.

In 1856, the attention of students of the Inferior Oolite and Lias was directed by Dr Thomas Wright to the question as to where the precise line of demarcation between Lias and Oolite should come. Dr Wright gave excellent records of the sections at Frocester and Wotton-under-Edge, and was the first to apply the term "Cephalopod-Bed" to the richly ammonitiferous deposit that occurs at the base of obviously Inferior-Oolite rocks in these sections. He grouped it, together with the Cotteswold Sands, with the Lias.[1]

James Buckman, in a paper on "The Oolite Rocks of Gloucestershire and North Wilts," published in 1857,[2] however, strongly objected to Wright extending the Upper Lias so as to include the Sands and Cephalopod-Bed, because he thought that the Sands and Cephalopod-Bed were the equivalents of the "mixed pisolitic beds" of the neighbourhood of Cheltenham. No doubt his erroneous correlation arose from the idea that what is now called the Lower Limestone at such sections in the South Cotteswolds as Frocester Hill was equivalent to the Lower Freestone of such localities as Leckhampton Hill, and since the Pea-Grit Beds came *below* the Lower Freestone at Leckhampton, their equivalents in the Stroud district must be looked for *below* the Lower Limestone.

The same year saw the production of two memoirs intimately concerned with the Inferior Oolite of the Cotteswold Hills. The one was by Prof. E. Hull on "The Geology of the Country around Cheltenham" (Mem. Geol. Surv.); and the other was by Dr J. Lycett, entitled "The Cotteswold Hills."

1 Quart. Journ. Geol. Soc., vol. xii. (1856), pp. 292-325.
2 *Ibid.* (1858), pp. 98-130.

Until the appearance of the former work the subdivision now known as the *Clypeus*-Grit had not attracted any particular attention; but then Hull remarked that "towards the south-eastern part of the district, the Ragstone gives place to a coarse, rubbly, white oolite, which always occurs at the top of the formation immediately below the Fullers' Earth. This bed, which may be called the *Clypeus*-Grit, is characterised by many of the fossils of the Ragstone."

Lycett, in his "Cotteswold Hills," dealt in some detail with the Inferior-Oolite Series as a whole, introducing the classic—if now seldom-used terms "*Cynocephala*-," "*Fimbria*-," and "*Spinosa*-Stages."[1] The first term covered the "Sands" and Cephalopod-Bed: the second, the beds between the Cephalopod-Bed and Ragstones; and the third, the Ragstones. Lycett, like Hull, had noticed that "the beds of the '*Spinosa*-Stage' higher than the Upper *Trigonia*-Grit," were worthy of separate designation, and suggested the appellation "*Pholadomya*-Grit" for them; but as Hull's term "*Clypeus*-Grit" has priority by a few months, it is the one that should be used. Lycett's correlation of his three stages with the deposits at Dundry Hill, near Bristol, was unsuccessful, and his comparison of the beds, which are now known to be *Buckmani*- and Lower *Trigonia*-Grits, at Rodborough Hill, was equally unfortunate.

In 1858, in the joint memoir by A. C. Ramsay, W. T. Aveline, and Prof. E. Hull on the "Geology of Parts of Wiltshire and Gloucestershire," the *Clypeus*-Grit of Rodborough Hill is spoken of as the "Upper Ragstone," and the subjacent beds of the "*Spinosa*-Stage" there as the "Lower Ragstone"; while a thickness of 25 feet is assigned to the latter.[2] At Wall's Quarry, north of Minchinhampton, however, the thickness of the "Lower Ragstone" is given as only 9 feet, but "this fact" is stated to be "in harmony with the observed alternation of the Inferior Oolite, both towards the east and south from Leckhampton Hill, the typical section of the formation."

The year 1858 saw the completion of Dr A. Oppel's "Die Juraformation Englands, Frankreichs, und des Südwestlichen

1 "Cotteswold Hills," p. 72. 2 *Loc. cit.*, p. 10.

Deutschlands," in which work the author draws the line between Lias and Oolite immediately below his *Torulosus*-Zone. This is the present *Moorei-aalensis* deposit, so that it follows that he considered the line of division between the Lias and Oolite to come between the *Moorei*- and *Dumortieria*-Beds.

On February 15th, 1859, Sir William V. Guise communicated his valuable "Notes on the Inferior Oolite Beds in the Neighbourhood of Bath."[1] In it, he pointed out that the Inferior-Oolite freestones of that neighbourhood, and of Dundry Hill as well, were not equivalent to the *Fimbria*-Stage as Lycett had suggested, but came above, instead of below, the Upper *Trigonia*-Grit. Having made this important correction, however, he fell into the error of correlating the Inferior-Oolite freestones of the Bath district with the Dundry Freestone, not noticing that whereas the former came *above* the Upper Coral-Bed the latter came *below*.

Wright, in his paper of 1860, "On the Subdivisions of the Inferior Oolite in the South of England, compared with the equivalent beds of that formation on the Yorkshire Coast"[2]—which marked a very great advance in our knowledge of the Inferior-Oolite rocks of this country, and was an excellent attempt to effect more widely-extended correlation—placed 2 feet 6 inches of "Intervening-Beds" at Rodborough Hill as Gryphite-Grit, and 1 foot as Lower *Trigonia*-Grit. His ideas were no doubt somewhat influenced by Lycett, who held that *all* the "Intervening-Beds" at Rodborough belonged to the Gryphite-Grit. As to the age of the Inferior-Oolite freestones near Bath, he thought that they probably belonged to the "upper subdivision," but was not very emphatic about the matter.

Dr H. B. Holl, in his paper "On the Correlation of the Inferior Oolite in the Middle and South of England," overlooked Sir William Guise's paper. As already remarked, Sir William showed sufficiently-clearly that the Dundry Freestone and the Inferior-Oolite Freestone near Bath, both belonged to a higher horizon than Lycett had imagined. Holl also undertook to point this out, and went further, attempting a more precise correlation.[3]

1 Proc. Cotteswold Nat. F. C., vol. ii. (1854-1860), pp. 170-175.
2 Quart. Journ. Geol. Soc., vol. xvi. (1860), pp. 1-48.
3 *Ibid.*, vol. xix. (1863), pp. 306-317.

At Horton, in the South Cotteswolds, there are, in descending order, these beds: White Oolite, *Clypeus*-Grit, and Upper *Trigonia*-Grit, and the first two equal the *Clypeus*-Grit of such places as Leckhampton Hill. Holl called the White Oolite the "Upper Ragstone," and thought it represented the *whole* of the *Clypeus*-Grit of more northern sections. The local *Clypeus*-Grit of Horton, together with the Upper *Trigonia*-Grit, he denominated "Lower Ragstone," and paralleled them with the Upper *Trigonia*-, *Buckmani*-, and Lower *Trigonia*-Grits of Rodborough. Holl also noticed that while his "Lower Ragstone" rested directly upon the "Building Freestone" at Horton, in the Vale of Nailsworth it reposed upon the Oolite Marl (which was a few inches thick); while when followed still further north it became increasingly-widely separated from the Oolite Marl by the wedge-like incoming of the Upper Freestone.

Between 1863 and 1880 little of importance appeared. Prof. James Buckman returned to the discussion on the allocation of the "Sands," and endeavoured to indicate the dates of the various deposits thus colloquially designated and their equivalents; but his conclusions have not proved very satisfactory.[1]

In 1880 Edwin Witchell communicated a useful paper entitled "Notes on a Section of Stroud Hill, and the Upper Ragstone Beds of the Cotteswolds."[2] Witchell noticed above the true *Clypeus*-Grit of Stroud and Rodborough Hills some beds of "compact white fine-grained oolite," which he thought worthy of distinct designation, and therefore called them the "White Oolite." Hull had said that the beds immediately below the Fullers' Earth "towards the south-eastern part of the Cheltenham district" were also "rubbly white oolite." So Witchell thought his beds must correspond to Hull's. Nevertheless, he could not understand why Hull termed them "*Clypeus*-Grit," for the rocks that merited that name in the Stroud district came *below* his White Oolite. Therefore he ventured to amend matters, applying his term "White Oolite" to the topmost beds and restricting the appellation "*Clypeus*-Grit" to the beds full of *Clypeus Ploti* and *Terebratula globata*, auctt. non Sow.

1 Quart. Journ. Geol. Soc., vol. xxxiii. (1877), pp. 1-9, and vol. xxxv. (1879), pp. 736-743.
2 Proc. Cotteswold Nat. F. C., vol. vii., pt. 1 (for 1879-80), pp. 117-135.

Witchell very nearly succeeded in unravelling the stratigraphy of the beds above the Upper *Trigonia*-Grit. Apparently he was the first to discover the Upper Coral-Bed at Rodborough Hill; but he was not aware that it extended any further south than this. It was doubtless his failure to see in the "Coralline Beds" of Dundry the equivalent of the Rodborough Hill Upper Coral-Bed that led him into the error of correlating his White Oolite with the Dundry Freestone—a mistake Holl had made before him.

In 1882 Witchell published "The Geology of Stroud and the Area drained by the Frome."[1] It is a useful book, and contains much valuable information. In the "General Section" of the Inferior Oolite in the vicinity of Stroud, "sandy limestone" and "freestone" is mentioned as occurring between the Cephalopod-Bed and Pea-Grit proper. Witchell described the freestone as the "Lower Limestone," and dealt with it in some detail, giving, amongst others, a section at Selsley Hill to show its correct stratigraphical position. He also commented upon the "thinning out" of the Pea-Grit to the south of Stroud, and to the difficulty of distinguishing between the Lower Limestone and the Lower Freestone, when that bed is absent. Concerning the "Ragstone Beds," he did not give much additional information. The "Intervening Beds" at Rodborough he grouped all together as Gryphite-Grit, and the lower 2 feet of the Upper *Trigonia*-Grit of Leigh's Quarry on Selsley Hill he assigned to the same subdivision.

The next two papers to be noticed are also by Witchell. The one "On the Pisolite and the Basement Beds of the Inferior Oolite of the Cotteswolds," was contributed to the Quarterly Journal of the Geological Society for 1886;[2] the other, with very nearly the same title, to the Proceedings of the Cotteswold Club.[3] Both have the same object, but, as it happens, the Quarterly-Journal paper is the more satisfactory of the two. The common purpose was to point out that there were beds between the Cephalopod-Bed and Pea-Grit proper which were worthy of distinct appellation. Lycett and Wright had both of them thought that the lower portion, or Witchell's "sandy ferruginous beds" corresponded to the Pea-Grit of the

1 Pp. 37-68. 2 Pp. 264-271. 3 Vol. viii., pt. 1 (for 1881-82), pp. 35-49.

Cheltenham district, and therefore paralleled the overlying Lower Limestone with the Lower Freestone. It might have been thought that what remained of the Pea-Grit at Selsley Hill was sufficiently typical to prevent any such mistake being made. Lycett did not omit to notice it, but thought it was simply a marly bed in the *Fimbria*-Stage, and therefore at a higher horizon than the Pea-Grit of the Cheltenham district.

Witchell's essay "On the Genus *Nerinæa*, and its Stratigraphical Distribution in the Cotteswolds,"[1] although eminently palæontological, contains some interesting observations on the extension of the Pea-Grit to the south of Stroud, and clears up effectually the confusion that had arisen through Lycett and others thinking that what is really Pea-Grit was a bed in the "Freestone" division.

In 1887 appeared part 1 of "A Monograph of the Inferior Oolite Ammonites of the British Islands," by S. S. Buckman, and in part 2 detailed records of the Cephalopod-Bed Sections at Frocester Hill, Coaley Wood, Stinchcombe, and Nibley Knoll, are given; but little attention is paid to higher beds.

In 1888 Witchell wrote "On a Section of Selsley Hill."[2] The geology of the hill is set forth in detail, but there is really very little that is new, for he had announced his important discoveries in earlier papers. The "dapple-beds" of the Lower Limestone are described at some length, and reference is made to the "Gryphite-Grit." The strain of his statement, that "the Gryphite-Grit of Selsley Hill is without the characteristic fossil *Gryphæa sublobata*. This is another peculiar feature of the Selsley beds," almost suggests that he was beginning to doubt if his identification of the bed as Gryphite-Grit were correct. As a matter of fact, of course, it was not, for it is now known that he had mistaken a portion of the Upper *Trigonia*-Grit for the Gryphite-Grit.

In 1889 there appeared Mr S. S. Buckman's paper "On the Cotteswold, Midford, and Yeovil Sands, and the Division between the Lias and Oolite."[3] The old controversy is again reviewed, sections of the Cotteswold Sands at Buckholt Wood, Coaley Wood, Nibley Knoll, and Little Sodbury are discussed, and it is shown that the Cotteswold, Yeovil and Midford Sands

1 Proc. Cotteswold Nat. F. C., vol. ix., pt. 1 (1885-6), pp. 21-37. 2 Proc. Cotteswold Nat. F.C., vol. ix., pt. 2 (for 1886-87), pp. 96-107. 3 Quart. Journ. Geol. Soc., vol. xlv. (1889). pp. 440-473.

are not of the same date. Some of the sections named above had been previously noticed in his Monograph, but in this paper some corrections and additions are made.

The late W. H. Hudleston, in his "Monograph of the British Jurassic Gasteropoda. Part 1. Gasteropoda of the Inferior Oolite," gives a general account of the Inferior Oolite of the South Cotteswolds;[1] but the Horton section is the first he describes, while the other sections he notices are "Nailsworth Hill and District" and "Rodborough Common." With regard to Rodborough, he makes the noteworthy observation that it is the last place, working in a southerly direction, where the "characteristic gryphite" occurs in the "Gryphite-Grit." He apparently accepted Witchell's statement that Rodborough Hill was the furthest point south at which the Upper Coral-Bed occurred.

In the Memoir of the Geological Survey, "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)" vol. iv. (1894), a general account is given of the Inferior Oolite of the South Cotteswolds.[2] The section at Horton is noted, and three subdivisions of the Ragstones are made, namely, the Upper *Trigonia*-Grit, *Clypeus*-Grit, and White Oolite; but as regards the rest of the district, little subdivision or correlation of its beds is made. A quarry on Break-Heart Hill is noticed, but as to the precise age of the beds exposed there the author is in doubt. They are now known to belong to the Freestone (Aalenian) division of the Inferior Oolite.

In 1895 Mr S. S. Buckman published "The Bajocian of the Mid Cotteswolds."[3] The only portion of the South Cotteswolds referred to is Rodborough Hill; but the author clears up the mistake that had been made there with regard to the "Intervening Beds." He shows that one portion is Lower *Trigonia*-Grit, and the other probably *Buckmani*-Grit; but as he had found no specimens of *Terebratula Buckmani* or other distinctive fossil *in situ* in the latter subdivision, he could not say for certain whether or not it was *Buckmani*-Grit. In a report of an excursion of the Geologists' Association

1 *Loc. cit.*, pp. 56-65. 2 *Loc. cit.*, pp. 102-119. 3 Quart. Journ. Geol. Soc., vol. li. (1895), pp. 388-462.

to the quarry in 1897, he records that the "Upper *Trigonia*-Grit rests directly upon the Lower *Trigonia*-Grit, all the other beds seen at Cleeve Hill the day before not being represented here."[1]

For a gap, then, of about ten years, the Inferior Oolite of the South Cotteswolds received no recorded attention; but in 1905 the Cotteswold Club visited the sections between Hawkesbury and its hamlet of Hawkesbury Upton. The present writer has described the sequence of the beds exhibited there in the account of the excursion, recognising—in ascending order—the *Opaliniforme*- and *Scissum*-Beds, Lower Limestone, Upper *Trigonia*-Grit, White Oolite (or Limestone), and Fullers' Earth—the Inferior Oolite measuring in all some 60 feet. The section called the "Hawkesbury-Monument Quarry" is also described, but the correct allocation of a certain "bed 9" between the *Clypeus*- and Upper *Trigonia*-Grit is left unsettled, although provisionally grouped with the former. It may be provisionally paralleled with the Dundry Freestone.[2]

On June 2nd, 1906, Rodborough Hill was visited by the same Club, under the guidance of the writer.[3] At this excursion the correctness of Mr S. S. Buckman's provisional identification of the *Buckmani*-Grit was endorsed by the discovery *in situ*, at "The Fort" Quarry, of *Terebratula Buckmani*. In the Mount-Vernon Quarry the Upper Coral-Bed was seen and studied, and the writer quoted Witchell's view with regard to its assumed limited geographical extent, but stated how widely-distributed it really was, being represented at Midford and Dundry Hill, to mention but two places. He then added some remarks on the post-Upper-Coral-Bed deposits of the Bath-Doulting district and their equivalents in the Cotteswold Hills.

In the June of the same year this Club visited Selsley and Frocester Hills. In the report of the excursion, some notes on the former hill are published, and the sequence at the latter is set forth—the *Opaliniforme*- and *Scissum*-Beds, Lower Limestone, Pea-Grit-Equivalent and Lower Limestone being identified.[4]

The discovery of a *Prosopon*, probably from beds occupying the position of the White Oolite of Witchell, or the

1 Proc. Geol. Assoc., vol. xv., pt. 5 (1897), p. 182. 2 Proc. Cotteswold Nat. F. C., vol. xv., pt. 3 (1906), pp. 192-195. 3 *Ibid.*, vol. xvi., pt. 1 (1907), pp. 12-16. 4 *Ibid.*, vol. xvi., pt. 1 (1907), pp. 16-19.

Anabacia-Limestones of the Bath-Doulting district, and its naming by Dr Henry Woodward, F.R.S., afforded an opportunity of pointing out in a short note entitled "On the Stratigraphical Position of the Beds from which *Prosopon Richardsoni*, H. Woodward, was obtained," the probable equivalents of the Doulting Beds in the South Cotteswolds.[1] In the Bath-Doulting district, above the Upper Coral-Bed, the subdivisions that have been made are the Doulting-Stone, *Anabacia*-Limestones, and Rubbly-Beds. The Doulting-Stone finds its equivalent in the local *Clypeus*-Grit of Horton and of Scar Hill, Nailsworth; the *Anabacia*-Limestones in Witchell's White Oolite at Horton; while the Rubbly-Beds are represented in the variable deposit, as regards thickness, that caps this White Oolite and yields *Terebratula globata*, auctt. non Sow., abundantly.

Lastly, in 1908, the Geologists' Association visited that portion of the South Cotteswolds which lies between Stroud and Wotton-under-Edge, and the stratigraphical details recorded in the present paper, in so far as that portion is concerned, were pointed out on the ground and checked.[2]

This brings the historical retrospect down to the present time, and prepares the way for the presentation of Plate XXI., which shows the subdivision and correlation of the Inferior-Oolite rocks of the South Cotteswolds that has been accomplished by the exertions of former investigators, combined with the contributions of the present writer.

(ii.) *On the Lower and Upper Limits of the Inferior-Oolite Series.*—At the southern end of the South Cotteswolds the Inferior Oolite is about 30 feet thick, and at the northern, about 182 feet 8 inches. Above, throughout the South Cotteswolds, is the Fullers' Earth; below, the Upper Lias (Toarcian).

"In the Bath-Doulting district there is no Inferior-Oolite deposit of pre-*Garantianæ* date." The deposit of this date, the Upper *Trigonia*-Grit, there rests directly, but non-sequentially, upon the Liassic beds, except in the immediate neighbourhood of the Mendip Hills. North of the Avon Valley, however, additional beds begin to come in between the Upper *Trigonia*-Grit and the Upper Lias, and eventually these two deposits, which are in apposition at the southern end of the South Cotteswolds, are parted by at least 160 feet of strata at the northern end.

1 Geol. Mag., 1907, pp. 82-84. 2 Proc. Geol. Assoc., vol. xx. (1908), pp. 514-529.

The cause of this incoming of beds from south to north, and their mutual relations, must be left to be discussed at a later page (pp. 84-85), because it is first of all desirable to mention what deposits immediately over- and under-lie the Inferior-Oolite Series in the South Cotteswolds.

The bottom-bed of the Inferior Oolite, and therefore that which rests directly upon the Upper Lias over the southern portion of the South Cotteswolds, is the Upper *Trigonia*-Grit. The deposit that occupies this basal position in the northern portion is the *Aalensis*-Bed, but it is usually ill-defined, and its successor, the *Opaliniforme*-Bed, or "hard cap to the Cephalopod-Bed," as it is often colloquially called, is more readily identified.

The Series upon which the Inferior Oolite reposes is thus divisible:

(1) Marls, brown, ironshot, with impure limestones, forming the Liassic portion of the Cephalopod-Bed.

(2) Sands, yellow, with hard bands, and nodule-shaped masses called "burrs" (constituting the "Cotteswold Sands"); passing down into

(3) Clays, blue, with hard blue-grey limestone-bands resting upon the Marlstone of the Middle Lias.

At the southern end of the South Cotteswolds there are few exposures of these Upper Lias beds; but at the northern end many. The best are at Wotton-under-Edge.

The Liassic clay (3) is mainly of *falciferi-bifrontis* date. The "Sands" (2) at the northern end of the district under review are of *Lilli-variabilis* date—pre-*striatuli*, and at the southern end mainly, if not wholly, post-*striatuli*; while in the intervening district, near "The Springs," the *striatulum*-niveau comes *in* the Sands, which means that here their greater bulk is of *striatuli* hemera (Sodbury Sands).

The Cephalopod-Bed is only well-exposed from Hawkesbury northwards, and is then best seen in the neighbourhood of Wotton-under-Edge and Dursley. The hard cap to the Cephalopod-Bed is of *opaliniformis*-date, and, like the ill-defined *Aalensis*-Bed that underlies it, belongs to the Inferior Oolite. Therefore a more detailed account of it will be found at a later page. Of the remaining component zones of the Cephalopod-Bed, it may be pointed out that, with the aid of Mr S. S. Buckman, the *Struckmanni*-Bed has been indicated in most of

the sections, and also a new horizon distinguished by a special ammonite—the *Pedicum*-Bed. The limits of this zone are generally co-extensive with those of the well-known "Linseed-Bed," so it will not be difficult to locate; and Mr Buckman writes (February 28th, 1909), "it always occurs above the main mass of the *Striatulum*-Beds, over the lowest stone-bands, and always contains its own species of *Pseudogrammoceras*."

Throughout the district dealt with, except, of course, where it has been removed by denudation in comparatively recent times, the Inferior Oolite is succeeded by the Fullers' Earth. Near Bath it is said to be about 148 feet thick, and in the neighbourhood of Stroud, between 70 and 80. Satisfactory sections, however, are few and far between, and therefore our knowledge concerning its faunal and lithic characters is not nearly so extensive as might be desired. Springs and damp ground, however, occupying a position between the scarps of Inferior and Great Oolite, constitute a ready index to its presence, and there are a number of minor exposures. The principal of these are:

(1) Near "Prospect Stile," on the hill north-west of Weston, near Bath:
(2) In the path across the fields near Ringswell (at a place five-sixteenths of a mile south-east by south of Marshfield Church), where argillaceous limestones, crowded with specimens of *Ornithella ornithocephala* (Sow.), and its varieties, and similar to the equivalent beds at Dyrham, crop out:
(3) In the lane-side, a quarter of a mile south-south-west of Cold-Ashton Church, where *Rhynchonella Smithi*, Walker, was found:
(4) In the road-side near the barn, a quarter of a mile north-east by north of Horton Rectory:
(5) In the road-sides below Hawkesbury Monument, where there are bands of limestone crowded with *Ostrea acuminata*, Sow.:
(6) In the track-side near the head of Tresham Combe, and at the top of a quarry in the same combe (where the associated beds of limestone yielded *Ostrea acuminata*, Sow, and *Pseudomonotis echinata* (Sow.), and the clay, *Cristellaria cultrata*, Montf, and *Cytheridea Bradiana* (Jones).
(7) On Tor and Symond's-Hall Hills, near Wotton-under-Edge—at both of which places *Ostrea acuminata* abounds, almost wholly composing limestone-beds:
(8) On Break-Heart Hill, where the clay yielded to Mr C. Upton five species of *Ostracoda* and the associated limestones are full of *Ostrea acuminata*:
(9) At Bown Hill, immediately to the south of Selsley Hill, whence Mr Upton has obtained *Cristellaria* sp., and five undetermined species of Ostracoda: and
(10) Near Avening, where *Ostrea acuminata*, Sow., is again conspicuously abundant.

All these exposures, however, are insignificant. The only good one now open is at the head of the little combe east of Dyrham Wood, and distant about a mile from the village in a southerly direction. As this section is the most important in the South Cotteswolds, a sketch-map is given to show its precise position (text-figure 1). The dot at the eastern end of the wood under the word "exposure" indicates its position.

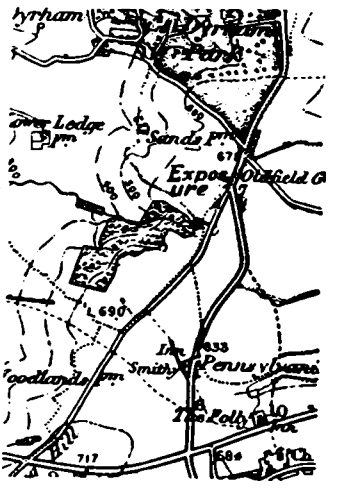


FIG. 1.—Map to show the position of the Fuller's-Earth Section, near Dyrham. (1 inch = 1 mile).

The deposits exposed are beds of argillaceous limestone, intercalated in the usual kind of Fullers' Earth. They abound in specimens of *Ornithella ornithocephala* (Sow.), in all stages of growth; while the other fossils include *Belemnopsis* sp. (fragment), *Ostrea acuminata*, Sow., *Goniomya angulifera* (Sow.), *Isocardia nitida*, Phillips, *Rhynchonella Smithi*, Walker, *Ornithella triquetra* (Sow.), *Serpula plicatilis*, Münster, and *Serpula quadrilatera*, Goldfuss.

Of good sections not now open may be mentioned those:

(1) In the tunnel at Box:[1]

(2) On the slopes of Lansdown, when some excavations were being made: and

(3) In the tunnel works east of Old Sodbury.

It was from data supplied by the Box Tunnel that Lycett arrived at his estimate of 148 feet for the thickness of the Fullers' Earth in the neighbourhood of Bath. Mr H. B. Woodward, F.R.S., has criticised it as being too great, because none of the wells near Bath that he knew of had proved more than 70 feet;[2] but at the Monkswood Reservoir the Rev. H. H. Winwood has found it to be between 150 and 180 feet thick.[3]

A shaft in connection with the tunnel near Old Sodbury, proved the Fullers' Earth—exclusive of 45 feet of "passage-beds" into the Great Oolite—to be 90 feet thick, and to

1 "The Cotteswold Hills" (1857), p. 85. 2 Mem. Geol. Surv., "The Jurassic Rocks of Britain," vol. iv. (1894), p. 93. 3 Proc. Bath Nat. Hist. and Antiqu. F. C., vol. vii. (1895), p. 150. Prof. H. Reynolds and Dr A. Vaughan, Quart. Journ. Geol. Soc., vol. lviii. (1902), pp. 740-742.

contain a " fairly constant series of argillaceous limestone (10 feet)," comparable apparently with the *Ornithella*-Beds of Dyrham. They yielded *Pseudomonotis echinata* (Sow.), *Chlamys vagans* (Sow.), *Rhynchonella Smithi*, Walker, *Rhynchonella* sp. nov., and *Ornithella ornithocephala* (Sow.)

There is not a sufficiency of evidence for dating precisely the Fullers' Earth of the South Cotteswolds, but the following remarks will show what is probable.

Ammonites subcontractus, Morris and Lycett, and *Ammonites Morrisi*, Oppel, have been recorded from the Fullers'-Earth Rock of Somerset and the Weatherstones and Shelly Beds of Minchinhampton Common, near Stroud. If the Fullers'-Earth Rock is equivalent to these Minchinhampton beds, as this evidence seems to indicate, then the *Ostrea-acuminata*-Clays—which occur just below the Fullers'-Earth Rock in Somerset—must be equivalent to the Fullers'-Earth clays with *Ostrea-acuminata*-Limestones in the northern portion of the South Cotteswolds. *Ostrea Knorri*, Voltz, is abundant at the base of the Fullers' Earth in the neighbourhood of Doulting; but, so far, has not been recorded from the South Cotteswolds. It has been found, however, (first by Mr C. Upton, and subsequently by the writer, in company with Mr Upton), on the north side of the Slad Valley, and the writer has seen specimens—presumably from the Fullers' Earth—from Cooper's Hill, near Gloucester, also in the Mid Cotteswolds.

Specimens of *Zigzagiceras* have been procured from the base of the Fullers' Earth between Midford and Coombe Hay (in a cutting on the new railway); Mr Winwood has obtained one, near to, if not identical with *Zigzagiceras procerum* (Seebach), from the Fullers' Earth of Lansdown, near Bath; while as far north as Kingscote, a specimen—probably of the same species—has been collected.

Hence it would appear that the bottom-portion of the Fullers' Earth, throughout the South Cotteswolds, is of *zigzag* hemera.

TABLE I.—FOSSILS FROM THE FULLERS' EARTH OF THE SOUTH COTTESWOLDS

SPECIES	Lansdown, Bath	Ringswell	Near Cold Ashton	Near Dyrham	Sodbury Tunnel	Tresham Combe	Break-Heart Hill	Kingscote	Bown Hill
Protozoa									
1. Rhizopoda									
Foraminifera									
Cristellaria cultrata, Montf.						*	*		
——— sp.									*
Vermes									
5. Annelida									
Serpula plicatilis, Münster				*					
—— *quadrilatera*, Goldfuss				*					
Molluscoidea									
2. Brachiopoda									
Ornithella ornithocephala (Sow.) and varieties		*		*				*	
Rhynchonella Smithi, Walker				*	*				
——— sp. nov.					*				
Terebratula globata, auctt. non Sow.								*	
Mollusca									
1. Pelecypoda									
Goniomya angulifera (Sow.)				*					
Isocardia nitida, Phillips				*	*				
Ostrea acuminata, Sow.				*		*			
Chlamys vagans (Sow.)					*				
Pseudomonotis echinata (Sow.)					*	*			
5. Cephalopoda									
Zigzagiceras procerum (Seebach)	*							*	
Belemnopsis sp.				*					
Arthropoda									
1. Branchiata									
1. Crustacea									
Ostracoda									
Cytheridea Bradiana, Jones						*			
5 other spp. not identified							*		*

II. Subdivisions recognizable in the Inferior Oolite of the South Cotteswolds, and the probable causes that governed their distribution.

The subdivisions recognizable in the Inferior Oolite of the South Cotteswolds are shown in Plate XXI. (end of paper). Therefrom it will be observed that the series has been divided into two main parts, the Freestone and Ragstone Divisions, which are very different lithically, the former consisting mainly of massive freestones, and the latter principally of rubbly ragstones. The Ragstone Beds have been further separated into "Intervening Beds" and "Top-Beds"—the latter being uppermost. The Top-Beds have the most extensive geographical distribution in the South Cotteswolds; the Intervening-Beds the least; while the Freestone Beds occupy an intermediate position as regards geographical extent.

(xxvii.) *Aalensis*-Bed (hemera *aalensis*).—In the South-Cotteswold sections it is not always easy to separate the *Aalensis*- from the *Moorei*-Bed as regards lithic structure, and ammonites indicative of the former hemera have usually been labelled simply "*Moorei*-Bed." When separated on the palæontological evidence, the *Aalensis*-Bed is found to be extremely thin, and best seen at Coaley Peak and Wotton-under-Edge. On the Dorset coast the equivalent beds are much thicker and more readily discernible (see S. S. Buckman, Quart. Journ. Geol. Soc., vol. lxvi., 1910, p. 64).

(xxvi.) *Opaliniforme*-Bed (*opaliniformis*).—This stratum forms the hard cap to the Cephalopod-Bed. As regards lithic structure, it is easily separable from the beds *below* by its non-"marly," but pale-yellow arenaceous-limestone character, and by being usually speckled with angular irony grains instead of smooth oval limonite-granules; and from the beds *above* by its more metallic ring when struck with a hammer, and its more compact but less arenaceous character. The bed certainly extends as far south as the neighbourhood of Sodbury, but it is best exposed at Frocester Hill, in Coaley Wood, at Cam-Long Down, Wotton Hill, and Nibley Knoll. It is important to notice that at the base of the *Opaliniforme*-Bed, and joined on to it, there is often present a rubbly deposit, of

which the component pebbles are frequently coated with iron-oxide, while the interstices between them are filled up with the same material. In other words, there are distinct signs of a non-sequence between the *Opaliniforme-* and underlying beds in many of the sections in the northern portion of the South Cotteswolds.

(xxv.) *Scissum*-Beds (*scissi*).—These beds have been traced as far south as Sodbury, and are usually considerably-arenaceous limestones with specimens of *Gresslya, Pholadomya, Volsella* and *Pinna* of very nearly if not the same species as occur higher up in the *discitæ* deposits. Indeed, it is noteworthy how much the *Scissum*-Bed fauna resembles that of the Lower *Trigonia-* and *Buckmani*-Grits. The beds are well-exposed at Wotton Hill, Nibley Knoll, and the top of the "Long-wood" section, where Mr Charles Upton has collected *Tmetoceras scissum* (Benecke), and several other interesting ammonites.

The upper surface of the *Scissum*-Beds frequently shows signs of erosion that presumably took place during the pause in the process of deposition that evidently preceded the initiation of the necessarily changed conditions that favoured the formation of the Lower Limestone.

(xxiv.) Lower Limestone (early *Murchisonæ*): now—1910—dated as *Ancolioceras*.[1]—At many places in the neighbourhood of Cheltenham, the *Scissum*-Beds are almost immediately succeeded by the pisolitic beds of the Pea-Grit, but in the South Cotteswolds there follow oolitic limestones measuring, at Selsley Hill, some 38 feet. These beds have been actively-worked on Selsley Hill, where many of the component strata are "dapple-beds," that is, limestones with pebbles of very similar material, which are evidently the product of a pene-contemporaneous erosion. The fossils, also, are very few in number, and only the small specimens (gastropods) are at all well-preserved, and even they are rolled; while the larger forms, as a rule, are represented by fragments only.

(xxiii.) Pea-Grit (*Murchisonæ*).—The Pea-Grit is first definitely recognizable in coming north from Bath in the large quarry in Coaley Wood, but it is probable that the thin rubbly layer at Wotton Hill and the Nunnery-Lane Quarry, near

1 S. S. Buckman, F.G.S., Quart. Journ. Geol. Soc., vol. lxvi. (1910), p. 79.

Dursley, is on its horizon. That is all that can be said, and south of Dursley it is perhaps best to designate the beds between the Upper *Trigonia*-Grit and *Scissum*-Beds simply the "Freestone-Beds." From Coaley Wood northwards, however, the Pea-Grit can be traced by way of Frocester Hill to Selsley Hill, where it is found to have expanded and to be replete with fossils which at Crickley Hill, near Gloucester, characterise the *top-portion* of the Pea-Grit. This, combined with the fact that the upper surface of the underlying Lower Limestone is waterworn, and frequently has small oysters attached to it, suggests that the lower portion of the Pea-Grit is absent from Selsley, and that the top-portion there rests non-sequentially upon the Lower Limestone. The gap is partly bridged over at Rodborough Hill, where massive pisolitic limestones have come in, and the top-portion has also become more pisolitic. Specimens of *Nerinæa* are frequently abundant in the Pea-Grit, and connect the deposit in which they occur in point of time with the *Nerinæa-cingenda*-Bed of Blea Wyke or Ravenscar, on the Yorkshire coast.

(xxii.) Lower Freestone (late *Murchisonæ*).—This rock is of the usual lithic aspect, and—amongst other places—can be studied at the Coaley-Wood Quarry and Frocester Hill. At Selsley Hill it is very indifferently exposed, the paucity of sections in it probably being due to its inaccessibility, owing to faulting and land-sliding, rather than to non-presence. Witchell thought it might be as much as 70 feet thick, and I see no reason to differ from him.

(xxi.) Oolite Marl and (xxii.) Upper Freestone (*bradfordensis*.—These deposits have a less extended geographical distribution than the underlying Lower Freestone, not extending further south on the western face of the hills than Pen Wood, but owing to certain earth-movements are present further south *away* from the hill-edge in the neighbourhood of Nailsworth.

It is difficult to indicate precisely where the line of demarcation between the Oolite Marl and Upper Freestone comes in the South-Cotteswold sections, and although I have done so where possible, it must be remembered that while the marl *usually* occupies the inferior position, marly conditions may extend upwards and replace even the whole of the Upper Freestone, as is the case at "The Frith" Quarry, near Stroud.

In the deposit of *bradfordensis* hemera exposed on the flanks of the Minchinhampton-Common and Rodborough-Hill upland, specimens of *Nerinæa* are not uncommon, and on the evidence of other sections would appear to occur at about the same horizon as *Rhynchonella Tatei*, although where the one is common, the other is not, and *vice versa*.

It may be that at the northern end of the South Cotteswolds only the top-portion of the Oolite Marl is present. Certain sections in the Mid and North Cotteswolds have suggested either a slight break between the deposits of *Murchisonæ* and *Bradfordensis* hemeræ, or very little deposit being made locally in early *bradfordensis* times. But be this as it may, towards the close of *bradfordensis* hemera there was considerable crust-flexuring and production of slight anticlines and synclines. It is improbable that any important deposit was made over the site of the present South Cotteswolds during the *concavi* hemera. If it was, then there is no trace of it left now. The elevation which took place in late *bradfordensis* hemera and the erosion which ensued, have been termed the "Aalenian Upheaval" and "Denudation." Probably the anticlinal and synclinal axes were not widely divergent from those which were developed at the close of the time-of-formation of the Bajocian deposits.

Upon the disturbed Aalenian rocks the Bajocian deposits were laid down—the successive beds overlapping one another as subsidence proceeded. In the South Cotteswolds, and then only at the northern end on Rodborough Hill, the Lower *Trigonia*-Grit immediately succeeds the Upper Freestone, and it is in turn followed by the *Buckmani*-Grit, which does not extend across the Nailsworth Valley on to Selsley Hill.

(xiv.) Lower *Trigonia*-Grit (*discitæ*).—This is of the usual lithic aspect—a grey-brown shelly ragstone with iron-specks, and contains the ordinary assemblage of fossils. From it, at Rodborough Hill, many new species were obtained by Lycett.

(xiii.) *Buckmani*-Grit (post-*discitæ*).—The *Buckmani*-Grit, which has about the same geographical extent as the Lower *Trigonia*-Grit in the South Cotteswolds, is definitely identifiable on account of its having yielded at Rodborough Hill specimens of *Terebratula Buckmani* and *Ter. cricklcyensis*, and separable, as regards lithic structure in the relative absence of iron-specks, and by its more arenaceous character.

(vi.) Upper *Trigonia*-Grit (early *Garantianæ*).—The Upper *Trigonia*-Grit reposes non-sequentially upon the *Buckmani*-Grit at Rodborough Hill, and spreads southwards over the whole of the South Cotteswolds, overlopping the basset edges of the inferior subdivisions of the Oolite.

BAJOCIAN DENUDATION.—Between the Upper and Lower *Trigonia*-Grits at Rodborough Hill is a considerable stratigraphical break: the Gryphite-Grit, Notgrove Freestone, *Witchellia*-Grit, *Bourguetia*-Beds and *Phillipsiana*-Beds, deposits present near Cheltenham, and also deposits of *Blagdeni* and *niortensis* hemera as well, are absent. It is undesirable to commit one's-self to saying if all these subdivisions, or which of them, were probably laid down over the site of a portion of the South Cotteswolds. For the present it will perhaps be best to say that some were no doubt laid down over the northern portion of the South Cotteswolds, and were removed during the Bajocian denudation, which preceded the deposition of the Upper *Trigonia*-Grit.

(vi.) Upper-*Trigonia*-Grit (cont.).—In the South Cotteswolds, except at the extreme southern end, where portions look as if they had been subjected to some working-up, the Upper *Trigonia*-Grit is of the usual aspect—a hard, grey, shelly limestone full of fossils. At Nibley Knoll it is only 1 foot 4 inches thick, and at Wotton Hill is scarcely typical; but it should be noticed that throughout this portion of the Cotteswolds fragments of *Trichites* are common at the top. The upper surface of the Upper *Trigonia*-Grit is generally covered with oysters, and is frequently bored, even when there is a thin bed present which may be referred to the horizon of the Dundry Freestone.

(v.) Dundry Freestone (late *Garantianæ*).—A thin limestone bed, sometimes occurring as lenticular masses, at others as a continuous stratum, is recognisable in certain sections. It rests upon an oyster-covered and bored surface of the Upper *Trigonia*-Grit, and exhibits the same phenomena itself, only the borings in it are much more conspicuous. The identification of this deposit with the Dundry Freestone is only of scientific interest.

(iv.) Upper Coral-Bed (*Truellei*).—Above the thin bed of Dundry Freestone, or where it is absent, the Upper *Trigonia*-

Grit, occurs very sporadically indeed, the Upper Coral-Bed—a deposit which indicates by its wide extent in the Cotteswold Hills, Bath-Doulting District, and Dundry Hill, near Bristol, a prevalence of very similar conditions in this part of the West of England at the time of its formation. It was by the discovery at the Coombe-Hill Quarry, near Wotton-under-Edge, of a specimen of *Lissoceras psilodiscum* (Schloenbach) that the date of the deposit was first definitely fixed.

(iii.) Doulting Stone or *Clypeus*-Grit.—At Doulting the Doulting Stone is about 44 feet thick, but at Midford only 11 feet 9 inches. At the southern end of the South Cotteswolds it is probably about the same, and has similar faunal and lithic characters. Traced to the north, however, it gradually changes. At the Horton-Rectory Quarry it is easy to see in the massive-bedded local *Clypeus*-Grit of that locality, although it has become more rubbly and fossiliferous, the equivalent of the Doulting Stone: and even as far north as Selsley and Rodborough Hills, the massive character is still to a large extent preserved in the equivalent deposit. It is possible that the bottom-portion of the Doulting Stone, or local *Clypeus*-Grit, of certain localities is equivalent to the top-portion of the Upper Coral-Bed of certain others.

(ii.) *Anabacia*-Limestones or White Oolite.—The *Anabacia*-Limestones are generally very distinct in the Bath-Doulting district on account of their being whiter and more flaggy than the underlying yellower and more massive-bedded Doulting Stone, and are usually characterised by an abundance of the little coral *Anabacia complanata* (Defrance). At the southern end of the South Cotteswolds they are much the same in appearance, but at the Horton-Rectory Quarry they are somewhat softer and more oolitic; while at Scar Hill, Nailsworth, they have changed again, being more compact and less-conspicuously oolitic. Nevertheless, the identity of these limestones of the more northern sections with those of the southern is evident. North of Sodbury it is best to use Witchell's term "White Oolite" for these beds, for the characteristic coral is not abundant thence. Interesting to relate, however, when the White Oolite has assumed the appearance of typical, rubbly *Clypeus*-Grit, along with the Doulting Stone, as in the Cheltenham district, this little coral is frequently in evidence, and at places is quite common.

It should be mentioned here, that it is probable that Edwin Witchell did not always apply the term "White Oolite" to contemporaneous deposits. He identified the white limestones of Horton as his "White Oolite," and so when I use the term "White Oolite," I mean deposits of the same date as those at Horton.

(i.) Rubbly-Beds.—The Rubbly-Beds are not well-developed in the South Cotteswolds, and often are not much more than a rubbly development of the top-portion of the White Oolite, with occasional specimens of *Terebratula globata*, auctt., and *Holectypus depressus*. At the Stancombe Quarry on Stinchcombe Hill, however, they are typically developed, being rubbly limestones with those conspicuous yellow-coloured pisolite-like spherules, and crowded with *Terebratula globata*, and less commonly *Holectypus depressus*, etc.

The changes which the Doulting Stone, *Anabacia*-Limestones and Rubbly-Beds undergo during their course through the South Cotteswolds may be summarised as below, and it is important to note the restricted use of the term *Clypeus*-Grit in the Middle South Cotteswolds.

Southern end of the South Cotteswolds	Middle South Cotteswolds	Mid Cotteswolds
(i.) Rubbly Beds	(i.) Rubbly Beds	
(ii.) *Anabacia*-Limestones	(ii.) White Oolite	(i.-iii) *Clypeus*-Grit
(iii.) Doulting Stone	(iii.) *Clypeus*-Grit	

The massive bedding of the true Doulting Stone is faintly preserved all through in the more-bedded lower portion of the *Clypeus*-Grit.

III.—Local Details.

For descriptive purposes the South Cotteswolds may be divided into four areas, namely, (1) the Bath-Dodington, (2) the Dodington-Dursley, (3) the Dursley-Selsley, and (4) the Rodborough-Nailsworth Areas.

In the first of these the only sections worth visiting are at North Stoke, Tog Hill, and "The Springs," near Dodington: in the second there are excellent sections near Horton Rectory and Hawkesbury Monument; on Winner's Hill, near Alderley; on the hill north of Wotton-under-Edge; and on Stinchcombe Hill: in the third at Uley Bury, Frocester and Selsley Hills:

and in the fourth, at "The Fort" and Mount-Vernon Quarries on Rodborough Hill, and near Nailsworth at Scar Hill, Hazelwood and Longfords.

(1) The Bath-Dodington Area.

On the south side of the Avon Valley the Inferior Oolite is thus divisible:

Sequence of Inferior-Oolite Beds at Midford

			Thickness in feet	inches
		Fuller's Earth		
Inferior Oolite (Bathonian)	(i.)	Rubbly Beds (top-portion only) ..	0	6
	(ii.)	*Anabacia*-Limestones	11	0
	(iii.)	Doulting Stone	11	9
	(iv.)	Upper Coral-Bed	8	0
		Non-sequence: Dundry Freestone wanting		
	(vi.)	Upper *Trigonia*-Grit	5	0
		Non-sequence: Bajocian and Aalenian wanting		
Upper Lias (Toarcian)		Midford Sands	100	7

On the north side of the Avon Valley there is the same succession, but the Upper Coral-Bed is only very poorly developed, and at the Box Tunnel (according to the late Robert Etheridge) the total thickness of the beds is only 30 feet.[1]

I have investigated all the numerous valleys running up northwards into the southern end of the South Cotteswolds, but have found few sections worthy of note. The rocks are frequently greatly disturbed by landsliding: sometimes so much so as to give the impression that the Great Oolite underlies the Inferior—a phenomenon noticed by the Rev. H. H. Winwood near the Monkswood Reservoir.[2]

At this southern end of the South Cotteswolds then, the Upper *Trigonia*-Grit rests directly upon the Sands. These appear to be of *? Dumortieriæ*,[3] *dispansi* and *Struckmanni* hemeræ;[4] and may be of *striatuli* hemera as well.

A well at Primrose Hill, to the east of Weston, proved Sands with sand-burrs, from which Mr Winwood obtained "*Dumortieria radians* and *Lima toarciensis*, Desl.,"[3] and therefore of *Dumortieriæ* hemera; resting upon a local Cephalopod-Bed, which contained "*Ammonites communis, A. bifrons*, and *Rhynchonella Moorei*." From this it would appear that the lithological succession of the Toarcian beds is similar to that at Timsbury Sleight.[5]

1 "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)." Mem. Geol. Surv., vol. iv. (1894), p. 98. 2 Proc. Bath Nat. Hist. and Antiqu. F.C. vol. vii. (1895), p. 153. 3 Geol. Mag. (1888), p. 470. 4 Quart. Journ. Geol. Soc., vol. lix. (1903), p. 452. 5 *Ibid.*, vol. lxiii. (1907), table facing p. 416.

At the Monkswood Reservoir, however, Mr Winwood observed the Upper *Trigonia*-Grit resting directly upon blue clay, from which a specimen of *Ammonites capricornus* was obtained. This phenomenon again may be due to slipping; but, if not, it opens up some very interesting questions in connection with the relations of the Cotteswold-Hills and Dundry-Hill areas of sedimentation in late Liassic times.

The Upper *Trigonia*-Grit is of the usual aspect, but in places shows evidence of having been worked up again after its original deposition, possibly by an erosion following the crust-pressures that governed the limits of the area over which the Dundry Freestone was laid down.

(1) The Upper *Trigonia*-Grit has been exposed at Hill House, to the north-west of Box (where it can form but a very small outlier):[1]
(2) At the Monkswood Reservoir:
(3) In the Woolley-Langridge Valley at Turner's Court, or "Torney's-court," as it is now called:
(4) At Charlcombe: and
(5) In a road-cutting just after leaving North Stoke for Kelston.

In the quarry at Torneyscourt the rock is much disturbed, and comprises white, oolitic, seldom-fossiliferous limestones at the top (Doulting Beds); and brown, slightly-ironshot limestones below, which yielded the following fossils that are indicative of deposits of *Garantianæ* and *Truellei* hemeræ; *Acanthothyris spinosa* (Schlotheim), *Acanthothyris*, sp. nov., *Zeilleria Hughesi* (Walker), *Ctenostreon pectiniforme* (Schloth.), *Lithophagus inclusus* (Phillips), *Trigonia costata*, Sow., *Ostrea*, sp., *Myoconcha* (internal cast), and corals (*Isastræa*).

In the Kelston-Road Section (5) the Upper *Trigonia*-Grit has a thin layer of corals on top of it, and separating it from the succeeding Doulting Stone.

The Doulting Beds were formerly exposed in a number of quarries in this part of the Bath District, for example, "at the northern end of Beacon Hill, near Charlcombe"; "south-west of Gwenfield Farm," and again at Primrose Hill; but are now best seen at Slade's Farm, Ditteridge, and in a deep water-course at Charlcombe, where is the section that was described by Sir William V. Guise. The Upper *Trigonia*-Grit here is 4 or 5 feet thick.[2]

1 "The Jurassic Rocks of Britain," etc., vol. iv. (1894), p. 98. When I visited the locality in 1905, extensive drain-excavations revealed blue clays between the farm and the road to the north. No fossils were found in the clays. 2 Proc. Cotteswold Nat. F.C., vol. ii. (1865), pp. 171-172.

Coming now to the western face of the hills, in the lane from North Stoke to Bitton, is the section that was recorded by Prof. S. H. Reynolds and Dr A. Vaughan,[1] on the authority of Mr S. S. Buckman. It is at the top of the lane in which Charles Moore found what he thought might be a thin representative of the Marlstone.[2] It is unnecessary to recapitulate here all the details that have been given by Prof. Reynolds and Dr Vaughan; it will suffice to say that they record that the Upper *Trigonia*-Grit rests upon sands and sandstones of *Dumortieriæ-striatuli* hemeræ.

In the road-side near the schools at Upper Cheney, there is an exposure of much-disturbed rock; but the sequence appears to be as follows:

SEQUENCE AT UPTON CHENEY

III. Doulting Stone	1. Limestones, pale-yellowish oolitic.
IV. Upper Coral-Bed and VI. Upper Trigonia-Grit	2. Limestone, rubbly, somewhat ironshot, with corals (principally near the top); *Ostrea* sp., *Trigonia costata*, Sowerby, *Ctenostreon pectiniforme* (Schlotheim), *Terebratula globata*, auctt. non Sow., and a fragment of *Polyplectites* cf. *linguiferus* (d'Orbigny).
	Non-sequence: Bajocian and Aalenian wanting.
Cotteswold Sands	3. Sandstone, hard, calcareous. (In a sand-pit on the right-hand side of the road, a short distance to the east, is seen a considerable thickness of yellow, micaceous sands with "sand-burrs.")

Although no definite indications of the Cephalopod-Bed occur in this section, deposits of the hemeræ ? *aalensis*, *Moorei*, *Dumortieriæ* and *dispansi*, have been observed in the neighbourhood.[3] The record of *Polyplectites* is particularly interesting, in that this ammonite occurs at the base of the deposit of *Truellei* date in Normandy, and there gives its name to a bed ("*Linguiferus*-Bed") that immediately overlies the *Garantiana*-Bed.[4]

The top-portion of the *Anabacia*-Limestones—of which the uppermost layer is considerably bored—with the overlying Rubbly Beds (similar to those at Twerton Hill), is seen in an old quarry in the corner of a field east of the road at Tog-Hill Farm.

1 Quart. Journ. Geol. Soc., vol. lviii. (1902), pp. 736, 737. 2 Proc. Somerset Arch. and Nat. Hist. Soc., vol. xiii. (1867), p. 152. 3 Proc. Bristol Nat. Soc., vol. x.. p. 1 (1903: issued for 1901), p. 9; and *ibid.*, pt. 2 (1903: issued for 1902), p. 154. 4 Proc. Cotteswold Nat. F.C., vol. xvi. pt. 2 (1908), p. 188.

A little under a mile south-by-east of Dyrham, and east of Dyrham Wood, is the Fullers'-Earth section which was noticed above (page 78).

The quarries by the road-side in Dyrham Camp (near the 10th milestone), are in Doulting Stone; but the same subdivision is better seen in a quarry between "The Springs" (the source of the R. Boyd) and Dodington Ash, in the neighbourhood of which the sequence of beds is as follows:

SEQUENCE BETWEEN DODINGTON ASH AND "THE SPRINGS."

Pond north-east of the clump of trees on the south side of the road.

			Thickness in feet	*inches*
	Fullers' Earth.	1. Clay.		
I & II.	Rubbly-Beds and top-portion of the *Anabacia*-Limestones, not exposed.			
		"The Springs" Quarry.		
II. *Anabacia*-Limestones		2. Limestones, oolitic: at the top single examples of *Syncyclonema demissum* (Phillips), *Terebratula globata*, auctt. non Sow., and *Rhynchonella hampenensis*, S. Buckman, seen: ..	5	0
III. Doulting Stone		3. Limestones, shelly. The bottom-portion of this bed is rather rubbly, and much more shelly than the strata below; *Trichites* (fragments), *Ctenostreon pectiniforme* (Schlotheim), *Ostrea*, *Terebratula globata* auctt. non Sow., and *Rhynchonella hampenensis*, S. Buckman	2	0
		4. Limestones, dense, white, non-oolitic, sparry: shell-fragments, and a *Rhynchonella* near the top: seen ..	6	6
	Rubble on the bank on the opposite side of the road yielded fossils indicative of deposits of Truellei-Garantianæ hemeræ.			
IV. & VI.	Upper Coral-Bed and Upper *Trigonia*-Grit	5. Ragstone, shelly: *Acanthothyris spinosa* (Schlotheim), *Terebratula globata*, auctt. non Sow., *Zeilleria Waltoni* (Dav.), *Rhynchonella hampenensis*, S. Buckman, *Parkinsonia* (fragment), *Isastræa Richardsoni*, E. & H. (large mass), *Opis similis* (Sow.) *Clypeus Hugi*, Agassiz, and ? *Microsolena excelsa*, E. & H.		
	Non-sequence.	*Bajocian and Aalenian wanting.*		
		In the deep and usually dry watercourse.		
	Sodbury Sands	6. Sands and sandstones: numerous ammonites—*Haugia* cf. *inæqua*, S. Buckman, *H. fascigera*, S. Buckman, *Haugia* (nearest to *H. fascigera*), *Grammoceras toarciense* (d'Orbigny) and *Phlyseogrammoceras dispansum* (Lycett).		

H. B. Holl noticed that fragments of *Trichites* were abundant in the quarry here, and their occurrence along with *Ctenestreon* reminds one of the Vallis-Vale section, where there is a similar association at or about the same horizon.

The actual junction of the rubbly rock, with an assemblage of fossils of *Garantianæ-Truellei* hemeræ with the Sands was not observed, but it is not likely that any limestone of pre-*Garantianæ* date intervenes.

The Sands exposed in the deep and usually dry water-course are particularly interesting on account of their being for the most part of *striatuli* hemera. To the south, at Timsbury Sleight, the *Striatulum*-Beds come *below* the ("Midford") Sands; but to the north *above* the ("Cotteswold") Sands.

From the succession indicated above, it will be seen that at the northern end of the Bath-Dodington Area the sequence is the same as at the southern: the main difference being that the equivalent of the Doulting Stone has become more fossiliferous.

(2) The Dodington-Dursley Area.

This area is characterised by having a well-marked and typical Cephalopod-Bed at the top of the Cotteswold Sands, and freestone-beds (which increase in thickness to the north) between the Cephalopod-Bed and Upper *Trigonia*-Grit.

It is in this stretch of country that the principal change from the typical Doulting Stone to the true *Clypeus*-Grit—as developed at the Bath-Road Quarry, Nailsworth—takes place; but there is not a corresponding change in the *Anabacia*-Limestones. They retain, more or less, their usual appearance throughout the whole area: only in places do they exhibit at the top a rubbly appearance that is suggestive of the Rubbly Beds.

Between "The Springs" and Old Sodbury there are no exposures of any use.

Sequence in the neighbourhood of Old Sodbury.

From time to time the neighbourhood of Old Sodbury has furnished some very valuable details. These, combined with those still obtainable here and at the Horton-Rectory Quarry, render it possible to present the following generalized section:

SEQUENCE IN THE NEIGHBOURHOOD OF OLD SODBURY.

			Thickness in feet	inches
	Fullers' Earth	1. Clay (*exposed in various openings*)		
Inferior Oolite (55 feet) — Bathonian	I. Rubbly-Beds or their equivalents, and the top of the II. White Oolite	—not exposed: say	8	2
		HORTON-RECTORY QUARRY.		
	II. White Oolite	1. Limestone, white, oolitic, flaggy; a few brachiopods: seen ..	10	0
		2. Rubble, cemented together by infiltrated carbonate of lime, and resembling old mortar ..	0	2
	III. *Clypeus*-Grit	3. Limestone, brown and grey, obscurely oolitic, with a very irregular top; *Terebratula globata*, auctt. non Sow. (common), *Rhynchonella hampenensis*, S. Buckman	8	0
		4. Limestone, grey and pale-brown sparry limestone, massive, top well-planed and has oysters adhering to it in places. At 1 ft. 6 ins. below the base of bed III, 3, the limestone is rubbly; *Terebratula globata*, auctt. non Sow., and *Rhynchonella hampenensis*, S. Buckman, not uncommon in the lowest portion; *Syncyclonema demissum* (Phillips), *Nerinæa Guisei*, Witchell, *Acrosalenia spinosa*, Agassiz, and *Isastræa*, sp. indet. ..	7	4
	IV. & V. Horizon of Upper Coral-Bed and Dundry Freestone	5 Brown marly material, containing pebble-like bodies	0	2
	VI. Upper *Trigonia*-Grit	6. Limestone, yellowish-brown and grey, ironshot, shelly, with a very irregular and water-worn surface, oysters in places; *Trigonia costata* (Sowerby), *Ctenostreon pectiniforme* (Schloth.), *Alaria hortonensis*, Hudleston, *Pentacrinus*-ossicles, etc. ..	3	6
		Non-sequence. Beds VII. *to* XXIII. *wanting.*		
Aalenian	XXIV. Lower Limestone	7. Limestone, brownish-grey, oolitic, well-bedded, passing down into browner and less regularly-bedded hard limestones, with more conspicuous shaly partings, and containing fragments of a *Rhynchonella* and *Pentacrinus*: seen 9 feet. According to Holl, these limestones are 12 feet thick, and rest upon "yellow sandy rock containing *Gresslya*," 2 to 3 ft. in thickness	12	0

SECTION AT LITTLE SODBURY (AFTER S. S. BUCKMAN).

			Thickness in feet	inches
Aalenian	XXV. ? *Scissum*-Beds	8. Straw-coloured, shelly, sandy limestone: about	2	0
	XXVI. *Opalini-forme*- & XXVII. *Aalenia*-Beds	9. Reddish-brown, very hard ironshot limestone: about .. .. (Beds XXV., XXVII., Mr Buckman parallels with the "sandy ferruginous limestone," and, with a query, with the "*Opalinum*-Beds")	1	0
Upper Lias (205 feet 4 inches) Toarcian	*Moorei*-Beds	10. Greyish, much ironshot marl; *Dumortieria Moorei* (Lycett), *Rhynchonella cynocephala*, auctt.	4	6
	Dumortieria-Beds	11. Darker, soft mudstone, much ironshot; *Dumortieria metita*, S. Buckman, *Rhynchonella cynocephala*, auctt.	2	6
		12 Grey ironshot marl..	3	0
	Dispansum-Beds	13. Grey sandstone	0	4
		Details obtained during the construction of the South-Wales Direct Line—(S. H. Reynolds and A. Vaughan).		
	Striatulum-[*variabilis*-, & ? *Lilli*-] Beds	14. Sands, micaceous, with lenticular bands of hard sandy limestone	185	0
		15. A pyritous bed full of "*Hildoceras bifrons* (Bruguière)"	10	0
	Bifrons-Beds	16. Limestone, compact, marly, with angular jaspery fragments; *Dactylioceras commune* (Sow.), *Dacty. Holandrei* (d'Orbigny) "*Hildoceras Levisoni* (Simpson)" and *Rhynchonella Moorei*, Davidson		
		17. Marl, compact, cream-coloured; *Belemnites* aff *vulgaris*, Y. & B. *Rhynchonella* sp., *Harpoceras falciferum*, auctt.		
	Marlstone	18. "Rock-Bed."		

As will be seen from this record, the Inferior Oolite appears to be some 55 feet thick near its escarpment, but further to the east it may increase in thickness, for Prof. Reynolds and Dr A. Vaughan, from details obtained during the construction of the South-Wales Direct Line, estimate it at about 70 feet.[1]

Messrs Reynolds and Vaughan had to construct the detailed sequence of Inferior-Oolite beds in the neighbourhood of the Cross-Hands Inn, and estimate their thicknesses from specimens brought up from the shafts and labelled as to the depth from which they had been obtained. They had also to

1 Quart. Journ. Geol. Soc., vol. lviii. (1902), pp. 734-739.

assign the fossils picked up off the spoil-heaps to their probable subdivisions on the evidence of any matrix which might be adhering to them, or in which they might be embedded.

These authors assign a thickness of 10 feet to the Upper *Trigonia*-Grit. At the Horton-Rectory Quarry, which is barely a mile and a half away to the north, it certainly does not exceed 3 feet 6 inches. Probably the 10 feet includes the Doulting Stone. The rock-specimens described by Messrs Vaughan and Reynolds, and numbered in their paper 3, 4 and 5 (pp. 737, 738), are probably all Upper *Trigonia*-Grit. Their records of *Ctenostreon pectiniforme* (Schlotheim), which is so common in the top-portion of the Upper *Trigonia*-Grit of the South Cotteswolds, and of the *Montlivaltia* sp. (which is of the same form as that which is abundant at Stantonbury Hill in the Bath-Doulton District) are of distinct interest.[1]

Above the 10 feet of rock that these authors referred to, the Upper *Trigonia*-Grit, was "blue, yellow and white oolite." Judging from their record of *Thamnastræa* aff. *mettensis*, E. and H., *Cladophyllia*, and *Collyrites ovalis*, Leske, I should think that these beds embrace the *Anabacia*-Limestones, for corals are sparsely distributed through the *Anabacia*-Limestones of such sections as Avoncliff, near Bradford-on-Avon; while *Collyrites ovalis* is also a distinctive fossil. There appears to be no evidence of the Upper Coral-Bed at Sodbury, and it is absent also from the Horton section.

In a disused quarry, a little to the south-east of the "Cross-Hands Inn," are white oolitic limestones—the equivalents of the *Anabacia*-Limestones and Doulting Stone. They contain a few specimens of *Terebratula globata*, auctt. non Sow., and *Syncyclonema demissum* (Phillips): the two subdivisions being separated by a layer of crystalline carbonate of lime as at Horton (page 93).

Before leaving the beds of *Garantianæ* and post-*Garantianæ* date, it may be remarked that the "White Oolite" was identified by Holl with his "Upper Ragstone" and the *Clypeus*-Grit, *plus* the Upper *Trigonia*-Grit, with his "Lower Ragstone."

At Sodbury there are the first definite indications of the presence of beds between the Upper *Trigonia*-Grit and Cephalopod-Bed. Now, unfortunately, the sections of them are few and indifferent, but in Holl's time there were some in the lane leading from the "Cross Hands Inn" to Old Sodbury, and—as far as he could determine—the thickness of the intervening beds was 8 to 11 feet. Of this, the bottom 2 or 3 feet was his "*Gresslya*-Bed"—our *Scissum*-Beds. Messrs Reynolds and Vaughan allocate a thickness of from 30 to 35 feet to these sub-Upper *Trigonia*-Grit Inferior-Oolite beds.

1 Quart. Journ. Geol. Soc., vol. lxiii. (1907), pp. 419 420.

Below the *Scissum*-Beds comes the Cephalopod-Bed. The *Moorei*- and *Dumortieria*-Bed portion, of the usual richly-ironshot and fossiliferous type, is to be seen in an opening below the fine ancient earthwork on the hill above Little Sodbury, and formerly was visible (with inferior beds) in the deep lane above the same village. Now, however, this latter section is quite overgrown, and it is necessary to rely upon the details obtained and recorded by Mr Buckman,[1] and re-stated —with certain emendations—in the generalized section given on page 94.[2]

Horton-Rectory Quarry.

The section now under consideration is certainly one of the most interesting in the South Cotteswolds, affording as it does a view of the beds in an area none too rich in exposures. The Fullers' Earth, Rubbly Beds, and the top-portion of the *Anabacia*-Limestones have been removed by denudation, but there is a considerable thickness of the last-named subdivision still remaining. Holl identified it with his "Upper Ragstone,"[3] and Edwin Witchell with his "White Oolite."[4] When I use the term "White Oolite" henceforth in this paper I mean rock on the same horizon as this Horton "White Oolite," because it is by no means certain that the white-coloured limestones of various localities that Witchell called "White Oolite" are of precisely the same age.

The thick-bedded limestones between the conspicuous White Oolite and the fossiliferous Upper *Trigonia*-Grit correspond to the Doulting Stone of the Bath-Doulting district, and to the *Clypeus*-Grit of such sections as that of the Bath-Road Quarry, Nailsworth; and its massive nature is certainly reminiscent of the Doulting Stone of the typical locality. In the lower portion of the *Clypeus*-Grit, *Nerinæa Guisei*, Witchell, is not uncommon. It will be recollected that this gastropod characterises this subdivision as far south as Radstock, and—so far as is known at present—as far north as Rodborough Hill, near Stroud.

1 Quart. Journ. Geol. Soc., vol. xlv. (1889), p. 446. 2 The fossils that were procured by the Rev. Steinhauer, and were figured by Sowerby, came no doubt from the Upper *Trigonia*-Grit of a quarry "situated at the very top of the road which runs straight up the hill." 3 Quart. Journ. Geol. Soc., vol. xix. (1863), p. 306. 4 Proc. Cotteswold Nat. F.C., vol. vii., pt. 2 for 1879-80 (1880), p. 120; "Geology of Stroud" (1882), p. 62.

The Upper *Trigonia*-Grit is richly-fossiliferous, even more so than in the neighbourhood of Stroud: specimens of *Trigonia costata* (Sow.) and gastropods being particularly abundant and well-preserved. The late W. H. Hudleston has dealt with the gastropods in his monograph, and has given a section to show the horizons whence they came,[1] which differs in but a few unimportant points from that recorded in the present paper. The same remark applies to Mr H. B. Woodward's record.[2] It will be noticed that there is no Upper Coral-Bed here.

The Upper *Trigonia*-Grit rests upon a very well-planed and bored surface of the underlying Freestone. The total thickness of the Freestone at Horton is said to be 12 feet, and on the evidence of a number of specimens of *Amusium personatum* (Goldfuss) would appear to be correlative with the bottom-portion of the Pea-Grit or the top-portion of the Lower Limestone of sections around Cheltenham. There is no evidence of the bed called the "*Rhynchonella subringens*-Bed" in this quarry.

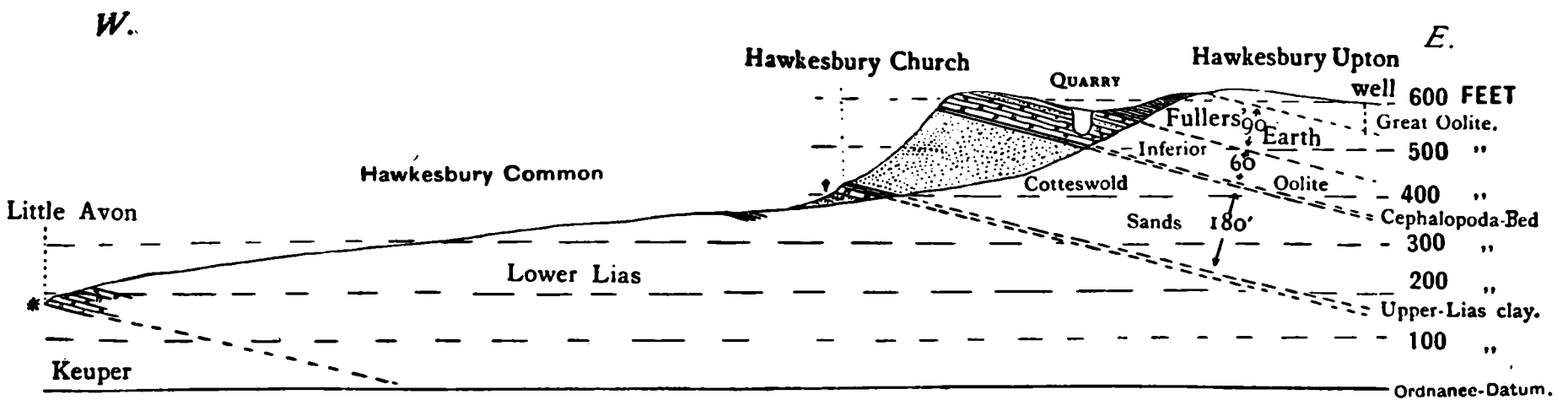
A mile and a half further north the same succession of beds as at the Horton Quarry is to be made out in the sides of the cart-track near the barn on Church Hill, Hawkesbury; but it is unnecessary to record details of this somewhat indifferent exposure, as the succession is so much plainer in the large quarry alongside the road between Hawkesbury and its hamlet of Hawkesbury Upton.

Sequence between Hawkesbury and Hawkesbury Upton

It is remarkable that the sections here have not attracted more attention. Holl noticed that the section was similar to that at Horton, but that there was the Fullers' Earth exposed above, and a greater thickness (probably 25 feet) of Freestone below;[3] Mr H. B. Woodward passed over it altogether in his historic survey of the Oolites;[4] and it was not until 1906 that it received detailed notice, when it was described by the present writer.[5]

1 "Gasteropoda of the Inferior Oolite," Monogr. Palæont. Soc. (1888), pp. 57-59. 2 "The Jurassic Rocks of Britain, etc.," Mem. Geol. Surv., vol. iv. (1894), p. 106. 3 Quart. Journ. Geol. Soc., vol. xix. (1863), p. 310. 4 "The Jurassic Rocks of Britain, etc.," Mem. Geol. Surv., vol. iv. (1894), p. 106. 5 Proc. Cotteswold Nat. F.C., vol. xv., pt. 3 (1906), pp. 192-194.

FIG. 2.—SECTION ACROSS THE ESCARPMENT OF THE SOUTH COTTESWOLDS.



* Rhætic. † Marlstone. (Scales: vertical, 1 inch = 400 feet; horizontal 3 inches = 1 mile.

Between the Marlstone, upon which Hawkesbury Church is situated, and the Fullers' Earth is about 262 feet 6 inches of deposit. Of this, about 12 feet is Upper-Lias clay; 180 feet Cotteswold Sands; and about 60 feet Inferior Oolite.

A certain portion of the Cephalopod-Bed, with the *Scissum*-Beds above, is to be seen in an opening on the left-hand side of the road just before arriving at the main quarry. In the main quarry about 27 feet of Freestone—over twice as much as at Horton—are present. Upon the Freestone rest non-sequentially the Ragstones, but they are difficult of access here, and are best investigated in some quarries to be noticed shortly ("Hawkesbury-Monument Quarry").

A spring, also by the road-side, denotes the presence of the Fullers' Earth, which is here full of specimens of *Ostrea acuminata*, Sowerby.

The following is the sequence at Hawkesbury:

SEQUENCE AT HAWKESBURY

				Thickness in feet	*inches*
		Fullers' Earth	1. Grey and yellow clay with some argillaceous limestone-beds, full of *Ostrea acuminata*, Sowerby		
Inferior Oolite	II.	White Oolite.	2. Limestone, white, oolitic: about	10	4
	III.	*Clypeus*-Grit.	3. Limestone, rubbly in places	9	6
		Non-sequence.	*Upper Coral-Bed and Dundry Freestone absent.*		
	VI.	Upper *Trigonia*-Grit	4. Ragstone, very shelly: usual fossils	4	10
		Non-sequence.	*Beds* VII-XXIII (*inclusive*) *absent*		
	XXVI.	Lower Limestone	5 to 9. Limestones, massive-bedded; *Amusium personatum*	20	4
			[Gap: probably similar beds, for say	6	10]
	XXV.	*Scissum*-Beds	10-14. Limestones, somewhat sandy	7	4
	XXVI.	*Opaliniforme*-Bed	15. Limestone, pale-brown, somewhat sandy; *Volsella sowerbyana* (d'Orb.), *Montlivaltia*	1	4
Upper Lias		Cephalopod-Bed	16-24. Impure ironshot limestones and marls	9	2
		Cotteswold Sands	25. Sands, fine-grained, pale-yellow, micaceous ..	180	0
		Upper-Lias Clay	26. Clay, blue: about	12	0
		Marlstone	27. "Rock-Bed."		

By the side of the road to Wickwar, below Hawkesbury Monument, the Top-Beds of the Oolite are very well displayed

in a quarry in work. This section I have described in detail in the Proceedings of the Cotteswold Naturalists' Field Club,[1] so only a summary of the sequence need be given here:

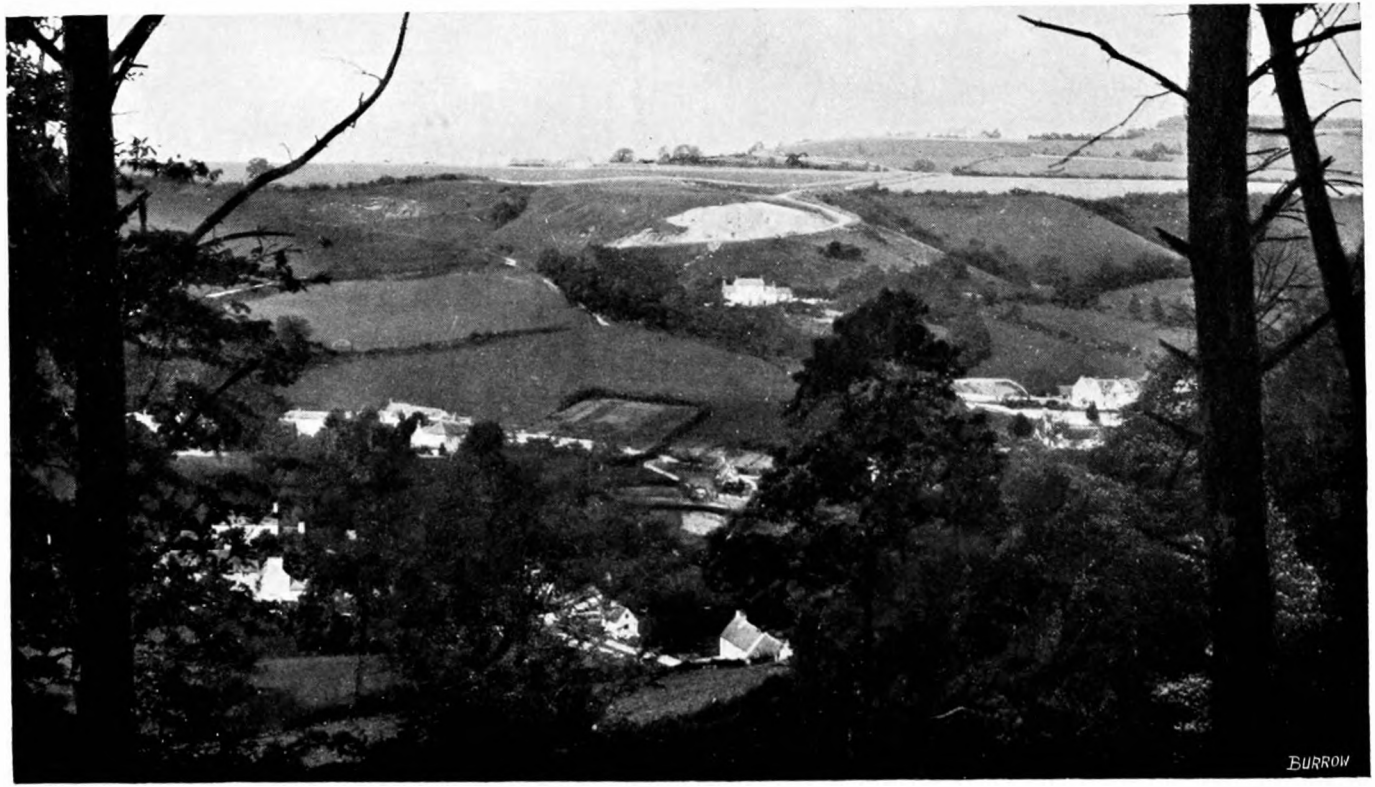
HAWKESBURY MONUMENT QUARRY

		Thickness in feet	inches
Fullers' Earth.	1. Clay: has filled in cracks in the White Oolite		
II. White Oolite.	2. Limestones: seen in quarry about 6 feet, add say 4 feet	10	0
	3. Fairly regular deposit of rubble and calcite (compare Horton and quarry near the "Cross-Hands Inn," pp. 93 and 95 respectively)	0	1
III. *Clypeus*-Grit.	4-8. Limestones, with well-marked partings, not very fossiliferous ..	9	3
	Non-sequence. Upper Coral-Bed absent.		
V. Dundry-Freestone Equivalent.	9. Shaly, very much iron-shot limestone, resting upon an oyster-covered surface of the underlying bed..	0	2[2]
VI. Upper *Trigonia*-Grit.	10. Ragstone, shelly, well iron-shot: usual fossils ..	4	6
	Non-sequence. Beds VII.-XXIII. (*inclusive*) *absent.*		
XXIV. Lower Limestone.	Limestone: top well-planed, bored, and oyster-covered: seen	3	0

At the the time I wrote the report of the excursion of the Cotteswold Club to Hawkesbury I was uncertain to which bed 9 should be given. I now think it had better be designated the Dundry Freestone Equivalent. Probably it represents only a small portion, as it rests upon a bored surface of the Upper *Trigonia*-Grit, and is itself bored.

The Freestones, replete with specimens of *Amusium personatum* (Goldfuss) along certain horizons, and having the Upper *Trigonia*-Grit resting on their bored and planed surface, are to be seen in the old disused quarry in the woods at Chandler's Cliff, between Hawkesbury Upton and Hillsley. The small quarry in work by the road-side is in the Freestones, and lower down the hill is an exposure of Cotteswold Sands

1 *Loc. cit.*, vol. xv., pt. 3 (1906), p. 194. 2 Erroneously printed as 2 feet 2 inches in the Cotteswold Club Report.



FREESTONE QUARRY AND COOMBE VALLEY FROM WARREN WOODS WOTTON-UNDER-EDGE

(Albert Durn, photo.)

(From Burrow's "Guide to Wotton-under-Edge.")

with traces of the Cephalopod-Bed above. *Pseudogrammoceras pedicum*, S. Buckman, was found here.

North of Hawkesbury the hill-country is greatly intersected by ramifying valleys with lateral combs, but the geologic structure is very simple, and readily-read with the aid of a geological map.

In Tresham Comb, there is an exposure of the Cephalopod-Bed shortly beyond the second gate that is passed through in ascending the valley; while a little higher up (on the same side of the wheel-tract—the right) is a quarry in the Freestones and Upper *Trigonia*- and *Clypeus*-Grits. *Amusium personatum* occurs in the Freestones, and a specimen of *Parkinsonia Parkinsoni* (Sow.) was obtained from the Ragstones. Owing to rock-sliding, it was not possible to obtain reliable details of the Top-Beds, but Fullers' Earth occurs above, and has yielded *Cristellaria cultrata*, Montf., and *Cytheridea Bradiana*, Jones. The usual *Ostrea-acuminata*-Limestones are present, and contain not uncommonly *Pseudomonotis echinata* (Sow.).

On the hill east of Alderley is the quarry in which *Prosopon Richardsoni*, H. Woodward, was found. The section was described in the Geological Magazine for 1907 (pp. 82-84), so it will suffice to say that it shows the ? Rubbly Beds, White Oolite, *Clypeus*-Grit, Dundry-Freestone-Equivalent, and Upper *Trigonia*-Grit.

On Tor Hill is a large quarry in which the Freestones are worked. In the shallower northern portion the Upper *Trigonia*-Grit is seen above, and has 1 foot 2 inches above its base a layer crowded with *Rhynchonellæ*.

Similar Freestones to those at Tor Hill have been worked at Boxwell, and again in the conspicuous quarry on the hill north of Coombe, near Wotton-under-Edge: that in which the Dursley Rural District Council have placed a reservoir. Here the basal layers of the Upper *Trigonia*-Grit are seen resting upon the "Bored-Bed," at 20 feet below which is a rubble-bed that may well be on the horizon of the Pea-Grit. In the limestones below it *Amusium personatum* is particularly abundant.

To the north of Wotton-under-Edge, between Wotton and Symond's-Hall Hills, are several sections which afford an almost complete view of the succession from the Cotteswold Sands to the Great Oolite. The satisfactory nature of the locality

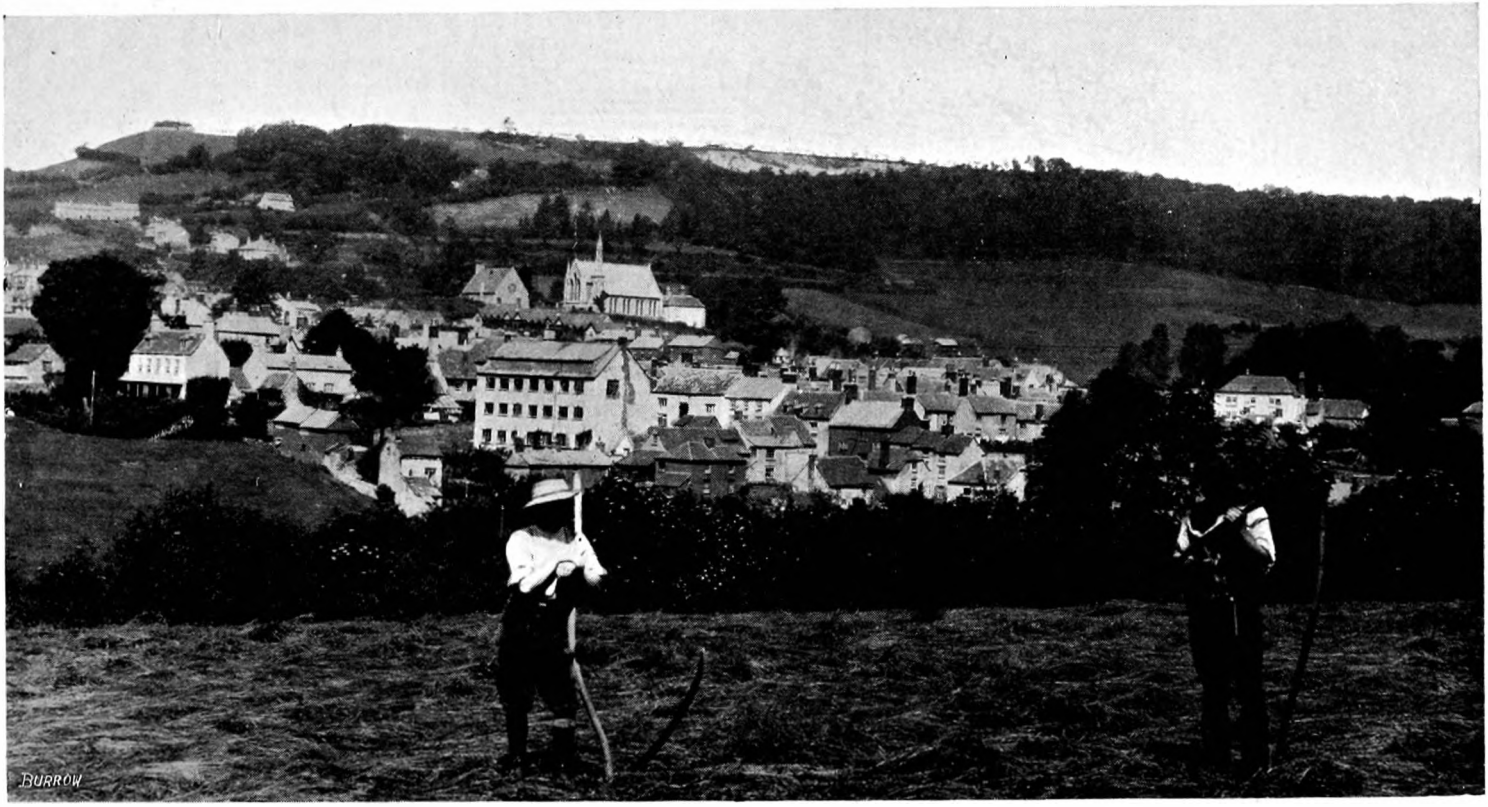
for studying these beds was long ago recognised by Lycett[1] and Wright:[2] the latter geologist giving a generalized account and section (text-figure) of beds from the Lower Lias to the top of the Inferior Oolite.

Ascending Wotton Hill, the first exposure (Wotton-Hill Quarry—II.) is in an old quarry, now much overgrown, on the north side of the road. It shows the top-portion of the Sands, the Cephalopod-Bed, and the basal portion of the Oolite. It has long been known as a locality rich in specimens of *Grammoceras striatulum* (Sow.), and *G. toarciense* (d'Orb.), and, in my opinion, is the best place in the South Cotteswolds for studying the Cephalopod-Bed and its relations with the sub- and super-jacent deposits. It will be observed that the two rather prominent limestone-bands and intervening marl below the *Dispansum*-Beds, usually referred to as the "*Striatulum*-Beds,"[3] have been more precisely dated. The *Scissum*-Beds occur at the top of the quarry, and, as at Haresfield, yield *Pholadomya fidicula*, Sow., and *Volsella sowerbyana* (d'Orb.) not infrequently.

There is a gap between this section and the large quarry where the Freestone and Ragstone-Beds have been worked for road-metal; but the Freestone must be between 30 and 40 feet thick. The beds seen in this second, and very large, quarry are detailed under the heading of "Wotton-Hill Quarry—I." in the record given on page 104. Of previous workers, Mr H. B. Woodward has mentioned its existence,[4] and the late W. H. Hudleston noticed that the Upper *Trigonia*-Grit rested upon the Freestone without the intervention of any Gryphite-Grit; that *Nerinæa Guisei* occurred in its usual position in the *Clypeus*-Grit; and that about the middle of the Freestone there was a "slight unconformity in connection with a bed of *Nerinæa*."[5]

The Upper *Trigonia*-Grit is not typically developed in this quarry; but the most interesting points are that there is a layer of lenticular masses of coral on the horizon of the Upper Coral-Bed, and that between it and the Upper *Trigonia*-Grit is a thin deposit referable to the Dundry Freestone.

1 "Cotteswold Hills" (1857), pp. 16-18, 50. 2 Quart. Journ. Geol. Soc., vol. xii. (1856), pp. 306-309: see also "Jurassic Rocks of Britain—Lower Oolitic Rocks of England (Yorkshire excepted)," Mem. Geol. Surv., vol. iv. (1894), pp. 106-107. 3 See Proc. Geol. Assoc., vol. xx. (1908). p. 525. 4 *Ibid.*, p. 106. 5 "Gasteropoda of the Inferior Oolite," Monogr. Palæont. Soc. (1888), p. 59.



WOTTON HILL, SHOWING THE FREESTONE QUARRY, FROM MOUNT PLEASANT, WOTTON-UNDER-EDGE

(Albert Durn, photo.)

(From Burrow's "Guide to Wotton-under-Edge.")

The Top-Beds are much more accessible in a quarry about a mile away, which may be called the "Coombe-Hill Quarry." It was from the Upper Coral-Bed here that a specimen of *Lissoceras psilodiscum* (Schloenbach) was procured. The discovery was of particular importance, in that it afforded the first definite evidence for the date of the Upper Coral-Bed, namely, *Truellei* hemera, which has now been recognised at such widely-separated localities, and has proved so valuable a datum-level in correlating the "Top-Beds." This quarry also reveals the fact that the *Clypeus*-Grit is becoming increasingly fossiliferous, and the appearance of *Clypeus Ploti*, Klein, is interesting.

Continuing up the road in the direction of Symond's-Hall Hill, the presence of the Fullers' Earth is easily discerned in the hummocky nature of the ground. There is a small exposure in the field to the right of the road at an altitude of about 670 feet, and deposits of clay and limestone-bands replete with *Ostrea acuminata*, Sow., are visible. Still higher up the hill, about 780 feet above ordnance-datum, is a quarry in the basement-beds of the Great Oolite, the lowest of which have an initial Stonesfield-Slate aspect.

SEQUENCE AT WOTTON-UNDER-EDGE.

SYMOND'S-HALL-HILL QUARRY.

			Thickness in feet	inches
Great Oolite.		1. Limestone, fissile at the base		
IN THE FIELDS ON THE HILL-SIDE.				
Fullers' Earth.		2. Clay, with limestone-bands, full of *Ostrea acuminata*, Sow.		
Inferior Oolite	I. Rubbly Beds	3. Not exposed. Add say ..	3	2
		COOMBE-HILL QUARRY		
	II. White Oolite	4. Limestones, flaggy: seen ..	2	6
		5. Limestone, oolitic, but harder than the beds above and below, and containing *Terebratula globata*, auctt. non Sow., abundantly.. ..	1	8
		6. Rubbly parting	0	4
		7. Limestone, white oolitic ..	5	0
	III. *Clypeus*-Grit	8. Limestone, hard, yellowish pisolite-like spherules ..	1	0
		9. Limestone, rubbly; *Pleuromya Goldfussi* (Lycett), *Limatula gibbosa* (Sow.), *Syncyclonema demissum* (Phillips), *Holectypus depressus* (Leske), etc.	0	5

SEQUENCE AT WOTTON-UNDER-EDGE.—SYMONDS-HALL-HILL QUARRY *continued*

			Thickness in feet	inches
		10. Parting, irregular	0	0½
		11. Limestones, hard, rubbly in places at the top; *Homomya gibbosa*, Sow., etc... ..	3	4
		12. Limestones, two layers ..	0	8
		13. Limestone, shaly: 1 to 2 ins.	0	1
		14. Limestone; *Acanthothyris spinosa* (Schloth.): average	0	6
		15. Limestone, bored, very irregular upper surface with pebbles adhering: average	0	7
		16. Parting	0	0½
Inferior Oolite	IV. Upper Coral-Bed	17. Limestone, whitish, shelly, with lenticular masses of coral at the base; *Lissoceras psilodiscum* (Schloenbach), *Terebratula globata*, auctt. non Sow.	0	6
		Non-sequence		
	VI. Upper *Trigonia*-Grit	19. Ragstone, very shelly, being full of the usual fossils, and joined on to bed 17 here: seen	2	0

WOTTON-HILL QUARRY—I.

	IV. Upper Coral-Bed	17. A whitish shelly rock in lenticular masses, and with lenticular masses of coral (*Isastræa*) mixed with marly lime-washed matter; *Ctenostreon*	0	9
		Marly layer	0	1
		Slight non-sequence.		
	V. Dundry-Freestone-Equivalent	18. Limestone, hard, shelly, slightly iron-speckled, bored in places	0	2
		Slight non-sequence.		
	VI. Upper *Trigonia*-Grit	19. Limestone, hard grey, top bored and waterworn in places; *Ostrea* sp... ..	1	8
		20. Limestone, rubbly; fossils scarce	0	10
		Non-sequence. Beds VII. *to* XXI. ? *(inclusive) wanting.*		
	? XXII. Lower Freestone	21. Limestones, coarsely-oolitic	14	0
		22. Rubble and marl	0	1
		23. Limestones, massive ..	1	10
		24. Rubble: 1 to 3 inches ..	0	2
		25. Limestone, under side very irregular; *Nerinæa* ..	1	8
	? XXIII. Pea-Grit Horizon	26. Rubble; *Trichites* (fragments); 4 to 8 inches	0	6
	XXIV. Lower Limestone	27. Limestone, massive: seen 16 to 20 feet	18	0
		[28. Limestone: add say ..	3	9]

WOTTON-HILL QUARRY—II.

				Thickness in feet	inches
Inferior Oolite	XXV.	*Scissum*-Beds	[29. Limestone: add perhaps ..	3	5]
			30. Limestones, arenaceous; *Pholadomya fidicula*, Sow., *Terebratula euides*, S. Buckman, with *Actinopora diplopora*, Branco, and *Stomatopora* on it	0	9
			31. Rubbly, but otherwise similar limestone	0	6
			32. Limestones, massive; *Volsella sowerbyana* (d'Orb.) ..	3	4
	XXVI.	*Opaliniforme*-Bed	33. Limestone, hard, slightly iron-speckled	1	0
			? Indications of a non-sequence.		
	XXVII.	*Aalensis*-Bed	34. [6] Dirty-grey, ironshot, indurated marl, very ferruginous where it is joined on to the bed above	0	6
			35. [7] Layer of dark-brown clay; *Rhynchonella cynocephala*, auctt.	0	2
Upper Lias	Cephalopod-Bed	*Moorei*-Bed	36. [8] Grey and brown ironshot marl; *Zeilleria* ? sp. nov. near the top, *Lytoceras Wrighti*, S. Buckman, *Syncyclonema demissum* (Phillips)	1	6
			37. [9] Similar rock, but indurated to form a hard bed; *Rhynchonella cynocephala*, auctt.: maximum ..	1	4
			(At the western end the beds have slipped forward and down).		
		Dumortieria-Bed	38. [10] Brown and grey-dappled ironshot marl, with thin and impersistent hard bands; *Catulloceras Leesbergi* (Branco) (pl. xxxix. figs. 10, 11,)[1] *Dumortieria* sp. (pl. xlv., 15, 16), *Hudlestonia serridens* (Quenstedt), *Dumortieria novata*, S. Buckman; *Terebratula haresfieldensis*, Dav., in lower part	3	0
			39. [11] Marl, indurated, grey, sparsely ironshot, very ferruginous in places.. ..	0	8
		Dispansum-Bed	40. [12] Similar bed to the preceding; large belemnites, *Phlyseogrammoceras dispansum* (Lycett)	2	6
		Struckmanni-Bed	41. [13] Limestones in two beds with marl-parting, coarsely, but not richly-ironshot ..	1	8

WOTTON-HILL QUARRY—II.—*continued*

			Thickness in feet	inches
Upper Lias	Cephalopod-Bed	*Pedicum*-Bed "Linseed-Bed" 42. [14] Marl, coarsely-ironshot, dark-coloured; *Belemnites* spp., *Pseudogrammoceras Saemanni* (Dumortier) (Suppl., pl. xl.: or beds above)	1	0
	Cotteswold Sands	*Striatulum*-Bed 43. [15] Limestone, massive, ironshot; *Grammoceras striatulum* (Sow.), *G. toarciense* (d'Orb.)	1	2
		Variabilis- & ? *Lilli*-Beds 44. Sands, fine-grained, micaceous, yellow, indurated near the top: *according to T. Wright*	123	0
		Falciferum-Bed 45. Clays, grey, sandy, with some limestone-nodules (exposed in a brick-yard): *according to Wright*	10	0
Middle Lias		*Spinatum*-Bed 46. "Rock-Bed"	12	0

N.B.—The numbers in square brackets against the beds are to connect this record with that given by Mr S. S. Buckman at Nibley Knoll.—Q.J.G.S., vol. xlv., 1889, *p.* 445.

Near the Monument on Nibley Knoll, which is such a land-mark, is a quarry in which the Upper Coral-Bed is very well displayed: better so than anywhere else in the South Cotteswolds, with the exception of Rodborough Hill. The section was noticed by Mr S. S. Buckman, but he simply recorded that the "Upper *Trigonia*-Grit" overlies the Freestone, which in turn succeeds to beds which he refers with a query to D[1], that is, to the "Sandy ferruginous beds" of Witchell.[2] He gives, however, a detailed account of the "*Opalinum*-Zone," Cephalopod-Bed, and Cotteswold Sands, which are exposed at the top of the bank by the lane-side between the quarry and North-Nibley village. This account is amplified in a paper published by the same author in 1889, the Freestone being referred to the "*Murchisonæ*-Zone"; while the Upper Lias deposits are more minutely subdivided.[3] Mr H. B. Woodward gives a record of the beds exposed in the quarry; but only makes two subdivisions—Ragstones and Freestones; while he publishes a summary of Mr Buckman's record of the beds in the lane-section.[4]

1 The numerals and figures in square brackets after the names of fossils refer to specimens figured in Mr S. S. Buckman's "Inferior Oolite Ammonites of the British Islands." Monogr. Pal. Soc. (1888-1908). Mr Buckman very kindly furnished me with this information. 2 *Idem.* (1888), pp. 46-47. 3 Quart. Journ. Geol. Soc., vol. xlv. (1889), p. 445. 4 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), p. 107.

NIBLEY-KNOLL QUARRY.

			Thickness in feet	inches
III.	*Clypeus*-Grit	1. Limestone, whitish-grey, with small soft pisolite-like spherules, which, falling out, give the rock a pitted nature; *Pleuromya Goldfussi* (Lycett), *Syncyclonema demissum* (Phillips), *Ceromya striata* (Sowerby), *Serpula* sp., *Terebratula globata*, auctt. non Sow., all rare: seen	6	0
IV.	Upper Coral-Bed	2. Limestone, rubbly, whitish, and coated with lime; *Terebratula subsphæroidalis*, Upton (along a line at the top), *Clypeus Hugi*, Agassiz, [*Acrosalenia pustulata*, Forbes], *Ctenostreon pectiniforme* (Schloth.), *Limatula gibbosa* (Sow.), *Plagiostoma bellulum*, (M. & L.), *Syncyclonema demissum* (Phillips), *Chlamys articulata*, auctt., *Isastræa* sp.: 1 to 7 ins.	0	4
		Non-sequence. Dundry Freestone wanting.		
VI.	Upper *Trigonia*-Grit	3. Ragstone, very shelly, usual fossils, but *Acanthothyris spinosa* very abundant at 4 inches from the base ..	1	4
		Non-sequence. Beds VII.-XXI. (*inclusive*) *wanting.*		
? XXII.	Lower Freestone	4. Limestone; top-bed much bored and oyster-strewn	13	0
? XXIII.	Pea-Grit Equivalent	5. Rubbly layer; *Belemnites* spp.: 0 to 6 inches	0	3
		6. Limestone; *Amusium personatum* (Goldfuss)	10	0
		7. Rubbly layer; *Belemnites* sp... ..	0	5
XXIV.	Lower Limestone	8. Limestone, more massive; *Amusium personatum* common: seen	8	0

The sequence of the component layers of the Cephalopod-Bed is so essentially the same as at Wotton Hill that it is unnecessary to detail it here. It will be sufficient to draw attention to the presence of the newly-recognised *Pedicum*-Bed, better known to collectors as the "Linseed-Bed."

STINCHCOMBE HILL.

The sections now to be noticed are on that conspicuous promontory, Stinchcombe Hill, and its south-easterly extension, Break-Heart Hill.

Under the guidance of the writer, both the Geologists' Association and the Cotteswold Club have studied its structure, and reports of the excursions have appeared in the Proceedings of these Societies.[1] It will be unnecessary, therefore, to do

1 Proc. Geol. Assoc., vol. xx. (1908), pp. 526-529; Proc. Cotteswold Nat. F. C., vol. xvi., pt. 3 (1909), pp. 212-216 and pls. xviii. and xix.

more than record the actual succession, and to briefly indicate where the several deposits can best be studied.

The hill is most conveniently approached from Berkeley-Road Station. A slight rise leads up to the platform formed by the Marlstone, which—in this area in particular—has been extensively quarried for road-metal. At the south-eastern end of the large quarry still (1910) in work, near the Yewtree Inn, indications of the richly-fossiliferous "Transition-Bed" of the Midlands (a deposit of *acuti* hemera) have been noticed by Messrs Beeby Thompson and W. D. Crick; but they are difficult to find now.[1]

To the Marlstone succeeds the Upper-Lias clay, which may be anything up to 40 feet in thickness. A well sunk in the field in the hollow between the Yewtree Inn and the hill, and now marked by the windmill, proved the *Falciferum*-Beds; while in a "Section in the road at Stinchcombe," opposite Peers Court, Mr S. S. Buckman informs me, he obtained evidence of the *Bifrons*-Beds with the Cotteswold Sands above.[2]

On the way up the hill there is ample evidence of the Cotteswold Sands, and near where the wall commences above the gravel-pit, the Cephalopod-Bed is seen cropping out in the bed of the road. It is only indifferently exposed here, and is best seen in the deeply-cut lane leading from Break-Heart Hill down to the inn near Fording Brook. In this lane there is also the finest section through the Sands that there is in the Cotteswold Hills—the Sands being about 230 feet thick, and visible for nearly their entire thickness. Near the bottom of the lane some hardish bands are interstratified in the Sands, and have yielded a few specimens of *Haugia*. The lithic and faunal characters and sequence of component layers of the Cephalopod-Bed here are so similar to their equivalents at North Nibley and Wotton-under-Edge that a detailed record of this section is really unnecessary.

Passing on to the Common on the hill, a number of old quarries will be observed. The beds exposed in them are described in the record given on page 112. A rubbly layer is queried as being on the horizon of the Pea-Grit, and if this surmise is correct it makes, of course, the Freestone *above* it, Lower Freestone, and that below it, Lower Limestone.

1 Rep. Brist. Assoc. for 1891, p. 350. 2 Quart. Journ. Geol. Soc., vol. xlv. (1889), p. 446.

There are several other quarries in the Freestones on this hill, for example, near the top of the lane leading up from Fording Brook; at the top of Nunnery Lane; at Break-Heart Hill; and again in Hillside Wood.

There are no beds between the Upper *Trigonia*-Grit and Freestones in this hill-mass. Everywhere the former rests upon a water-worn and bored surface of the latter.

The quarry at Break-Heart Hill is the one concerning the date of the limestones in which Mr H. B. Woodward entertained some doubt. He leaned to its Inferior-Oolite age, but referred the beds to the horizon of Witchell's White Oolite instead of to the freestones of *Murchisonæ* hemera.[1] Actually, there are three feet of Upper *Trigonia*-Grit overlying about five times that thickness of Freestone.

Mr Woodward also referred to the Nunnery-Lane Quarry, describing it as the "section south of Dursley."

NUNNERY-LANE QUARRY.

(*Opening in the abandoned working above the main quarry.*)

			Thickness in feet	inches
III.	*Clypeus*-Grit	Rubble; *Limatula gibbosa* (Sow.), etc.		
VI.	Upper *Trigonia*-Grit	Ragstone, shelly: seen *in situ*, about ..	3	0
? XXII.	L. Freestone	Limestone: seen .. .. (*In the main freestone quarry*)	6	0
? XXII.	Lower Freestone	Limestone: seen	8	0
? XXIII.	Pea-Grit Horizon	Rubbly rock of a yellower colour than the contiguous limestones, pisolitic in places, pebbly; *Rhynchonella subangulata*, Dav., *Terebratula* (*? T. plicata*, J. Buckman): about	0	10
XXIV.	Lower Limestone	Limestone: seen about	27	0

The Upper *Trigonia*-Grit is only thin here in comparison with its normal development in the Mid Cotteswolds; but is quite typical and replete at the top with fragments of *Trichites*. Its surface is oyster-strewn, and thereon rests a marly layer correlative with the Upper Coral-Bed, which at Stancombe Quarry has yielded quite a number of highly-interesting echinoids. The upward succession is best made out in the Stancombe Quarry, which is on the east side of Hollow Combe. It is divided into two portions by a trackway.

1 "The Jurassic Rocks of Britain, etc.," Mem. Geol. Surv., vol. iv. (1894), p. 88; see also Proc. Geol. Assoc., vol. xx. (1908), p. 527.

There is nothing particular to record with regard to the southern portion. The northern portion is also divisible into two parts—this time by a grass-covered slope, which marks a line of fault. In the first part of this northern portion is seen about 3 feet of the usual kind of Upper *Trigonia*-Grit, with a well-marked layer of oysters on top. Then comes a rubbly deposit, which is of exceptional interest, in that—as already mentioned—it has yielded a number of comparatively rare echinoids. In the Coral-Bed equivalent, and in presumably the basal portion of the overlying limestone-rubble, *Terebratula subsphæroidalis*, Upton, is by no means uncommon.

At the extreme northern end of the other portion of the quarry are bedded, unfossiliferous limestones, passing up into more rubbly rock, which contains *Clypeus Agassizi*, Wright, while this is followed by distinctly fossiliferous limestone—the whole constituting the local *Clypeus*-Grit. The White Oolite is represented by greyish, rather sandy-looking limestones, with few fossils except for *Acanthothyris spinosa* (Schlotheim); and then, capping the section, are the Rubbly-Beds—quite typical and abounding in *Terebratula globata*, auctt. non Sow., *Holectypus depressus* (Leske), etc.

Returning to the combe at the northern end of the hill, at the head of which a new house has been erected and a reservoir constructed, a number of interesting exposures were available when the pipe from the windmill in the bottom, near the Yew-tree Inn, to this reservoir on the hill-top, was being laid. The freestones were disclosed with the Upper *Trigonia*- and *Clypeus*-Grits above. Then in a trial hole, occupying a position *between* the *Clypeus*-Grit and Rubbly-Beds, and therefore *presumably* on the horizon of the White Oolite, were the interesting beds detailed below. Here and there on Stinchcombe Hill it seems probable that there are pockets of Fullers' Earth; but this deposit is best seen in a pond-side close to the road on Break-Heart Hill.

DEPOSITS EXPOSED IN A TRIAL-HOLE ON STINCHCOMBE HILL.

	Thickness in feet	inches
1. Limestone, rubbly, pale-brown: *Pholadomya* epp., *Goniomya angulifera* (Sow.), *Natica bajociensis*, d'Orb., *Terebratula globata*, auctt. non Sow., *Perisphinctes pseudo-martinsi*, Siemiradzki	1	3
2. Clay, marly; Ostracoda and Foraminifera (*see below*)	0	2

3.	Limestone, as before; *Terebratula globata*, auctt. non Sow., *Aulocathyris carinata* (Lamarck), *Acanthothyris spinosa* (Schlotheim) *Galeolaria socialis* (Goldfuss), *Collyrites ovalis* (Leske), etc.	0 10
4.	Shaly marl with lumps of limestone in places; Ostracoda and Foraminifera: 3 to 5 inches	0 4
5.	Limestone, brown, crystalline: seen	0 10

Associated apparently with the basal portion of the Rubbly Beds, and revealed in material thrown out of the excavation for the pipe, was some more greenish-yellow clay, very rich in Ostracoda and Foraminifera. Mr C. Upton mounted the specimens, and Mr Joseph Wright, F.G.S., of Belfast, very kindly identified them for me as far as was possible.

MICROZOA FROM STINCHCOMBE HILL.

SPECIES	Marl-Bed at the base of the Rubbly Beds	Marly Beds on the horizon of the White Oolite
Anomalina ammonoides (Reuss)	*	
Cornuspira cretacea, Reuss..	*	*
Cristellaria acutauricularis (Fichtel)	*	*
—— *exilis*, Reuss	*	*
—— *italica*, Defrance	*	*
—— *Marcki*, Reuss	*	*
—— *rotulata* (Lamarck)	*	*
—— *tricarinella*, Reuss	*	*
—— sp. (intermediate between *C. acutauricularis and C. rotulata*)	*	*
Discorbina globularis, d'Orbigny	*	
Flabellina pulchra, d'Orbigny	*	*
? Globerigina bulloides, d'Orb.	*	
? —— *cretacea*, Reuss	*	
? Lagina sp.	*	
Lingulina semiornata, Reuss	*	
Marginulina bullata, Reuss..	*	*
Nodosaria communis (d'Orb.)	*	
—— *farcimen* (Sold.)..	*	
—— *obliqua* (Linné)	*	
—— *scalaris* (Batsch.)	*	
—— *raphanus* (Linné)	*	*
Planularia Bronni, Roemer..	*	*
—— *parvula* (d'Orb.)		*
—— *pauperata*, T. & P.	*	*
Textularia trochus, d'Orb.		*
Verneuilina aff. *pygmæa* (Egger)	*	*
Cytheridea craticula, (Jones and Sherborne) ..		*
—— cf. *fullonica*, J. & S.		*
and 25 or 26 unidentified species		*
Chirodota-spicules (6-rayed)..		*
Sponge-spicules		*

Sequence at Stinchcombe Hill, near Dursley.

			Thickness in feet	inches
		(*Pond in the wood by the road-side on Break-Heart Hill*)		
	Fullers' Earth	1. Clay, bluish-grey and yellow, with *Cristellaria cultrata*, Montford, Ostracoda, 5 spp. and intercalated limestone bands almost wholly made up of *Ostrea acuminata*, Sow.		
		(*Stancombe Quarry : north-west portion.*)		
I.	Rubbly Beds	2. Limestones, rubbly, pisolitic; *Terebratula globata*, auctt. non Sow., one specimen with *Kololophus Terquemi* (Haime) on it, *Rhynchonella* spp., *Acanthothyris spinosa* (Schlotheim), *Limatula gibbosa* (Sow.), *Ceromya striata* (Sow.), *Natica bajociensis* (d'Orb.), *Clypeus Ploti*, Klein, *Holectypus depressus* (Leske), and var. *conicus*, Paris, etc.: seen	2	0
II.	White Oolite	3. Limestones, rather sandy-looking; *Ceromya plicata*, Agassiz, *Acanthothyris spinosa* (Schloth.) : about 4 ft. seen : add say 1 ft.	5	0
III.	*Clypeus*-Grit	4. Limestone, somewhat hard, rather barren at the base, passing up into less-bedded oolite that contains *Clypeus Agassizi*. Wr., and this into a very shelly rock : seen	7	0
		(*Stancombe Quarry : south-east portion.*)		
		5. Limestone; *Camptonectes* sp. *Terebratula subsphæroidalis*, Upton, *Acanthothyris spinosa* (Schloth.) : seen	2	6
		6. Limestone, rather hard	0	8
IV.	Upper Coral Bed	7. Rubbly deposit, very fossiliferous; *Acrosalenia pustulata*, Forbes, *Clypeus Hugi*, Agassiz, *Echinobrissus clunicularis* (Llhwyd), *Acanthothyris spinosa* (Schloth.), *Terebratula subsphaeroidalis*, Upton, *Serpula* 2 spp.	0	3
		Non-sequence. Dundry Freestone wanting.		
VI.	Upper *Trigonia*-Grit	8. Ragstone; usual fossils : seen ..	2	6
		(*Small opening near the seat on the summit of the hill.*)		
VI.	Upper *Trigonia*-Grit	9. Ragstone, very shelly; *Ctenostreon pectiniforme* (Schloth.). *Trichites undulatus*, Lycett, *Zeilleria Hughesi* (Walker), and usual fossils : seen about	3	0
		Non-sequence. Beds VII *to* ? XXI *incl. wanting.*		
		(*Gap : grass-covered slope to old quarries : 8 to 10 feet.*)		
? XXII.	Lower Freestone	10. Limestone : 4 to 6 feet	5	0

CAM LONG DOWN AND DURSLEY

(G. A. Powell, photo.)

(From Burrow's "Borough Guide to Dursley.")

SEQUENCE AT STINCHCOMBE HILL, NEAR DURSLEY—*continued*

			Thickness in feet	inches
? XXIII.	Pea-Grit horizon	11. Somewhat iron-stained rubbly deposit; *Pentacrinus*-ossicles, *Rhynchonella granulata*, Upton: 6 to 12 inches	0	9
XXIV.	Lower Limestone	12. Limestone: oolite	6	0
		13. Noticeable deposit of white "sand," made up of oolite granules: no microzoa	0	1
		14. Limestone, coarsely-oolitic	0	8
		15. Dark-red deposit of quartz sand: no microzoa	0	1
		16. Limestone, oolitic. top well-planed: seen	6	0
		[Unexposed: say	13	0]
XXV.	*Scissum*-Beds		7	4
XXVI. & XXVII.	*Opaliniforme* and *Aalensis-Beds*	*estimate*		
	Cephalopod-Bed (Liassic portion): *estimate* ..		13	6
	Cotteswold Sands: estimate		230	0
	Upper-Lias clay: estimate: 30 to		40	0

(3) DURSLEY-SELSLEY-HILL AREA.

The physical feature of the district between Dursley and Uley is the deep, gulf-like hollow, out of which rise curious, smooth-sided, grass-clothed hills, of which Downham Hill ("Warren Hill" on the Geological Survey-Map) and Peaked Down are conical, and Cam Long Down is noticeably flat-topped (Plate XVII). These outlying masses are the product of ordinary subaërial denudation, assisted by the "lie" of the rocks. They are based upon the easily-located Marlstone, to which succeeds the Upper-Lias clays and sands—together some 270 feet thick.

Ascending Cam Long Down by the track which passes through a deep cutting in the Cotteswold Sands, where that track emerges at the top of the Common, there is on the left an exposure of the *Dumortieria-Struckmanni*-Beds of the Cephalopod-Bed, while a little higher up is one in the portion which is of *opaliniformis-aalensis* date. The *Opaliniforme*-Bed is remarkable for its large, hard, yellow-coated granules, which render it readily identifiable. Yet higher up is a quarry in the Lower Limestone.

The details that have been obtained at Cam Long Down may thus be summarized:

SEQUENCE AT CAM LONG DOWN

(Quarry on Cam Long Down)

			Thickness in feet	inches
XXIV.	Lower Limestone	1. Limestones, massive		
XXV.	*Scissum*-Beds	2. Limestones, sandy; *Galeropygus agariciformis* (Wright)		
		(Opening by the track-side to the west.)		
XXVI. and XXVII.	*Opaliniforme*- and *Aalensis*-Beds	3. Limestone, hard, with yellow-coated specks; Ammonites much perished, and without test, [Walkeria, spp.], *Lytoceras Wrighti*, S. Buckman, *Pholadomya fidicula*, Sow.	2	6
		(In another opening still further west.)		
?	*Moorei*-Bed	4. Yellowish sandy marl with belemnites	0	7
	Dumortieria-Bed	5. Stone, bluish-yellow [*Dumortieria costula* (Reinecke) (xxxvii., 12 and 13), *D. signata*, S. B. (xlii., 6 and 7), *D. radians* (Reinecke) (xlii., 8 and 9), *D. metita*, S. B. (xlii., figs. 11, 22), *D. diphyes*, S.B. (xlii., 13-15), *Hudlestonia serrodens* (Quenstedt) (xxxviii., 11 and 12)], *Trigonia Ramsayi*, Wright, etc.		
		6. Yellowish marl	0	1
	Struckmanni-Bed	7. Limestone, with brown grains [*Pseudogrammoceras subquadratum*, S. B. (xxxv., 3-5), *P. pachu*, S. B. (xxxiv., 1 and 2), *Volsella sowerbyana* (d'Orb.), *Opis carinata*, Wright, *Protocardia Hulli* (Wr.), *Gresslya abducta* (Phillips), *Astarte lurida*, Sow.]	0	6
	Pedicum-Bed	8. "Linseed-Bed." Brown marl, with numerous dark grains	0	2
	Striatulum-Bed	9. Limestone, brown, with dark-brown grains; *Haugia Eseri* (Oppel.) ..	0	5
		10. Marl, dark-brown, filling in the inequalities of the bed below.		
	Variabilis- and *Lilli*-Beds	11. Limestone, bluish-grey, sandy *(Exposed in "The Gully.")*		
		12. Sands, yellow; *estimated at*	220	0
	Falciferum-Beds	13. Clay, blue, tenacious; *estimated at*	70	0
	Marlstone	14. "Rock-Bed"; *Rhyn. amalthei* (Quenstedt), and *Belemnites* spp. very abundant		

I am indebted to Mr S. S. Buckman for certain stratigraphical details, and for the information with regard to the ammonite-fauna.

COALEY WOOD

The large quarry in Coaley Wood is plainly visible from Cam Long Down. Descending the steep eastern slope of the hill, getting into the lane, and proceeding along it to "The Moors," the first turning to the right leads up through Coaley Wood. Soon after the lane becomes sunk, the hard sandy limestone which yields *Hildoceras semipolitum*, S. Buckman, so abundantly, and is of *Lilli* date, is seen projecting from the bank on the right-hand side. Then high up on the left, is the well-known Coaley-Wood section of the Cephalopod-Bed.

SEQUENCE IN COALEY WOOD

(Old Quarry at Crawley Barns.)

			Thickness in feet	inches
II.	White Oolite	1. Limestones, white, flaggy, oolitic, with a noticeable amount of calcite in the matrix; *Acrosalenia spinosa*, Ag., *Terebratula globata*, auctt. non Sow. (rare)		
		2. Marl, yellowish: average	0	1
III.	*Clypeus*-Grit	3. Limestones; *Cardium citrinoideum*, Phillips		

(Coaley-Wood Quarry.)

VI.	Upper *Trigonia*-Grit.	4. Ragstone, shelly, usual fossils		
		Non-sequence. Beds VII.-XXI. (incl.) wanting.		
XXII.	Lower Freestone	5. Limestones, oolitic: about	35	0
XXIII.	Pea-Grit horizon	6. Rubble and Marl	0	6
XXIV.	Lower Limestone	7. Limestones, oolitic: 20 to 25 feet ..	22	0
		(Section of the Cephalopod-Bed at the top of the bank below the above quarry.)		
XXV.	*Scissum*-Beds	8. Limestones, somewhat sandy: about	5	6
XXVI.	*Opaliniforme*-Bed	[4.] Limestone, hard, grey-brown, with numerous small brown-grains; *Pseudolioceras Beyrichi* (Schloenb.) (xx., 7 & 8), *Canavarina* sp. (xiii., 4 & 5)	1	4
XXVII.	*Aalensis*-Bed	[5.] Limestone, rubbly, conspicuously ironshot, and full of belemnites ..	0	6
	[*? Aalensis*- &] *Moorei*-Bed	[6.] Limestone, rubbly; *Pleydellia leura*, S. B. (xxxiii., 8 to 10), *Astarte lurida* Sow., *Opis carinata*, Wr., *Cypricardia brevis*, Wr., and in this bed or that below, *Hinnites abjectus*, Phil., *Pleuromya, Gervillia fornicata, Lycett* ..	0	8

SEQUENCE IN COALEY WOOD—*continued*

			Thickness in feet	inches
Dispansum- and *Struckmanni-* Beds	[7.]	Limestone, hard, compact, pale-yellow with darker grains; *Pseudogrammoceras doerntense* (Denckm.) (xxix., 1 to 5), *P. placidum*, S. B. (xxix., 8 to 10 and xxxiii., 11 and 12), *P. Bingmanni* (Denckm.) (xxxiv., 3 to 5), *P. quadratum* (Haug) (xxxiv., 6 and 7), *P. regale*, S. B. (Suppl. p. cxlvi.), *P. Struckmanni* (Denckm.), *P. compactile* (Simpson), *Polyplectus discoides* (Zieten), *Hammatoceras insigne* (Schübler), *Phlyseogrammoceras dispansum* (Lycett), etc.	0	6
Pedicum-Bed	[8.]	"Linseed-Bed." Brown rubbly marlstone; *Haugia Eseri* (Oppel.) (xxv., 3 and 4), *H.* aff. *illustris* (Denckmann) (xxvi., 4), *Pseudogrammoceras subfallaciosum*, S. Buckman (xxxiii., 17 to 18), *P. expeditum*, S.B. (xxxiv. 10 and 11), *P. thrasu*, S.B. (xxxvi., 6 to 8), *P. pedicum*, S.B. (Suppl. p. cxlvii.)	0	7
Striatulum- Bed	9*a*.	Marl, with *Grammoceras toarciense* (d'Orbigny) (xxviii., 9 and 10), and *G. audax*, S.B. (xxviii., 4 to 6) ..		
	9*b*.	*filling up* inequalities between lumps of hard bluish-grey sandy stone: 2 to 3 inches	0	3
Variabilis- Bed	[10 to 15]	Sands, yellow, with more or less nodular bands of sandstone; *Phymatoceras pauper*, S.B. (Suppl., iii., 7 to 9), in bed 13 etc.	65	6
	[16]	Sandstone; *Haugia grandis*, S. B. (xxxii., 14 and 15), *Denckmannia obtecta* (Suppl., iv., 4 to 6).. ..	0	9
Lilli-Bed	[16*a* to 18]	Sands, fine, yellow, with a band of sandstone containing *Hildoceras semipolitum*, S.B. (xxii., 30 and 31), *Pseudolioceras quadratum* (xx., 3 and 4), *Plagiostoma* sp., *Hinnites objectus*, Phil., etc., estimated by Mr Buckman at	66	0
Bifrons- & *Falciferum*-Beds	[19.]	Clay, blue		
		"Rock-Bed"		

(*The numbers in square brackets refer to the numbers of the beds given in Mr S. S. Buckman's record in Quart. Journ. Geol. Soc., vol. xlv.*, 1889, *p.* 444.)

I am indebted to Mr Buckman for the more accurate dating of the deposits seen in this section, and for the allocation of the ammonite-fauna. The annexed sketch-section (fig. 3), will probably aid in the identification of the deposits, and it may be pointed out that between the line of oysters in

bed 6 and the top of bed 7 is the horizon where evidence for the *Dumortieria*-Bed should have been found if that bed had been present.

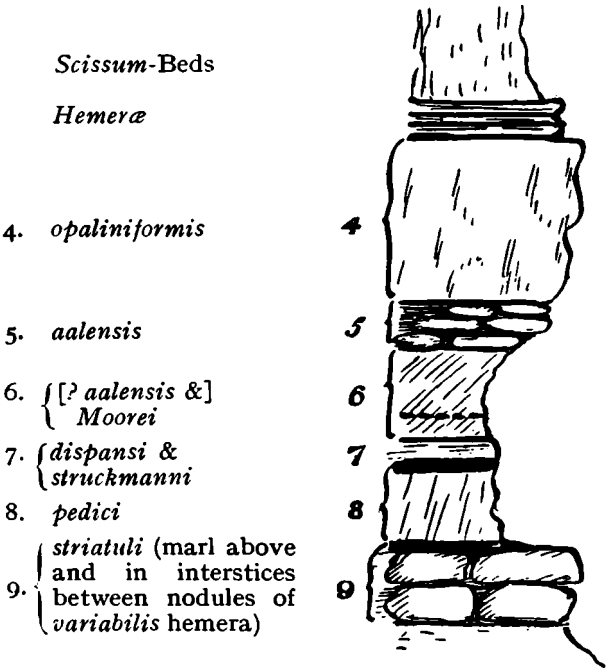


FIG. 3.—Profile-sketch of the Cephalopod-Bed in Coaley Wood, near Dursley.

Leaving Crawley Barns and proceeding towards Stroud, the "Money Quarry," as it is locally called, will be noticed after some 600 yards have been traversed. It exhibits the least typical Top-Beds of the Oolite that I have seen in the Cotteswold Hills, north of Sodbury. At the base of this section are yellowish-grey oolitic limestones (probably belonging to the top-portion of the *Clypeus*-Grit: seen 3 feet); then come flaggy, well-oolitic yellowish-grey limestones, without any marly partings (4 feet); while at the top are more rubbly limestones with specimens of *Clypeus Ploti* abundant. Some yellowish-green clay on the spoil-heaps showed that the Fullers' Earth had not long been removed, geologically speaking, by denudation.

Frocester Hill.—Leaving on the right the celebrated Uley Tumulus, or "Hetty Pegler's Tump," as it is locally called, the breezy and view-commanding Frocester Hill is soon reached. Here there is a very large quarry in the Lower Freestone and

Lower Limestone; while in the bank below, by the side of the main-road, is the section of the Cephalopod-Bed which has been examined by so many geologists.

Witchell was the first to point out that the main mass of the freestone in the large quarry was Lower Limestone and not Lower Freestone, and that the rubbly-bed about 12 feet from the top was on the horizon of the Pea-Grit. Certain authors had thought that the *Scissum*-Beds here were correlative with the Pea-Grit of the neighbourhood of Cheltenham, and therefore naturally paralleled the Lower Limestone and the Lower Freestone of Frocester with the Lower Freestone of the Cheltenham area. Brodie found a frond of a fern in the *Scissum*-Beds here, and Dr Wright recorded an exceptionally large number of fossils from the Sands. Wright estimated the thickness of the Sands here at "? 150 feet," and the blue clay at 80 feet.[1]

There are two tolerably satisfactory exposures of the Cephalopod-Bed. The one is by the side of the main-road below the quarry, and may be known as the "Frocester-Hill Section" proper. It is the one which I described in the report of the excursion of the Club to this locality. In that account I recorded such subdivisions of the Bed as were at once apparent on inspection, and it is unnecessary to say more concerning it than has already been published. The other exposure is a little further to the north, high up in the steep hill-side well above the road. It may be called the "Coaley-Peak Section."

Mr S. S. Buckman has very kindly sent me the following record of the Frocester-Hill roadside-section, which he made on October 24th, 1893, and has compared it with the section at Haresfield. Mr Buckman correlated, in a general way, these two sections as far back as 1888. The following record, however, is brought up to date. Mr Buckman comments in his notes sent to me on the lack of evidence here for deposit of *Dumortieriæ* hemera, and this, as he remarks, is the more noticeable when it is remembered how rich is the ammonite-fauna at Pen Wood, only a comparatively short distance further north.

1 Quart. Journ. Geol. Soc., vol. xii. (1856), p. 304.

FROCESTER-HILL SECTION.—*S. S. Buckman*, 1893.[1]

		Thickness in feet	inches
XXVI. *Opaliniforme*-Bed (15 *of Haresfield*)	1. Hard, pinkish, very little ironshot stone. "Bottom-Bed of Bugstone or Ragstone" of quarrymen.. ..	1	0
XXVII. *Aalensis*-Bed (16 *of Haresfield*)	2. Soft ironshot yellowish mudstone, attached to the base of bed 1 with a very uneven junction; *Rhynchonella cynocephala*, auctt., small and rare, *Canavarina folleata*, S.B. (xxx.. 1, 2), *? Cotteswoldia limatula*, S. B. (xxx., 5-7), *C. crinita* S.B. (xxxi., 3, 4), *C. superba*, S. B. (xxx., 1, 2), *C. costulata* (Ziet.) (fig. spec., xxxiii., 3, 4), *Pleydellia fluens*, S.B. (xxxi., 1, 2), *P. aalensis* (Ziet.) (fig. spec., xxx., 3-6), etc.	0	4
Moorei-Bed* (17 & 18 *of Haresfield*)	3. Soft yellowish ironshot mudstone, with softer marly streaks. Band of *Rhyn. cynocephala*, auctt. 7 inches from the top (*Rhyn. ? cynica*, S.B), and in the bottom 2 inches *Rhyn. ? cynoprosopa*, S.B., *Dumortieria subfasciata*, S. B. (xxx., 18) or lower, *D. munda*, S. B. (xliv., 10-12—or lower), *D. Moorei* (Lycett).. ..	0	10
	4. Yellow, very ironshot mudstone; *Rhyn. cynoprosopa*, S. B. at top, *Lytoceras* cf. *Leckenbyi*: (Lyc.) ..	0	7
	5. Yellowish, often blackish ironshot mudstone; *Cotteswoldia subcandida*, S. B. (xxx., 7, 8) or higher, *Lytoceras Leckenbyi* (Lycett), *Lytoceras* sp.	0	10
Dispansum-Bed	6. Very black-stained ironshot mudstone; *Chartronia binodata*, S. B. (Suppl. i., 11-15) evidently belongs here and was wrongly attributed to the *Dumortieria*-Zone	0	9
Struckmanni-Bed [& *Pedicum*-Bed]	7. Yellow ironshot mudstone, dark in places [*Pseudogrammoceras thrasu*, S. B., *P. Bingmanni* (Denckm.), *P.* cf. *pedicum*, S.B.	0	6
Striatulum-Bed	8. Soft marl, with blocks of hard sandrock, redeposited	0	1
	6. Lumps of sandrock in irony coatings, cemented together by marly stone, which contains *Grammoceras striatulum* (Sow.), etc.		

* The following type-specimens came from Frocester, and from this horizon:—*Dumortieria Moorei* (Lyc.), *Lytoceras Leckenbyi* (Lyc.), *Protocardia Hulli* (Wr.), *Opis carinata*, Wr., *Lima ornata*, Wr., *Cucullæa ferruginea*, Wr., *Astarte rugulosa*, Lyc., and *Trigonia Ramsayi*, Wr.

Returning to the Stroud Road, on the east side of the road above the main Frocester-Hill Quarry, is a smaller one,

1 "Many of the ammonites of beds 2 and 3 were obtained from the adjacent Coaley-Peak Section (where only the *Aalensis*- and *Moorei*-Beds are exposed), and are included here for the purposes of reference (see Monograph 'Inf. Ool. Amm.')." S. S. B. (*in litt.*).

also in the Lower Freestone. Continuing northwards, the remains of the "Nympsfield Tumulus," opened by the Cotteswold Club in 1862, will be seen on a slight rise in a field on the left, and then—also on the left—at the very commencement of Buckholt Wood, but invisible from the road, is another large quarry in the Lower Limestone and Lower Freestone. The Pea-Grit here, according to Witchell, "is represented by a freestone bed with ferruginous stains." ("Geology of Stroud," p. 43).

The wood which extends from the tumulus to the combe just before Pen Hill is generally known as "The Long Wood." On the 6-inch map it bears the names of Buckholt and Stanley Woods; and it is in the former—in the side of the lane leading down to Frocester Cottages—that the Buckholt-Wood Section of Mr S. S. Buckman is situated. He described this section in 1889, but has supplied me with details, which, combined with those already recorded, enable me to present the appended reading fully up-to-date:

SECTION AT BUCKHOLT WOOD

		Thickness in feet	inches
Moorei-Beds	1. Brownish limestones with darker-brown grains; *Dumortieria subexcentrica*, S.B. (xliv., 7 & 8), *D. subundulata* (Branco) (xlv., 1 to 3), *D. exacta*, S.B. (xlv., 6 and 7), *D. sparsicosta*, Haug. (xlv., 17 to 20), *D. externicompta* (Branco), *Cotteswoldia bifax*, S. B. (Suppl., p. cxxxvi.) or above, *C. paucicostata*, S.B., *C. particostata*, S. B,, *C. egena*, S.B., *C. attrita*, S.B. (Suppl., xxiii., 1 to 14), *C. crinita*, S. B., *Pleydellia mactra* (Dumortier) (xxx., 3 to 7), *Rhynchonella cynocephala* (Richards), *Terebratula haresfieldensis*, Dav., *Belemnites* spp., *Pseudomelania procera* (Desl.), *Tancredia* sp.	1	9
Dumortieria-Beds	2. Yellowish, but more often dark-grey, almost black mudstone, with dark-brown grains. *Ammonites* scarce and badly preserved; *Dum. rhodanica*, Haug, *Rhyn. cynocephala* (Richards), *Terebratula haresfieldensis*, Dav., and varieties, etc.	2	0
	3. Reddish-yellow, somewhat sticky, gritty marl; in places numerous *Belemnites*	0	6
Dispansum-Beds	4. Dark-grey ironshot soft stone; *Phlyseogrammoceras dispansum* (Lycett) (common), *P. metallarium* (Dumortier), (xxxvi., 1 & 2), *Hammatoceras insigne* (Schübler), *Astarte* sp...	1	0
	5. Marl	0	2

SECTION AT BUCKHOLT WOOD—*continued*

		Thickness in feet	inches
Struckmanni-Beds	6. Light yellow soft stone; *Pseudogrammoceras doerntense* (Denckm.)	0	9
Pedicum-Beds	7. "Linseed-Bed." Brownish marl with numerous dark brown grains. *Pseudogrammoceras cotteswoldiæ*, S.B. (xxxv., 4 to 6: misprint bed 6 in explanation of plate)..	0	7
Striatulum-Beds	8. Yellowish stone with brown grains; *Grammoceras striatulum* (Sowerby), abundant	0	6
	This bed lies above, and fills the interstices of the very uneven-topped		
Variabilis-Beds	9. Hard, blue-hearted sandstone; *Canavarella ? arenacea*, S.B. (xxviii., 20 & 21)	1	3
	10. Yellow micaceous sands		

At 4¼ miles from Stroud is a quarry in a field on the right-hand side of the road, which may be called the "Stanley-Wood Quarry."

STANLEY-WOOD QUARRY

III.	*Clypeus*-Grit	1. Limestone, obscurely-oolitic, rather sandy-looking: seen	4	0
V.	Horizon of Dundry Freestone	2. Limestone, shelly, ironstained; a few oysters adhering to its upper surface	0	4
VI.	Upper *Trigonia*-Grit	3. Ragstone, shelly; crowded with *Trigonia costata*, Sow.	1	11
		4. Rubbly ragstone	0	2
		5. Ragstone, the median portion crowded with *Acanthothyris spinosa* (Schloth.), *Rhynchonella* spp.	1	10
		6. Parting	0	0¼
		7. Ragstone, massive, shelly; usual fossils	3	2
		Non-sequence. Beds VII. to XXI. (incl.) wanting.		
XXII.	Lower Freestone	8. Limestone, massive, top-portion slightly bored: seen	6	0

Workings on the same side of the road further along, and in Pen Wood, all show the Upper *Trigonia*-Grit resting upon the Lower Freestone—no beds in between.

By the path-side, close to the cottage at the foot of the northern slope of Pen Hill, is the site of the Pen-Wood Section of Mr Buckman. The section was only a temporary one, an excavation being made and then filled up. However, Messrs Buckman and Charles Upton obtained a number of fossils therefrom, and the former geologist has supplied me with the appended record of the beds which were revealed.[1]

1 "In the original section Beds 2 to 4 were called '*Opalinum*-Zone,' Bed 4 being '*Opalinum*-Zone, *Moorei*-Beds'; Beds 5 to 9 '*Dumortieria*- and *Dispansum*-Beds'; Beds 10 and 11 '*Striatulum*-Beds.' These details will explain the horizons given in the earlier part of the Monograph."—S. S. Buckman (*in litt.*)

PEN WOOD, NEAR STROUD.—S. S. BUCKMAN

(*Temporary artificial excavation*)

			Thickness in feet	inches
XXIV.	Lower Lime-stone	1. Limestone, in large blocks		
XXV.	*Scissum*-Beds	2. Limestone, hard, yellow sandy; *Lioceras striatum*, S. Buckman, *Tmetoceras regleyi* (Thiollière), *Montlivaltia* sp., *Volsella sowerbyana* (d'Orb.), all found near the top	4	0
XXVI.	*Opaliniforme*-Beds	3. Limestone, hard greyish-yellow, slightly oolitic	0	10
XXVII.	*Moorei*-Beds	4. Limestone, yellowish-brown with some darker grains; *Dumortieria declinans*, S.B. (xl., 10 to 12), *D. diphyes*, S. Buckman (xliii., 5 to 7), *D. exigua*, S.B. (xliii., 10 to 12), *D. rustica*, S.B. (xlv., 10 to 12), *D. Moorei* (Lycett) (Suppl., p. clxxxii.), etc.	0	4
		5. Softer darkish-brown oolitic rock; *Dumortieria* sp. (xlii., 1 and 2), *D. peneexigua*, S.B. (xlii., 3 to 5), *D. lata*, S.B (xliv., 1 to 3 or bed 4)..	1	4
	Dumortieria-Beds	6. Marl, yellowish-brown oolitic; *Hudlestonia serridens*(Quenstedt),*Hudlestonia affinis* (Seebach) (xxxviii., 1 to 3), *Catuloceras aratum*, S.B. (xxxix., 1 to 3), *Dumortieria externicosta* (Branco), (xl., 1 and 2), *D. mutans*, S.B. (xl., 3 to 8), *D. prisca* S.B., *D. novata*, S.B. (Suppl., p. clxxiii.), *D. multicostata*, S B. (Suppl., p. clxxvi.), *D. rhodanica*, Haug, (*D. tabulata*, *D. explanata*, *D. radians*, Suppl. xxii., 25 to 33), *D. Nicklesi*, Benecke, etc.	0	6
		7. Marl, indurated, yellowish-brown; *Phlyseogrammoceras dispansum* (Lycett) ..	0	4
	[? *Struckmanni-* &] *Pedicum*-Bed	8. [? Linseed-Bed]. Dark chocolate-coloured marl with dark granules ..	3	4
	Striatulum-Bed	9. Soft yellowish-brown stone	0	6
		10. Harder stone; *Haugia* aff. *illustris* (Denckmann) (xxvi., 3 or bed above)	0	10
		11. Marl	0	9
	Variabilis-Beds.	12. Blue-hearted nodule-shaped sandy stone	0	4
		13. Yellow sands		

Returning to the Stroud Road and proceeding towards Selsley Hill, Bown Hill—an outlier of Fullers' Earth capped with the basal Great-Oolite beds—is seen on the right. The broken ground over the wall on the right is where there was formerly a clay-pit for brick-making, but it has now been closed some twenty years. Mr Charles Upton washed some of the clay from here, and obtained a few specimens of *Cristellaria* and an ostracod.

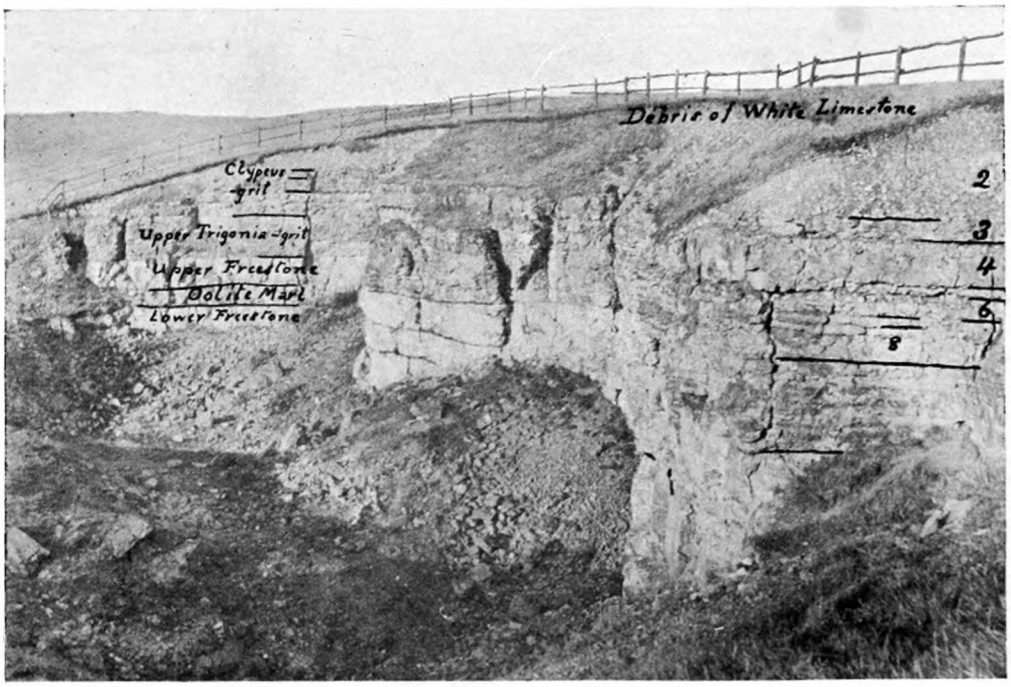


Fig. 1.—LEIGH'S QUARRY, SELSLEY HILL

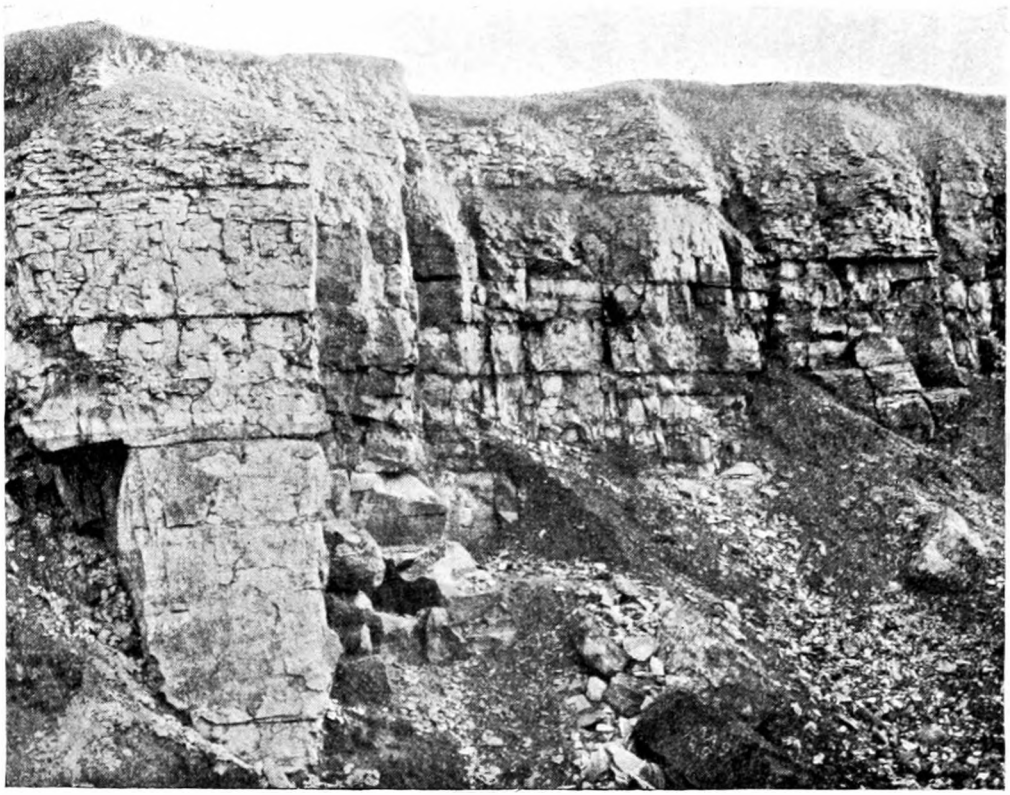


Fig. 2.—No. 4 QUARRY, SELSLEY HILL
(*C. Upton, photo.*)

SELSLEY HILL

Witchell thought that the thickness of the Inferior Oolite at Selsley Hill was about 150 feet.[1] This does not appear to be far wrong; but I should be inclined to say 160 feet. This total embraces the deposits detailed in the general section on pages 125-126. It is very difficult to arrive at estimates of the thicknesses of the Lower Limestone and Lower Freestone from details obtainable at Selsley Hill itself; but in a deeply-cut water-course which traverses the steep hill-side clothed by Pen Wood, a-sixth of a mile to the west of Selsley-Hill Farm, these beds are very fairly exposed, and it was here that the estimates of their thicknesses were obtained.

It is perhaps best to study the sequence of Inferior-Oolite beds at Selsley Hill in ascending order.

Ascending the hill from Dudbridge Station (see map, text-fig. 4), the first quarry to be noticed is on the Common on the right (No. 6), and is in the Lower Limestone. It is the "No. 6" of Edwin Witchell, who has described the geology of this hill in some detail.[2] The Lower Limestone is here noted for its "Dapple-Beds"—limestones with peculiar pebble-like inclusions of oolite, evidently the product of a pene-contemporaneous erosion. Since the Geologists' Association visited the quarry, it has been developed in a southerly direction, and an interesting fault, with

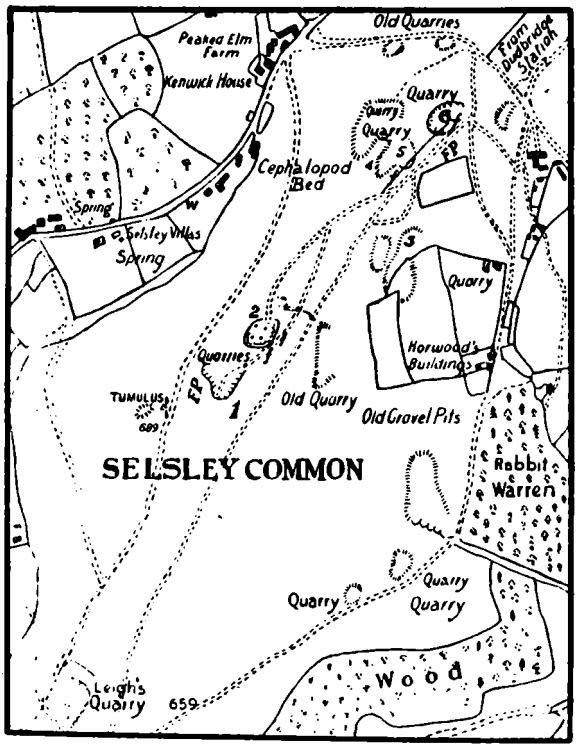


FIG. 4.—Map of Selsley Hill (3 inches = 1 mile) to show the positions of the quarries.

1 Proc. Cotteswold Nat. F.C., vol. ix., pt. 2 (for 1886-7), p. 99. 2 *Ibid.* pp. 96-107.

the Pea-Grit let down beyond, has been disclosed. The Pea-Grit here resembles its equivalent in the next quarry (No. 5), and yields *Terebratula Whitakeri*, *T. plicata*, J. Buckman, *T. pisolitica*, S. Buckman, *Rhynchonella subangulata*, Dav., etc.

In the next quarry (Nos. 4 and 5 of Witchell) the top-portion of the Lower Limestone is visible with Pea-Grit above. In the eastern portion of the southern face the Pea-Grit is let down by faulting some 4 feet, and this fault is probably a continuation of that noticed in the preceding quarry. A view of the western portion of the south face of the quarry is given in Plate XVIII., fig. 2, and details of the beds in the general record on page 126. Attention may be specially directed to the regular and worn aspect of the top-surface of the Lower Limestone, and to the probable occurrence of a slight non-sequence between the Limestone and the Pea-Grit—the Pea-Grit present being the top-portion of that subdivision.

About 300 yards further on up the trackway is quarry No. 2 of Witchell, in which is seen the top-portion of the Lower Freestone, the Oolite Marl, Upper Freestone and overlying Upper *Trigonia*-Grit: *but no Gryphite-, Buckmani-, or Lower-Trigonia*-Grits it should be noted. In the south-eastern corner a trough-fault will be noticed—the Upper *Trigonia*-Grit having been introduced in between the *Bradford-ensis*-Beds, which therefore flank it. The Oolite Marl is very feebly developed here, and at its horizon the beds exhibit considerable variation, and are consequently difficult to measure accurately. The main feature is the large replacement of marl by limestone replete with a new *Rhynchonella*, *Rhyn. Witchelli*, Richardson, which is common here but comparatively rare elsewhere.

In the shallow quarry near the Tumulus (No. 1 of Witchell), the top of the Upper *Trigonia*-Grit can readily be found by means of the layer of oysters, and resting thereon is a bed of very distinctive lumps of limestone containing *Terebratula subsphæroidalis*, Upton, and a new species of *Rhynchonella*. Rubble of typical *Clypeus*-Grit succeeds.

The sequence from the Lower Freestone to the *Clypeus*-Grit is excellently seen in Leigh's Quarry (see map and Plate XVIII., fig. 1). The lower portion of the Upper *Trigonia*-Grit Witchell thought was Gryphite-Grit; but there are no "Intervening-Beds" here.

SEQUENCE AT SELSLEY HILL, NEAR STROUD.

(Leigh's Quarry)

			Thickness in feet	inches
II.	White Oolite	1. Débris of white oolitic limestone: seen	1	0
III.	*Clypeus*-Grit	2. Limestone, somewhat flaggy, broken up and mixed with some marl; *Terebratula globata*, auctt. non Sow., *T. globata* var. *birdlipensis*, Walker, *T. permaxillata*, S. Buckman, *Rhynchonella hampenensis*, S. Buckman, etc., *Amberleya hudlestoni*, Richardson, *Ceromya striata* (Sow.), *Limatula gibbosa* (Sow.), *Holectypus depressus* (Leske), etc.	5	0
		3. Limestone; *Berenicea* sp., *Bourguetia striata* (Sow.)	1	3
		4. Limestone, massive, top bored by *Lithophagi* in places; *Ter. globata*, auctt. very common, *Syncyclonema demissum* (Phillips); 2 ft. to 2 ft. 6 ins. ..	2	2
		5. Limestone, with a most irregular under surface resting upon lumps of limestone; *Pleuromya Goldfussi* (Lyc.), *Trigonia costata* (Sow.), common, *Holectypus depressus* (Leske), etc.	0	8
		6. Limestone, grey-brown, with a most irregular top; few fossils: 6 ins. to 1 ft.	0	9
		7. Limestone	0	7
		8. Limestone, rubbly, with few fossils ..	2	6
		Non-sequence. Beds IV. & V. wanting		
VI.	Upper *Trigonia*-Grit	9. Limestone, very shelly, with a layer of oysters on top	0	10
		10. Lumps of pale-brown, non-oolitic, and not very shelly limestone and shaly marl: average	0	6
		11. Ragstone; usual fossils	2	0
		12. Parting	0	1
		13. Limestone, rubbly; few fossils ..	0	6
		14. Ragstone; usual fossils (= Gryphite-Grit of Witchell)	2	1
		Non-sequence. Beds VII. to XIX. (incl.) wanting.		
XX.	Upper Freestone	15. Limestone, white, oolitic, top-bed conspicuously bored by annelids; *Trigonia costatula*, Lycett, *Nerinæa oppelensis*, Lycett: average	4	2
		16. Parting	0	1
XXI.	Oolite Marl	17. Limestone, rubbly, whitish; *Spiropora*, *Pentacrinus*-ossicles, *Rhynchonella granulata*, Upton, [*Acrosalenia Lycetti*, Wr., *Trochotiara depressa* (Ag.), *Hemipedina tetragramma*, Wr.] ..	1	3
		18. Parting; small sponges	0	0½
		19. Limestone; *Terebratula fimbria*, Sow., *Rhynchonella subobsoleta*, Dav., *Rhynchonella Witchelli*, Rich.: average..	2	0

SEQUENCE AT SELSLEY HILL, NEAR STROUD—*continued*

			Thickness in feet	inches
		20. Marl; same fossils as in 19, and *Ter. submaxillata*, Morris, *Rhyn. granulata*, Upton: 1 to 4 inches	0	2
		(*This deposit alone—No. 20—is paralleled by Witchell with the Oolite Marl*).		
XXII.	Lower Freestone	21. Limestone, massive-bedded, white, oolitic: seen	13	0
		(*In Quarry No. 4.*)		
XXIII.	Pea-Grit	22. Limestone, rather flaggy, pisolitic; *Rhyn. subangulata*, Dav., etc.	3	0
		23. Brownish "marly" deposit, with numerous loose pisolite-spherules; *Pseudoglossothyris simplex* (J. Buckman), *Terebratula plicata*, J. Buckman, *Ter. pisolitica*, S. Buckman, *Ter. Whitakeri*, Walker, *Rhynchonella granulata*, Upton, *Rhyn. subangulata*, Dav., *Proboscina Jacquoti*, Haime, var. *expansa*, Gregory, *Rhyn. oolitica*, Dav., *Nerinæa oppelensis*, Lycett, *Stomechinus germinans*, Phil., *S. intermedius* (Ag.), *Pygaster semisulcatus*, Phil., *Nerinæa pisolitica*, Witchell, *Plagiostoma* sp., etc.	1	0
		24. Rubbly pisolitic rock; *Nerita costulata*, Deshayes, *Nerinæa pisolitica*, Witchell, *Ter. plicata*, J. Buckman, *Plagiostoma Lycetti*, auctt., *Acrosalenia Lycetti*, Wright		
		25. Brown marly layer, with pisolite-spherules: 1 to 3 inches	0	2
XXIV.	Lower Limestone (38 ft.)	26. Limestone, even top-surface, but uneven bottom; *Spiropora*, small *Ostreæ*, echinoid-radioles: 2 ft. to 2 ft. 8 ins.	2	0
		27. Parting	0	2
		28. Limestone; small gasteropods, *Nerinæa pisolitica*, Witchell, *Nerinæa* sp., *Pseudoglossothyris simplex* (J. Buckman): seen	17	0
		(*Not exposed: say 18 ft. 4 ins. of Lower Limestone, and 1 ft. of Scissum Beds*)	18	4
		(*Opening in the hillside near the cottages.*)		
XXV.	*Scissum*-Beds (7 ft.)	29. Limestone, coarsely oolitic: seen ..	5	0
		30. Limestone, hard, sandy; *Amusium personatum* (Goldf.)	1	0
		(*Just below, but a little more to the north*)		
XXVI.	*Opaliniforme*-Bed	31. Limestone, hard, with iron-grains, forming the cap to	1	0
	Cephalopod-Bed	Limestone, well ironshot, passing down into	1	0
		Marl, indurated, richly-ironshot; *Trichites* (fragments)	1	0
		Limestone, hardish, ironshot: seen ..	0	10

The position of the Cephalopod-Bed exposure will be seen upon reference to the map (text-fig. 4).

Between Selsley Hill and Nailsworth two long valleys run westwards into the hill-mass.

The first is the Woodchester Valley. There are no exposures of note in it now, but in times past

> "a landslip on the eastern side of the Woodchester Valley, one mile from Nailsworth, exposed the chocolate-coloured sandstone charged with *Lima Electra*, *Gervillia fornicata*, *Trigonia Ramsayi*, *Perna rugosa*, and *Turbo capitaneus*. Some shaly bands of the blue Lias marl beneath contained many specimens of *Posidonia* [*Posidonomya*] *Bronni*, a shell which is invariably found in the same position in France and Germany." [1]

Also a quarry in the building freestones "has produced many large testacea, including *Trichites nodosus*, Lyc., and *Perna quadrata*, Sow....." [2]

In the next valley, to the south, in "a deep lane cutting adjoining Nailsworth, on the way to the hamlet of Shortwood," Lycett found at the base of the Cotteswold Sands (to be exact, a few feet above the blue Upper-Lias clay) a very fossiliferous bed, apparently of *variabilis* date. It yielded a number of fossils at that time new to science, and most of them were described and named by Wright[3] and Lycett.[3] At the present time the road-cutting is quite overgrown, and nothing more than that it is in the bottom-portion of the Sands can be made out.

Mr S. S. Buckman, F.G.S., informs me that "many specimens of *Hildoceras semipolitum*, S. Buckm., came from a bluish sandy bed exposed in an excavation for the gasholder at Nailsworth.

The Freestones have been worked at a number of places up the Horsley Valley; but the sections call for no particular comment.

1 Lycett, "Cotteswold Hills" (1857), p. 23.
2 *Ibid.*, pp. 43-44.
3 The type-specimens of *Cypricardia brevis*, Wr., and *Protocardia Oppeli* (Wr.) came from "the fossiliferous nodules at the base of the Sands" here (Q.J.G.S., vol. xii. (1856), pp. 324-325) as well as that of *Natica oppelensis*, Lycett ("Cotteswold Hills," pl. i., fig. 4, and p. 123).

The Nailsworth and Rodborough-Hill Area.

On the Bath Road, about half-a-mile to the south of Nailsworth, is a large disused quarry, affording a view of these beds:

Bath-Road Quarry, Nailsworth

			Thickness in feet	inches
II.	White Oolite	1. Limestones, well oolitic, much broken up, but forming, nevertheless, a noticeable capping to the section; *Rhynchonella* sp., and *Terebralula globata*, auctt., rare: seen	5	0
III.	*Clypeus*-Grit	2. Limestone, hard, lumpy: usual fossils: average	0	8
		3. "Marl"; *Ter. globata*, auctt., common	0	1
		4. Limestone, regular bed, but rarely fossiliferous	0	7
		5. "Shale," or calcite	0	1
		6. Limestone, rubbly, especially at the base, where the usual pisolites are numerous; large specimens of *Ter. globata*, auctt., *Pleuromya Goldfussi* (Lycett), *Limatula gibbosa* (Sow.), *Ceromya striata* (Sow.), *Gresslya*, etc.: 10 ins. to 1 ft. 8 ins.	0	10
		7. Limestone, rubbly at the top and bottom; *Clypeus Ploti*, Klein, *Pholadomya* sp. and *Nerinæa Guisei*, Witchell, *Ter. globata*, auctt., etc.	3	10
		8. Limestone, hard, few fossils	1	1
		9. Shale	0	1
		Non-sequence. Beds IV. & V. wanting		
VI.	Upper *Trigonia*-Grit	10. Ragstone, very shelly, in three beds; usual fossils	6	0
		Non-sequence. Beds VII. to XXI. (incl.) wanting		
XXII.	Lower Freestone	11. Limestone, top-bed harder than the rest, and well bored: seen	15	0

It is easy to see in the capping limestones the equivalent of the *Anabacia*-Limestones, and it is not uninteresting to find them so well marked thus far north.

A somewhat similar section is to be seen a little over a quarter of a mile to the north-north-east (by the side of the Tetbury Lane); but the White Oolite (seen 3 feet 6 inches), *Clypeus*-Grit (8 ft. 2 ins.), and Upper *Trigonia*-Grit (5 ft. 4 ins.), are all more fossiliferous. The last-named subdivision rests upon the Lower Freestone, of which about 10 feet is seen. I think the Freestone here and at the Bath-Road Quarry is all Lower Freestone, because of the absence of *Nerinææ*, its massiveness, and suitability for working right up to the base of the "Grit."

At the Hazelwood Quarry, however, there appears to be a trace of the *Bradfordensis*-Beds.

HAZELWOOD QUARRY

			Thickness in feet	inches
III.	*Clypeus*-Grit	1. Limestone, rubbly, grey-brown, with numerous soft yellowish pisolites; *Syncyclonema demissum* (Phillips), *Stomechinus intermedius* (Ag.), etc.	3	6
		2. Limestone, with rather a sandy feel; *Ter. subsphæroidalis*, Upton	0	8
		Non-sequence. Beds IV. & V. wanting		
VI.	Upper *Trigonia*-Grit	3. Ragstone, massive: usual fossils. The upper surface is irregular, water-worn, and usually covered with oysters ..	3	0
		4. Ragstones..	2	4
		5. Parting of brown clayey matter: 1 to 2 inches	0	1
		6. Ragstone, shelly; looks like a cap to the Freestone	0	3
		Non-sequence. Beds VII. to XIX. (incl.) wanting		
XX.	Upper Freestone	7. Freestones, hard, massive, top-bed very much bored, and covered with oysters; *Nerinæa* sp.: seen	5	0

Between Longfords Mill and Avening are two disused quarries by the road-side, and not far apart. They afford much the same section. In the western one there is this sequence:

QUARRY NEAR LONGFORDS MILL

			Thickness in feet	inches
VI.	Upper *Trigonia*-Grit	1. Ragstone, very shelly, usual fossils ..		
		2. Rubbly deposit, made up of limestone-rubble and brown clayey marl ..	0	9
		Non-sequence. Beds VII. to XIX. (incl.) wanting.		
XX.	Upper Freestone	3. Freestone, rather irregularly-bedded; *Terebratula fimbria*, Sow., *Rhynchonella Tatei*, and a few corals (spp. indet.)..	9	0
XXI.	Oolite Marl	4. Brownish marly deposit: 2 to 6 inches	0	3
		5. Limestone, hard, obscurely-oolitic; *Ter. fimbria*, Sow., *Rhyn. Witchelli*, Rich.	1	6
XXII.	Lower Freestone	6. Limestone, massive, formerly mined: seen	20	0

In the south bank of the road near Longfords Mill and Lake (Plate XX., fig. 2) the basement-beds of the Lower Freestone are exposed, and are separated from the Pea-Grit by a layer of brown shaly material, from which specimens of *Terebratula plicata*, J. Buckman, *Plagiostoma Lycetti*, auctt. were obtained. It was from the Pea-Grit here that Edwin Witchell procured many specimens of *Nerinæa*. "The section

at Longfords Mill, Nailsworth," he wrote, "contains a bed of Pea-Grit, in which the grains are in a soft marly paste, overlying a bed of pisolitic limestone charged with several species of *Nerinæa*, the whole being about five feet thick." [1]

The other quarry, a little further on, affords much the same section; but the "Top-Beds" are exposed for a greater thickness, although somewhat difficult of access. There are some seven or eight feet of Upper *Trigonia*-Grit with the basal *Clypeus*-Grit beds above.

At Balls Green the Freestones are being worked by the United Stone Firms Ltd., in surface and underground workings —now, principally in the former. The Prospectus of the Firms states:

> "Until acquired by this Company these Quarries were held by Messrs Andrews and Provis, of Coleford, and Mr C. Essex, of Avening, near Stroud.
>
> The Stone is very little known to Architects and Surveyors, owing to the Quarries having been worked on a very small scale in the past, and almost entirely for local purposes.
>
> The Stone is of the Oolite formation, and resembles Portland in quality and appearance, so much so that the difference is hardly discernible. It is very considerably cheaper, and great hopes are entertained that when it is well-known it will be extensively used in London and the Provinces in preference to Portland.
>
> The possibilities of these Quarries are enormous. The beds of rock are entirely free from defects, and can be obtained in huge sizes, thus giving a splendid average cubical measurement for Random Block. It is very mild working when freshly quarried, but hardens very considerably and quickly when brought to the surface, and is very hard after a few weeks' exposure, when the moisture has evaporated.
>
> It is an excellent durable Stone for external and internal purposes, and weathers well. It is a particularly desirable Stone where cost is a consideration, as it can be supplied at a very low finished cost without any risk as to strength, quality and durability."

Commercially it is known as "Nailsworth Stone."

On the north side of the Nailsworth Valley is the old Scar Hill Quarry (Plate XX., fig. 1). Ascending the hill from the Railway Station, the Cotteswold Sands are seen in the left bank of the road. On the Common the Lower Limestone is exposed in a scarp above the road, and is capped by Pea-Grit, which is of the same general facies as at Longfords, containing amongst other fossils *Plicatula tuberculosa*, Morris and Lycett, *Rhynchonella subangulata*, Dav., *Ter. pisolitica*, S. Buckman, etc.

1 Quart. Journ. Geol. Soc., vol. xlii. (1886), p. 266; Proc. Cotteswold Nat. F.C., vol. ix., pt 1 (1885-86), pp. 21-37.

In the disused quarry on Scar Hill the Freestone has been mined, and, as usual, its top-bed is bored. Above it, is the Upper *Trigonia*-Grit, and then comes the *Clypeus*-Grit.

A number of geologists have investigated the Scar-Hill sections, and first amongst them was Lycett. He remarked that we find here "the entire marl group reduced to a thickness of four feet, destitute both of corals and Brachiopoda, but containing Gasteropoda and Conchifera, generally of same size."[1] He also noticed the sequence of Top-Beds, and apparently thought that the lower part of the Upper *Trigonia*-Grit was Gryphite-Grit, "but without the characteristic gryphite."[2] It must be borne in mind, however, that there is no Gryphite-, *Buckmani*-, or Lower *Trigonia*-Grit (nor any "Intervening Bed") at Scar Hill, and that fossils from the Inferior Oolite of Nailsworth must have come from the Upper *Trigonia*- or *Clypeus*-Grits, or from the Aalenian.[3]

Wright also identified the representative of the Oolite Marl at Scar-Hill, and repeated Lycett's observations concerning it, namely, that it "contains neither corals nor Brachiopods," and continues: "but is charged with long spiral univalves belonging to the genera *Chemnitzia* and *Nerinæa*, with a few conchifera and small Gasteropoda. The Nerinæa limestone is a fine argillaceous rock, close in texture, and feebly oolitic....."[4]

The late W. H. Hudleston gives a general section of "Nailsworth Hill and District" in his Monograph, "partly derived from observations, partly from other sources," and follows Lycett in his recognition of "Grit without Gryphites."[5]

The chief feature of the Scar-Hill section is undoubtedly the fossiliferous *Nerinæa*-Bed. Lycett obtained a large number of lamellibranchs from this bed and the underlying Freestones. They are now housed at Jermyn-Street Museum.

It will be unnecessary to detail the sequence observable at Scar Hill, because it can be much more satisfactorily made out in a large quarry in work on Culver Hill, Amberley.

1 "Cotteswold Hills" (1857), p. 49. 2 *Ibid.*, pp. 69-70. 3 Fossils are often found in old collections labelled "Inferior Oolite, Minchinhampton." As their matrix is usually a shelly white oolite, very similar to the shelly Great Oolite, and the locality given is "Minchinhampton," one is at first sight disposed to think that the Great Oolite is meant instead. 4 Quart. Journ. Geol. Soc., vol. xvi. (1859)pp. 12-13. 5 Monogr. Brit. Jurassic Gasteropoda—Gasteropoda of the Inferior Oolite, pp. 59-61.

CULVER HILL, AMBERLEY

			Thickness in feet inches
II.	White Oolite	1. Limestone, whitish, and apparently some marl, but inaccessible: seen ..	3 0
III.	*Clypeus*-Grit	2. *More conspicuous deposit of marl and rubble; Terebratula globata*, auctt. non Sow., very common. (*Holectypus depressus* (Leske), at Scar Hill. This is the highest bed now visible at Scar Hill)	1 0
		3. Limestone, oolitic, thicker-bedded in the lower portion, passing up into whiter, thinner-bedded limestones; *Ter. globata*, auctt., non Sow., not uncommon in the massive beds: about	4 0
		4. Yellow, softish pisolitic marl and rubble; *Ter. globata*, common, *Clypeus Ploti*, Klein, *Pleuromya Goldfussi* (Lyc.), etc. (At Scar Hill, 1 ft. 2 ins. thick, and *Ter. globata* very common)	0 10
		5. Limestones, yellowish-grey massive (three main beds), but in places, at the top and bottom of the beds, rubbly. The lower portion is less fossiliferous. *Clypeus Ploti*, Klein, *Holectypus depressus* (Leske), etc.	6 0
		6. Parting	0 1
		Non-sequence. Beds IV. & V. wanting.	
		Limestone, shelly iron-speckled, coarsely oolitic, yellow and white-blotched; oysters on the top, bored	0 4
VI.	Upper *Trigonia*-Grit	Ragstones, shelly, in two massive beds; crowded with *Terebratula globata*, auctt. and *Rhynchonella* spp. and usual fossils	8 0
		Non-sequence Beds VII. to XIX. (incl.) wanting.	
XX.	Upper Freestone	Limestones in two beds, very hard, conchoidal fracture, top very even, waterworn and oyster-strewn, bored; topmost six inches of rock very shelly, and *Nerinæa* spp., corals frequent, *Astarte; Terebratula fimbria*, Sow., 3 inches from the base	3 0
XXI.	Oolite Marl	Well-marked parting above band of yellower oolitic limestone[1] joined on to the well-planed surface of Limestone	0 4
		that has, in the top-portions especially, *Nerinæa*, corals and lamellibranchs ..	1 4
XXII.	Lower Freestone	Limestones, well-oolitic, in massive beds: seen	12 0

The *Bradfordensis*-Beds here (*i.e.*, Upper Freestone and Oolite Marl), are again very fossiliferous, and would doubtless repay detailed working.

1 This adheres to the Upper Freestone at Scar Hill, where that deposit is 2 feet 10 inches thick, and the Oolite Marl 1 foot 10 inches.

RODBOROUGH HILL

At Rodborough Hill the general sequence of beds is as follows:

				Thickness in feet
U. Inf. O.	Top-Beds	I.	Rubbly Beds	$14\frac{1}{2}$
		II.	White Oolite	
		III.	*Clypeus*-Grit	
		IV.	Upper Coral-Bed: max. ..	$2\frac{1}{6}$
			Non-sequence. Bed V. wanting	
		VI.	Upper *Trigonia*-Grit	6
			Non-sequence. Beds VII. to XII. (incl.) wanting	
	Intervening-Beds	XIII.	*Buckmani*-Grit	About 3
		XIV.	Lower *Trigonia*-Grit	
			Non-sequence. Beds XV. to XIX. (incl.) wanting	
L. Inf. O.	Freestone-Beds proper	XX.	Upper Freestone	14
		XXI.	Oolite Marl	7
		XXII.	Lower Freestone	79
	Pea-Grit series	XXIII.	Pea-Grit	13
		XXIV.	Lower Limestone ..	44
		XXV.	*Scissum*-Beds	
		XXVI.	*Opaliniforme*-Bed	? 1
			Cephalopod-Bed	
			Cotteswold Sands	
			Upper-Lias clay	
			Marlstone	

Of the Inferior-Oolite subdivisions, the lowest now seen is the Lower Limestone. The top-portion of this rock, with the Pea-Grit, and basal portion of the Lower Freestone, is exposed in a long disused quarry(1)* close to the Old Pound,[1] and it will be noticed that the Pea-Grit has greatly increased in thickness.

In the next quarry,(2) also now disused, the *Bradfordensis*-Beds are seen. The upper portion (said by Witchell to be 14 feet thick, and by Hudleston 20 feet) is comparable with the *Nerinæa*-Bed of Nailsworth; while the true equivalent of the Oolite Marl occurs below, and is 7 feet thick (*teste* Witchell). As Witchell wrote, the *Nerinæa*-Beds "contain *Nerinæa cotteswoldiæ* in great abundance. Several other species of *Nerinæa* occur; indeed it is almost impossible to fracture the rock without exposing the transverse sections of these shells; the outskirts of a coral-reef appear to have been their habitat."[2]

The top-portion of the Upper Freestone and the overlying Lower *Trigonia*-, *Buckmani*-, Upper *Trigonia*-, and *Clypeus*-Grits, but no Upper Coral-Bed, are excellently and best seen in

1 "Geology of Stroud," p. 43. 2 *Ibid.*, p. 49.
* These numbers refer to those on the map, fig. 5.

the now enclosed "Fort" Quarry.[3] It was from the Lower *Trigonia*-Grit here that Lycett and Wright obtained such a number of beautifully-preserved lamellibranchs, many of which were new. The *Buckmani*-Grit is the bed that immediately overlies the Lower *Trigonia*-Grit. It is 1 foot 9 inches thick, and has yielded *Terebratula Buckmani*,Dav.[1]

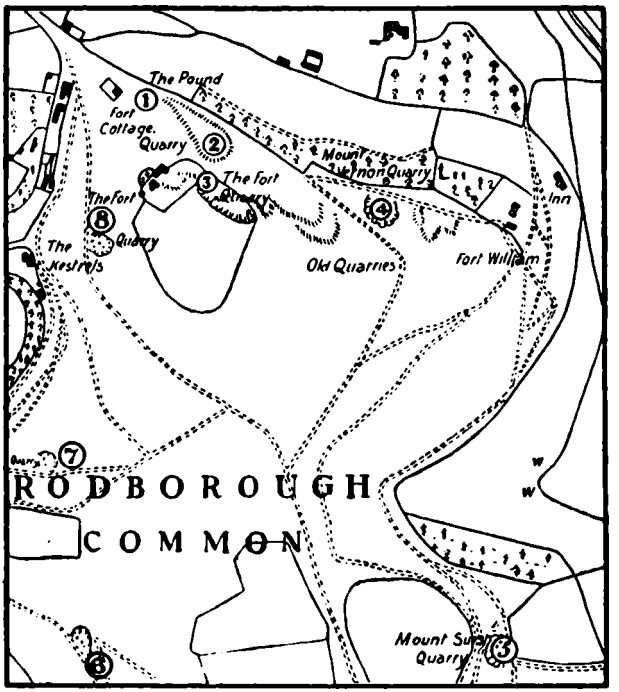


FIG 5.—Map of Rodborough Hill (3 inches = 1 mile) to show the positions of the quarries.

In his work on "The Cotteswold Hills,"[2] Lycett identified the present Lower *Trigonia*- and *Buckmani*-Grits with the Gryphite-Grit; but Dr Wright, two years later (1859), stated his opinion that the bottom foot of Lycett's "Gryphite Grit" was Lower *Trigonia*-Grit. Lycett, however, while admitting that Wright's description of this portion of the bed was correct, failed to see how it could be separated from the rest of his Gryphite-Grit at Rodborough, although he thought it might be possible where the subdivisions were thicker, and therefore the successive characteristic faunas more distinct.[3]

1 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 1 (1907), p. 72; see also S. S. Buckman, Quart. Journ. Geol. Soc., vol. li. (1895), pp. 394-395. 2 "Cotteswold Hills" (1857), p. 62. 3 Quart. Journ. Geol. Soc., vol. xvi. (1859), pp. 44-45.

At The-Fort Quarry there is a non-sequence between the Upper *Trigonia*- and *Clypeus*-Grits, for neither the Dundry Freestone nor Upper Coral-Bed are present. But the latter is developed a short distance away at the Mount-Vernon Quarry.(4)

It is unnecessary to append a detailed section of The-Fort Quarry, or of those at Mount Vernon and Mount Surat, for I have already given such in the Proceedings of the Club, and to them I have nothing to add.[1] For the sake of completeness, however, it will be as well to state that at The-Fort Quarry the *Clypeus*-Grit is very well developed. The lowest beds are brown and rather bare of fossils, as is generally the case in the Stroud district. But the higher beds are rubbly and fossiliferous, *Terebratula globata*, auctt., being very abundant along certain horizons.

The Lower *Trigonia*- and *Buckmani*-Grits are represented at the Mount-Vernon Quarry by deposits 1 foot 4 inches and 1 foot 7 inches thick respectively. Above them comes the Upper *Trigonia*-Grit (7 feet 10 inches), and this is overlaid by a very interesting development of the Upper Coral-Bed. The Upper Coral-Bed has yielded a number of most interesting fossils, including crowds of micro-organisms, which have been identified by Mr Charles Upton.[2] The *Clypeus*-Grit completes the section.

At the next quarry, the Mount Surat (or Montserrat), the Upper *Trigonia*-Grit rests directly upon the Upper Freestone: the Lower *Trigonia*- and *Buckmani*-Grits have disappeared,[3] neither is there any Upper Coral-Bed present.(5)

None of the Intervening-Beds are present along the south side of the deep Stroud-Sapperton Valley east of Rodborough Hill.

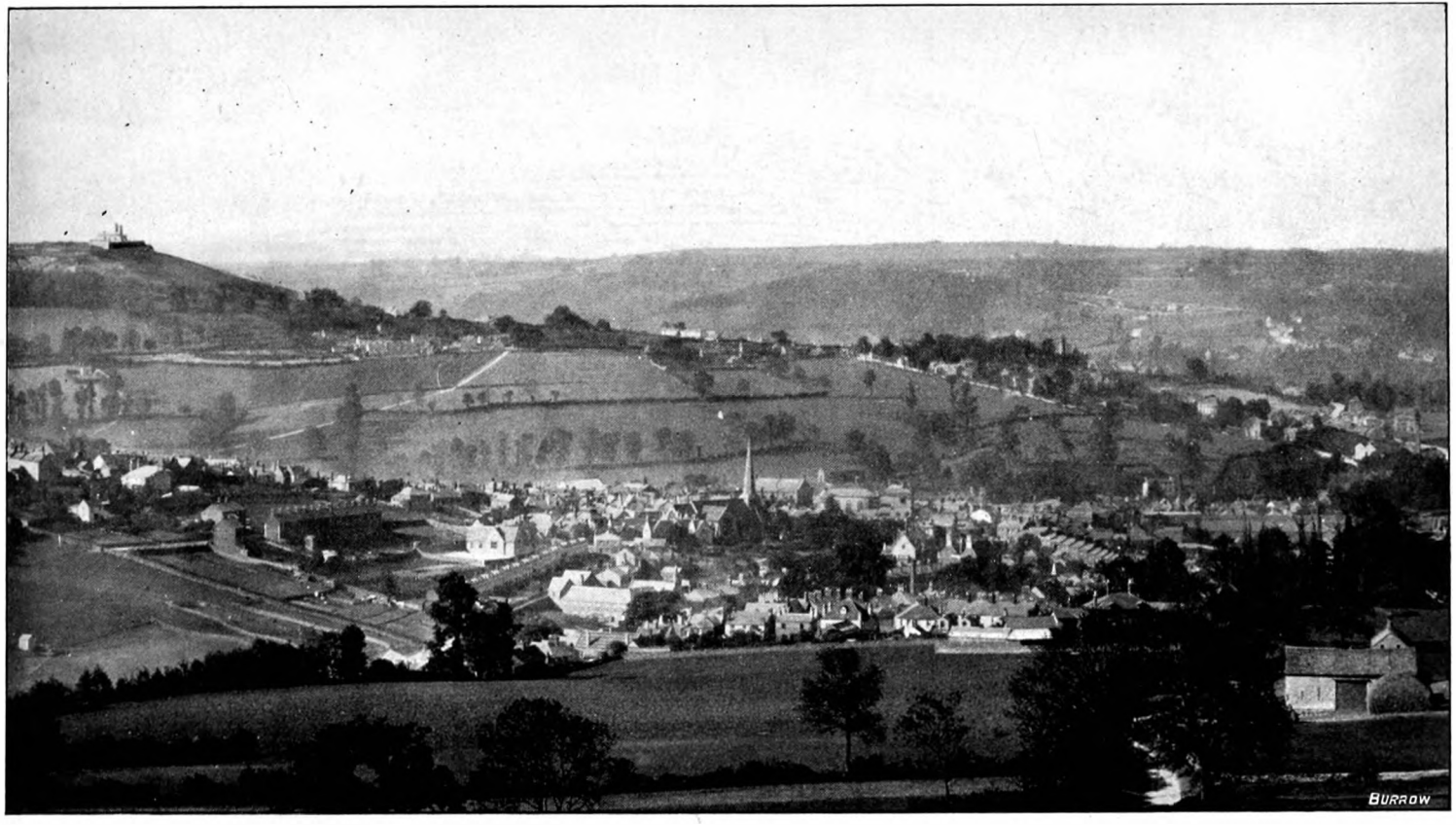
The Lower Freestone is exposed in a number of small quarries, and is especially well seen in the abandoned workings at the hamlet called "Wall's Quarry,"[4] and in the old quarry in the wood by the road-side near the house called "Hyde Brae," Chalford. At both these localities the Lower Freestone has been mined, and has typical Oolite Marl (at Wall's Quarry about 5 ft. thick, and at "Hyde Brae" from 8 to 10 ft. thick) parting it from the Upper Freestone. It should be noticed that

1 Vol. xvi., pt. 1 (1907), pp. 71-80. 2 *Idem.* p. 75. 3 See S. S. Buckman, Quart. Journ. Geol. Soc., vol. li. (1895), p. 394. 4 See Lycett's "Cotteswold Hills" (1857), p. 47.

the Oolite Marl is recognizable as a distinct deposit up this valley, and is *not* with difficulty separable from the Upper Freestone, as is the case at Rodborough Hill and the Frith, near Painswick. Upon the Upper Freestone, which at both localities is about 9 or 10 feet thick, reposes the Upper *Trigonia*-Grit. Hull, in the Geological Survey Memoir on the "Geology of Parts of Wiltshire and Gloucestershire," grouped together all the ragstone-beds between the *Clypeus*-Grit and the Upper Freestone, and called them "Lower Ragstone,"[1] applying the term "Upper Ragstone" to the *Clypeus*-Grit. Therefore, it will be understood that in his record of the Wall's-Quarry section, the term "Lower Ragstone" there means Upper *Trigonia*-Grit, for there are no Intervening-Beds present. The Upper *Trigonia*-Grit, from Wall's Quarry eastwards to the Sapperton Tunnel, maintains a thickness of between 8 and 10 feet. The precise thickness of the *Clypeus*-Grit has not been ascertained, but probably it measures somewhere about 15 to 20 feet.

The Fullers' Earth is seen in many small openings, and on the steep valley-side at Cowcomb is very tolerably exposed. It contains, throughout its course along this side of the valley, bands of impure limestone absolutely crowded with specimens of *Ostrea acuminata*.

1 *Loc. cit.*, p. 10.



THE NORTHERN END OF THE SOUTH COTTESWOLD, NAMELY RODBOROUGH AND SELSLEY HILLS, AS SEEN FROM FOLLY LANE, STROUD

(H. J. Comley, photo.)
(From Burrow's "Stroud Valley Illustrated.")

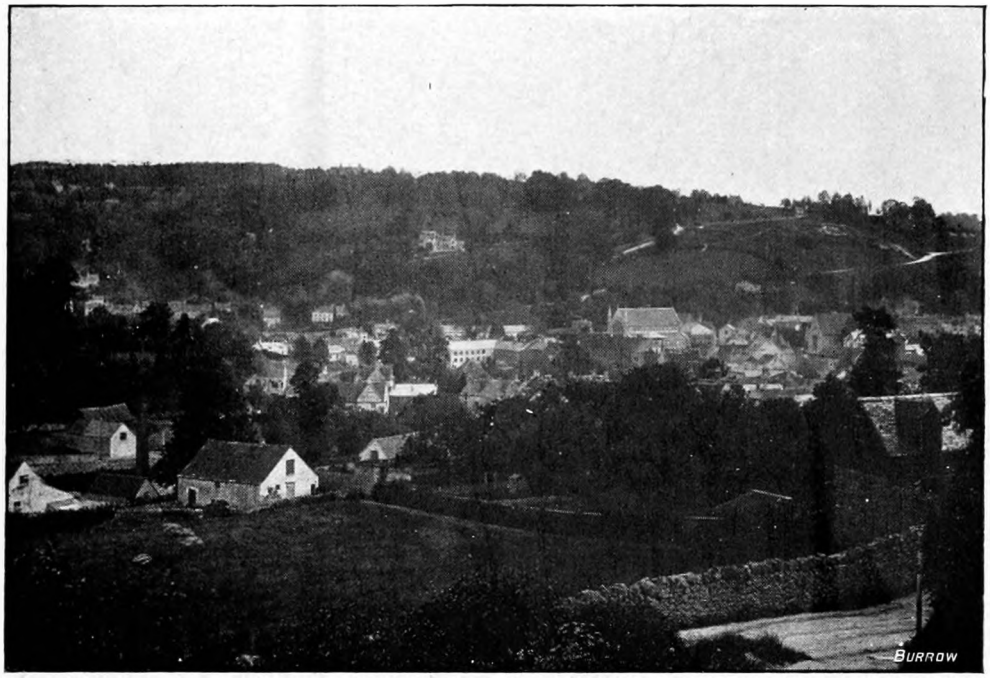


Fig. 1.—NAILSWORTH AND SCAR HILL

(Paul L. Smith, photo.)

(From Burrow's "Stroud Valley Illustrated.")

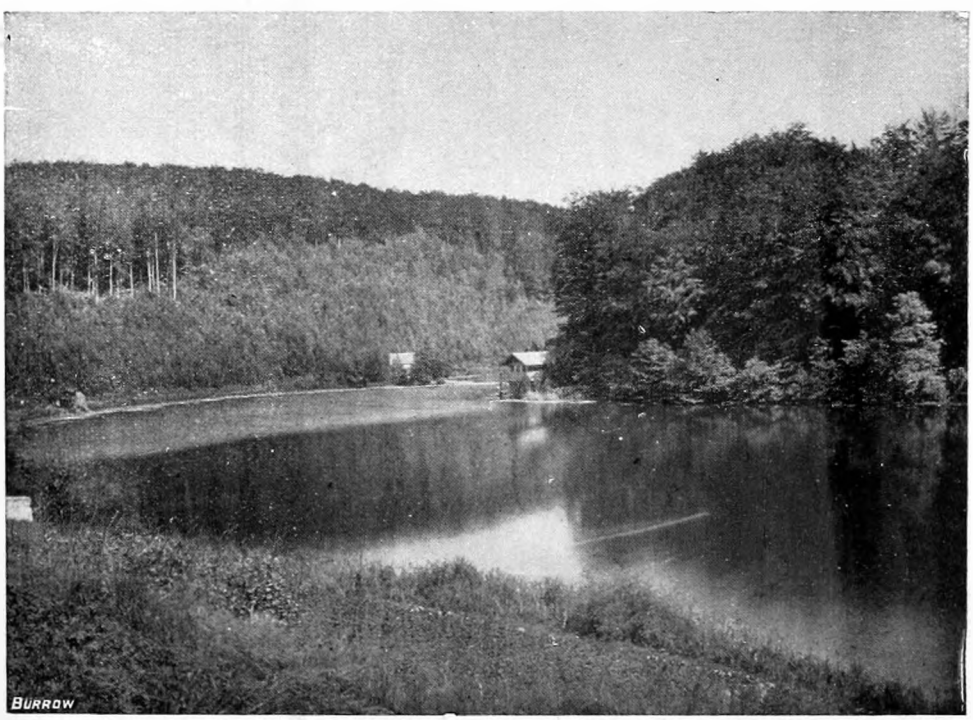
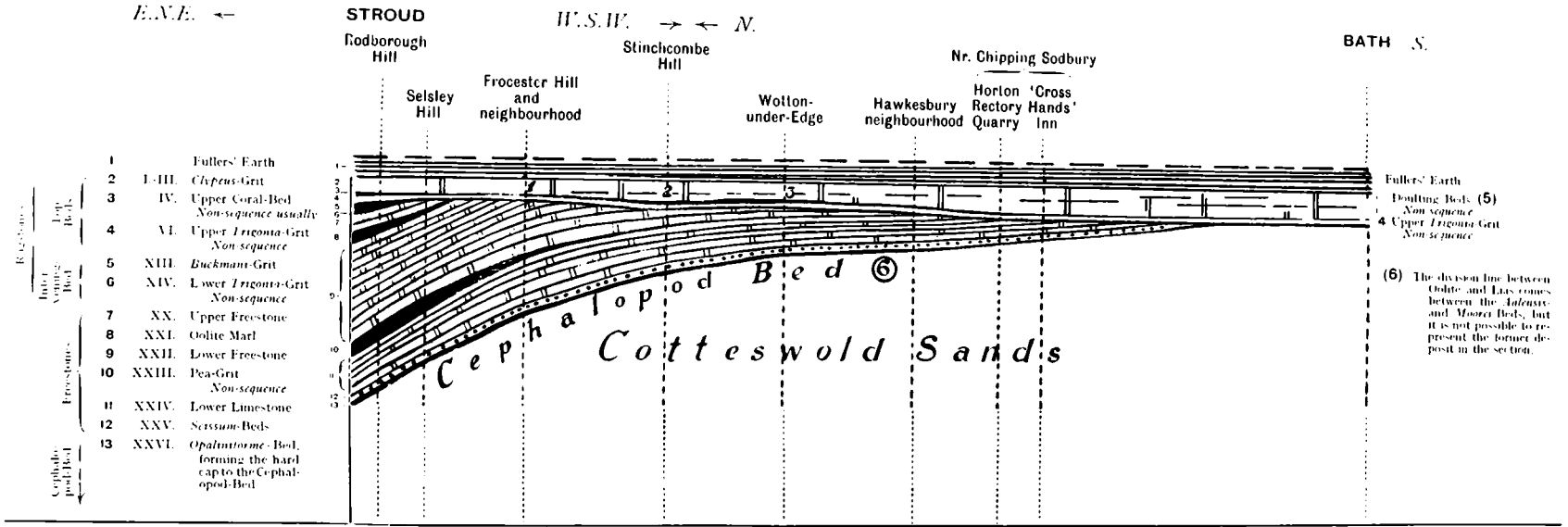


Fig 2.—LONGFORDS LAKE, NEAR NAILSWORTH

(Paul L. Smith, photo.)

SKETCH-SECTION, SHOWING THE RELATIONS OF THE INFERIOR-OOLITE BEDS OF THE SOUTH COTTESWOLDS TO THE DEPOSITS ABOVE AND BELOW THEM, ETC.



I.-III.—*Clypeus*-Grit or Doulting Beds	14′6″	15′2″	15′0″	17′	15′5″	19′10″	26′4″	25′ (5)
IV.—Upper Coral-Bed	2′2″	—		(2) 3″	(3) 10″		Rubble	(4) Trace
V. Dundry Freestone	—	—	(1) 4″	—	(3) 2″	Trace	2″	
VI.—Upper *Trigonia*-Grit	6′	6′1″	6′2″	4′	2′6″	4′10″	3′6″	5′
XIII.-XIV.—*Buckmani*- & L. *Trigonia*-Grits	3′	—	—	—	—	—	—	—
XX.—Upper Freestone	14′	8′3″	—	—	—	—	—	—
XXI.—Oolite Marl	7′	3′6″	—	—	—	—	—	—
XXII.—Lower Freestone	79′	70′	45′	14′	17′9″	—	—	—
XXIII.—Pea-Grit		10′	5″	9″	6″	—	—	—
XXIV. Lower Limestone	57′	58′	40′	25′10″	21′9″	27′2″	12′	
XXV. *Scissum*-Beds		7′	7′8″	8′	8′	7′4″	2′	
XXVI. *Opalinitorme*-Bed		2′	1′11″	1′2″	1′	1′4″	1′	—
Totals	182′8″	160′	118′	80′	63′	60′	45′	30′

[*Thicknesses given in italics are estimated thicknesses.*]

(5) At the southern end of the South Cotteswolds, the Doulting Beds comprise the Rubbly Beds, *Inabacia*-Limestone, and Doulting Stone. At the northern end, they have almost completely passed into the *Clypeus*-Grit.