

**MEMOIRS OF THE GEOLOGICAL
SURVEY. ENGLAND AND WALES.
THE GEOLOGY OF THE COUNTRY
BETWEEN WHITBY AND
SCARBOROUGH**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649340620

Memoirs of the Geological Survey. England and Wales. The Geology of the Country Between Whitby and Scarborough by C. Fox-Strangways & G. Barrow

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C. FOX-STRANGWAYS & G. BARROW

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P R E F A C E.

THE north-eastern parts of Yorkshire, with their admirably clear coast-sections of the Jurassic rocks, have been classic ground to the geologist since the first general sketch of their structure was published in 1815 by William Smith. From that date down to the present time they have been the subject of a voluminous literature. Smith himself elaborated his first outlines, and published a more detailed map of Yorkshire (1821). Shortly afterwards came the "Geological Survey of the Yorkshire Coast" by Young and Bird (1822), followed a few years later by Phillips' "Geology of the Yorkshire Coast" (1829). Of the numerous fossil mollusca obtained by various collectors from these shores, figures and descriptions continued to appear in Sowerby's "Mineral Conchology" (1812-1829), and furnished the first basis for palaeontological comparison. The more recent contributions are too numerous to find even mention here. But reference may be made to the important labours of Blake, Davidson, Hudleston, Leckenby, Lycett, Morris, Simpson, Tate, Williamson, Wright, and others.*

The Maps, Sections, and Memoir, now published by the Geological Survey from original observation, afford some measure of the advance made in geological mapping since Smith's first masterly outlines were published, sixty-seven years ago. From the manner in which the Jurassic rocks of Yorkshire, as exposed on the coast line and in the interior, can be subdivided and traced, they present an admirable area for the study of geological structure and the relations of this structure to the forms of the ground. The quarter-sheet of which the following chapters are an explanation affords ample material for the prosecution of this study. Regarding the interesting estuarine character of the Lower Oolites, already discussed in previously published Memoirs (95 S.W. and S.E. and 96 S.E.), further information is here given, the whole series of strata being well developed in the district, and the marine bands being specially distinct. From an economic point of view much importance attaches to the ironstones of the Middle Lias. These are briefly referred to here, but fuller information regarding them will be given in the Memoir descriptive of the typical Cleveland district where the ironstone is so largely developed (Sheet 104 S.W. and S.E.)

ARCH. GEIKIE,
Director General.

9th October 1882.

* Full references to the literature of the subject will be given in a subsequent more general Memoir. It may be mentioned here that a list of published writings on the Geology of Yorkshire up to 1875 was appended by Mr. Whitaker to the 3rd Edition of Phillips' "Geology of the Yorkshire Coast" (1875), and that this List has been supplemented by Mr. J. W. Davis in the Proceedings of the Yorkshire Geol. and Polytech. Soc., N. S., vol. vi., pp. 128, 318, and vol. vii., pp. 97, 212, 319, 453.

NOTICE.

The survey of the area described in the following Memoir was conducted under the superintendence of Mr. H. H. Howell, District Surveyor. Mr. Strangways surveyed part of the Oolitic district; Mr. Barrow surveyed the Lias and part of the Oolites.

Mr. Barrow describes the Lias, the Oolites to the top of the Lower Estuarine Series, and the Whinstone Dyke. The Cornbrash and all the later Oolites are described by Mr. Strangways. The rest of the work is written by both authors jointly. The Lists of Fossils have been revised by Mr. Etheridge.

Eight of the corresponding six-inch maps of Yorkshire, wholly or partly comprised in this Quarter Sheet (95 N.W.; Sheet 44, New Series, of the Ordnance Survey), are published by the Geological Survey, viz.:—Sheets 32, 33, 46, 47, 62, 77, and 78. Sheets 61 and 76 are not intended for publication, but MS. coloured copies are deposited in the Office for reference. Sheet 67 of Vertical Sections illustrates the Lower and Middle Oolites of the Yorkshire Coast. Horizontal Section, Sheet 130, is engraving; others are in course of preparation.

H. W. BRISTOW,
Senior Director.

Geological Survey Office,
28, Jermyn Street, London, S.W.,
9th August 1882.

THE GEOLOGY
OF
THE OOLITIC AND LIASSIC ROCKS
BETWEEN WHITBY AND SCARBOROUGH.

CHAPTER I.
INTRODUCTION.

It is intended in this pamphlet to describe the geology of that part of the moorlands and seacoast lying between Whitby and Scarborough.

The map, although covering a land area of not more than about 88 square miles, includes some of the most interesting parts of East Yorkshire.

The only town of any importance is Scarborough, the south edge of the map just crossing the northern part of the town. There are, however, several villages of considerable size, the principal being Hackness, Scalby, Cloughton, and Burniston, in the neighbourhood of Scarborough; and Robin Hood's Bay, Fyling Thorpe, Aislaby, Sleights, and Sneaton, near Whitby.

The greater part of the area is wild moorland; but the numerous intersecting valleys are generally brought into cultivation, and are covered with small farms.

The principal rivers are the Derwent and the Esk. The former of these takes its rise in these moors, and flows south through the picturesque gorges of the Oolites to join the Humber; the latter, with its tributaries, flowing north and east to the sea at Whitby. The rest of the drainage of this district is carried on by the small becks which run down to the coast at Hayburn Wyke and Robin Hood's Bay. There is also an artificial branch to the Derwent, which takes the flood-water of that river, and, draining the low country near Scalby and Burniston, enters the sea at Scalby Ness.

The watershed dividing the drainage of the Derwent from that of the Esk rises to a height of 978 feet above the sea at Lilla Cross.

The rocks coming to the surface in this map comprise the whole series of the Middle and Lower Oolites as they occur in Yorkshire, and descend to beds well down in the Lower Lias.

The following are the geological formations which occur in the district:—

Table of Formations.

Post Tertiary	-	Recent and Post Glacial.	-	Alluvium. Peat.		
Tertiary?		Glacial		Basalt (Whinstone).		
				Upper Calcareous Grit.		
	}	Middle Oolite	}	Upper Limestone and Coral Rag.		
					Middle Calcareous Grit.	
					Lower Limestone and Coral Rag.	
					Greystone or Passage Beds.	
					Lower Calcareous Grit.	
					Oxford Clay.	
					Kellaways Rock.	
					Cornbrash.	
					Upper Estuarine Series.	
					Scarborough or Grey Limestone.	
Secondary		}	Lower Oolite	Middle Estuarine Series.		
				Millepore Bed.		
				Lower Estuarine Series, with 'Eller Beck Bed.'		
				Dogger.		
				Blea Wyke Sands.		
				Upper Lias.		
				Middle Lias.		
				Lower Lias.		
				}	Lias	

CHAPTER II.

LIAS.

Lower Lias.—In the district embraced by Sheet 95 N.W. the Lower Lias consists of a mass of dark argillaceous shales, slightly sandy, with hard marly bands in the lower part. It may be roughly divided on lithological and palaeontological grounds into two parts, each of which may be subdivided into two zones or regions characterised by a distinct fauna. The only section which exposes any considerable portion of these beds is that in the cliffs and scars of Robin Hood's Bay. The following table is a summary of the rocks there seen:*

B. Soft shales with rows of ironstone doggers and pyritous nodules, 320 ft.	}	(b.) Soft shales with rows of ironstone doggers: <i>A. capricornus</i> ; <i>Gryphaea obliquata</i> . (Zone of <i>A. capricornus</i> .)
		(a.) Soft shales with rows of pyritous nodules: <i>A. Jamesoni</i> , <i>Gryphaea obliquata</i> , <i>Pinnu folium</i> . (Zone of <i>A. Jamesoni</i> .)

* This and all succeeding tables and sections are arranged in descending order.

- A. Soft shales with a succession of sandy and marly bands, 140 ft.
- (b.) Shales with hard sandy bands, the upper parts covered by fucoidal markings: *Gryphaea incurva* in scattered groups of 5 or 6; *Ammonites* abundant. (Zone of *A. oxynotus*.)
 - (a.) Shales with marly calcareous bands, generally very shelly: *Gryphaea incurva*; *Hippopodium ponderosum* occurring in bands; *Ammonites semicostatus*. (Zone of *A. Bucklandi*.)

A. (a.) These beds, which form the zone of *A. Bucklandi* of Tate and Blake,* are only seen at low water, forming the series of outer scars in the bay, dipping in a direction at right angles to the coast line. The average dip is about 4°, and as the breadth of the outcrop is about 300 yards the thickness of rock exposed is about 60 feet, consisting of rather soft grey shales with harder sandy and somewhat calcareous bands interspersed. Near the shore *A. Turneri* is the predominant form, often accompanied by layers of *Hippopodium ponderosum*, whilst *A. semicostatus* is abundant on the further scars, *A. Bucklandi* being also found occasionally.

These scars are often so covered with weed that it is impossible to examine them, but at the end of a hot summer the weed dies and is washed away, so that the scars can be best studied in September and October. As, however, they are only exposed for any distance seaward at low spring tides, they are never very easily investigated. The following is a list of the chief fossils found here:—

- Gryphaea arcuata*, Lam.
- Lima Hettangiensis*, Terg.
- Monotis inaequalis*, Sow.
- Pecten calvus*, Goldf.
- *Thiollieri*, Dumort.
- *textorius*, Schloth.
- Perna infraliassica*, Quenst.
- Cardinia hybrida*, Stutch.
- Protocardium oxynoti*, Quenst.
- Hippopodium ponderosum*, Sow.
- Leda galathea*, D'Orb.
- *Renovieri*, Opp.
- Lucina limbata*, T. and P.
- Modiola laevis*, Sow.
- Nucula navis*, Piette.
- Pholadomya glabra*, Ag.
- Chémnitzia trivisa*, Tate.
- Cerithium*, sp.
- Dentalium Etalense*, Terg. and P.
- Ammonites Bucklandi*, Sow.
- *semicostatus*, Y. and B.
- *Turneri*, Sow.
- Belemnites acutus*, Miller.

* The Yorkshire Lias, by Ralph Tate and J. F. Blake. 8vo, Lond., 1876.

A. (b.) These beds consist of alternating layers of soft shale and bands of sandy marl, the latter being remarkable for the fucoidal impressions upon them, which are rendered visible by the action of the sea water. As a whole, these beds are not very productive of fossils, if we except *Ammonites*, which, both in variety of species and number of individuals, are more abundant here than in any other part of the Lower Lias in this district.

Besides being abundant the *Ammonites* of this group are very restricted in range, and occur in definite lines. The uppermost portion contains *A. armatus* and *A. densinodus* in considerable numbers. At about the middle of the beds there are two lines of small doggers or nodules, in almost every one of which the small *A. gagateus* occurs, often accompanied by small specimens of *A. oxynotus*. *A. Simpsoni* is also characteristic of this horizon. Towards the base, fragments of *A. sagittarius* are frequently found, and form another well-marked horizon in this group of beds; whole specimens are very rare.

A point of interest is the occurrence, about the middle of the series, of large lenticular discs of ironstone, usually unfossiliferous, with cone-in-cone structure developed in the lower part. They generally rest on a mass of broken crinoidal fragments, principally remains of *Pentacrinus tuberculatus*, in such a manner as to suggest the origin of the cone-in-cone structure immediately above. These discs are sometimes as much as 15 feet in diameter.

The highest of these beds of the *A. oxynotus* zone forms the scar opposite Bay Town, at which point they are dipping nearly due north; from this point southwards they rise into the cliff until near the middle of the bay, where the highest bed is about 90 feet above sea level, the beds now dipping nearly due west. The dip gradually changing to south, the strata descend till the bed that is opposite Bay Town forms part of the scar against the Peak fault, about 100 yards from the foot of the cliff. Thus we have two nearly complete sections, from which the following has been compiled:—

Section of *A. oxynotus* Beds, Robin Hood's Bay.

	Ft.	In.
Soft dark shales resting on hard sandy calcareous bed with fucoidal markings, <i>Gryphaea</i> and <i>Belemnites</i>	1	0
Soft sandy shales: <i>A. varicosatus</i> , <i>A. armatus</i> , <i>A. dudleyi</i> , <i>Gryphaea obliquata</i>	5	6
Hard sandy band	0	2
Hard sandy shale: <i>Rhynchonella variabilis</i>	5	6
Hard calcareous sandy band, forms the second well-marked scar <i>Modiola sculptum</i>	2	0
Sandy shale with irregularly scattered discs of ironstone resting on crinoidal remains: <i>A. armatus</i> , several species of <i>Ammonites</i> in hard nodules	8	6
Hard ferruginous sandy shale, almost an ironstone	0	8
Hard sandy shale with crinoidal fragments	3	6
Hard shaly calcareous sandstone, fourth well-marked scar: <i>A. obsoletus</i>	0	9