19.

Physical Geology
Yorkshire –

Phillips.

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from the author

[*Extracted from the* Geological Magazine, Vol. III. No. XXVIII. *October*, 1866.

NOTES ON THE PHYSICAL GEOGRAPHY OF EAST YORKSHIRE.[1]

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THE district of Cleveland, long known for the beauty and variety of its scenery, has during the past few years acquired great importance through the discovery of valuable beds of iron ore in the Middle Lias. So much has been written on this district, and in a lesser degree on East Yorkshire generally, that the geological structure of this country must be tolerably well known.[2] My object then is not so much to describe the beds as to give some notes on the physical geography of the country, explaining the relation of its present surface outlines to its internal structure, and to enquire by what means those external features have been produced.

It may appear presumptuous on my part to attempt this after the very able treatment the subject has received from Prof. Phillips in a work devoted, in part, to this question.[3] But I venture to think that the origin of the present scenery of Yorkshire is due, in the main, to subaërial denudation, not to marine action as stated by Prof. Phillips.

The characteristic features of Yorkshire are shown by a glance at its river courses. These run in a general direction from the north and west to the south and east. This is therefore the direction of the general slope of the ground, and corresponds with the *dip* of the beds beneath. The Vale of York, stretching uninterruptedly from the Tees to the Humber, forms a well-marked boundary between the Secondary rocks on the east and the Palæozoic rocks on the

[1] Read before the British Association at Nottingham, August 24th, 1866.

[2] See especially—

Young and Bird,	Geological Survey of the Yorkshire Coast, 4to. 1822.
Winch (N. J.)	Observations on the Eastern parts of Yorkshire. Geol. Trans. 2nd Series. Vol. V. p. 545.
Phillips (J.)	Illustrations of the Geology of Yorkshire. 4to. Vol. I. 1829.
,,	Geological Map of Yorkshire. 1853.
,,	Manual of Geology. Ed. 1855.
,,	Quart. Journ. Geol. Soc. Vol. XIV. (1858) p. 84.
Marley (J.)	Trans. N. of Eng. Inst. of Mining Engineers. Vol. V. (1857 p. 165.
Bewick (J.)	The Cleveland Ironstone. 8vo. 1860.
Pratt (C.)	Geologist for 1861, p. 81.

[3] Rivers, Mountains, and Sea Coast of Yorkshire. 8vo. 1853.

west. It is composed of Permian and New Red strata thickly covered with Boulder-clay and gravel. The secondary beds on the east crop out in a series of escarpments; their scarped edges being presented towards the north and west, while the gentler slope, or "dip slope," falls towards the south and east. The chalk, as the highest secondary bed, occupies the south-eastern corner, and rising as a bold escarpment from the Vale of Pickering (Specton and Kimmeridge clays), sweeps round to the west and south, overlooking the Vale of York. The Lower Secondary beds rise from beneath the Chalk, their scarped faces likewise facing northwards. These owing to a great unconformity, do not pass south parallel to the Chalk. The escarpment of the Lias however is almost continuous from the Tees to the Humber.

The scarped hills of Cleveland (Lias capped by Inferior Oolite) are highly picturesque. The Oolitic capping weathers into a steep face overlooking a more gentle slope of Lias shale. The bare rugged top of Rosebury Topping and the top of the escarpment seen south-west from Guisboro' are examples of precipitous Oolitic[1] cappings.

These escarpments, in common with all analogous hills in England, have this striking character. The same bed, or its representative, crops out at about the same height of the escarpment all along its course. Thus, in the North Cleveland hills, the "Ironstone and Marlstone series" crop out some way down the side, and the hills are capped by the same bed of Sandstone (Inf. Oolite). In other words, these escarpments *run along the strike* and their scarped sides *face the dip.* Thus, if the beds are dipping to the south the scarped side will face the north, and the escarpment will run east and west. Now, how can this fact be accounted for if these escarpments are old sea cliffs? To learn what a Lias sea cliff is like we have only to examine the present coast line of Cleveland. Here the beds are seen to dip in the cliff section, and therefore the cliff is not formed along the strike. Moreover beds are seen to dip one under the other and disappear, so that a cliff section at one place may give a set of beds quite different from another section taken a few miles off. Thus, on the Yorkshire coast, we pass in the *same line of cliffs* from Lias in the north, through all the Oolitic series in succession, to Chalk in the south.[2] Such is never the case with an inland escarpment. This presents the same set of beds throughout its entire length. Now, since "escarpments" run along the strike, whilst the present sea cliffs rarely or never do, it would seem that we must no longer look to marine action as the mode of formation of these escarpments. They are assuredly not "river-cliffs," since rivers by no means always run parallel to them or even near them. There remains then only pure subaërial agencies to account for them. This subject has already been written upon by Mr. Jukes,[3] Prof. Ramsay,[4] Mr. Geikie,[5]

[1] The Inferior Oolite here is a Calcareous Sandstone. ("Dogger.")

[2] This is well shown in the coast section appended to Prof. Phillips' "Geology of Yorkshire." Vol. I.

[3] On the River Valleys of the South of Ireland. Quart. Journ. Geol. Soc. Vol. xviii. (1862.) p. 378.

[4] Phys. Geog. and Geology of Great Britain. 2nd Ed. 1865, p. 81 *et seq.*

[5] Scenery and Geology of Scotland. 1865. p. 138.

and by Dr. Foster and the author.[1] To these various publications I would refer for a fuller discussion of the question, merely noting now the general principles involved.

The sea, wherever we now see it at work, exerts a *levelling* power, planing off to a more or less uniform slope the various beds which come within the range of its breakers. This forms what Prof. Ramsay has called a plain of marine denudation.[2] Vast masses of rocks have thus been swept away, often far exceeding in amount those subsequently removed by atmospheric agencies. Now, since we know that the beds have been *unequally upheaved,* proved by their present dip, the action of the breakers would plane off the various beds as they successively came within its range. Hence the resulting plain of denudation would present a succession of beds cropping out along its surface. Of these, some would be hard, some soft: the former resisting atmospheric denudation would stand out as escarpments; the latter would weather into *longitudinal* valleys. The surface drainage of this area would collect into streams joining eventually into main rivers running down the main slope. This will usually be the dip slope, because the line of greatest upheaval will be the line of strike and will determine the direction of the marine plane of denudation. Thus originate the *transverse* valleys which cut across escarpments. These two kinds of valleys can be well studied in the Weald and the bordering chalk country. I think the Humber is a transverse valley of this description; it corresponds to the main channel of the Medway where the latter cuts through the Greensand and Chalk on its way to the Thames. The Ouse with its tributaries the Swale and the Ure, coming from the Vale of York and the Lias hills, correspond to the Eden and its tributaries in Kent. The Derwent, rising far within the Oolitic country and running in a direction opposed to the general dip, corresponds exactly to the tributary of the Medway which rises near Ightham and runs down past Plaxtole and Hadlow into the Weald Clay valley to join the main river. The beautiful valley of Eskdale begins *within* the Oolitic country and runs with the general dip. Its river has excavated a channel through the harder Oolite which forms the steeper part of its slopes down to the Lias below. Eskdale corresponds to such valleys as the Cray and Little Stour in Kent.

If the present valleys were all made by the sea we might expect that they would always drain into the sea by the nearest way. But this is by no means the case. The upper branches of the Derwent rise close to the sea near Filey, and again near Robin Hood's Bay; but they drain *inland,* and after a long course reach the sea by the Humber. Again the river Wiske which rises up in the moors near Osmotherly runs down towards the Tees for about eight miles of its course, and at one place approaches it within $1\frac{1}{2}$ mile, then turning south it runs past Northallerton into the Swale, and finally, after

[1] On the Medway Gravels and Denudation of the Weald. Quart. Journ. Geol. Soc. Vol. xxi. 1865. p. 470.

[2] See a paper on the Physical Features of Cardiganshire. Brit. Assoc. Reports. 1847. Trans. Sects. p. 66; also *Op. cit.* pp. 79 *et seq.*, p. 139.

traversing the whole length of the Vale of York, its waters are carried into the Humber. Many such examples might be given in other districts.[1]

SYNCLINAL HILL AND ESCARPMENT.

Plain of Marine Denudation

1 1. Hard bed (Sandstone or Limestone). 2 2. Soft bed (Clay).

The connection between the internal structure of a district and its physical geography is well illustrated in the case of isolated hills separated from the main mass of a formation. These have very commonly a *synclinal* structure, the beds dipping into the hills on most sides. Every hill of this kind may be considered as an escarpment returning upon itself, constantly changing its direction as the dip changes. The picturesque hills of North Cleveland are synclinals. This is plainly seen when looking south from Redcar at Eston Nab and Upleatham Hill. The Middle Lias is here worked for Ironstone, and the waste heaps on the hill sides shew the dip of the beds. Mr. Marley, in his paper already referred to, gives a section which shows the same arrangement in a transverse direction, so that the beds composing these hills dip on all sides *into* the hill, and the sides are all somewhat steeply scarped.

It is evident that such hills retain their form because of this synclinal dip, in the same manner that an escarpment, with its beds dipping *into* the hill, retains its steep slope. If the beds dipped in the reverse direction the sharply scarped face could not long be retained, as in the process of weathering masses would slip away and slide down with the dip.

This tendency of hills having an inward dip to resist atmospheric degradation and thus preserve their form has been pointed out by Mr. Ruskin in his "Modern Painters,"[2] and by Mr. J. P. Lesley in a little book on "Coal and its Topography."[3] Many examples of synclinal hills and conversely of anticlinal valleys might be given. Thus Mr. Hull, in describing the Physical Geography of the Cotteswold Hills, says,[4] "the anticlinals have produced *lines of weakness*, originating valleys; and the synclinal *lines of strength*, originating headlands." Mr. Geikie has noted similar facts in Scotland. He says,[5] "Ben Lawes is in reality formed of a trough of schists, while the valley

[1] See Ramsay, *Op. Cit.* p. 80.

[2] Vol. IV. "Mountain Beauty." 1856. Chap. xiii., xiv.

[3] 12mo. Philadelphia, 1856. Chap. iii. "Topography as a Science."

[4] Quart. Journ. Geol. Soc. Vol. XI. (1855) p. 483.

[5] Scenery and Geology of Scotland. (1865) p. 96.

of Loch Tay runs along the top of an anticlinal arch. Hence that which in geological structure is a depression, has by denudation become a great mountain, while what is an elevation has been turned into a deep valley." Mr. Whitaker informs me that detached hills in the London Tertiary country have very commonly this inward dip; so too have the Tertiary hills west of Canterbury.

I venture to call the attention of geologists to this generally *basined* or synclinal forms of detached hills. There is no reason, if hills and valleys are due to marine action, why the hills should be synclinals and the valleys sometimes anticlinals, since the sea where we now see it at work pays no regard to dip and strike.

Postscript.—Although not immediately bearing upon the district described in the foregoing paper, I should like to call attention to a work by Mr. William Wallace,[1] in which the structure of the Alston Moor district, and the Tyne valley generally, is described. The author clearly recognises the power of rain and rivers in excavating valleys, and also that marine action had previously, and during the upheaval of the country, largely denuded the beds. I subjoin a few passages from this interesting work (pp. 45, 48): "It is difficult to resist the inference that the bed of the Tyne river above Alston must have been some 200 feet higher than at present." "There are less clear indications of its having occupied still higher positions." "As the river deepened its channel, and the sides of the hills were decomposed and carried away by pluvial agency, all marks of ancient river beds must have been destroyed." ". . . . the sheets of strata, which once stretched from the more elevated sides of the mountain across the valleys far above the bed of the present stream, were gradually removed by the action of the waves and currents of the sea; and further, that previously the strata had been thrown out of their original horizontal position, the erosion being regulated by those portions which were most elevated, as the range of the Pennine mountains, and by the anticlinal axis stretching from the summit of Cross Fell to the sources of the Tyne, and from there north-eastwards to Kilhope Law. The exact point, however, where breaker action ended, and the erosive action of the streams now flowing in the country began, is not, perhaps, determinable."

[1] "The Laws which regulate the deposition of Lead Ore in Veins." 8vo. 1861. Chap. ii. "Elevation of the Strata and Denudation of the country."

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