XXIX.—*Observations on the Eastern Part of Yorkshire ;*

By N. J. WINCH, Esq.

HONORARY MEMBER OF THE GEOLOGICAL SOCIETY.

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DURING the course of the year 1814, I had the honour to lay before the Society a paper on the geology of Northumberland and Durham.* It is now my intention to extend that sketch towards the South, taking the Humber and the great north turnpike road for the southern and western boundaries of the district to be described, and the German ocean and the river Tees for the western and northern ones.† It is here proper to remark, that the former are only ideal limits to the formations under consideration ; but the latter are real terminations of the rocky strata, a brief account of which will constitute the subject of the following observations.

The length of this district is about 60 miles, and its extreme breadth 40 ; and though the mineral treasures it contains will bear no comparison in respect to number and value with the productions of the country situated to the north and north-west, yet extensive quarries of alum-shale, together with freestone, limestone, chalk, ironstone, and a few thin seams of coal, add in some degree, to the

* This was printed in the Transactions, vol. 4.

† By referring to Mr. Greenough's Geological Map of England, most of the places mentioned in this Memoir will be found.

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riches of the landed proprietors, and give to many of the poorer inhabitants the means of comfort and support.

To begin at the northern extremity of this tract of country, it is necessary to recur to a circumstance mentioned on a former occasion, * viz. that the Tees flows over rocks of fine-grained red and white calcareous sandstones devoid of mica, from a short distance above Croft bridge to the sea.

These beds, which must not be mistaken for the old red sandstone, certainly rest upon the magnesian or Sunderland limestone, and are covered by the alum-slate; though I must acknowledge I have never had an opportunity to ascertain this important fact. This might be done by ascending the little river Leven, from Stokesley towards its source in the mountains; for near the mouth of the Tees, the places where these formations come in contact are buried below alluvial soil or extensive sand banks.

This sandstone formation, containing gypsum, skirts the hilly country on its northern and western acclivities for a considerable distance from the Tees, and may again be recognised on the banks of the Trent near Newark, where the hills are gradually lowered into level plains. The soil arising from the detritus of this sandstone partakes of the brick red colour of the rocks from which it is detached; and the fine crops produced in the vale of Cleveland prove it to be highly favourable to the growth of wheat.

Of the mineral springs rising at Dinsdale and Croft, notice has been taken on a previous occasion;† and for the analysis of the former, I must again refer to Mr. Peacock's pamphlet. I have never heard that any brine spring had its source in this series of strata, though red sandstone in which gypsum abounds seems a

* See Vol. 4, page 2, Transactions of the Geological Society.

† See Geol. Trans. Vol. 4, page 3.

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likely locality for rock salt ; and notwithstanding water impregnated with salt is a common product of the Newcastle coal field.

On quitting the country just mentioned, the eastern side of Yorkshire, bounding the coast from the Tees to the Humber, comprises three ranges of hills :

1. The eastern Moorlands, or alum-shale district.
2. The oolite limestone hills, rising to the south-west of Robin Hood's Bay.
3. The Wolds, composed chiefly of hard chalk.

In this order I shall attempt to describe them.

The eastern Moorlands rise abruptly from the vale of Cleveland, and continue to do so to the south of Gisbro', between which place and Ayrton, Roseberry Topping is a well-known land-mark for mariners on the German ocean, and measures, according to Colonel Mudge's computation, 1022 feet in height. Together with Danby beacon, and other hills of inferior elevation, it forms the northern escarpment of the Cleveland chain, which from thence declines towards the south till it reaches the vale of Esk, and is succeeded by the oolite limestone ridge.

The outline of the alum-shale district is extremely irregular. The immense bed of schistose clay just appears at the Salt Scar rocks, lying in the sea about two miles north of Redcar, which are covered by the tide at half flood. From this point it may be traced to the west of Gisbro' ; then receding towards Newton and Ayton ; after that bending to the east of Stokesby ; from thence passing south-west to Arncliffe, and south to Cosley, till, in the vicinity of Thirkleby, its western limit is reached : but the coal mines near Easingwold, situated still farther south, appear to be worked in the upper strata of this formation. From hence it turns north-eastward, and at length terminates on the coast below Scalesby,

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south of Old Peak. The general inclination of the shale, together with the strata reposing upon it, is towards the south-west, and their dip at the rate of about 1 in 100. Fig. 1, Plate 38, represents a section of the strata from the Yorkshire Wold to Easington height.* On the north side of Whitby harbour they appear to be depressed by a downcast dyke about 90 to 100 fathoms. Fig. 2, 3, and 4, (Plate 38) are sections on a large scale of particular places.

The alluvial soil lying upon the rocky beds is in many places from 50 to 100 feet thick, and contains large blocks of granite, sienite, porphyry and grauwacke, the wreck of mountains situated far to the west.

Immediately below this superficial covering, a thick stratum of sharp-grained sandstone is met with, in which considerable quarries have been worked on the banks of the Esk, and enormous blocks shipped for London, where it has been used for the interior structure of Waterloo bridge, the exterior being built with Cornish granite.

Alternate beds of bituminous shale, sandstone, and ironstone, succeed the sandstone; and from this repository, numerous fragments and nodules of argillaceous iron-ore are detached by the action of the sea, and lie scattered on the beach at the foot of the cliffs.

From hence the Tyne Iron Company have for some years past supplied their furnaces with large quantities of this species of ore. The same kind of ironstone is now calcined at some of the alum works as a material in the manufacture of Roman cement.

This thin coal formation covers the alum-shale, except where it bassets out, or is exposed to view by deep ravines, chiefly worn by the action of the water; and it dips in different directions accord-

* For this, besides much other valuable information, I am indebted to the kindness of Mr. Bird.

ing to situation, or, in other words, forms a basin. Towards the north, the dip is to the south-west; but at Coxwold, to the east. The thickness of the coal varies from 6 or 7 to 14 inches, but, to use the pitman's phrase, is frequently *nipped* out; the beds of sandstone meeting, and not leaving a vestige of the coal. In the swellies the seam is thickest, and best in quality. This stratum, with its accompanying thil, when it does occur, is situated between the white or grey post and the white freestone, the former of which is about $1\frac{1}{2}$ foot, and the latter 21 feet thick. This thin coal formation upon the alum-shale undulates with the surface, which is not the case in the Newcastle coal field.

A bed called the *dogger* rests upon the alum rock. It is a hard sandstone, containing a considerable quantity of iron. Its thickness is from 7 to 13 feet, and colour a dark grey iron-grey, containing rounded pebbles of the same substance, together with numerous small grains of shining smoke-grey quartz, and specks of white disintegrated felspar. Ammonites, belemnites, and trigonia clavelata, are occasionally imbedded in it.

To this succeeds the enormous bed of alum-shale, from which alum has been manufactured ever since the days of Queen Elizabeth. The depth to which this stratum reaches has never been ascertained; but to give an idea of its thickness, I need only mention that the cliffs at Bowlby are 600 feet high, 400 of the lower part being an entire mass of shale: and to what depth it may descend below the level of the sea remains to be proved.

The upper part of the stratum of alum-shale is less compact than the lower, and containing a greater quantity of pyrites, produces more alum. Its colour is iron-grey; and as large heaps continue to burn till the whole mass is reduced to reddish-grey ashes, when

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once ignited by a small quantity of brushwood, I suspect some portion of bitumen must be blended with it.

For the process of manufacturing alum, as practised at present, I beg leave to refer to the Appendix to Aikin's Chemical and Mineralogical Dictionary.

At the time when the history of Whitby was published, alum works were carried on at Loftus, Boalby, Kettleness, Sandsend, Eskdaleside, Littlebeck, Stoupbrow, and Peak, but had previously been discontinued at Gisbro', Ayton, Carlton, Osmotherly, and other inland places.

At the depth of 200 to 250 feet from the top of the bed of alum shale, it is intersected and mixed with layers of sand for the space of 50 to 70 feet in thickness. These bands of sand are blended with clay, and contain nodules of thin bands of ironstone, in one of which large pectenites are found ; in another a species of oyster ; and in a third a shell resembling a cockle. This admixture of sand and clay is observable in the cliffs wherever the alum rock is exposed to view. Besides the fossils enumerated, madreporite, (See Jameson, edit. 2d, and Aikin's Min.) with liquid bitumen, occurs in this rock ; and the tusks of sharks are occasionally scattered through it.

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The following Sinkings for Coal at Baysdale, 12 miles west from Whitby, will illustrate the nature of these Beds.

No. 1.			No. 2.—Sinking.		
	Yds.	ft. in.		Ft.	in.
Sand and gravel	1	1 4	Walling from the surface	10	6
Brown sandstone	1	—	Drab-coloured stone	19	6
Metal	1	—	Blue metal	34	6
White freestone	1	1 6	White freestone	4	4
Blue metal	1	—	Blue metal	9	—
Blue bind	0	1 6	White post	1	8
Blue metal	1	—	Blue metal	6	—
Blue flinty stone	—	1 5	Here Coal was expected		
White freestone	3	1 6	White freestone	21	—
Blue metal	1	1 6			
White freestone	9	—			
Blue metal	—	1 —			
White freestone	1	1 6			
White freestone	5	1 6			
Blue metal	1	—			
White freestone	—	1 —			
Blue metal	—	1 4			
White freestone	—	6			
Blue metal	—	1 6			
White freestone	3	2 2			
	Yards 40	— —			

No. 3.—Boring.

	Fth.	ft.	in.		Fth.	ft.	in.
Peat moss	—	4	—	brought over	6	—	6
Blue clay	1	—	—	Blue metal with post girdles	1	—	—
Blue metal	—	3	—	White freestone	—	4	6
White freestone	—	1	6	Blue raggy stone	—	4	6
Blue bind	1	4	6	Dark brown post with water	1	3	0
Blue metal	—	1	6	Blue metal mixed with ironstone	—	4	—
White stone	—	4	—	balls			
Blue stone with coal pipes	1	—	—				
	Fathoms 6	—	6		Fathoms 10	4	6

Left off at a coarse white post with a large feeder of water.

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Section of the Engine pit in Newbury Park Colliery, the Seat of the late Lord Falconberg, near the village of Coxwold, Yorkshire.

	Fth.	ft.	in.
Soil	1	—	—
Blue metal	—	4	6
Soft blue metal	5	—	—
Strong grey metal with cat heads.....	—	1	—
Coarse strong grey post	1	1	—
Coal	—	1	4
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	Fathoms	8	1 10

The Seam of Coal is of irregular thickness; seldom under 10, or about 16 inches. It dips to the East 2 or 3 inches per yard. The Coal is of an inferior quality.

Section at Gillingmoor, near Helmsley.			Section at Gerick Howl. on Skelton Moor.		
	Fth.	ft. in.		Yds.	ft. in.
Limestone	3	— —	Blue shale	8	— —
Freestone	6	— —	Sandstone with coal pipes	10	— —
Blue plate	3	— —	Blue plate and stone	10	— —
Hard blue stone called galliad	—	2 —	Hard girdle stone	1	— —
Blue plate	2	— —	Blue stone and plate	30	— —
Coal	—	— —	<hr/>		
Soft stone and plate	10	— —	Yards 59 — —		
Blue limestone	1	1 —	At Sealing Dam bored 70 yards in beds of		
Soft stone plate	1	1 —	Stone similar to the above.		
Strong grit, blue mixed with red	17	— —	Boring at Osmotherly Moor.		
Soft blue plate	2	— —	Freestone	10	— —
Strong plate nearly black	10	— —	Blue plate	4	— —
Soft blue stone	2	— —	Red grit	2	— —
Fine soft plate	—	2 —	Soft blue plate	—	2 —
Coal	—	6 —	Coal	—	6 —
Black Hull (Thil)	—	2 —	Freestone	40	— —
<hr/>			<hr/>		
Yards 60 0 0			Yards 56 2 6		

After this the borers appear to have kept no regular account, but say they bored 50 yards deeper through alternate beds of blue plate and soft stone, each bed being from 18 inches to 2 feet thick; and were in a soft white stone when the undertaking was discontinued.

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A stratum of blue limestone containing iron, from nine to ten feet thick, crops out at Cold moor, four miles south of Stokesby. It is not met with in the cliffs at Whitby, where the borings were made twelve miles inland from that place, nor at Coxwold; and therefore cannot be a bed in the thin coal formation. The dip of the strata of Coxwold is different from that on the coast.

About three miles south of Robin Hood's bay, a lower range of round topped hills rise to view. This district consists of alternate strata of soft yellowish sandstone and oolite limestone, which rocks decline in the same direction as the alum slate, till they reach the vale of Derwent, where the oolite is covered in turn by the hard chalk.

The oolite, which may be seen cropping out at Filey head, Pickering, Kirby moor-side, and Helmsley, is a pale yellow, or yellowish-brown limestone; some of its beds, comprising numerous bivalve shells and other marine exuvizæ. It is used as a building stone, and with this material York Minster and other edifices in the neighbourhood are constructed. When in a state of disintegration from the action of the air and rain, it becomes valuable to the farmer as a manure; but when burned does not make good mortar.

On the sea beach near Scarborough, numerous masses of pea-iron ore lie dispersed, and the same curious mineral occurs *in situ* among rocks of this series in a ravine south of the town. This locality, which is the only one I am acquainted with in Britain, agrees exactly with the formation where it abounds in France, according to the testimony of Brongniart (see vol. i. p. 170). Jameson says, this species of ore, which is met with in Germany, Switzerland, and Dalmatia, yields from 30 to 40 per cent of iron. The Tyne Iron Company used formerly to collect it in large quantities for their works at Lemington. Its colour is bluish-grey, and the

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grains or globules of which the mass is composed, vary from the size of mustard seed to those of large peas.

In the vale of Pickering, and even as far west of Thirkleby, a hard shell-limestone is quarried. Its situation appears to be subordinate to the oolite and sandstone; for at Thirkleby it basets out at no great distance from the alum-shale formation. It is of a pale bluish colour, close grained texture; fracture slaty when broken, with large fragments; lustre glimmering (probably from numerous minute fragments of shells); and containing small bivalves. When weathered it becomes externally rusty brown. It is sonorous, and breaks into tabular fragments.

The Yorkshire wolds are undulating hills occupying a considerable part of the south and south-west, the district of Yorkshire to which our observations are confined. These commence on the Derwent, and stretching southwards, dip under the alluvial soil which covers the flat country in the vicinity of the Humber.

Hard chalk is the prevailing rock through the whole of this part of the district, and the high cliffs at Flamborough head serve to convey a just notion of its thickness. With the exception of iron pyrites this chalk does not appear to be metalliferous, but nodules of grey flints frequently occur in it.

Here it may not be amiss to mention that the same species of rock skirts the sea shore below Lowth in Lincolnshire, and there rests upon numerous beds of ash-grey bituminous shale, which crop out towards the west. When burnt, this shale emits a fetid odour, which I thought might arise from animal matter, as it is filled with the fragments of small bivalve shells, but on analysis no ammonia was detected.

Among the rejectamenta of the sea on this coast, fragments of a peculiar kind of coal abound, resembling the brown or Bovey coal

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in structure, but in colour being black as jet. Seams of this fossil are suspected to exist between the strata of bituminous shale before mentioned.

On the Yorkshire beach, common and jasper agates, together with resplendent felspar, are collected. These must be the products of the Northumberland and Scotch mountains, where amygdaloids and porphyries are the predominant rocks.

Of the organic remains in this district, the first particularly worthy of notice are the tusks and teeth of the Siberian elephant or mammoth, and which are not mineralized, but remain in their original state. Tusks supposed to belong to the same species of quadruped, have been found on the coast near Scarborough.

The mineralized skeletons of animals formerly supposed to be those of alligators, occur in the Whitby cliffs. One of these was noticed in the year 1758, by Capt. William Chapman, and his account is printed in the Philosophical Transactions, at p. 688, and that of Mr. Wooller, at p. 786, plate 9, fig. 5. From the vertebræ, which I had the opportunity to examine, I make no doubt but these bones belonged to the same species of animal as the one found in the lias between Lyme-Regis and Charmouth, on the Dorsetshire coast, and accurately described by Sir Everard Home, in the same publication, at p. 571, and pl. 17, 18, 19, 20, and since called by him Proteo-saurus.

The following petrefactions in the alum-shale are also worthy of notice :

Echinus vulgaris . . .	Parkinson, vol. 3, tab. 2, fig. 3.
Ammonites serratus . . .	Sowerby, tab. 24.
. armata . . .	Sow. tab. 95.
. heterophillus	Sow. tab. 166.
Nautilus lineatus . . .	Sow. tab. 41.

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<i>Nautilus imperialis</i>	. . .	Sowerby	tab.	1.
. <i>discus</i>	. . .	Sow.	tab.	12.
<i>Modiola depressa</i>	. . .	Sow.	tab.	8. mid. fig.
<i>Orthocera conica</i>	. . .	Sow.	tab.	6. fig. 1 & 2.

Belemnites

Mya 2 species

Chama digitata . . . Sow. tab. 174.

Helix

Trigonia

Pentacrinite

Pectenite resembling the common scallop.

These are all mineralized by clay ironstone, iron pyrites, and calcareous spar.

Gigantic reeds resembling *arundo donax*, are found in the sea cliffs opposite High Whitby. They appear to have been rooted in a bed of shale or slate clay, and their remains protrude into a stratum of sandstone five feet thick. Those which stand erect retain their shape, but those which do not are compressed. Their tops seem to have been broken off; the woody matter has disappeared, leaving sandstone casts. Casts of *Euphorbia* are also found in the sandstone strata above the alum rocks. Wood mineralized by iron is frequently found at Kettleness and Snowbrow. Trunks and branches of fossil trees, the bark and softer parts of which have been changed into jet, are frequently met with in the alum-shale; and leaves and impressions like those of the palm, are found in the sandstone and ironstone.

Galena is met with occasionally in nodules of the latter mineral; and hair pyrites (Sowerby, tab. 28) is found, though rarely, at Kettleness.

In the oolite at Malton and other places in that neighbourhood,

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enormous casts of ammonites, similar to those found in the west of England, occur in abundance.

Pinna marina—in sandstone, Troutsdale.

Trigonia clavellata—Parkinson, vol. 3, p. 12, f. 3, limestone, Pickering.

Nautilus nobilis—Malton.

Cardium resembling *C. edule*—Malton.

Ostrea edulis?—Malton and Pickering.

O. diluviana—Park. vol. 3. pl. 15. fig. 1. on the sands.

Solen ensis—on the Sands.

Bivalve, Park. vol. 3. p. 13, fig. 4. on the sands.

Terebratula coarctata?—Park. vol. 3, vol. p. 16, fig. 5.—in sandstone at Malton.

Mytilus edulis?—Troutsdale in sandstone, and Malton in limestone.

A small rivulet called Peacham beck, brings down a magnetic iron-sand, most probably Iserine.

A short distance below the town of Yarm, a basaltic dyke crosses the river Tees, in an east-south-east direction; and basaltic eminences may be traced in the same line by Stainton, Newton Danby, Derwent head; and terminate at Blea hill, in Harwood dale, seven or eight miles north-west from the coast. But whether these masses have any connection with the dyke it is impossible to ascertain.

That it is really a dyke where it crosses the river Tees appears very evident; but in the moorlands I suspect the low eminences of basalt are similar to those at Shewingshield in Northumberland.

It may be here observed, that the basaltic dykes in the Newcastle coalfield are known to terminate abruptly; for instance, those at Coley hill and Walbottle Dean, noticed in my former paper, are not found in the mines situated a short distance to the east of those

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places ; nor is the dyke known in Walker colliery detected in any of the mines adjoining.

The rock where it is quarried for mending the roads in the vicinity of the Tees is of a dark iron-grey colour, and fine grained texture. It consists of blocks, lying horizontally and coated with ochre, as is also the case at Coley hill, and various places in Northumberland. Where the dyke crosses the Pickering road at Sill Howell its texture is fine grained.

Siliceous sandstone

Interbedded clay with limestone and thin sandstone

Dwyer

Shale

Section of the Road at Old Fish on South shore of Robson Woods bay
about 500 ft. in height. — see C.....D Fig 1.

Faction of the Park at New-Suff' or Easington heights.
see E.....F Fig 1.

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