

EXPLANATION OF PLATES X. & XI.

PLATE X.

- Fig. 1. Fragment of the tusk of *Trichecodon Huxleyi*; terminal portion, showing the fluting of the dentine. From the Red Crag of Suffolk. One-third the natural size.
2. A flatter specimen of the same, with point complete, and the surface of cement preserved. One-third the natural size.
 3. Basal portion of the same, with the cement preserved. One-third the natural size.
- [These three specimens are in the cabinet of W. Whincop, Esq., of Woodbridge.]
4. Section of a portion of the tusk of *Trichecus rosmarus*, showing the microscopic structure of the three layers. Drawn from specimens prepared for the author.
 5. Section of a portion of the tusk of *Trichecodon Huxleyi*. Drawn from specimens prepared for the author.
 6. Transverse section of the specimen drawn in fig. 1, showing the "core" of granular "osseo-dentine." Natural size.

PLATE XI.

- Fig. 1. Restoration of the tusk of *Trichecodon Huxleyi*.
2. Tusk of *Trichecus rosmarus*.
 3. Tooth of a large Ziphioid Cetacean, probably one of the *Belemnoziphi* (*Balenodon physaloides* of Owen), from the Red Crag, Felixstow: in the author's cabinet. Three-fourths the natural size.
 4. Tooth of *Squalodon*, Van Beneden & Gervais; from the Red Crag, Suffolk. In the Woodwardian Museum, Cambridge.
 5. *Balenodon physaloides*; from Owen's 'British Fossil Mammalia,' p. 536.
 - 6 & 7. Teeth of *Squalodon*, more or less worn, sometimes attributed to the *Balenodon* of Owen.

2. *Note on the GEOLOGY of HARROGATE.* By JOHN PHILLIPS, M.A. Oxon., LL.D. Dublin, F.R.S., F.G.S., Professor of Geology in the University of Oxford.

DURING more than forty years the uncommon arrangement of the strata about Harrogate has attracted my attention, and I have made frequent examinations of the surrounding country to learn the peculiarities of structure of the Upper Palæozoic rocks which are there exposed. Of late years the information furnished by many quarries has been increased by the cuttings on the North-Eastern Railway, and thus not only the ranges of Millstone-grit, calcareous roadstone, and Yoredale shales have been settled, but some light has been thrown on the relation of the Permian grits to those of the older series, which was formerly doubtful. The mineral springs are also much more surely referable to a deep source along an axis of movement than was possible when, now almost thirty years since, I published my map of the north-western tract of Yorkshire*.

Founded on a mass of particular notices, I propose now to offer to the Society a few results relating to this district, such as it may be well to consider before the closer scrutiny of the Geological Survey

* Illustrations of the Geology of Yorkshire, vol. ii. 1836.

shall have completely mapped out and measured the whole of the large region of elevated Mountain-limestone, Millstone-grit, and Coal-measures of the North and West Ridings.

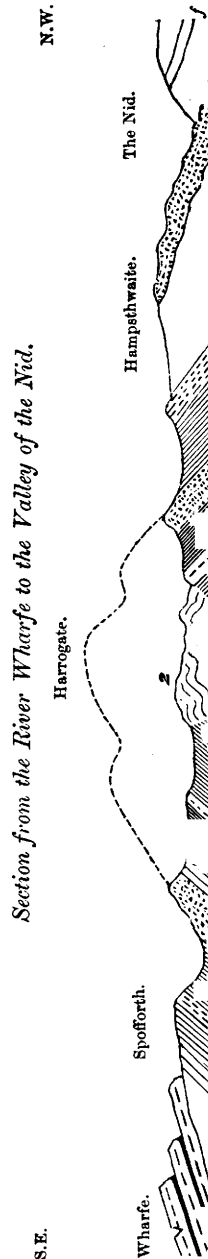
On the map of this part of Yorkshire, and further to the west, the whole country south of the Craven fault, for a length (E. to W.) of fifty miles and a breadth of twenty, is marked by many nearly parallel anticlinals, by which the Great Scar limestone and the black limestones of the Yoredale series are frequently brought up in narrow elliptical patches, whose direction is about E.N.E. or N.E. Thus at Greenhow Hill, Nursa Knot, Skipton Castle, Coningby, Thornton, Gisburn, and many other places these ridges occur, until we reach the remarkable examples at Clitheroe, Whitwell, and Trough of Bolland.

To this list Harrogate must be added; its anticlinal is in the same direction, and I am now satisfied, and have been for some years, that the strata exposed at Low Harrogate are part of the Yoredale series of limestones, shales, and grits. Formerly (1836) I classed them with the Millstone-grit.

In a line of section between the Wharfe and Harrogate the strata appear as in the Section, all in a general sense dipping away to the S.E. from the broad and somewhat complicated and faulted anticlinal of Harrogate. Placed in succession downwards, this appears to be the order of the beds below the unconformable Permian rocks:—

Rocks.	Estimated thicknesses.
11. Spofforth Hags roadstone and fossils.	10 ft.
10. Dark coal-shales and <i>Stigmara</i> ..	unknown.
9. Follifoot coal-grit, with <i>Stigmara</i> ..	30
8. Shales	500
7. Almes Cliff Millstone-grit	50
6. Pannel roadstone	30
5. Shale	unknown.
4. Harrogate Tunnel sandstone	20
3. Shale	unknown.
2. Harrogate roadstone	50
1. Shale	unknown.

Similarly in the continuation of the section to the Nid, the strata follow in the same order, but are not to be observed with the same clearness and certainty. No. 6 is not recognized there. There is probably a fault-line both on the north-west and on the south-east of the Harrogate roadstone-beds. The Almes Cliff grit, No. 7, is remarkably well seen



on the north on the road to Blubber Houses, covered by Nos. 8 and 9 at Acton Houses, and equally well on the S.E. at Pannal. By these outcrops the other parts of the section may be adjusted.

I regard this Millstone-grit as probably the lowest of three bands (namely, the grit of Ingleborough, Penyghent, and Pendle Hill), having poor Coal-measures above it, with Stigmarian grits and shales. I have not determined whether it is the same grit (*g*), raised by faults, which sinks down to the Nid through the picturesque grounds of Hampsthwaite, or that the shelly subcalcareous stone (*f*) which was cut through in the railway under the village of Clint, appearing again at Padside, west of Dacre, and at Hartwith, on the road from Ripley to Pateley Bridge, belongs to the Follifoot beds. I suppose not*.

The beds here called roadstone are calcareous according as they contain Crinoids or Shells. Crinoidal fragments abound in the lowest Harrogate roadstone. Crinoids, *Producti*, *Strophomenæ*, *Goniatites*, and *Euomphali* occur in the upper or Follifoot bands. In these latter bands, about the year 1800, W. Smith found a remarkable discoid shell (which formed part of his collection, now in the British Museum), with a row of nodules on each side. The Pannal band is cherty and slightly crinoidal. I am rather of opinion that the Harrogate band corresponds to the main or 12-fathom limestone at the top of the Yoredale series: all these limestones lose themselves in cherty or sandy representatives as we go to the east and south. On the line of the Harrogate anticlinal we have several mineral springs, in each of which the essential bases seem to be chloride of sodium, with sulphates of lime, soda, &c. Several of them issue through peaty deposits, and there probably undergo the usual change when sulphates come into contact with decomposing vegetable matter and release the sulphuretted hydrogen, for which particular springs are remarkable at Harrogate. One general subterranean source, determined by the axis of dislocation, and subdivided toward the surface into several branches, which follow the fissures of the rocks, and there meet with various local conditions, seems enough to explain the diversity of the waters of Harrogate, Starbeck, and Bilton.

Another point deserves attention. Few rocks are more variable in composition, while regular in sequence, than the Lower Permian sandstones and shales. Where the sequence is immediate from the upper Coal-measures to the Permian beds, as in Durham, North Staffordshire, and part of Yorkshire and Derbyshire, the analogy of the two sets of strata is considerable, even if they do not exchange beds. But in this part of Yorkshire the Permian beds are in no sense or manner conformed to the Coal-system or to any part of it. They are strictly transgressive, and very much so, resting on extremely different members of the great Carboniferous system, and of very different age. In this particular district the Millstone-grit probably underwent enormous waste after the anticlinal was formed, and before the Permian beds were deposited. These Permian beds of coarse and fine purple sandstone are full of the detritus of Millstone-grit. The felspar is

* See Geology of Yorkshire, vol. ii. p. 58, &c.

rolled, but quite recognizable; and the mica appears in ferruginous patches. The rock is often quite undistinguishable from Millstone-grit in hand-specimens; even the purple colour (due to decomposed ferruginous mica) fails sometimes, and, as at Plumpton, great and lofty cliffs of solid rock appear, such as may have yielded the Devil's Arrows, those massive monoliths of the British settlement which preceded ancient Isurium. As we proceed to the south, and reach the Leeds coal-basin, the Permian beds lose their similitude to Millstone-grit; and as we pass to the north and encounter the Mountain-limestone, so also the resemblance to Millstone-grit is lost; nor is it recovered in Durham or Northumberland, nor does it occur in any other part of the kingdom, though quartzose pebbles and coarse sand accompany it in many parts. From this we may draw a confirmation of the opinion, very probable on other grounds, that the Lower Permian beds were of littoral aggregation, by currents operating on the waste of the neighbouring coasts.

On Harrogate Common, the railway-cutting exposed northern Drift, the usual Boulder-clay, with much variety of rock-fragments, all, as far as I saw, from the limestones and gritstones lying to the north.

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C. Gainer, Esq., M.A., St. Mary's Hall, Oxford; John Wesley Judd, Esq., 2 Burngreave View, Sheffield; Francis R. Spry, Esq., Ashford, near Hornsey; The Hon. Arthur Strutt, 88 Eaton Square, W.; and Samuel Long Waring, Esq., The Oaks, Norwood, were elected Fellows.

The following communications were read:—

1. *On the LOWER SILURIAN ROCKS of the SOUTH-EAST of CUMBERLAND and the NORTH-EAST of WESTMORELAND.* By Professor R. HARKNESS, F.R.S. L. & E., F.G.S.

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3. The Lower Silurian Rocks of the North-east of Westmoreland.
4. Fault through the Lower Silurian Rocks of the South-east of Cumberland and the North-east of Westmoreland.

1. *Introduction.*—The district to which this memoir has reference consists of a narrow band of country on the western side of the Pennine Chain, possessing external features which indicate a difference in mineral nature from the rocks which form those Pennine escarpments, and also from those which, in Cumberland and Westmoreland, usually lie on their western side. The area occupied by this narrow band of Lower Silurian rocks extends in length about fourteen miles in a N.N.W. and S.S.E. direction; and it has a varying breadth from a very narrow strip to about a mile and a