THE GEOLOGY OF THE NORTH RIDING OF YORKSHIRE.

THE Government Geological Survey is now in active progress in the North Riding; maps of the eastern and western parts have already been published, but for the central part (Vale of York) we shall probably have to wait some time longer. We are not ignorant, however, of the general geological features of the district. The arrangement of its rock-masses has been well described by several authors, some of whom indeed have laboured at their elucidation with special care for the sake of the county which gave them birth. First we must place Professor John Phillips; his works on the "Mountain Limestone" and the "Yorkshire Coast," together with his geological map of the entire county (published in 1853), are of the highest interest and accuracy. Mr. J. G. Baker's "North Yorkshire" (1863), is a very useful compendium. The "Yorkshire Lias," by Tate and Blake, and two important papers by Mr. W. H. Hudleston on the Oolites, lately published in the Proceedings of the Geologists' Association of London, give minute details respecting the beds of the eastern division. Much has also been done by Messrs. Tiddeman, Dakyns, De Rance, L. C. Miall, Binney, M. Simpson, J. Rofe and others. Mr. Wood may be named as a great collector of the fossils of the mountain limestone, and Messrs. Williamson, Bean and Leckenby for the coast. The museums at York, Scarborough, Whitby and Richmond contain local collections of rocks and fossils, which may be freely inspected.

The great extent of the North Riding from west to east causes it to include a large variety of rocks, for it is well known that in England the strata, or beds of rock, run across the country from north-east to south-west, resting one upon the other, the oldest or first-formed lying most to the west. This order of succession holds good in North Yorkshire. The beds of the Pennine chain in the west are the oldest, and those which form the south-east corner of the coast between Scarborough and Filey are the newest of all the stratified rocks which enter into the "solid" geology of the district. The glacial deposits of clay and gravel with travelled blocks of stone of all sizes rest indiscriminately on the edges of the rock-beds of which we have been speaking, and must be considered separately.

THE CARBONIFEROUS FORMATION.—The rocks which bear this name form all the west of the county, from the Pennine ridge as far east as a line drawn from Pierce Bridge on the Tees to near Tanfield on the Ure. Here we can distinguish three main divisions, viz.: (1) the Carboniferous Limestone, also called the Mountain Limestone and Great Scar Limestone, (2) the Yoredale Rocks, (3) the Millstone Grit. The total thickness of these beds is about 3,000 feet, but it is not easy to say exactly how much of this belongs to each division. The reason for this is that as we go northwards we are approaching the shore-line of the ocean in which these Carboniferous beds were deposited. Consequently the Limestone, which to the south in the West Riding and Derbyshire forms an undivided mass some thousands of feet in thickness, becomes much reduced as we go northwards, and beds of shale and sandstone are interpolated in it: it is well exposed along Yoredale (or Wensleydale) between Hawes and Middleham.

The Yoredale Rocks, which succeed, were so named by Professor Phillips from their occurrence higher up on the sides of the same valley: they are composed of sandstones (flagstones) and shales with some limestone bands; the latter are quarried at Gilling. They contain good veins of lead ore, which are worked at several points in Arkendale &c. The total amount of lead-ore raised in Yorkshire in 1877 was 5,010 tons, this yielded 3,620 tons of lead and 7,472 ounces of silver. Arkendale and Old Gang were the most productive mines. The veins in which the ores occur were doubtless once fissures or cracks in the rocks, and the minerals they now contain have been deposited by water holding them in solution as it circulated through these fissures.

The Millstone Grit owes its name to the hard coarse beds of sandstone which mainly compose it: altogether it is from 500 to 600 feet thick. Between Masham, Bedale and Melsonby the Millstone Grit forms comparatively low, flat ground, an undulating moorland gritstone country, whose surface is about 300 feet above the level of the sea. But as we follow it westwards it rises and forms a capping to the highest hills, which indeed, owe their existence to the weather-resisting powers of the hard sandstones which compose it: it forms lofty ridges separating Teesdale from Swaledale, and the latter from Wensleydale, rising to heights of over 2,000 feet, and still rising westwards crowns Shunnor Fell (2,329 feet), Water Crag (2,186 feet), and Micklefell (2,600 feet).

The scenery of the Carboniferous tract is very varied. On the Pennine escarpment, the fine perpendicular "scars" formed by the limestones, are conspicuous, and it is to the alternation of hard limestones with softer beds of shale and sandstone, that the numerous "forces" or waterfalls of the same region and the dales are due. Subterranean caverns and "swallow-holes" abound in the limestone rocks, and although the surface vegetation is scanty, yet ferns of great beauty line the frequent fissures which traverse the rock. The Millstone Grit forms a somewhat dreary moorland surface.

The fossils of these rocks confirm the ideas already stated concerning their origin. In the limestones we get remains of *crinoids*, and marine shells such as *Productus giganteus*, *Orthoceratites* and *Bellerophon*. Messrs Wood and Rofe both formed fine collections of *Crinoidea* from this district, and of a new genus named *Woodocrinus* after its discoverer many very beautiful specimens have been found showing the long stem, cup-like body and branching tentacles of this curious "sea-lily." Higher in the series the shales and grits contain scanty plant-remains, and even thin coal seams. Chert is common; it is an impure variety of flint.

THE PERMIAN FORMATION.—No coal measures are present in the North Riding, so the Permian beds rest directly upon the Millstone Grit. Doubtless, the coal field of Durham was once continuous with that of the West Riding, but before the deposition of the Permian strata, a great upheaval took place in an east and west direction, and from the district so raised beween the Tees and Wharfe the coal measures were denuded or swept away.

The Permian or Magnesian limestone crosses the Ure half-a-mile west of Tanfield Bridge: thence it runs N.N.W. to Thornton Watlas, forming an escarpment 300 feet high with an easterly slope. We then only see it in irregular patches near Little Crakehall and Catterick, until it again appears on the south side of the Tees at Pierce Bridge, where it forms the lower part of the cliffs.

THE TRIAS, or New Red Sandstone, forms the vale of York, a comparatively low level tract of land which runs from Middlesbrough and Croft on the north, southwards past Northallerton and Myton, to and beyond York. The Red Sandstones and Marls are scarcely ever exposed to view in this district, being deeply covered up by glacial deposits of clay, gravel &c. The lower Triassic beds are called the *Bunter* (or variegated) *Sandstone*. They run along the west side of the vale, whilst the *Keuper* (copper-bearing) *Marls* occupy the eastern side. In a boring made at Middlesbrough, by Messrs. Bolckow and Vaughan, in 1868, after passing through 58 feet of surface deposits they penetrated 81 feet of red marls and clays, containing two beds of gypsum 2 feet and 6 feet thick respectively. Next came no less than 1,067 feet of white and red sandstone with gypsum veins. At a depth of 1,206 feet, the borer entered a bed of rock-salt, and continued in it to a total depth of 1,306 feet, thus giving a thickness of 100 feet of salt. Here the boring stopped, the total thickness of the salt bed not having been proved. It is in the Trias of Worcestershire