

other insects were taking advantage of a few gleams of sunshine, and I had great sport amongst them.

The current of the Kama is a little more rapid than the Volga, and here, with the wind blowing against it, it was curled up and flecked with patches of white foam. Our repairs being ended, we started up the Kama. We had, however, not been very long afloat, when, through running on a sandbank, our machinery again gave out, and we were detained for the remainder of the night. Next day we were again afloat. Upon our western side an occasional red cliff was to be seen, whilst nearer to the river brownish earthy banks were well marked with lines which showed the height to which the water sometimes rises.

During our second evening on this river an immense number of delicate white ephemeral-looking flies fell upon our deck and into the water. These were so thick in places that they fringed the windward shore of the river with a white line. On the Dneiper a somewhat similar fly sometimes occurs in such quantities that the fishermen light fires to attract them. The creatures, whilst hovering round the light, get their wings singed, and fall down on and round the fire like snow. They are then swept together, mixed with clay, and used for ground bait.

A passenger on board, a man apparently of some intelligence, told me that mineral coal had been found on the Kama near Piani-Vor. If this is proved to be correct, it will not only give a new locality for the mineral, but also another point for the outcrop of the Carboniferous formation. In the Kama there are a few low islands, which take the place of the sands I saw upon the Volga. With this exception, I do not think that there is any choice, as far as picturesqueness is concerned, between the two. As a whole, they are both flat and dull. As we progressed upwards, we saw some pleasant upland slopes chequered over with square plots of cultivation. In outline these hills are not unlike our downs, but they are perhaps more furrowed by the small streams which cut through the soft red Permian strata of which they are composed. The shore is everywhere slippery and muddy. As we neared Perm, we had upon our western side high sloping hills of red earth bounded with white rock.

On the afternoon of Thursday, September 3rd, we came in sight of Perm, and in the afternoon we landed, after a wearisome eight days' steaming along two rivers, which, for flatness and monotony, would rival, I think, any in Europe.

(To be continued in our next Number.)

II.—A SKETCH OF THE GEOLOGY OF KEIGHLEY, SKIPTON, AND GRASSINGTON.¹

By J. R. DAKYNS, M.A., of H.M. Geological Survey.

IN Derbyshire the Millstone-grit series consists of four or five well-marked grits, separated by shales, viz. the so-called first or topmost grit, named, from its coarse character, the rough rock;

¹ Originally read with the Director's permission before the British Association at Bradford, but not heretofore published.

the second grit, which is generally a flagstone; the third grit, a bold, well-jointed rock; and lastly, the Kinder Scout grit, which sometimes consists of two beds. In advancing northwards this type undergoes considerable changes; the second grit becomes merely a basement bed to the rough rock, not always separable therefrom; the third grit loses its massive character, and other beds of sandstone begin to show themselves amid the shales overlying the Kinder Scout grit. When one reaches the valley of the Colne, four separate sandstones have developed themselves between the rough rock (locally known as the sand rock) and the recognized Kinder Scout grit. This type prevails also in the valley of the Yorkshire Calder; but is not to be found on crossing the watershed into the basin of the Aire. There the series consists in descending order, first of the rough rock, which throughout maintains its usual marked character till it is buried beneath the Permian; secondly, of a very variable basement bed to the last, consisting, when well developed, of valuable flagstones. These are extensively quarried at Nab, above Oxenhope Moor; and also in an outlier at the Penistone quarries, near Haworth. Below this bed comes a fresh series of variable sandstones and shales. There may be in places as many as fifteen or sixteen distinct sandstones below the basement of the rough rock and the regular Kinder Scout grit. But this set of beds may conveniently be divided into two by means of a conspicuous grit which is continuous with the third grit of Lancashire. This grit forms the bold escarpment of Hallan Hill and Earl Crag, so conspicuous with Wainman's monument on its crest, as seen from the railway between Keighley and Skipton. We may conveniently speak of it as the middle grit. It generally has three grits between it and the base of the rough rock; these four beds are presumably the four grits of the Calder and Colne valleys mentioned above. I will now briefly point out the general run of the beds in the basin of the Aire. The rough rock runs in a nearly unbroken manner from the latitude of Penistone, and enters the basin of the Aire above Oxenhope Moor; its basement flags form the lofty escarpment of Nab, whence may be had a glorious view of the northern fells from Ingleborough on the west to Great Whernside on the east.

A large fault, ranging across Thornton Moor in a W.N.W. direction, throws down the Coal-measures of Denholme on the north, from beneath which the rough rock rises to form Black Moor and Brow Moor. Another W.N.W. fault throws the beds up again near Cullingworth, so that Harden Moor, between Bingley and Keighley, consists of an outlier of rough rock, while various members of the third grit series occupy the flanks of the hill. West of the river Worth the rough rock forms, with a dip slope, the wide expanse of Keighley Moor; but at Exley Head another W.N.W. fault throws up the beds to the north, so that an outlier of rough rock forms the hill on which is situated Keighley tarn. Going N.W. from the town we pass successively over the various members of the third grit series. The middle grit can clearly be traced by its massive character running down to the valley south of Hawkcliff Cottage; it

ascends on the north side of the Aire, somewhat broken by faults, and forms Brunthwaite Crag; is thrown up by a W.N.W. fault to form White Crag, and again in the escarpment of Addingham High Moor. It is this rock which forms the well-known Brimham Rock near Pateley Bridge. Below the escarpment of the middle grit there is no conspicuous rock south of the Aire; but on the north of that river several beds of sandstone appear, one of which becomes important further north as the hard siliceous grit with ganister, which forms the summit of Great Whernside. Owing to the number of sandstones that now have come in, it is somewhat uncertain what ought to be taken as the top of the Kinder Scout grit, though there is no doubt about the main mass of the bed. This well-marked, coarse, and massive grit is brought in by a W.N.W. fault (south of the river Aire), which is remarkable as one of the few instances in which galena has been found away from the limestone area. North of the Aire the Kinder Scout grit rises up regularly from beneath the overlying beds at Kildwick. Near Cononley a N.E. fault throws down the beds on the N.W., so that the upper part of the Kinder Scout grit is again found in the valley. The bed here consists generally of three separate rocks. It is immediately underlain by a thick but variable set of sandstones, with shale partings, which have hitherto been styled Yoredale grits; but this is a very bad and misleading term, as the beds are merely the basement part of the Kinder Scout grit, from which they cannot always be separated without forcing; and, moreover, these grits are nowhere, that I know of, found in Yoredale. Beneath these are found, at Skipton, shales and limestones, a narrow band of contorted limestone, forming the crest of an anticlinal, appearing between the road and railway about half a mile south of Skipton. The strike of the beds hitherto described is generally N.E. and S.W., the dip increasing as we go westward; but about the latitude of Skipton the beds bend round so as to strike nearly E. and W., with a dip of 20 deg. to the south along Skipton Moor. In fact, the country between the latitudes of Skipton and Grassington has been much disturbed and thrown into a series of east and west rolls. Thus a strong anticlinal ranges down the Skibeden Valley from Skipton to Bolton Abbey, with a steady dip to the north, and many minor folds on the south. The effect of this is that a mass of Mountain Limestone forming the green boss known as the Haw Park has been brought up in the Skibeden Valley between two ranges of Millstone-grit hills, viz. Skipton Moor on the south, and Emsay Moor on the north. The Mountain Limestone here is a dark thin-bedded limestone. It is extensively quarried for road material both at Haw Bank and also at Thornton, where similar beds are found. Either of these quarries is well worth a visit. The beds are much faulted and contorted, particularly along the south side of Skibeden Valley; good instances of contortion are to be seen at Draughton and the Wheelam Rock quarries, as also at the Hambleton Rock quarry, near Bolton Bridge; an excellent section of contorted beds is also to be seen in Halton Gill. The strike of the beds of Mountain Limestone seems to indicate that they

have partly been brought up by a fault ranging along the south side of the Skibeden Valley;¹ but on the north they dip regularly under the Yoredale and Millstone-grit beds. On that side, where the series is much clearer than on the south, there are two limestones above the Mountain Limestone. On the south side of the Skibeden Valley and anticlinal the Kinder Scout grit strikes E. and W. along Skipton and Draughton Moors, and descends to the river Wharfe north of Addingham. Its high southerly dip carries it up the slope of Langbar Moor, its base running just below Beamsley Beacon; it then, under the influence of a branch of the Skipton anticlinal, plunges down northward to Kex Beck, where the beds bend up again and rise northward to Hazlewood Moor and Bolton Park; here, on the strike of the Skipton anticlinal, the beds bend over northward and recross the Wharfe below Laund House; south of this, as far as Bolton Abbey, limestones and shales of the Yoredale series are seen along the river. These are cut off opposite Bolton Abbey by a N.E. fault bringing in the upper beds. The so-called Yoredale grits run along the slopes of Skipton Moor to Fairfield Hall; and east of the Wharfe are found about Beamsley and Storriaths. They have not been everywhere identified on the north side of the Skibeden Valley. On the west side, though the beds are in several places broken by N.W. faults, yet their general run is tolerably plain. A set of bold crags marks the escarpment of the Kinder Scout grit along Halton and Embsay Moors, Rylstone, Burnsall, and Thorp Fells. Beneath the western escarpment of the Kinder Scout grit, the Yoredale grit is found forming at intervals promontories on the sides of the fells, probably caused by a local hardening of the rock, which appears to be of a very variable character. It has not been traced further east than the northern extremity of Burnsall Fell. The Kinder Scout grit, whose escarpment has been briefly indicated above, lies in the shape of a synclinal trough dipping east, and thus occupies with its various members the whole extent of Burnsall Fell, Barden, and Embsay Moors. The rock is well seen along the river Wharfe, particularly at the celebrated 'Strid' in Bolton Woods. On the east of the Wharfe these grits rise up in a sort of broken dome with a quaquaversal dip to form the summit of Barden Fell, well marked by the bold crags of Simon Seat, whence a magnificent view is to be had, and York Minster may be seen on a clear day. Near these crags, at the very summit of the fell, 1700 feet above the sea, some pot-holes (one of which, in the dialect of the country, is, from its great size, called the Great Shak) indicate the presence of limestone at no great distance. The beds may be seen in Howgill and on the path through Fell Plantation, dipping steeply to the N.W. into the valley; but along the Skyreholme beck they turn up again, and dip steeply to the S.E. From Appletreewick the grits are seen striking north-eastward, underlain by a mass of shale, from beneath which massive white scar limestone rises regularly with a similar strike, as far as a set of

¹ I now consider it doubtful whether there is not also a fault along the north side of Skibeden.

bold crags, marked by the Ordnance station, 1350 feet above the sea-level; here the beds end abruptly, being cut off by the Craven fault. The position of this fault is also shown by the abrupt termination of similar grit crags at Fancarl, by great disturbances of the beds at Thurskell Well, near Hebden, and by disturbed beds on the banks of the Wharfe near Lyth House, whence the fault runs by Skirethornes, with limestone on its north side and grit on its south, to join the line of bold cliffs which mark the line of the fault from Malham to Settle. East of the river Dibb we have, north of the Craven fault, massive white limestone, dipping north at 19°, closely overlain by the grit of Grimwith Fell, from which the main mass of limestone is separated merely by a thin band of mixed shales and limestones. The green mass of Greenhow Hill forms the dome-shaped end of this band, which is in fact an anticlinal, broken up by the Craven fault. Between the river Dibb and Grassington the ground is very obscure; but the Millstone-grits seem to be separated from the great limestone by a considerable thickness of shales, with but poor limestone bands. At Grassington, however, the limestones swell out, and with the exception of two bands of hard sandstones, known as the Dirt Pot Grits, there is solid limestone from the grits of Grassington Moor to the river Wharfe. Northwards the limestone gradually breaks up, and finally takes on the Yoredale type, so well known from the writings of Professor Phillips.

III.—NOTES ON THE CORRELATION OF THE BEDS CONSTITUTING THE UPPER GREENSAND AND CHLORITIC MARL.

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CONSIDERABLE uncertainty has for some time existed with regard to the formations known by the names of Upper Greensand and Chloritic Marl.

The series of beds which are thus denominated have been accurately described as they exist in several different localities, and the strata supposed to constitute these divisions have been shown to vary greatly both as regards their lithological characters and their fossil contents; but very few attempts have been made to ascertain the lateral extension and the exact stratigraphical relations of these component beds; they have been like the fragments of a puzzle which no one has succeeded in putting together.

Geologists, indeed, were for a long time contented to receive all the sandy and glauconitic deposits intervening between the Gault-clay and the Chalk-marl of any locality in England as belonging to the Upper Greensand. Afterwards, when the Chloritic Marl was separated from the series in the Isle of Wight, its existence in other parts of England was not properly established—or, to speak more correctly, different inland horizons were assigned to it by different writers.

The type of the Upper Greensand was supposed to exist in