

V.—NOTE ON THE SILURIAN ROCKS OF CASTERTON LOW FELL,
KIRKBY LONSDALE, WESTMORELAND.

By THOMAS McKENNY HUGHES, B.A., F.G.S.

I SHOULD not have presumed to publish an opinion as to the geological position of the rocks of Casterton Low Fell without having examined the typical region of Coniston and Windermere, had not Mr. Woodward thought it desirable to notice the occurrence there of a species of *Ceratiocaris* and asked me to furnish him with a note on the bed from which I obtained it. Having therefore collected all the evidence I could in that limited and complicated area, I now, with the permission of the Director of the Survey, send him some extracts from my notes, which may be of interest, as showing the character and relations of the rocks there seen.

The Silurian Rocks of Casterton Low Fell, and Barbon Low Fell, are bounded on the West and South by a great fault which brings various parts of the Old Red, Carboniferous, and Permian, against the Silurian Rocks. This may well be seen in Barbon Beck, near the church; where the Old Red is faulted against the Carboniferous Limestone, and this again, in less than fifty yards, is faulted against the Silurian Rocks. The fault runs in a southerly direction bending round to the S.S.W. by Whelprigg, where the Old Red Conglomerate is seen, not in contact with the Silurian, but very close by it. From this point the boundary is entirely obscured by drift till we come to Leck Beck where the Permian beds are thrown against the Silurian. Here again they are not seen in contact, but they occur near one another in such a manner that we cannot explain the phenomena by the unconformity of the Permian on the Silurian. On the East and South East of this the ground is entirely covered by drift, but proceeding up the stream to Bullpot we soon find evidence of a great double fault, like that seen on the other side of the hill in Barbon Beck, running North and South, and bringing the Yoredale Rocks against the Mountain Limestone, and that in a few yards more against the Silurian. These two sets of faults are connected by a series of transverse faults, running nearly W.N.W. and E.S.E. on the South side of Barbon Beck. Thus it will be seen that the Silurian rocks of the area under notice are cut off all round by enormous faults, and therefore that their age must be determined by the evidence we can obtain within that area. I have frequently searched for fossils in company with Mr. Gibbs, Fossil Collector to the Survey, and also with Mr. Hindson, and Mr. Haythornthwaite of Kirkby Lonsdale, but the number, both of species and of individuals, that we were able to obtain, was small.

The accompanying section is drawn from the Permian beds in Leck Beck, due North, to beyond the second of the set of faults on the North slope of Barbon Low Fell, about a quarter of a mile South of Barbon Beck.

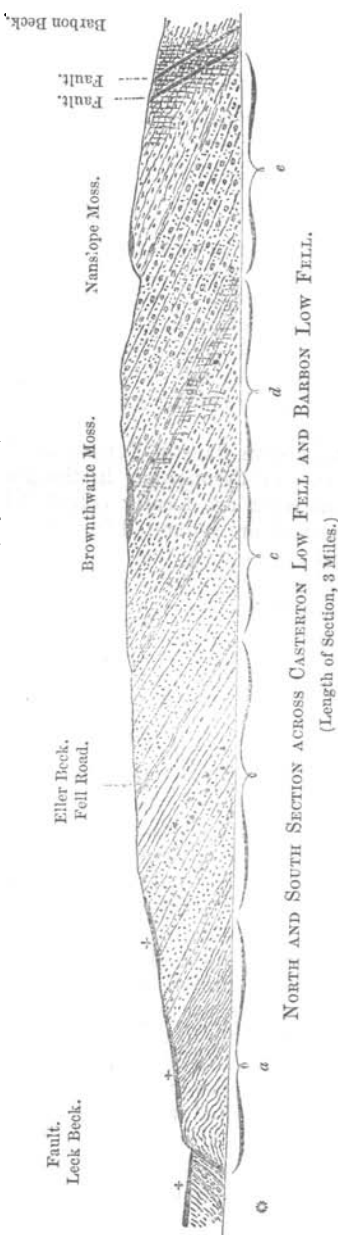
The first beds seen are dark grey coarse flags; the dip is at first irregular, but afterwards tolerably steady in a North-Westerly direction at from 20° to 30° , and this dip prevails with small minor

variations all along the ridge. In the lowest beds *Graptolites*, probably *G. priodon*, and an *Orthoceras*, like *O. tenuicinctum*, occur. Further North we find these flaggy beds succeeded by alternations of a coarse greywacke, with joints at right angles to the bedding and a roughly cleaved, distinctly bedded sandstone. All this part of the series I have included under (a), and would estimate its thickness at about 1000 feet.

It is succeeded by about 1200 feet of unfossiliferous greywacke (b), with occasional bands of red earthy nodules in the upper part, and alternations of finer sandstone sometimes roughly cleaved.

These are succeeded by a set of dark grey shivery sandstones (c), (d) and (e), about 3000 feet thick, with occasional beds of tough greywacke and generally a rough cleavage in the softer beds. *Cardiola interrupta* occurs all through (c) and (d), but the specimens are not so fine or so numerous in the middle part (d) as in the lower (c). I procured many fine ones from the Fell Road side near where it crosses Eller Beck. In the middle part (d) a very interesting set of fossils occurs, among which the following have been determined by my colleague, Mr. Etheridge:—

¹ I use the word greywacke merely as a lithological term for the rough, tough, gritty sandstones, so common in the Palæozoic rocks; the term grit being required for the coarse-grained rock intermediate between sandstone and conglomerate, e.g. Millstone grit.



^a Dark-grey coarse flags, with alternations of coarse Greywacke and roughly-cleaved, distinctly-bedded Sandstone—about 1000 feet.
^b Unfossiliferous Greywacke, with red nodules and alternations of finer Sandstones—about 1200 feet.
^{c, d, e} Dark-grey shivery Sandstones, about 3000 feet thick, with occasional beds of tough Greywacke: fossiliferous.

Acidaspis, n. sp.
Phacops, sp.
Petrata elongata
Heliolites interstinctus
Pterinea tenuistriata

Pterinea, sp.
Cardiola interrupta
Orthoceras, sp. like *tenuicinctum*
Graptolites priodon

and the *Ceratiocaris* now described by Mr. Woodward.

The general character of the rock in the upper part (e) is very similar to that in (c) and (d), but I was unable to procure many fossils except a *Graptolite*, probably *G. priodon*, and an *Orthoceras*, like that found all through the series.

On the whole, I find that the lithological character of the rock is very similar throughout, except that at the bottom the tough grey-wacke passes into dark blue flags, and towards the top there is more of the roughly cleaved dull dark grey sandstone which alternates with the harder beds all through.

Prof. Ramsay at once pointed out the general resemblance of these beds to the Denbighshire grits, and the fossils seem to bear out this suggestion.

The micaceous flags of Benson Knot, from which the specimens of the carapace of *Ceratiocaris* in the British Museum were obtained, belong to what are locally called Kirkby Moor Flags—i.e. Upper Ludlow—and are separated from the beds of Casterton Fell by an enormous series, the exact position and thickness of which I shall not be able to determine until I have worked much further north into a clearer country.

VI.—NOTE ON COAL AND CANNEL.

By JNO. ROFE, F.G.S.

ALTHOUGH many theories have been suggested to account for the formation of coal-beds, all of which agree in the vegetable origin of the coal itself, none have yet appeared which meet many of the difficulties which surround the subject of their origin, and probably they have been deposited under so many varying conditions that no one supposition would account for the difference in the constituents of the mineral, or for the mode of its formation in different localities. From the *Stigmaria* found in the underclay, in the great majority of cases, it seems fair to assume that the vegetation from which the coal above it was formed, grew where the coal is found, and there are other reasons for coming to the same conclusion in these cases, but in some places, where the underclay is wanting, this may be doubtful.

There can, however, be but little doubt that coal and cannell must have been deposited under different circumstances, and yet in some places they are found interstratified and in contact.

This subject was named at the meeting of the British Association at Birmingham, when one of the speakers suggested that the vegetable matter of the cannell was so far decayed as to be reduced to a pulp, like thoroughly rotted peat, which gave the cannell its homogeneous structure, whilst that from which the coal was formed was less de-