ON THE RED BEDS AT THE BASE OF THE CARBONIFEROUS LIMESTONE IN THE N.W. OF ENGLAND. BY CHARLES BIRD, B.A.; SCIENCE MASTER IN THE BRADFORD GRAMMAR SCHOOL; HONORARY SECRETARY TO THE BRADFORD PHILOSOPHICAL SOCIETY. (PLATES II. AND III.)

Between the silurian and the carboniferous systems there occurs a great thickness of red and yellow sandstones and conglomerates, to which the name of old red sandstone has been given. These beds appear to have been deposited in shallow, brackish, or fresh waters, caused by the gradual shallowing and contracting of the silurian sea. The fossils of the upper silurian beds become fewer in number and dwarfed in form as they pass upwards and finally disappear, and all traces of marine shells die out, while land plants and fresh water fishes become the characteristic forms.

The old red sandstone of Shropshire, Hereford, and Wales lies regularly and conformably upon the upper Ludlow rocks, and after attaining a thickness of 10,000 feet, passes upwards conformably and without any break into the carboniferous limestone.
In Scotland there are two old red districts, one south, and the other north, of the Grampians. The beds of the southern region are divided into three groups. The lower lies conformably upon the upper silurian, the middle lies unconformably upon the lower, while the upper lies unconformably upon the middle, but passes upwards conformably into the carboniferous rocks. In the northern region also three divisions are recognisable, but there is no unconformability between them. The lower rests unconformably upon lower silurian rocks, and the carboniferous rocks are absent.

In the South of Ireland, the beds which intervene between the silurian and carboniferous systems are naturally divided into two sets; the Dingle beds, consisting of coloured grits, slates and conglomerates, apparently resting conformably upon and passing gradually downwards into the representatives of the Ludlow rocks; and a set of red sandstones and conglomerates resting unconformably upon the Dingle beds, and passing insensibly upwards into the base of the carboniferous rocks, which here consists of a vast series of grits and slates, known as the “carboniferous slates.”

In Devonshire, the series of beds which occupies a position corresponding to the preceding, differs entirely from it both in mineral character and in fossils. It is a marine formation—slates, limestones, and marbles; and contains abundance of shells and corals. It was first recognised as contemporaneous with the old red sandstone of the north by Lonsdale, Murchison, and Sedgwick, in 1836, after the recognition of the anthracitic shales and sandstones of North Devon as carboniferous. In 1866, Mr. Jukes read a paper before the Geological Society, in which he maintained that the beds which underlie the anthracitic beds of North Devon were not of old red sandstone age, but were contemporaneous with the carboniferous slates of the South of Ireland. Palaeontological evidence, however, is in favour of the former view.
Thus we see that in the South of England, in Wales, in Scotland, and in Ireland, the carboniferous rocks are separated from the silurian by a great thickness of strata, and wherever the junction can be seen, the lower beds of these intervening strata are found to graduate downwards into the upper silurian, and the upper to pass upwards, without any break, into the carboniferous. In Cumberland, there is another silurian district, and around it are carboniferous rocks, but here the enormous thickness of red strata is nearly absent. The carboniferous limestone dips in all directions from the silurian lake district as a centre, and only in isolated patches is there anything which can by any means be compared with the old red sandstone of Wales and Scotland, the limestone, for the most part, lying unconformably upon the contorted, metamorphosed, and denuded silurian rocks. It is the same in the Isle of Man; the carboniferous limestone, the most recent formation not tertiary in the island, is separated from the silurian schists by a few comparatively thin red beds. It is these isolated patches of red, which in these localities intervene between the silurian rocks and the carboniferous limestone, which are more especially the subject of this paper.

First, as to their character and mode of occurrence. They form almost always a coarse conglomerate. The included stones vary much in size, and some are very large. They are angular or subangular, rarely well rounded. In mineral character they are the same as the underlying silurian rocks, and appear to have been always derived from the immediate neighbourhood. The matrix is generally red, but is sometimes of a light grey or green, and sometimes a deep purple, and it contains a large quantity of iron. The conglomerate presents a rough stratification, and often contains thin, irregular, false-bedded, and ripple-marked beds of sand or sandy clay. No fossils have been found in it, except silurian fossils in the included
fragments. The fossils mentioned by Dr. Nicholson* were found, not in conglomerate, but in beds above it, which Professor Harkness and the geological surveyors place in the carboniferous series.†

The limestone is not generally found superimposed directly upon this mass of conglomerate, but beds of an intermediate texture and composition intervene, as will be hereafter shown, so that, supposing this conglomerate to be of old red sandstone age, it is difficult to determine where the line between the two systems shall be drawn.

I will now proceed to describe briefly the various localities where these conglomerates are met with.

1. **Kirkby Lonsdale and Barbon.**—Here the conglomerate rests unconformably upon silurian grits and shales—the Kirkby Moor flags, the equivalents of the upper Ludlow. It is well seen on the banks of the Lane, near Kirkby Lonsdale church, where it appears as a very coarse, thick-bedded conglomerate, apparently dipping in the same direction as the carboniferous limestone (S.E.) which may be seen a little lower down the river. The conglomerate is, however, bounded on all sides by faults and cannot be actually traced upwards into the limestone.

About two miles further N. it is exposed on the banks of a small brook which flows W. into the Lane. It is here, in many places, decomposed on the surface, and might be easily mistaken for recent drift.

It can also be examined in Barbon Beck, near the railway station, where the fault which throws down the limestone to the E. can be well seen. This Barbon conglomerate is, like the preceding, bounded by faults.

2. **Sedbergh.**—Here a mass of conglomerate, two or three miles in length, occupies the valley of the Rawthy. Two

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* Essay on the Geology of Cumberland and Westmoreland, 1868.
miles above Sedbergh, a good section may be seen, where it
occupies the whole of a cliff 50 or 60 feet high, and it can be
examined in many other places. It is a coarse red con­
glomerate throughout. It rests unconformably upon the
Coniston grits—the equivalents of the Wenlock—and does
not, in this locality, pass into the carboniferous limestone.

3. 
Kendal.—Near Kendal there are several patches,
once, in all probability, continuous, resting unconformably
upon the Bannisdale slates (Lower Ludlow and Wenlock
shale). The conglomerate is interstratified with red sand­
stones, and is well seen in the river Mint, about two miles
N.E. of Kendal. Lying conformably above it, and sepa­
rated from it by thin shales and sandy limestones, are thick­
bedded, grey carboniferous limestones.

4. 
Tebay and Shap.—This is perhaps the most instructive
region for studying these conglomerates in their connection
with the overlying limestone. The series may be seen in
ascending order by proceeding N. up the Birk Beck. The
lowest beds consist of red conglomerate dipping N.E. resting
unconformably upon the Bannisdale slates. Further N. the
conglomerate becomes somewhat finer, has a light grey
matrix, and is interstratified with coarse, false-beded thin
sandstones. Above these are fine whitish sandstones, marked
with dark spots. Dr. Nicholson, who calls nearly all the
beds below the limestone “upper old red,” classes all the
above as “lower” division. Above the light coloured sandstone
occur beds of red sandstone, and red sandy shale, which the
same author calls “middle.” These are followed by beds of
conglomerate and sandstone, which he classes as “upper,”
and in which he has found the remains of coal plants. They
are succeeded conformably by the “Dun limestone.” Prof­
cessor Harkness has estimated the thickness of these Birk
Beck beds at 370 feet. Further N. they are much thinner,
and the whole series may be seen in section in the railway
cutting near the Shap granite works. The lower beds here consist of very coarse angular conglomerate or breccia, resting unconformably upon the green slates and porphyries (lower silurian). They are succeeded by beds of red sandstone and finer conglomerate, which make up the bulk of the section. Above them are beds of variously coloured clays and thin bands of impure nodular limestone, and on the top, thicker beds of light yellow, sandy limestone ("Dun limestone"). A very similar section is exhibited near Shap Abbey, but the lower coarse conglomerate is absent, perhaps overlapped. It can be well seen, however, in a small brook running W. into the Birk Beck, where it rests on the Coniston grits, and is succeeded by thick beds of red sandstone. Near Shap Fell the conglomerate contains crystals of orthoclase from the Shap granite.

5. Penrith.—The red conglomerate attains its greatest thickness in the district which extends three or four miles W. from Pooley Bridge, at the W. extremity of Lake Ullswater. It is here almost entirely thick-bedded conglomerate, without sandstones, and forms several hills, including Great and Little Mell Fell, 1,760 and 1,650 feet high respectively. Its thickness has been estimated at 2,500 feet, but taking into consideration the fact that it has an average easterly dip of 7° or 8°, it seems to me that it may be considerably less. It can be examined in the river Eamont and Dacre Becks and on the N. and N.W. shores of Ullswater. East of Ullswater, the limestone rests directly upon the green slate and porphyries. Tracking the conglomerate upwards towards Penrith, we find resting upon it a thickness of several hundred feet of limestone, followed by alternations of limestones, red sandstones, and shales, and then by the main mass of the carboniferous limestone.

6. Kirkby Stephen, &c.—These beds are again exposed to view on the E. of the Pennine Fault, near Kirkby Stephen
and Brough. Mr. Goodchild* gives the following sequence at Ash Fell:—

a. Main mass of the carboniferous limestone. (1,000 ft.)

b. Soft red sandstones, often conglomeratic, with traces of coal plants, alternating with thin shales and limestones. (500 feet.)

c. Limestone, rather impure, but not split up by sandstones and shales. (500 or 600 feet.)

d. Shales and thin impure limestones passing downwards, through calcareous beds of a more decidedly conglomeratic character, into a series of apple-green conglomerates and chocolate and grey shales.

e. Drift-like series of red conglomerates, sandstones, and shales of variable thickness. These are the beds which in various localities are seen resting unconformably upon the silurian rocks. They pass upwards into d without any clear line of demarcation.

A series, similar to a, b, c of the above, but less calcareous, is found near Brough, in the escarpment.

Thus we see that there is in several localities a mass of coarse conglomerate which passes upwards through a series of fine conglomerates, red sandstones, shales, and limestones, more or less pure, into the main mass of the carboniferous limestone.

7. Isle of Man.—In the Isle of Man there are two districts in which we find red beds resting on an irregular and denuded surface of silurian schists. The carboniferous limestone occurs in the S.E. of the island, and in various points showing from under it we have a thick-bedded red conglomerate, very similar to that in Cumberland. It is best seen in the small peninsula of Langness, opposite Castletown.

between high and low water mark, where it is about 50 feet thick, and perfectly conformable to the limestone. (Plate III. B.) Its junction with the silurian can be seen in many places; perhaps the most striking is a natural arch, the lower part of which is silurian and the upper conglomerate, the conglomerate being intersected by a dyke.* (Plate III. C.)

At Peel, the red beds are, almost entirely, the fine-grained thick-bedded sandstone of which the town is built. They form the cliffs for a distance of about two miles N. from Peel. The Rev. J. G. Cumming† has estimated its thickness at 300 feet, and has pointed out the fact that although there is no limestone on it now, beds of limestone, probably carboniferous, were removed from it some years ago for burning, and the shore is strewn with limestone blocks, probably washed up by the sea from beds still existing.

Having now touched upon the various localities in which these red beds are found, it remains to consider the mode of their formation, and their position in the geological series.

They are unconformable to the upper silurian, and pass upwards into the carboniferous limestone. They are, therefore, certainly not older than the upper old red. They are composed of coarse materials, and bear other evidences of rapid accumulation, and in many places pass by regular gradations of colour and mineral character into the carboniferous limestone.

Again, they rest upon an irregularly denuded surface of silurian rocks of all ages. Near Shap Fell they lie nearly horizontally upon the upturned edges of the elevated rocks.

* The dyke is the cause of the arch. Being more readily decomposed than either the schist or the conglomerate, the sea washed through, and then enlarged the hole to its present dimensions. On the other side of Langness, the decomposition of trap dykes which intersect the schists, has caused many long narrow inlets of the sea to be formed.

† "On the Geology of the Isle of Man." Quart. Journ., 1840.
and fragments from the granite are found in them. These facts tell of a long period during which these old silurian rocks were exposed to denudation and igneous action, and during which the country received the great general features of hill and valley which it now presents. Judging by the work done, this must have been a period of very long duration. In the southern silurian district, on the other hand, 10,000 feet of strata were deposited conformably upon the upper silurian. These periods of denudation and deposition must have been contemporaneous. By far the greater part of the materials removed from the Cumbrian region would be carried out into the Devonian sea and form new rocks elsewhere, but some would remain, choking up the valleys, and when the land began to sink the first thing done by the encroaching sea would be the sorting out and rearranging of these valley deposits. The work would be done with more or less thoroughness, according to the amount and nature of the deposit and its position with reference to the advancing waters. In some cases, as at Shap, it was sorted and spread out along the valley; in others, as at Ulleswater, it was left piled up as a great bank. Then, as the land still continued to sink, overlapping deposits of sand and mud were thrown upon and against the coarser deposits, becoming more and more interstratified with limestone as the water deepened, sometimes the sandy and muddy deposits predominating, and sometimes the limestone, till finally the latter prevailed over the former, and the carboniferous limestone was deposited in thick masses round the sinking land.

There can be little doubt that the conglomerates, sandstones, and shales, represent a part of the waste of this old silurian region. This material would be brought down into the valleys either by water or ice. Everyone must be struck on first seeing the conglomerate, both in the Isle of Man and
in the Lake District, with its resemblance to "till," especially
where it is somewhat decomposed. Its large angular and
subangular stones, its position in isolated patches, and in the
valleys, suggest its glacial origin. But the subsequent
action of water is also indicated by the following facts:—

(1) Scratched stones, so common in the till, are at least
rare.*

(2) There is less matrix than in more recent till, and
it is more sandy.

(3) Although many of the stones stand on end, yet,
on the whole, they seem to lie more horizontally
than would be expected had they been left undis­turbed.

Finally, we have the question, Are these beds to be con­
sidered as old red sandstone or carboniferous? The materials
which compose the beds were removed from the silurian land
and deposited not very far from their present position during
the old red period, but their present form and arrangement
are the result of those changes in level which brought the
carboniferous limestone round the Cumbrian region; the
waters which washed up the valleys and spread out the old
drifts, were, at the same time, depositing limestone out at sea,
and this limestone, as the water deepened, spread over the
rearranged drifts. It seems, therefore, simpler and more
logical to consider these beds, one and all, as basement beds
of the carboniferous limestone than to attempt to draw any
arbitrary line in a series whose members appear so closely
linked together. At the same time, the question as to the
name is of secondary importance.

* Professor Ramsay has noticed the occurrence of scratched stones.
Professor McKenny Hughes, in a paper read before this Society, in 1867,
pointed out that these stones are only found where the scratches might have
been caused by subsequent disturbance. This explanation, however, does not
seem quite satisfactory.
EXPLANATIONS OF PLATES II. AND III.

PLATE I.—Map showing the horizontal and vertical distribution of the red deposits near the Lake district. Unshaded portion—below 1,000 feet in elevation. Light shading—between 1,000 and 2,000 feet. Dark shading—above 2,000 feet.

PLATE II.—Section in railway cutting near Shap.
   a. Silurian rock.
   b. Very coarse and conglomerate, resting unconformably upon a.
   c. Finer red conglomerate with sand.
   d. Coloured clays and bands of limestone.
   e. Dun Limestone.
   f. Rubbish.

B.—Section between high and low water marks on W. of Langness.
   a. Silurian schist.
   b. Red conglomerate.
   c. Carboniferous limestone.

C.—Natural arch at Langness.
   a. Silurian schist.
   b. Red conglomerate.
   c. Dyke.
A Map showing the horizontal and vertical distribution of the red deposits near the Lake district.

- [ ] below 1000 feet.
- [ ] between 1000 and 2000 feet.
- [ ] above 2000 feet.