No. XII.—THE OLD RED SANDSTONE OF LANARKSHIRE, WITH
NOTES ON VOLCANIC ACTION DURING OLD RED AND CARBONIFEROUS TIMES. BY JOHN R. S. HUNTER, D.Sc., LL.D.,
F.R.P.H.S.E., ETC., *Honorary Member.*

[Read 28th May, 1885.]

THE Old Red Sandstones or Devonian formation, mainly composed of nearly pure sandstones and conglomerates, and lying above the Upper Silurians, is largely developed in Lanarkshire. The lower beds of conglomerate extend over a considerable portion of the parish of Lesmahagow. The matrix of this conglomerate is a coarse-grained sandstone of a dun or purple colour, with quartzite nodules of a slightly flattened oval shape of from half an inch to 15 inches in diameter, and pieces of red and bluish-grey jasper. These beds are quite different from the higher conglomerates of the Old Red, which are light brick red in colour.

The Old Red is best developed in the Hagshaw, Whitehaugh, Greenock, Avon, Glengaril, Kype Water, Lesmahagow, and Lanark districts, and the Tinto and Carmichael districts from Tinto Hill to the Clyde, also in the Kilncadzow or Carluke area to the N.-E. of the town of Lanark. All these are connected with each other.

A good idea of the structure of Lanarkshire may be got by supposing a ridge or axis of rock to run through the middle of the field in a sinuous, easterly and westerly direction. From the north side of this ridge, the limestones, coals, etc., dip northwards, forming the Clyde coal-field. On the south, a small area of the Ayrshire coal-field is seen round Glenbuck. The ridge itself consists chiefly of Lower Old Red, forming an expansion of the belt of that formation which stretches across the country from near Edinburgh into Ayrshire. On the west side, it is prolonged north-westward by the Lower Carboniferous volcanic rocks running from Stonehaven as a broad strip of elevated ground between the plains of Ayrshire and the valley of the Clyde. Owing to numerous foldings and fractures of the Old Red Sandstone, portions of the underlying Upper Silurian strata are brought to the surface, but the former wraps round them, and abuts against the great Lower Silurian uplands of the South of Scotland. The strata of the Old

Red attain a great development between the basin of the Clyde near Lanark and the Ayrshire coal-fields, reaching possibly a thickness of 12,000 to 15,000 feet. At Bonnington Falls, the rocks occur in layers of from an eighth of an inch to several feet in thickness, the former having clay nodules interspersed. From Bonnington to Cora Linn, the Clyde flows through a magnificent wild ravine of about half a mile in length, the waters of the Clyde being hemmed in by vertical jointed walls of Old Red strata, at Cora Linn the water descending a sheer fall of 84 feet, and a short way below the precipitous sides being about 150 feet high. The sandstone varies considerably in colour, sometimes resembling a hard ferruginous clay, while a large portion is thickly studded with plates of mica.

The lithological features at Stonebyres Falls are similar to those at Cora Linn, except that here and there we find a great cliff of conglomerate protruding into the stream from beneath the Old Red Sandstone. Thin seams of conglomerate are also interlaminated with the prevailing rock at various heights. The contained fragments are both rounded and angular, consisting of quartz, felstone, porphyry, claystone, greenstone, and jasper.

At Tinto the Old Red formation contains intercalated masses of trappean agglomerates, which, with interbedded felspathic rocks, extend north-eastwards towards the source of the Nith. In the valley of the Irvine Water at Lanfine, Ayrshire, it consists of a grey micaceous flagstone with trappean agglomerates and felspathic traps. Here it has yielded a few specimens of *Cephalaspis Lyellii*, being the only locality in the South of Scotland where remains of this fish have been found till very recently (1884). I have now the pleasure of showing you a magnificent specimen from the Lower Old Red of Lesmahagow, the portion represented being that of the buckler or shield-plate of the head. The position of the eyes is plainly visible, and from them two ridges extend backwards to the end of the shield-plate, but do not show any portion of the horn-like processes, which have probably been broken away. The most interesting point in connection with the specimen is the occurrence over the whole surface of the buckler-plate of a strongly marked system of vascular canals, which branch outwards in all directions from central stems, and which, as they reach the outward extremity bordering the rim, become very much branched. Where a portion of the buckler-plate has been lifted off on the

left hand side, the inner surface shows a peculiar strongly lobed appearance. The vascular ornamentation of the Lesmahagow specimen is more apparent than that of either English or Forfarshire ones. On comparing the canals on my specimen with those seen on a portion of the shield of *Zenaspis Salweyi*, I find the former to be much larger than those figured, (and magnified 4 diam.) in the valuable monograph on the fishes of the Old Red Sandstone by Mr. James Powrie, F.G.S., Reswallie, near Forfar.*

Before the Lesmahagow specimen was sent to Mr. Powrie, my kind friend, Mr. John Young, F.G.S., of the Hunterian Museum, Glasgow, carefully examined it, and as we came to the conclusion that it probably was a new species, I have ventured to name it provisionally *Cephalaspis Glottensis*, but I hope that before long other examples may be found in the same horizon, so that the doubtful points may be fully cleared up.

Organic remains of marine origin were found by the officers of the Geological Survey at Carmichael Burn in a thin shale about 5,000 feet above the base of the Old Red; but the formation, so far as yet observed in Lanarkshire, is very unfossiliferous, indicating a condition of things in which the waters were not conducive to organic life, probably from the excess of iron sediments in them. Peroxide of iron is also unfavourable to the preservation of organic remains, and may, in many cases, account for their disappearance. Lately, when examining a few cut corals which had been imperfectly cleansed from this substance, which is used for polishing them, I found that the smooth surfaces had, in the course of a few hours, been largely bitten into.

* Mr. Powrie, after comparing this specimen, wrote me as follows:—"From a large portion of the head being broken off, and thus its form when entire being lost, and also no portion of the outer surface of the cephalic plate being preserved, it is impossible to say with anything like certainty to what species it may have belonged, but on the whole I think it more probably belongs to *Cephalaspis Lyellii* than to any other with which I am acquainted. It is the impression of the inner surface containing the vascular canals, and these are better preserved in your specimen than in any one of the many others I have examined. Indeed, from the preservation of these canals, and their so distinctly marked character distinguishing it from those with which I am acquainted, I think it just equally probable that its species may be distinct from any of our Forfarshire Cephalaspids." Since the publication of the valuable monograph by the Palæontographical Society, very little has been added to our knowledge of this interesting genus.

The extremely red colour of the strata seems to indicate some peculiarity in the original medium of deposition by which it may have been communicated to the deposited sediments. What reason can be assigned for the various coloured sandstones we frequently meet with—red, white, yellow, and many different shades? Is it owing to the greater quantity of iron or other metallic oxides, or to some influence of electrical agencies by which rocks of all ages have been more or less affected?

A small space often separates, both horizontally and vertically, the white from the red-coloured sandstone, which favours the supposition that the elements of colour have been induced subsequent to the deposition of the rock. White circular spots are very common in this rock. In these it is evident that either the colour has never been present or has been afterwards expelled. It has often been supposed that such spots are due to the presence of organic matter, but as no traces of that have been found in them it is more reasonable to suppose that they are due to chemical causes.

One of the most remarkable features of the Old Red Sandstone in the West of Scotland is the occurrence of numerous basic trap dykes, probably of Tertiary age, with a general direction of west to east. The same dykes also traverse the coal strata of Ayrshire. Two areas of older volcanic action seem to have existed, one in the north-east, with its centre in the Pentland Hills area, where the porphyrites are thickest, the other in the south-west of Lanarkshire, while between them lay a space originally occupied by small islets of Upper Silurian rocks, over which the thick grits and conglomerates make their appearance. During the same geological period volcanic action was frequent along the whole of the midland valley of Scotland, since to that time we must refer the origin of the Ochil and Sidlaw Hills, part of eastern Berwickshire, and the long line of uplands from the Pentland Hills through Lanarkshire, across Nithsdale, and far into Ayrshire. Early in the Carboniferous period, and from then onwards through nearly the whole of the time occupied by the deposition of the Calciferous and Carboniferous limestone series, the district to the west of Edinburgh was dotted over with small cones, which were usually of tuff, but sometimes of different basic dolerites, more especially in the space between Bathgate and the Forth, where a long bank, chiefly formed of such lava flows, was piled up over and amongst the pools and shallows in which the

HUNTER—ON THE OLD RED SANDSTONE OF LANARKSHIRE. 165

limestones, sandstones, shales, and coals, were afterwards accumulated. Northwards, also, similar volcanic activity was shown in the Fife coal-tracts near the Forth, while eastwards between Haddington and Dunbar there lay a distinct volcanic centre or focus, from which great sheets of porphyrite were ejected so as to form a bank over which and around the Carboniferous limestone series was at length deposited.

An interesting feature is the series of doleritic dykes which show a marked uniformity of direction, generally westerly and easterly, and which, when they traverse tracts of trappean rocks, continue as readily separable from them as when they intersect sandstones or shales. These dykes run across a great part of Scotland and into the North of England.

Faults and dykes, as may be seen from the geological maps of the district under review, are numerous, both in the Old Red Sandstone and in the Carboniferous rocks. Dykes are fissures filled with foreign matter, generally of igneous origin, which cut the strata in a perpendicular or inclined position, and are frequently of great vertical extent, the strata having been in some instances tilted up, or in others depressed on one side or other of the dyke. They sometimes lie obliquely to flows in the plane of stratification. Faults have evidently been produced by earth movements and pressure from beneath, occasioned probably by the same subterranean forces which ejected the matter of the dykes, and of those interstratified and intrusive beds of igneous rock of such common occurrence in our coal-fields.

Intrusive sheets of diabasic rock or dolerite are frequently observed in some parts of the Old Red, but in other places they seem interbedded. A fine example of the former may be found in the great intrusive sheet which extends from the East Neuk of Fife westwards through the Lomond and Cleish Hills, appearing again in the Abbey Craig at Stirling, and continuing on to Kilsyth, but always near the horizon of the Main or Hurlet limestone. The changes produced on the surrounding strata by the trap have been in many places excessive, their structural characters being altogether altered. Coals and limestones are rendered valueless, while shales and sandstones are greatly indurated at the points of contact. Sandstones, shales, and limestones are often greatly jointed and fissured, and sometimes assume the external form of basalt, while the dolerite has become calcareous and felspathic.

In the Wishaw coal-field, Glasgow Iron Co.'s No. 2 pit, there is a body of trap of a whitish colour, thirty feet from the bottom of the splint coal, about two feet thick and perpendicular in position, running due north and south, and probably being an altered dyke of dolerite. In Newmains district numerous dykes are observed, some being greenish and others whitish, which is due to various stages of alteration of the dolerite. In the parish of Carlisle trap rocks, chiefly dolerites of various kinds, are seen at Hillhead, Barnhead, and Westerhouse. From Hillhead they run eastwards by Thorn and Bashaw. At Westerhouse they are merely seen projecting from a small elevation, and in Guildshields Burn they are seen passing towards Burnhouse. At Hillhead, where they are seen in beds 20 feet thick, and were at one time extensively worked for road metal, the columnar form is finely shown. The top and bottom is close grained and brittle, while the centre is highly crystalline. The wider fissures between the columns are filled with clay and boulders, while the smaller ones contain various crystals. The trap overlies clay shale, blackened in colour and otherwise altered. The dolerite terminates partly on the blue shale above the Hosie limestone, which is burnt of a brick colour. In some parts of its course it lies between the Hosie and the Main Post limestones. At Hillhead the Hosie limestone passes round the west point of it at a high angle, almost on edge, dipping on the north side to the north-west. At the west point of the dolerite the dip is west, on the south, south-west. At the extreme west point the ironstones are thrown back upon themselves, and the shale and its ironstone balls have a peculiar colour, while the limestone which lies on the dolerite is a soft mass of ochre. At Guildshields a volcanic rock is cut through by the stream. Near Kilncadzow several remarkable necks were exposed in the opencast ironstone workings. They cut the strata vertically and were circular in shape, being somewhat wider at the top of the quarry than at the bottom. They were filled with angular debris or agglomerate of Carboniferous rocks dipping towards the centre of the neck, where also the largest blocks of sandstone, shale, limestone, ironstone, etc., occurred. None of the fragments were igneous rock, but a few string-like veins of white dolerite penetrated the mass here and there. The white dolerite was seen at No. 2 pit, Old Hill, when sinking to the Raesgill ironstone, and was again observed at Langshaw when an air shaft was being put down to the main limestone workings.

HUNTER.—ON THE OLD RED SANDSTONE OF LANARKSHIRE. 167

Again, in No. 3 Main Limestone pit at Braidwood Station the same character of trap was again seen, but the bed was horizontal and formed the roof of the main coal formerly wrought by the author's firm. The limestone here was in a very confused condition, showing that probably other dislocations were near at hand.

Craigenhill doleritic rock, which is of a black colour, was frequently got below the main limestone, running from two feet upwards in thickness. At Coldstream in the Old Red Sandstone a reddish felstone is seen, and with a thickness of 30 feet is extensively worked for road metal. At No. 2 Orchard Gas Coal pit, near Crossford, a vein of dolerite runs from north-east to south-west. It penetrates up the shaft, so far as is seen, 27 fathoms, and its width is between two and three feet. In the dross coal above the gas coal the burning by the trap extends about three feet, while the gas coal is only altered for about one foot. The sandstone has also become very like kinglestone, and the fireclay is black and vitrified.

In the parish of Lesmahagow many of the hills are of igneous felspathic rock, intermixed with Old Red Sandstone, the most conspicuous being Todlaw in the upper and Blackhill in the lower end of the parish. Both of these hills consist of great outbursts of felstone porphyry, but, while the first is dark in colour the other is light. The Clarkstone, Dillar, and Boreland Hills, and Differick, which are composed of Old Red Sandstone, all lie in the lower end of the parish and slope towards the Clyde, whilst the Lowries, Gregstone, Wardlaw, Whiteside, Auchrobert, Skillyhill, and Chapel Hills, situated in the upper division, show eruptive action. At Cumberhead and Pockmuir Burn the white concretionary or nodular limestone appears, and, like the other rocks, in a vertical position. The Old Red rocks extend to the south and form Blackend Hill. In the burn beyond Craigenrigg, they again appear in conjunction with the concretionary limestone, expanding towards the south and forming the great masses of the Hagshaw Hills, which are only interrupted by hornblende, porphyry dykes, and small patches of Silurian rocks. At the other side of the parish they cross Kype Water and form Kyperigg and the surrounding moorland districts, with a few patches of igneous rocks. From the Kerse onwards by Auchenheath Cottage and Craignethan Castle to the Clyde at Evonford, rocks belonging to the Carboniferous formation are exposed, but have been greatly broken up by dislocations. Near Lochanbank Mill on the Nethan the strata have been upheaved to

the north at least 80 fathoms, so that instead of finding corresponding beds upon opposite sides of the dislocation, we must look for them on the north side about 450 feet higher up in the section. The upheaving force has evidently come from the east, probably proceeding from the felstone porphyritic beds found in the Old Red Sandstone on the Clyde near the village of Hazlebank.

Another great dislocation is found between Cora Mill and Craignethan Castle, and here the strata are upheaved to the north more than 100 fathoms, the disturbing element, which has here come from the east, raising up the rocks underlying the farms of Blair, Craignethan, etc., whilst upon the Auchenheath side the outcrop only has been affected, the coal beds at their outcrop on Hallhill Burn being nearly on edge, as if the result of pressure from Stonebyres Hill.

Numerous dykes or dislocations have recently been observed during the working of the Auchenheath gas coal, some being of great magnitude, and others very small. One of the smaller ones commences at a thickness of about four or five inches, and running to the north-west gradually increases to six feet and upwards.

Slickensides are often seen in perfection near these alterations of strata, showing fine groovings and markings, whilst in other places some of the strata are polished like a mirror. The fireclays are ribbed, and some of the shale is cut through as cleanly as if by a knife, with the faces as bright as glass.

Near Auchenheath the intrusive dolerite rock is from three to nine feet thick above the gas coal, which it often penetrates. It is seen at Langlee above the coal, while in No. 15 pit it is beneath it. In this last pit it extends up the shaft as far as the position of the second Carluke coal, and is again seen at Craignethan Crag.

The ironstone below the gas coal at No. 15 pit is in one locality completely charred, while the coal is rendered useless. The colour of the dolerite here is light grey, which changes to nearly white when near the coal, with here and there black patches. From these facts it is evident that volcanic action has been not only very frequent amongst the Lanarkshire rocks, but has extended over very different periods of time.