by varying, however slightly, the notions you connect with particular terms. This, not the reform of geological nomenclature, was my purpose. I hoped to suggest an instructive lesson for yourselves, not to propound rules for general acceptance. And in handing over, as I now do, my office to my colleague, Sir W. Thomson, I know that in place of the hints which alone I can offer you, you will receive from him positive practical guidance in the investigation of problems which it is foreign to my province even to touch upon.

IX.—*Notes on a SECTION OF STRATA containing Beds of IMPURE COAL and PLANT-REMAINS, showing STRUCTURE, at GLENARBUCK, near Bowling.* By JOHN YOUNG, V.P.

(Read 14th Dec., 1871.)

SINCE the period when the late Mr. Currie, of Bowling, communicated to this Society a short notice on the occurrence of one or two beds of impure coal, interstratified amongst the traps of the Kilpatrick hills, in Auchentorlie Glen, near Bowling, other evidence of interbedded strata, containing remains of plants and fishes of carboniferous age, has been obtained from the same district.* Another instance still of the occurrence of coal-beds and shales with plant-remains, in these hills, has recently come under my notice, and is to be seen in the gap of the hill above Glenarbuch House, a mile or so to the eastward of the former locality. As the beds are thus shown to have a considerable extension amongst the traps of the Kilpatrick hills, and as they clearly establish the carboniferous age of the various outflows of igneous rock-matter of which these hills are principally built up, I have thought it right that this other discovery should be recorded in the Transactions of the Society.

Before noticing, however, the coal-beds and plant-remains referred to, and the conditions under which they occur, I will point out briefly the relations of the various strata that underlie the traps of the Kilpatrick hills to the north-west, in order that their age may be more clearly placed before you. The lowest traps of this range

* See Trans. of this Society, Vol. II., p. 149; also Vol. IV., p. 77.

evidently erupt through, and at various points overlie, strata of the Ballagan series and the Old Red Sandstone. But probably those massive, thick-bedded white and red sandstones, which immediately underlie the Ballagan series, may yet be determined to be of lower carboniferous age, and found to rest conformably on a lower set of red sandstones of Devonian age that flank the Silurian schists of the Grampians and Dumbartonshire hills to the north-west.

The lithological character of the Ballagan series in this district does not differ much from that observed in the Campsie and Strathblane hills, described in a former paper.* The group to the west of the Kilpatrick hills consists, in descending order, of—1st, an upper series of yellowish-white sandstones that immediately underlie the trap; 2d, a group of thin bedded grey limestones and dark-grey marly shales, apparently devoid of fossils; and 3d, a lower series of thin bedded greyish-white sandstones, in which I have found some obscure plant-remains and scales of ganoid fishes, these being the only organisms yet detected in the group in that district. The best sections of these strata are to be seen in Auchenchreach and Dumbuck glens, a short distance from the town of Dumbarton, and north-east of the confluence of the Clyde and Leven, where they crop out on the hill sides beyond the termination of the trap.

The lower sandstones of the Ballagan series rest upon, and are apparently conformably to, a thick group of white and red sandstones which occurs in the valley of the Leven and along the shores of the Clyde, and which are extensively wrought for building purposes in the quarries near the town of Dumbarton and at other points in the Leven valley. So far as I am aware, these sandstones have yielded no fossils, and the only traces of anything organic yet observed in these rocks are numerous small spots and circular blotches of black carbonaceous matter, already described in the Transactions of this Society.†

The whole of the strata under review, to the west of the traps of the Kilpatrick hills, have a general rise to the north-west, or towards the Silurian schists of the Dumbartonshire hills, which extend in that direction. The bedded traps of the hills to the east also partake of the same general rise. From this it is evident that the latest movements which have elevated these Silurian rocks are

* Vol. II., pp. 33 and 207. † Trans., Vol. I., Part I.

of more recent date than the eruption of the various sheets of trap that form the upper portion of these hills.

None of the bedded traps of the Kilpatrick range extend into the district west of the Leven valley. In the northern portion of the hills, these igneous rocks are seen to rest on the white and red sandstone group before mentioned. Nearer the confluence of the Leven and Clyde they rest on the members of the Ballagan series. From the distinctness, therefore, with which the various outcrops of strata lying under the trap can be made out, the more recent age of the coal-beds and other strata containing plant and fish-remains that lie in their midst is satisfactorily established.

The section on the hill side at Glenarbuck, from which we have obtained the other evidence of coal-beds and strata with plant-remains, is one of considerable interest, from the satisfactory manner in which the woody structure of many of the plants have been preserved. Being found in a calcified condition, like those from the Arran ash-beds, the plants are wonderfully well preserved by the infiltration of carbonate of lime into the wood cells. The beds lie on the western slope of the hill, under a high precipice of trap which is opposite a lower and more depressed cliff facing the east—probably an extension of the same bed of igneous rock let down by a fault. The gap between these two cliffs—several hundred feet in width—forms a conspicuous feature of the landscape of this portion of the hill, when viewed from the low ground or the river Clyde. In the hollow of the gap there lie huge masses of trap fallen from these cliffs, and they are also to be found scattered along the banks of Glenarbuck burn for a considerable distance downward. The annexed woodcut will show more clearly the relation of the beds :—

Diagram section of the strata in the gap at Glenarbuck. a a, Bedded traps; b, Strata with plant remains and seams of impure coal; c c, Debris of trap, &c.

The above section, in which the seams of impure coal and plant-beds lie, may be from 20 to 30 feet in thickness. Probably it is

more, for its base is not well seen on account of the *débris* that covers it. The lower portion of the hill under these strata consists of massive bedded traps of varying mineral character; but amongst them I have observed no other coal strata, although in Auchentorlie Glen, to the westward, one of the coal-beds noticed by Mr. Currie is seen at this low level, so that it is possible the outcrop here is concealed.

The upper bed of peaty coal in Auchentorlie Glen is probably lying on the same horizon in the traps as that seen at Glenarbuck, except that, in the latter locality, the coal-seams appear to be more fully developed and in better preservation, although no traces of fish-remains have yet been discovered. It is more than probable that the beds of foul coal in the Glenarbuck section have been previously observed by persons wandering along these hills, but no notice, so far as I am aware, has ever been published. They only became known to me last summer while in Glenarbuck on an excursion with Dr. Young, Dr. Dickson, and the students attending the natural history and botanical classes at the University. While there I noticed, in the face of a small crumbling escarpment, under the high cliff of trap already mentioned, what appeared to be stratified deposits. On climbing up to the section I found that the beds consist of friable, yellowish-grey volcanic mudstones, or shales, with seams of foul coal, in which the woody structure of the plants is very distinctly preserved in a carbonised condition, as will be seen from the specimens submitted to the meeting. The highest layers of coal in the section are from 2 to 3 feet in thickness, and although of a very impure quality, and considerably altered by the heat of the overlying trap, yet they give off some flame in the burning. The beds dip to the south-east, and are overlaid by porphyrite, dolerite, and other traps, which are in different places amygdaloidal; and from them, in former years, good specimens of several varieties of zeolites were obtained, both at this place and at the Longcraigs, a little to the north-west; but these minerals are now very rarely met with on this tract of the hill.*

* Professor Dickson, during a second visit to Glenarbuck with his students in July, 1872, has discovered that there occur, in the shales under the coal seams, uncrushed roots of *Stigmaria*, in which the woody structure is wonderfully preserved in a calcified state, and all the various internal parts of the plant clearly defined. In some instances, indeed, their long, slender, hollow rootlets have had their structure preserved, a circumstance seldom observed in these plants from other localities.

On another visit to this interesting section, along with Dr. Dickson, we dug up a considerable number of other specimens of plants showing structure. Apparently they are all *Stigmaria* and portions of *Sigillaria*, though whether of the same species cannot be satisfactorily determined until microscopic sections be made. We could find no trace of erect stems of *Sigillaria* in this deposit, however, and concluded that such as had grown on the spot had decayed ere they were covered up, and that it is the partly macerated vegetable matter of these *Sigillaria* that has gone to form the beds of impure coal that overlie the Stigmarian beds.

The conditions under which these plants and coal beds occur are very similar to those which have been observed in the Arran ash-beds,* except that the beds at Glenarbuch are softer and more easily dug into. No other plant-remains were discovered but such as are referable to *Stigmaria* and *Sigillaria*; but as the Glenarbuch beds have been but little explored, future researches may reveal other genera.

One of the points of interest connected with these Stigmarian stems is the large size of the inner wood cylinders—the best preserved portion of the plant in this locality—which in some specimens measure fully two inches in diameter. These, in the cross-sections, show clearly the arrangement of the radiating wedge-shaped bundles of woody fibre which proceed from the central axis, and in the vertical sections the longitudinal striæ of the same. Very little of the loose vascular structure of the central axis or outside portions of these plants has been preserved except what is seen in the extension of the rootlets.

If I were to express an opinion as to the age of the coal-beds in the trap of the western extremity of the Kilpatrick range, I would be inclined to place them in the Calcareous Sandstone series, which underlies the lower carboniferous limestone of the West of Scotland. They are thus, in all probability, of the same age as the Arran plant-remains, found embedded amongst traps and ashes on the north-eastern shore of that island. These coal-beds and shales, with plant and fish-remains, reveal the interesting fact that, during the time when these traps and trappean ashes were being ejected by the volcanoes of the lower carboniferous period, long intervals occurred, in which forests of *Sigillaria*

* Vol. II., p. 97.

and other plants flourished over these tracts and accumulated vegetable matter sufficient to form thin seams of coal. These were subsequently overlaid in some cases by lake deposits, in which the remains of fishes were embedded; and these, in their turn, by other outbursts of igneous rock-matter and ashes. This portion of the Kilpatrick range accordingly reveals a geological structure similar to that of a more recent period shown in the bedded traps of Mull, enclosing coal and plant-remains of Middle Tertiary age.

NOTE.—Since the above was written, Mr. D. BELL, Secretary, has brought under the notice of the Society some plant-remains found embedded in the traps of the Lochwinnoch district, to the south-west of the locality above described. These were discovered in a bed of volcanic ash or mud, which occurs in the trap range to the north of Lochwinnoch; and though externally a good deal worn, and the structure not very well preserved, appear to belong to the genus *Lepidodendron*. The matrix in which they are found is quite similar in colour and composition to some of the interbedded ash or mud beds that lie amongst the traps of the Campsie hills.

X.—On the POST-TERTIARY FOSSILIFEROUS BEDS OF SCOTLAND.
By DAVID ROBERTSON, F.G.S., and Rev. H. W. CROSSKEY, F.G.S.

(Continued from page 45.)

XIII.—KILCHATTAN TILE-WORK, BUTE.

IN this series of papers on the Post-Tertiary Deposits, it has been our desire all along to confine our attention to their fossil remains, and to some facts connected with their inorganic contents, avoiding, as far as possible, the introduction of theoretical matter. This will account for our passing over unnoticed many topics of interest with regard to glacial phenomena.

The section now under review has been described by several writers, particularly by Mr. Jamieson in his valuable paper "On the Last Geological Changes in Scotland;"* and by Professor Geikie, in his well-known memoir on the "Phenomena of the Glacial Drift of Scotland," published in the Transactions of this Society.†

* Quart. Jour. Geol. Soc., Vol. XXI.

† Vol. I., Part 2.—Mr J. Coultas has also, with much industry, made a large collection of shells from Kilchattan, which were exhibited at a meeting of the Natural History Society of Glasgow.