

first meeting, great was the advance we had made when at our twelfth meeting we first assembled at Manchester in 1842. Presiding then as I do now over the geological section, I showed in an evening lecture how the palæozoic rocks of Silurian, Devonian, and Carboniferous age, as well as those rocks to which I had assigned the name of Permian, were spread over the vast region of Russia in Europe and the Ural Mountains. What, then, are some of the main additions which have been made to our acquaintance with the older rocks in the British Isles since we last visited Manchester?

Commencing with the oldest strata, I may now assume, from the examination of several associates on whose powers of observation as well as my own I rely, that what I asserted at the Aberdeen meeting, in 1859, as the result of several surveys, and what I first put forth at the Glasgow meeting of 1855, is substantially true. The stratified gneiss of the northwest coast of the Highlands, and of the large island of Lewis and the outer Hebrides, is the fundamental rock of the British Isles, and the precise equivalent of the Laurentian system of Canada, as described by Sir W. E. Logan. The establishment of this order, which is so clearly exhibited in great natural sections on the west coast of Sutherland and Ross, is of great importance in giving to the science we cultivate a lower datum-line than we previously possessed, as first propounded by myself before the British Association, in 1855.*

For hitherto the order of the geological succession, even as seen in the geological map of England and Wales or Ireland, as approved by Sir Henry De la Beche and his able coadjutors, Phillips, Ramsay, Jukes, and others, admit no older sediment than the Cambrian of North Wales, whether in its slaty condition in Merioneth and Caernarvon or in its more altered condition in Anglesen.

The researches in the Highlands have, however, shown that in our own islands, the older palæozoic rocks, properly so called, or those in which the first traces of life have been discovered, do repose, as in the broad regions of the Laurentian Mountains of Canada, upon a grand stratified crystalline foundation, in which both limestones and iron-ores occur subordinate to gneiss. In Scotland, therefore, these earliest gneissic accumulations are now to be marked on our maps by the Greek letter *alpha*, as preceding the Roman *a*, which had been previously applied to the lowest known deposits of England, Wales, and Ireland. Though we must not dogmatise and affirm that these fundamental deposits were in the pristine state absolutely unfurnished with any living things (for Logan and Sterry Hunt, in Canada, have suggested that there they indicate traces of the former life), we may

* See Reports of British Association for 1855 (Glasgow Meeting). At that time I was not aware that the same order was developed on a grand scale in Canada, nor do I now know when that order was there first observed by Sir W. E. Logan. I then (1855) simply put forward the facts as exhibited on the northwest coast of Scotland, viz. the existence of what I termed a lower or "fundamental gneiss," lying far beneath other gneissose and crystalline strata, and containing remains which I even then suggested were of Lower Silurian age. Subsequently, in 1859, when accompanied by Professor Ramsay, I adopted, at his suggestion, the word "Laurentian," in compliment to my friend, Sir William Logan, who had then worked out the order in Canada, and mapped it on a stupendous scale. I stated, however, at the same time, that, if a British synonym was to have been taken, I should have proposed the word "Lewisian," from the large island of the Lewis, almost wholly composed of this gneiss.

conclude, that in the highly metamorphosed condition in which they are now presented to us in North Western Britain, and associated as they are with much granitic and hornblende matter, they are for all purposes of the practical geologist "azoic rocks." The Cambrian rocks, or second stage in the ascending order as seen reposing on the fundamental gneiss of the North West of Scotland, are purple and red sandstones and conglomerates forming lofty mountains. These resemble to a great extent portions of the rocks of the same age which are so well known in the Longmynd range of Shropshire, and at Harlech in North Wales, and Bray Head in Ireland.

At Bray Head they have afforded the Oldhamia, possibly an Alga, whilst at the Longmynd, in Shropshire, they have yielded to the researches of Mr. Salter some worm-tracks and the trace of an obscure crustacean.

The Highland rocks of this age, as well as their equivalents, the Huronian rocks of North America, have as yet afforded no trace whatever of former life. And yet, such Cambrian rocks are in parts of the Longmynd, and especially in the lofty mountains of the North Western Highlands, much less metamorphosed than many of the crystalline rocks which lie upon them. Rising in the scale of successive deposits, we find a corresponding rise in the signs of former life on reaching that stage in the earlier slaty and schistose rocks in which animal remains begin clearly to show themselves. Thus, the Primordial Zone of Mr. Barrande is, according to that eminent man, the oldest fauna of his Silurian Basin in Bohemia.*

In the classification adopted by Sir Henry de la Beche and his associates, the Lingula Flags (the equivalent of the "Zone Primordial" of Barrande) are similarly placed at the base of the Silurian System. This Primordial Zone is also classed as the Lowest Silurian by De Verneuil, in Spain; by James Hall, Dale Owen, and others, in the United States; and by Sir W. E. Logan, Sterry Hunt, and Billings, in Canada.†

(To be continued.)

Cornish Engines.

The average duty of twenty-eight Cornish pumping engines, reported for August, was 51,200,000 lb., lifted 1 ft. high by the consumption of 112 lb. coal, the duty being equal to $4\frac{1}{2}$ lb. coal per actual (not indicated) horse power per hour.

* I learn, however, that in Bohemia, Dr. Fritsch has recently discovered strata lying beneath the mass of the Primordial Zone of Barrande, and in rocks hitherto considered azoic, the fossil burrows of annelide animals similar to those of our own Longmynd.

† In completing at his own cost a geological survey of Spain, in which he has been occupied for several years, and in the carrying out of which he has determined the width of the sedimentary rocks of the Peninsula (including the Primordial Silurian Zone, discovered by that zealous explorer, M. Casiano de Prado), M. de Verneuil has in the last few months chiefly examined the eastern part of the kingdom where few of the older palæozoic rocks exist. I am, however, informed by him, that Upper Silurian rocks with *Cardiola interrupta*, identical with those of France and Bohemia, occur along the southern flanks of the Pyrenees, and also re-occur in the Sierra Morena, in strata that overlie the great mass of Lower Silurian rocks as formerly described by M. Casiano de Prado himself. The southern face of the Pyrenees, he further informs me, is especially marked by the display of mural masses of Carboniferous strata, which, succeeding the Devonian rocks, are not arranged in basin-shape, but stand out in vertical or highly inclined positions, and are followed by extensive conglomerations and marls of Triassic age, and these by deposits charged with fossils of the Lias.