

Royal Institution of Great Britain.

WEEKLY EVENING MEETING,

Friday, April 24, 1857.

SIR BENJAMIN C. BRODIE, Bart., M.D. D.C.L. F.R.S. Vice-President, in the Chair.

PROFESSOR A. C. RAMSAY, F.R.S.

On certain peculiarities of Climate during part of the Permian Epoch.

THE subject was divided into two parts: 1st, The early geological history of the Longmynd and the neighbouring Lower Silurian rocks, between the Stiper Stones and Chirbury in Shropshire; and 2nd, The nature and glacial origin of the brecciated conglomerates of Worcestershire and part of South Staffordshire, that lie near the base of the Permian strata.

The Longmynd consists of a high tract of barren ground in Shropshire, formed of the Cambrian grits, conglomerates, and slates that lie beneath the Lower Silurian strata. They attain a height of about 1700 feet above the sea. The beds stand nearly *on end*, and measured across the strike appear to be about 14,000 feet thick. This appearance may, however, be deceptive, as it is possible they may be doubled over in large contortions, the tops of the curves having been removed by denudation. They have heretofore yielded no fossils except a doubtful trilobite, and the marks of annelides and fucoids. They are overlaid by an equal amount of Lower Silurian strata between the Stiper Stones and Chirbury.* These consist of *Lingula* flags, and Llandeilo slates and grits full of the ordinary fossils of the period, and are associated with bosses of eruptive greenstone and beds of felspathic trap and ashes. The slates have often a peculiar porcelanic and ribboned character imparted to them by the igneous rocks, and all the igneous phenomena of the district are of Lower Silurian date.

Certain strata, known as the *Pentamerus* beds or Upper Llandovery and May Hill sandstones, lie at the base of the Wenlock shale, quite unconformably on the Cambrian and Lower Silurian

* First described in the Silurian System.—*Murchison*.

rocks. These rocks contain a peculiar suite of fossils, among which *Pentamerus oblongus* is conspicuous. They are frequently highly calcareous and conglomeratic, and mixed with the fossils contain pebbles of green and purple grit and slate, derived from the waste of the Longmynd rocks, on the upturned edges of which they rest. These *Pentamerus* beds form an ancient consolidated beach that surrounded an island of Cambrian and Lower Silurian rocks, at the commencement of the Upper Silurian epoch. Outliers of this old beach lie on the flats and slopes at the Bogmine and elsewhere, near the summits of the Lower Silurian hills west of the Stiper Stones; and it was shown that during the formation of the beach the island slowly sank and was gradually encased in *Pentamerus* beds, and these in their turn were buried beneath the Wenlock shale and Ludlow rocks, and probably also the old red sandstone. This part of the subject was illustrated by an account of the gradual submergence of the coral islands of the Pacific. The ancient island was thus not only submerged, but also shrouded beneath many thousand feet of newer strata. While the island stood high above the water the *Pentamerus* beach began to be formed, but as it slowly sank the beach crept inward and upward at least 800 feet, with a gentle slope, so that finally before complete submergence only the higher summits stood above the sea, surrounded by a continuation of the beach. The higher prolongation of the beach was thus shown to be of later date than the parts formed round the earlier margin of the island, and *the opposite ends of a continuous stratum may thus be of different ages*. This was illustrated by the fossils that the *Pentamerus* beds of the Longmynd contain. In Wales the *Pentamerus* beds have been divided by Mr. Aveline, of the Geological Survey, into two sets, the Lower and Upper Llandovery beds, each characterised by its own group of fossils, or by peculiarities of grouping. It is the upper part only that surrounds the Longmynd. At the foot of the Longmynd and Lower Silurian hills the *Pentamerus* beds among other fossils contain *Pentamerus oblongus* in great plenty, and also *P. lens*. The first is scarce in the Lower Llandovery rocks, and common in the Upper. With the second the reverse is usually the case. It is found in the (geographically) lower part of the beach above described, but in the higher geographical prolongation at the Bogmine it does not occur. *Strophomena pecten* is common to all the Silurian rocks in and below the Wenlock strata, but it is especially abundant in the Wenlock rocks, and is common in the Bogmine outlier. *Goniophora cymbæormis* is essentially an Upper Silurian species. It is not found in the Upper *Pentamerus* beds of the ordinary type, but occurs at the Bogmine, and ranges through the Wenlock and Ludlow rocks up to the tilestone, close below the base of the old red sandstone. The same is the case with *Bellerophon trilobatus*, also a Bogmine and tilestone species. A trilobite *Phacops Downingia*, not known in the ordinary *Pentamerus* beds,

occurs in the Bogmine outlier, and low in the Wenlock or Denbighshire grits.* Other instances of the same kind might be cited. An undescribed species of *Pleurotomaria* has been found at the Bogmine, and nowhere else. These facts show that the assemblage of fossils in the inland and geographically higher part of the beach is more exclusively of an Upper Silurian type than the assemblage grouped in the geographically lower part of the same bed. Stratigraphically the bed was quite continuous, and yet its opposite ends are of somewhat different geological date. This point, though not essential to, is intimately connected with, the proofs of a period of cold during the deposition of the Permian conglomeratic breccias or Rothliegendes, seeing that some of these higher Silurian fossils are contained in the fragments that enter into their composition, and it is therefore particularly insisted on.

How long the island of the Longmynd remained buried beneath several thousand feet of Upper Silurian rocks and Old red sandstone is uncertain. It is, however, certain, that this covering was partly removed by denudation before the deposition of the upper coal measures, for in Shropshire, part of these rocks lie directly on the Cambrian strata, although Cambrian pebbles have not yet been detected in them. But in the Permian brecciated conglomerates of Worcestershire, many fragments, believed to be derived from the Longmynd and its neighbourhood, have been found. These breccias occur either themselves resting unconformably on the coal measures, or on older rocks, or else associated with Permian marles and sandstones that occupy like positions. These are found near Enville, at Wars Hill, and Stagbury Hill, where they lie on the coal measures; at Woodbury, one of the Abberley Hills, where they rest on the Upper Silurian rocks; on Barrow Hill, on the coal measures and old red sandstone; at Howler's Heath, in the South Malvern region, on the Upper Silurian strata; and on the Clent and Lickey Hills, Frankley Beeches, and at Northfield the Permian rocks below the breccia rest on the South Staffordshire coalfield. They also occur at Church Hill, $5\frac{1}{2}$ miles north-west of the Abberley Hills, where an outlier of breccia lies directly on the Coal measures of the Forest of Wyre. In all these places the brecciated stones are bedded in a hardened red marly paste. The stones which it contains are (with very rare exceptions) *not formed from the waste of the neighbouring rocks on which they lie*, but of fragments, many of them identical in composition and character with the Cambrian and Silurian beds of the Longmynd, and consist of pieces of quartz rock, greenstone, felspathic trap, felspathic ash, black slate, jasper, grey and purple sandstone, green sandy slate, ribboned altered slate, quartz conglomerate, and *Pentamerus conglomerate and limestone*. These are mixed with other foreign fragments; but those enumerated, always form by far the majority.

* Named on the authority of Mr. Salter.

They are of all sizes up to $2\frac{1}{2}$ and 3 feet in diameter. The majority are small, like the stones of the Pleistocene drift. Their forms are always angular and subangular, their sides usually smoothed, and sometimes polished, and scratched in a manner identical with some of the stones of the modern moraines of the Alps, or of the *glacial drift* of the Pleistocene period that spreads over the north of Europe and America. The manner in which the blocks lie rudely bedded in the marly matrix also precisely corresponds to many of the ice-drifted deposits of the Pleistocene epoch. In England, judging from their outcrops, they now occupy an area of at least 500 square miles, chiefly concealed by overlying deposits. If lithological character be any guide, they have mostly been derived from the conglomerates of green, grey, and purple Cambrian grits of the Longmynd and from the Silurian quartz rocks, slates, felstones, felspathic ashes, greenstones, and Pentamerus beds between the Stiper stones and Chirbury. Neither the Malvern nor the Abberley Hills, nor the South Staffordshire country, nor any of the other districts where the breccias occur contain rocks at the surface similar to them from whence the breccias have derived their materials. It has been asserted that they may have been formed from the waste of rocks concealed beneath the neighbouring New red sandstone. This is, however, an improbable assumption, and in the outlier of Church Hill, *which is altogether surrounded by coal measures*, the rocks are of the same far transported character as in other localities. If other patches were formed from rocks concealed by the New red sandstone, this outlier, according to the same reasoning, might be expected to be formed from the waste of the surrounding coal measures, which is not the case. If then the blocks of stone that form the breccias were derived from the Cambrian and Silurian rocks of the Longmynd, it is of importance to know how far they travelled. From the Longmynd region Church Hill is from 25 to 30 miles distant; Howler's Heath, at the south end of the Malvern Hills, from 40 to 50 miles distant; and the places where they occur near the South Staffordshire coalfield, from 35 to 45 miles distant; and it was shown that so many angular and subangular fragments, some of them 3 feet in diameter, and forming deposits in places 400 feet in thickness, could only have been transported by floating ice. At Northfield especially, many angular slabs of the Pentamerus beds of the Longmynd district were found, some of them 2 feet across, containing fossils of *the later age* of that deposit, and in the same Pentamerus rock, are enclosed fragments of the Cambrian green slates that were deposited in it when it formed a Silurian beach, as explained at the beginning of the lecture. *In no other part of England have the Pentamerus beds this character*; and the evidence is, therefore, in favour of the supposition that they were transported from the Longmynd. As no other agent that we know, except ice, transports so many large angular blocks to a distance, it was shown that the same transport-

ing agent must have been at work over large areas of Europe during the deposition of the Rothliegendes of the Permian period; and if we admit this kind of evidence for the Pleistocene drift, it is contended that the same kind of evidence of transportation from a distance, size, angularity, smoothing and scratched surfaces, should be admitted with regard to the stones and boulders of the Permian breccias.*

Proofs were also adduced to show that the internal heat of the earth has exerted no important climatal influence during any of the geological periods from Silurian times downwards; and a diagram exhibited illustrative of the analogies shown by the small development of molluscous life during the cold of the Permian and Pleistocene epochs, the last of which, as far as its fossil shells are concerned, may be considered but as a subdivision of the recent period.†

[A. C. R.]

* The Rothliegendes of Thuringia, in general appearance, closely resemble the Permian brecciated rocks of the Clent Hills (for example), and many of the blocks of granite in the Thuringian rocks have been derived from parent rocks, unknown in the neighbourhood where these conglomerates lie.

† This subject has, in some of its details, been treated more fully in the *Geological Journal* 1855, page 185.