XXXIII.—*Memoir descriptive of a Series of coloured Sections of the Cuttings on the Birmingham and Gloucester Railway.*

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[Read June 10, 1840, and June 16, 1841.]

PLATE XLVIII.

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PREFACE.

A FEW years ago, when the various lines of railway in this country were first projected, it was usual to hear geologists congratulate themselves on the acquisitions which the science would receive from the numerous opportunities that would be thus afforded for studying the British strata. These anticipations have been in some degree fulfilled, but it is undeniable that during the last ten years many golden opportunities of studying geological phenomena and collecting specimens have been irrecoverably lost, in consequence of the railway sections not having been visited by geologists during the brief period when they were exposed to view. The practice commonly followed by engineers of covering up the “slopes” or sides of the cuttings with vegetable soil as soon as the excavations are completed, detracts greatly from the advantages which the science would otherwise derive from them; for unless some geologist happens to inspect the section at the right moment, the interesting phenomena which it discloses are buried for ever beneath the verdant

sod. The only remedy for this evil seems to be for each line of railway to be systematically surveyed by a competent geologist, who should pay repeated visits to every section during the time of its excavation, in order to collect minerals and fossils, and to record the features of its stratification. It would be highly desirable if each railway company had a professed geologist on its staff, but as such an appointment would probably be considered foreign to the objects of these companies, the ends of science might perhaps be attained if the Geological Society were to make applications to the several railway companies, requesting from them a series of their published sections, the colouring of which might be undertaken by some member of the Society. Such sections, even if uncoloured, are still valuable as containing a vast fund of accurate measurements, levellings, and other geographical facts, which it is desirable to possess in our archives. But, if the geological phenomena be superadded to these sections by the aid of colour, it is evident that such documents will acquire the utmost value. And we must remember that the means of doing this is fast passing away; in a few years all the important lines of railway will have been completed, and future geologists will perhaps sigh for the opportunities which their ancestors neglected.

Anxious to contribute towards so desirable an end, I gladly yielded to a request made to me by Captain Moorsom, chief engineer of the Birmingham and Gloucester railway, to undertake a geological survey of that line. To Capt. Moorsom the Society are indebted for the accompanying lithographed sections, to which I have added the geological colouring; and I must here express my obligations to that gentleman, as well as to Capt. J. Vetch, F.G.S., for much valuable assistance during the survey*. The line had previously been surveyed by Mr. F. Burr (see Geological Proceedings, vol. ii. page 593), and I am happy in bearing testimony to the general correctness of his observations; but as none of the excavations were commenced when he made his survey, he had no other data than the "trial shafts" sunk from time to time, which of course could not exhibit geological phenomena with the same accuracy as open cuttings†.

The Birmingham and Gloucester railway is not perhaps geologically one of the most interesting lines, because, from running nearly parallel to the strike of the strata, it passes through but a small succession of formations. This circumstance, however, causes each stratum to be exposed in greater detail, and affords a wider scope for local variations.

* The sections here referred to, consisting of thirty-five folio sheets, are deposited in the Society's Collection of Maps, &c.

† The lithographed sections being made for engineering purposes alone, exhibit a great disproportion between their vertical and horizontal scales; the former exceeding the latter in the ratio of about 13 to 1. In the portion of these sections introduced in the Plate this disparity is diminished one half.

Description of the Deposits.

§ 1. *New Red Sandstone*.—The geological starting-point on this railway does not coincide with either of its locomotive termini. The lowest rock exposed is on the anticlinal axis of the Lickey, about ten miles S.S.W. of Birmingham. It will be remembered, that in the description given by Mr. Murchison of the Bromsgrove Lickey*, the effects of that trappean eruption are stated to extend many miles towards the S.S.E. in the shape of a long elevated tract called the Ridgeway, forming the western watershed of the river Arrow. The transverse sections of this ridge, afforded by the railway as well as by the Birmingham and Worcester canal a mile further south (see Burr, *Geol. Proceedings*, vol. ii. p. 594), sufficiently prove an anticlinal arrangement of the strata.

The cutting No. 95.† on the engineering section‡ crosses the anticlinal ridge of the Lickey, and being excavated to the great depth of fifty-six feet, it was naturally expected to exhibit some points of interest. About half a mile to the north of it, trap rock appears *in situ* §, elevating and altering the Caradoc sandstone or Lickey quartz. Neither of these rocks, however, appear in the railway excavation, which exhibits nevertheless clear proofs of the disturbance attending the upheaval of the Lickey.

The lowest rock visible in this cutting is a mass of very hard brownish or reddish sandstone, commencing about fifty yards to the east of the post which marks the railway summit, and extending about seventy yards to the eastward, where it attains the height of twenty feet above the railway, and is suddenly cut off by a nearly vertical fault (see section, Pl. XLVIII. figs. 1, 2.). Some of the beds of this sandstone are of a grey colour and uniform compact texture, with specks of white decomposed felspar; others are coarser-grained and of a brown or reddish tint, containing rolled fragments of ferruginous or dark red indurated marl. No organic remains were noticed in it, and it hence becomes difficult to fix the precise age of this rock. I at first considered it to be a portion of the Caradoc sandstone of the Lickey, but from a closer inspection of its mineral characters I should prefer classing it in the “Lower New Red Sandstone” of Mr. Murchison.

The strata of this rock dip at the high angle of about 60° to E.S.E., or *from* the great mass of trap composing the Upper Lickey (see Mr. Murchison’s map).

The rock above described is overlaid *unconformably* by a vast mass of conglomerate belonging to the “Upper New Red” or bunter sandstein. The latter deposit

* *Silurian System*, p. 569.

‡ See sheet 24 of the lithographed sections.

† The account of this cutting was read June 16th, 1841. § See *Silurian System*, p. 495.

exhibits an imperfectly anticlinal arrangement*. On the east of the fault above mentioned, it dips about 5° to E.S.E., while on the western side its dip may be estimated at about 5° to the S.S.E. or S. The bedding is however so irregular that great accuracy on this point is not attainable, but it will suffice to state, that the stratification never departs far from horizontality, and is hence most strongly contrasted with that of the highly inclined sandstones above described, on which the conglomerate reposes.

The cutting here described affords a rare opportunity of inspecting the conglomerates of the upper new red sandstone. For the depth of nearly sixty feet the section consists almost exclusively of rounded pebbles imbedded in soft red sand. The resemblance of this deposit to ordinary diluvial gravel is so perfect, that when the excavations were first begun, I considered it as such, and it was not till the completion of the cuttings, that I became undeceived. The gravel is now not only seen to contain numerous wedge-shaped masses of red sandstone and red marl (exhibited in the section, Pl. XLVIII. fig. 2.), but it is further shown to underlie the regular thick-bedded sandstone at each end of the section, so that its antiquity is thus most clearly proved.

From this stratum of new red conglomerate a large portion of the superficial or diluvial gravel of the surrounding counties has evidently been derived. At least nine-tenths of the pebbles of the conglomerate consist of quartz, either white and crystalline, or brown and granular, the latter doubtless derived from altered sandstones, such as are still seen *in situ* at the Lickey. The remaining portion of the pebbles includes various trap rocks, chiefly porphyritic, which are often decomposed into the condition of clay. Boulders of a hard quartzose conglomerate, probably derived from the old red system, also occur, together with pebbles of chert inclosing casts of *Spirifers* and *Crinoidea*†. The beds of conglomerate are interspersed and dove-tailed with bands of soft red sandstone, loose sand, and occasionally red marl, in the manner represented in fig. 2. Pl. XLVIII. At each end of the section, the conglomerates are seen to be overlaid by beds of massive red sandstone, varying in texture from a compact rock to a loose sand, which again appears about a mile to the S.W., in the cutting No. 89, at the top of the inclined plane.

The point which appears of the greatest interest in the section here described, is

* The arrangement of the new red sandstone on the south side of the Lickey is more properly *mantle-formed* than *anticlinal*. On the line of the railway the dip sweeps round from E.S.E. to S.S.E., S., and W.S.W.

† These fragments of chert appear to indicate a considerable transporting power in the sea which deposited the new red conglomerate, no chert being now known nearer than Derbyshire, a distance of about fifty miles from the Lickey.

the *unconformability* of the lowest rock, above mentioned, with the overlying new red conglomerate. Assuming that the lowest rock is correctly identified with the "Lower New Red," it follows that we thus obtain a tolerably exact date for the principal protrusion of the volcanic rocks of the Lickey. The sandstone in question dips at the high angle of 60° directly from the trap rocks, which exist *in situ* a short distance to the north-west, and it is overlaid by conglomerates which are not far removed from horizontality. It is therefore clear, that these trap rocks must have been erupted *after* the deposition of the lower new red, and *before* the conglomerates of the upper new red, and it is probable that the rolled pebbles of the conglomerate were derived in great measure from the shattered strata which were thus upheaved in the immediate vicinity*. It is further to be inferred, that additional elevations of the region of the Lickey took place at a later date, for we find these overlying conglomerates traversed by a fault, and upheaved into an anti-clinal position, which may be traced on each side of the ridge as far up in the series as the saliferous marls. Indeed it is probable that some of the dislocations connected with the Lickey were later than the age of the lias, for in the south of Worcestershire and Warwickshire the lias and red marl are affected by several extensive faults, the directions of which have an appearance of *radiating* from the Lickey. (See Geol. Trans. vol. v. pp. 333, 335.)

In Groveley Hill (fig. 1.), on the north-east of the Lickey ridge, the red sandstone passes occasionally into a hard conglomerate of quartz pebbles with a calcareous paste, forming nodular masses and thin strata. Similar conglomerates are described by Mr. Murchison as occurring in the upper new red sandstone in several parts of Worcestershire, Staffordshire and Warwickshire†. A considerable dislocation appears to traverse this hill, for, at the north end of Groveley Tunnel, the strata dip about 30° N.E., while at the south end the inclination is only about 3° S.E. (See the section, Pl. XLVIII. fig. 1.)

At Finstal, on the south-west flank of the Lickey ridge, the upper portion of the sandstone becomes light-coloured, contains obscure vegetable impressions (fig. 1, upper line), and is a prolongation of the stratum of light-coloured sandstone with vegetables exposed at Breakback Hill on the west of Bromsgrove‡. These decomposed fragments of plants form the only examples of organic remains exposed by the railway-cuttings in the new red sandstone.

* The age here assigned to the trap rocks of the Lickey coincides with that attributed to them as well as to those of Abberley and Malvern by Mr. Murchison (*Silurian System*, p. 67), though I believe he had nowhere noticed an example of unconformity between the upper and lower new red, such as is here exhibited. The elevation of the Nuneaton district seems also referable to the same epoch.

† See *Silurian System*, p. 42, and *Geol. Trans. 2nd Series*, vol. v. p. 347.

‡ See *Geol. Trans. 2nd Series*, vol. v. p. 341.

§ 2. *Red Marl*.—The red or Keuper marl overlies the new red sandstone on each side of the Lickey ridge. On the north-east it is traversed by the line of railway from Groveley Hill to Birmingham, which town stands on the new red sandstone, but is closely skirted by red marl on the south and east. The same formation extends from Birmingham along the London railway as far as Berkswell, forming, in North Warwickshire, a basin of red marl with the small lias outlier of Knowle in the centre*. This great extension of red marl was not known at the time of the construction of Mr. Murchison's map, in which the new red sandstone of Warwickshire is carried too far to the southward. The true boundary of the marl and sandstone ranges from Hewell Grange nearly north by Cofton Hacket to Northfield, and thence north-east to the south suburbs of Birmingham. The course of the railway is nearly parallel to this boundary line.

On the south-west side of the Lickey ridge, the new red sandstone becomes marly and thin-bedded in the upper part, and eventually passes into the incumbent red marl. The latter retains an inclination of 6° to 8° south-west, resulting from the elevation of the Lickey ridge, till we reach the salt-works at Stoke Prior†. The deep excavation made at this place is fully described by Mr. Murchison (Sil. Syst. p. 31), and I will therefore only remark, that, from the dip of the strata exposed by the railway, it is evident that the position of the salt rock must be near the bottom of the marl immediately above the sandstone.

The red marl presents no other feature of importance till we reach the neighbourhood of Hadsor, where the railway crosses a promontory of lias projecting from the main body of that formation (Pl. XLVIII. fig. 3.). On the north side, the marl is cut off by a fault, but on the south, at Dunhamstead, is an interesting section of the junction of the two formations.

The following section is here exposed :—

- a. Lias clay, with contorted beds of lias limestone containing saurian bones.
- b. White micaceous sandstone, two feet.
- c. Lias clay, six feet.
- d. Grey marl, thirty-five feet.
- e. Red marl.

The whole dipping 5° N.N.E.

The sandstone *b* has much resemblance to the “Keuper sandstone” described in Geol. Trans. vol. v. p. 332, but it occurs considerably higher in the series. It here contains numerous specimens of a smooth oval bivalve, larger and more oblong than the *Posidonomya minuta* of the Keuper (Geol. Trans. vol. v. Pl. XXVIII. fig. 4.),

* See Geol. Trans. 2nd Series, vol. v. p. 336.

† See sheet No. 20 of the Railway Section, and Plate XLVIII. fig. 1, upper line.

but too imperfect to exhibit generic characters*. In the hill south of Dunhamstead is a fault which causes the grey marl to abut against the red, as seen in the Railway section, sheet 17, and Pl. XLVIII. fig. 3. of this volume.

For the next five miles the railroad runs through red marl in a valley between the escarpment of the lias and a ridge caused by the "Keuper sandstone." On the south-east of Spetchley† is a dislocation which causes the Keuper sandstone to change its strike from south by east to south-west, forming a projecting angle which is intersected by the railroad. The stratum is here but a feeble representative of the Keuper sandstones of Burg Hill, Inkberrow, and Shrewley‡, consisting chiefly of greenish marl with thin laminæ of white sandstone, the whole forming a deposit of about twenty feet thick, with red marl both above and below. The bands of sandstone vary rapidly in thickness, and one wedge-shaped solid mass, about thirty feet long, is two feet thick in the middle, and thins out entirely at each end.

§ 3. *Lower Lias*.—About a mile further south, at Norton§, the railway traverses the lias escarpment, which presents a section exactly analogous to that at Dunhamstead, showing the same succession of lias-limestone, clay, white thin-bedded sandstone, grey marl, and red marl. The sandstone also contains the oval bivalve met with at Dunhamstead.

About a mile south of this point, the lias clay contains many calcareous concretions abounding with shells, including *Plagiostoma giganteum*||, *P. duplicatum*, *P. Hermannii*, Goldf., *Terebratula ornithocephala*, *Modiola minima*, and a *Caryophyllæa*, which is remarkable from the general scarcity of corals in the lias formation. Further south, near Abbott's Wood, the beds of fissile sandstone at the base of the lias are again exposed on the railway, being brought up by a fault. Thence the lias clay presents little interest till we reach Defford (Pl. XLVIII. fig. 5.), where numerous specimens of *Pachyodon*¶ *Listeri* (Stutchbury, Annals Nat. Hist., March 1842) (*Unio Listeri*, Sowerby), *Gryphæa incurva*, *Astarte lurida*, *Plagiostoma punctatum*, *P. duplicatum*, and several apparently new species of Ammonites, *Modiola*, &c., occurred in the cuttings.

The same shells are found also at Eckington (fig. 5.), on the south of the Avon ; but at Bredon (fig. 5.) we reach a higher stratum of the lias clay, and meet with an almost entirely distinct set of organic remains, among which *Pleurotomaria Anglica*, *Hippopodium ponderosum*, *Gryphæa Maccullochi*, *Nautilus striatus*, *Phola-*

* In a paper read December 1841, I have shown that this band of sandstone is the true equivalent of the "Bone-bed" of Somerset and East Devonshire. Note, 1842.

† See sheet No. 14, and Plate XLVIII. fig. 4.

‡ See Geol. Trans. 2nd Series, vol. v. p. 332 *et seq.* § See sheet No. 13, and Plate XLVIII. fig. 4.

|| All the shells included in this and the following lists are described in Sowerby's Mineral Conchology, unless a different authority is given.

¶ The name *Pachyodon* having been previously used by Von Meyer for a vertebrate genus, should here be superseded by the term *Cardinia* of Agassiz.

domya ambigua, *Modiola scalprum*, *Plagiostoma punctatum*, *P. duplicatum*, *Plicatula spinosa*, *Spirifer Walcottii*, *Corbula cardioides* (Phill.*), *Amphidesma donaciforme* (Phill.), *Pecten sublævis* (Phill.), *Ammonites planicosta*, *A. obtusus*, *A. Turneri*, *A. Conybeari*, and *A. Birchi*, have been identified. Between Bredon and Cheltenham the ground is very level, and but few sections of importance occur; but at the latter town, and between it and Gloucester, the excavations in the lias clay are very extensive, and have supplied large collections of organic remains to the cabinets of the Cheltenham geologists.

Some of these fossils are enumerated in Mr. Murchison's memoir on the Geology of Cheltenham, but a considerable number of species, especially of *Ammonites*, appear to be new, as I have been able as yet to assign names to only the three following:—*Ammonites armatus*, Sow., *A. ovatus*, Young and Bird†, and *A. lenticularis*, Young and Bird. With the exception of the *Hippopodium ponderosum*, *Gryphæa Maccullochi*, and one or two others, the Cheltenham fossils are wholly distinct from those of Bredon, proving how small a difference of vertical position will effect an almost total change of organic remains. At Hewlitts, east of Cheltenham, the lias near the base of the marlstone presents another series of distinct fossils, consisting of *Hippopodium ponderosum* (rugose variety, perhaps a distinct species), *Modiola scalprum*, *Spirifer granulosus*, Goldf., *Terebratula rimosa*, Bronn‡, *Perna ventricosa*, *Pachyodon attenuatus*, Stutchb., *Littorina imbricata* (*Trochus imbricatus*, Sow.), *Ammonites Henleyi* (*A. striatus*, Rein., *A. heptangularis*, Young, *A. Cheltiensis*, Murchison §), &c., so that in the lower lias alone we have evidence of at least five well-marked successions of molluscos faunæ ranging through a vertical height of about 400 or 500 feet, and unaccompanied by any change in the mineral character of the deposit.

Having now described the secondary formations along the line of the railway, we will recommence at the Birmingham end, and examine the deposits of superficial detritus.

The phenomena exhibited by the railway cuttings are entirely confirmatory of the views which I have announced elsewhere|| respecting the distinction between those ancient terrestrial alluvia in which mammalia occur and the general mass of submarine drift which covers most parts of the island. In pursuance of these views, the ancient superficial detritus of this district may be divided, according to its efficient cause, into *fluvatile* and *marine*; the latter, according to its origin, into local and erratic; and this again, according to its composition, into gravel *with flints* and *without flints*.

* Geol. Yorkshire, Part 1.

† Geological Survey of the Yorkshire Coast, 4to, 1828.

‡ Lethæa Geognostica, p. 292, Taf. 18, f. 6.

§ Outline of the Geology of the neighbourhood of Cheltenham, 1834.

|| See Report of British Association, vol. vi. Sections, p. 61.

§ 4. *Marine erratic gravel without flints.*—This detritus occurs at intervals along the railway from Birmingham till the line approaches the valley of the Avon. Vast accumulations of it (the “Northern drift” of Mr. Murchison) occur on all sides of Birmingham. My own personal inquiries addressed to resident geologists, railway engineers and excavators, aided by printed queries circulated in the Geological Section of the British Association* at Birmingham, all tend to prove the *utter absence* of mammalian remains in the deposits of this class in that neighbourhood. Chalk flints, though not absolutely wanting in the Birmingham gravel, are yet so extremely rare, as to prove that the current which transported it came from the north, and not from the east, and furnish a well-marked distinction from the flinty gravel described below.

At Mosely the railway is cut through a vast deposit of this gravel upwards of eighty feet thick, reposing upon red marl†. It is composed of rolled pebbles, rarely exceeding four inches in diameter, of various granitic and quartzose rocks and altered sandstones, imbedded in clean ferruginous sand devoid of argillaceous matter. A stratum of sand about thirty feet thick, free from pebbles, occurs in the middle of the gravel.

Between Mosely and the Lickey the railway-line is in general free from gravel. The only mass of stone of sufficient size to deserve the name of an erratic block occurred on the line of the railway between Cotteridge and Wytchall‡, and reposes on the red marl. It is shapeless, about five feet by four, with the angles partially rounded, and consists of greyish porphyritic trap.

Patches of gravel of this class occur on each flank of the Lickey ridge, though none, as before shown, were found on its summit at the part traversed by the railway. The singular manner in which the gravel reposes on an irregular surface of new red sandstone is shown in the cutting at the summit of the inclined plane, Pl. XLVIII. fig. 1. This superficial drift closely resembles the genuine new red conglomerate seen in the cutting on the Lickey ridge, as it consists in great measure of the same materials, but it may be distinguished by containing, in addition, many fragments of slaty rocks, and by the sand in which the pebbles are imbedded being freer from red argillaceous matter, and consequently of a whiter colour. This gravel attains on the line of the railway a height of 544 feet above the sea (not 387, as misprinted, or 587, as corrected in the Proceedings, vol. iii. p. 316). I may here remark, that the gravelly soil of the Lickey Beacon, 900 feet high, which has been quoted as an example of superficial gravel at a great elevation, may very probably not be derived from these recent or “diluvial” deposits, but from the genuine new red conglomerate, though its existence *in situ* cannot be de-

* See Report of British Association, 1839, Sections, p. 71.

† See sheets 30 and 31.

‡ See sheet 28.

terminated in consequence of the want of sections. For the present, therefore, the above-mentioned elevation of 544 feet is the greatest which can be assigned with certainty to the superficial gravel or "Northern Drift" of this part of England.

The next locality where gravel occurs is at Sugars Brook*. This deposit consists of quartzose pebbles, commonly less than three inches in diameter, and rarely equal to six. No stratification is observable. The surface of the bed is about twelve feet above the brook, and from its low position it appeared likely to belong to the fluviatile class, and to contain mammalian bones; but though many thousand tons of gravel have been raised for the use of the railway, I have not been able to learn that any organic remains have been found in it.

From this point no more gravel occurs on the line of the railway for the next sixteen miles; but a few hundred yards east of it, at Abbott's Wood, is an extensive deposit of quartzose gravel, mixed with ferruginous sand devoid of flints, and resting upon lias clay. Here also large quantities of gravel have been extracted, but the evidence of the engineers and workmen is unanimous as to the absence of organic remains.

§ 5. *Marine erratic gravel with flints*.—It was stated in a paper read at the Liverpool meeting†, that the gravel to the south-east of the Avon in Warwickshire and Worcestershire abounds in flints, indicating a current from the chalk district lying to the eastward, and accordingly no sooner does the railroad pass that river than we find a very large per centage of flints in the gravel. The village of Bredon stands on a platform about seventy feet above the ordinary surface of the Avon, capped with an extensive deposit of this kind of gravel from ten to fifteen feet thick‡. It reposes on an uneven surface of lias, and is mixed with much ferruginous clay. Its height above the Avon valley, though slight, has been sufficient to protect it from the modifying effects of fluviatile agency, and hence the extensive excavations near Bredon have furnished no example of mammalian bones.

§ 6. *Fluviatile gravel*.—The only instance of this description of detritus on the railway-line is on the two flanks of the Avon, at Defford and Eckington§. On either side of the river is a tabular platform, the surfaces of which do not exceed *forty-five* feet above the Avon; and they are capped by about ten feet of gravel, precisely similar in composition to the flinty gravel of Bredon, but with this important difference, that it contains an abundance of mammalian remains. These were found chiefly in the cutting in the north of the village of Eckington. The bones occur principally at the lower part of the gravel, and often on the surface of the subjacent lias clay, about thirty-five feet above the river. They are accompanied with numerous freshwater shells, agreeing in species with many of those enumerated

* See Plate XLVIII. fig. 1, upper line.

† See sheet No. 7. and Plate XLVIII. fig. 5.

‡ See Report of Brit. Assoc., vol. vi. Sections, p. 62.

§ See sheet No. 9, and Plate XLVIII. fig. 5.

in Mr. Murchison's Silurian System (p. 555) as found in a similar position at Cropthorne, a few miles higher up the Avon. The most abundant species are the *Cyclas amnica* and *C. cornea*. Great numbers of the bones have been broken and lost by the carelessness of the workmen but those ; which have been preserved, and which are in the cabinets of the Worcestershire Natural History Society, of Mr. Fowler of Cheltenham, Mr. Dudfield of Tewkesbury, and my own, are referable to *Elephas primigenius*, *Hippopotamus major*, *Bos urus*, and *Cervus giganteus*?

On the north or opposite side of the Avon, about twenty feet above the river, bones of *Elephas primigenius*, *Rhinoceros tichorhinus* and *Hyæna spelæa*, accompanied with freshwater shells, occur beneath a few feet of gravel and under similar circumstances to those at Eckington.

In endeavouring to account for the presence of freshwater shells and bones at this part of the railway-line, and their absence in all other portions of the district described, I can offer no other explanation than that formerly proposed*, viz. that *after* the beds of marine gravel had been deposited where we now find them, and had been laid dry by the elevation of the land, a large river or chain of lakes extended down the valley of the Avon at a height of from twenty to fifty feet above its present course, and that the gravel previously brought into the district by marine currents was remodified by the river-stream and mixed up with remains of Mammalia and Mollusca which tenanted its banks or its waters.

§ 7. *Local gravel*.—This occurs abundantly at Cheltenham†, and consists exclusively of detritus from the oolite and lias of the vicinity‡. The composition varies from the state of gravel to fine calcareous sand. No bones or other terrestrial remains have occurred in it, and it is therefore referred, in the absence of other evidence, to a marine origin.

§ 8. *Modern alluvia*.—No formations of any importance belonging to this class occur on the line of the railway, except the peaty deposits on the banks of the Avon and its tributary streams. In sinking through this peaty soil for the foundation of the bridge over the Avon at Defford, a human skeleton was found at the depth of eighteen feet from the surface.

Conclusion.—On a general review of the sections afforded by the Birmingham and Gloucester Railway, although they do not present us with any very striking or novel phænomena, yet we may justly attach some value to the evidence they afford of geological facts, whether as confirmatory or as corrective of those previous researches which were undertaken without the assistance now furnished by the railway cuttings. In conclusion, let me again express a hope that the time is not far distant when this Society may be in possession of a set of coloured sections of every railway in the kingdom.

* See Report of Brit. Assoc., 1837, vol. vi. Sections, p. 64.

† See Railway Sections, sheet No. 1.

‡ See Mr. Murchison's Outlines of the Geology of Cheltenham, p. 28.

SECTIONS OF CUTTINGS ON THE BIRMINGHAM AND GLOUCESTER RAILWAY TO ILLUSTRATE M^R STRICKLAND'S MEMOIR

Trans. Geol. Soc. 2nd Series Vol. VI. Pl. 18

Lower New Red New Red Sandst. & Conglom. Red Saliferous Marl Keuper Sandstone Grey Marl Lias Marine or Northern Drift Ancient Fluvialite Drift

Modern Alluvium

Fig. 1.

Fig. 2. Ridge of the Lickey, (on an uniform Scale of 80 feet = 1 inch.)

Fig. 4.

Fig. 3.

Fig. 5.

Figs 1, 3, 4, & 5 are drawn on a Scale of 240 ft-1 inch, vertical, and 1584 ft-1 inch, horizontal.

John Arrowsmith

H.E. Strickland del.