

XXXIV. *Additional Observations on the Drift-deposits and more recent Gravels in the Neighbourhood of Manchester.* By EDWARD HULL, B.A., F.G.S., of the Geological Survey of Great Britain.

Read December 29th, 1863.

DURING the past summer I have been occupied for the most part in an attempt to trace the subdivisions of the Post-pliocene or Drift deposits within the tract of country bounded by the Penine Hills on the east, and by the uplands of Rochdale, Bury, and Bolton-le-Moors on the north, and extending into the Cheshire plain; and I proceed to lay a brief account of the results of this examination before this Society, while the more enlarged details are in course of publication in the *Memoirs of the Geological Survey**.

Geologists have for several years been familiar with the classification of these deposits, as laid down by our President, Mr. E. W. Binney, F.R.S.†, and which may be succinctly stated in the order of superposition as follows:—

- | | |
|---------------------------|---|
| Recent..... | 1. Valley-gravel and river-terraces. |
| | 2. Forest-sand and gravel of Cheetham Hill, Kersal Moor, &c. |
| Postpliocene
or Drift. | 3. Till, or Boulder-clay. |
| | 4. Sand or gravel, more inconstant, and of less importance than No. 2, and only known in sinkings of wells, &c. |

The author of the above classification expressly confined his observations to the neighbourhood of Manchester, to which they are strictly applicable; and in my *Memoir*

* *Geology of the Country around Oldham and the Suburbs of Manchester.* 1864.

† "On the Drift-deposits of Manchester and its Neighbourhood," *Mem. Lit. and Phil. Soc.* vol. viii. 2nd series.

“On the Geology of the Country around Bolton-le-Moors” I accepted without hesitation that classification.

It was my intention, with the assent of the Local Director of the Survey, Professor Ramsay, to ascertain whether these several subdivisions of the Drift and more recent gravels could be followed out over a large tract of country, or were only true as regards the district embraced by Mr. Binney's paper; and I may state at the outset, that the regularity with which the various members of this formation have been found to spread over a tract which may be defined as the rain-basin of the Mersey has far exceeded my expectations, and that the classification of these members points to three different epochs of formation.

The district over which I have surveyed, and mapped each of the three members of the Drift here referred to, extends from Bolton-le-Moors on the north, to Oldham on the east, and Alderley on the south. My colleague, Mr. Green, has continued and verified these divisions still further south, as far at least as Congleton. Thus it may be said that they have been proved to maintain their regularity and order over an area of 600 square miles.

The result of our investigations has obliged us in some measure to modify the arrangement proposed by Mr. Binney. I had not long commenced to trace the upper and lower boundaries of the “Forest Sand” (No. 2), before I discovered that it was overlain by a second formation of Till, or Boulder-clay, quite as important, both in thickness and extent, as that which lies below it (No. 3 above). Now, over the greatest part of the hills of sand to the north of Manchester, this Upper Boulder-clay has been denuded away; but it sets in further to the north-east, in the direction of Oldham, and to the north-west, in the direction of Bolton. Mr. Binney, although he has not included it in his tabular view of the Drift-deposits, was, I believe, aware

of its existence, and mentions it as occurring in the neighbourhood of Cheetham*.

Another modification which we found it necessary to make, had reference to the lower sand (No. 4) underlying the Till in Mr. Binney's classification. We have nowhere been able to discover such a bed *in situ* during our examination; and it is remarkable that in the section of the Drift which was furnished to Mr. Binney as having been proved at St. George's Colliery, Manchester, and where it is stated that this sand and gravel (No. 4) is 10 feet 6 inches in thickness, there is no appearance whatever of it in the neighbouring quarries of Collyhurst, where the Till may be seen reposing directly on the Permian sandstone. I do not, however, wish to deny that there are occasional patches of sand or gravel underlying the Lower Till, because such bands occur in the Till itself. My only object is to remove this member from the dignity of a distinct subdivision of the Drift-series, at least until there is some better evidence of its existence than the reports of well-sinkers, the elasticity of whose system of nomenclature is, unhappily, proverbial. I therefore beg to submit the following classification, which, except in the above-named points, does not differ from that laid down by Mr. Binney:—

Drift and Recent Deposit of the Basin of the Mersey and its Tributaries.

- Recent. 1. *Valley-gravel and River-terraces.*
2. *Upper Boulder-clay, or Till.* Bolton Moor, Halshaw Moor, Clifton Moss, Moston, Oldham, Newton Heath, Denton, Cheadle, Hulme, &c.
3. *Middle Sand and Gravel.* Bolton, Pendlebury, Prestwich, Kersal Moor, Heywood, Middleton, Blackley, Gorton,

* I think the explanation of a section given by Mr. Binney, of the sand wedging apparently *into* the Till, will be found in supposing the Upper and Lower Till to meet each other, owing to the thinning away of the sand near the margin.

Stockport, Poynton, Wilmslow, Prestbury, Macclesfield, Crewe, &c.

4. *Lower Boulder-clay, or Till.* Monton, Salford, Manchester, Heaton Norris, &c.

It would be mere repetition were I to attempt to describe these subdivisions of the Drift; and I shall therefore not dwell at any length on the stratigraphical character of these beds, further than to make one or two observations.

The Upper and Lower Boulder-clays are in all respects similar. Of the stones and boulders which they contain, at least two-thirds exhibit marks of glaciation; and there can be no question that they are both subglacial deposits.

Both subdivisions are also laminated or rudely stratified. On this point Professor Ramsay and myself became convinced after a careful examination of many sections, some near Manchester, others along the estuary of the Mersey.

On the other hand, the Middle Sand and Gravel (No. 3) is altogether distinct in this latter respect from the Boulder-clays both above and below it. The pebbles it contains are always water-worn and rounded; and I am persuaded that during its deposition very different physical conditions must have pervaded this part of England from those which obtained the ascendancy during the periods of the Upper and Lower Till. I now pass on to notice certain facts regarding the arrangement of the several members in this district.

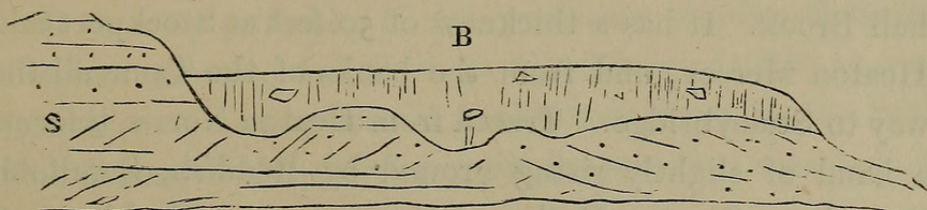
Denudation of the Middle Sand.—In confirmation of the views just stated, I may here draw special attention to the evidence afforded of a very extensive denudation of the sand previously to the deposition of the Upper Boulder-clay. The thickness of the sand undergoes the most rapid changes. In some places, as at Kersal Moor for instance, it attains a thickness probably not under 200 feet; and within a distance of not more than 4 miles (that is, at Newton Heath and Openshaw) the thickness is just one-

tenth of this amount, or 20 feet. Indeed, within a less distance than this, the sand dwindles down almost to nothing near St. Luke's, Cheetham Hill. Similar phenomena are observable in many places over the tract we have examined; and I have reason to doubt whether in some places, such as Atherton and Hindley, there is any sand separating the two Boulder-clays from each other.

This may be due in some measure to irregularity in the original deposition of these beds; but there is reason to think that it is due in a still greater degree to a subsequent denudation, or removal, of strata which were once deposited with more or less regularity. In confirmation of this view, several instances which came under my notice may be adduced, in which the Upper Till was observed to lie upon an eroded surface of the sand. Out of several I select two in the neighbourhood of Oldham; but similar examples were observed in a pit at Moston Hall, and in a new road-cutting at Whitefield. In some other places,

Fig. 1. *Section at Heyside near Oldham.*

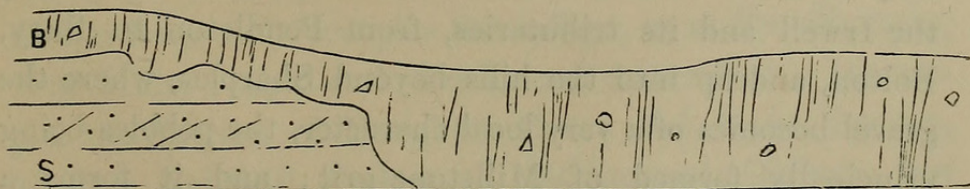
Length of section, 45 yards.



B. Upper Boulder-clay, resting in a hollow denuded in the sand.

S. The Middle Sand underlying the Till, but rising above it at the surface.

Fig. 2. *Section near Chadderton Workhouse.*



B. Upper Boulder-clay, on an eroded surface of the sand S.

The length of this section is about 50 yards, and the depth 6 yards.

however, the superposition of the two formations takes place along a very level and clearly defined line, as may be observed in a large pit at Openshaw and Clayton Hall.

The Lower Boulder-clay, or Till.—Over the district south of the Mersey, the Lower Boulder-clay rarely makes its appearance, the country being overspread by the Upper Till, resting on the sand. The Lower Till, however, may often be traced at the bottom of some of the deeper valleys, such as those of the rivers Dean and Bollin and that of the Tame above Stockport. North of the Mersey, at Stockport, it occupies the tract from Heaton Norris to the Irwell, west of Manchester; and on the opposite side of the river, from Salford to Leigh. It also crops out at the base of the high banks of sand along the river Roch, from Radcliff Bridge upwards for several miles. In the hill-country it seldom or never makes its appearance, as all the Boulder-clay there to be found belongs probably to the upper member of the series.

The Middle Sand.—This division occurs in great strength at Macclesfield, Prestwich, and Poynton. It forms the banks along the valleys of the Bollin and Dean and Bramhall Brook. It has a thickness of 50 feet at Stockport and Heaton Mersey, and from the banks of the Tame all the way to Staleybridge. Traced from Heaton Norris, it forms a band of slightly rising ground by Reddish, Sandfold, Openshaw, Clayton Hall, and Harpurhey to Blackley and Crumpsall, where it swells out considerably. It covers the country for the most part around Middleton, Royton, Heywood, and Rochdale. It forms the high banks along the Irwell and its tributaries, from Pendleton to Bury, Bolton, and up into the hills beyond Sharples, where the gravel becomes of a very local character, the pebbles being principally formed of Millstone-grit; and it forms a bank of rising ground on its southern outcrop, extending from Swinton westward by Worsley towards Ince in Wigan.

It also forms outliers over the Cheshire plain, as at Bowdon and High Leigh. Near its margin it often appears to thin away rapidly, the Upper Till descending to meet the Lower, as in the case at Cheetham Hill, mentioned by Mr. Binney. Such accidents I am disposed to refer to the period of the last denudation of the country, when these post-pliocene deposits were very largely removed by the waters of the retreating sea. The sand being extremely soft and porous, the sea along the margin would penetrate inwards to some distance, and, forming a running sand, might wash it away much more rapidly than the Upper Boulder-clay, which, from its stiff and plastic nature, would to some extent withstand the action of the waves.

The Middle Sand is, unfortunately for its consistency of character, not always free from bands of loam or clay. One of these, which is largely used for brick-making near Prestwich, Heywood, and Rochdale, occurs about the centre of the mass, and divides the sand into two members, the upper of which frequently occurs in detached hillocks. This bed is, however, of very local occurrence, and thins out southward.

It is very probable, if not positively certain, that the Bisplam gravels, described by Mr. Binney (1861) as containing nineteen species of shells now living in the Irish Sea, belong to this division. Shells are also abundant in it at Macclesfield.

The Upper Boulder-clay, or Till.—This member caps the sand over the flat ground extending from Stockport to Alderley. Amongst the hills of the Pennine Chain to the east, it frequently occupies the valleys, as at Broadbottom, New Mills, Chapel-en-le-Frith, and Saltersford. It occupies the districts of Haughton Green and Hyde, Denton, Newton, Fairfield, Failsworth, Hollinwood, Oldham, and the higher parts of Harpurhey and Blackley. It also forms a capping for the sand along the Irwell, from Pendlebury

House, by Clifton and Kearsley, to Bolton Moor ; and, in a similar position, it occurs at Little Lever, Bradshaw, Harwood, and Elton, near Bury. Its general tendency is to form flat or gently rising surfaces, of a wet or marshy character ; while the Middle Sand forms undulating banks, hillocks, and knolls, such as that of Tandle Hill, which reaches an elevation of 725 feet. Outliers of sand and gravel are also to be met with amongst the hills, as at Mossley, Lyme Park, and Bollington ; and these may probably be referred to the same formation.

The succession of these Drift-deposits now described bears a remarkable resemblance to that exposed to view along the cliffs north of Blackpool, described by Mr. Binney*. But, although I am disposed to think they are the exact equivalents, it would be rash to pronounce an opinion on this point until a survey of the intermediate country has been completed.

The Position of the Drift-deposits with reference to the older Rocks now requires our attention ; and in tracing the boundaries of these different divisions we become sensible of a universally pervading feature in their arrangement, namely, that they rise in the direction of the hills, or conversely slope from the hills towards the plains. This is true with regard to the high lands of millstone-grit which range from east to west, by Rochdale, Bury, and Bolton, as well as those which range from north to south, by Oldham, Staleybridge, Marple, and Macclesfield. This rise of the beds of Drift, both towards the north and towards the east, is more rapid than the slope of the brooks, until they actually enter the uplands, when the descent of the streams becomes in turn more rapid than that of the drift ; and on this account the Lower Boulder-clay seldom extends into the valleys of the Pennine Chain, as already stated.

* Mem. Lit. & Phil. Society, vol. x. (new series).

As an illustration, let us take the lower boundary of the Upper Boulder-clay along the valley which runs up from Manchester, by Bolton, to beyond Sharples, and examine the levels as taken from the Ordnance 6-inch maps. At Pendlebury the base of the Upper Boulder-clay is 275 feet above the sea-level; at Clifton, 285; at Kearsley, 300; at Halshaw Moor it descends again to 285; opposite Burnden Bridge it again reaches 300; at centre of Bolton, 300; Little Bolton, 370; the banks of the Tonge and Bradshaw brooks, near Bradshaw Bridge, 380; Sweetlove's Colliery, Sharples, 475; and still further north, at Holmes Farm, above Dunscar Bridge, 500 feet. Thus, in a distance of about nine miles along this valley, the base of the Upper Boulder-clay has ascended from 275 to 500 feet, that is, by an amount of 225 feet. The rise is therefore $\frac{1}{2 \cdot 1 \cdot 1 \cdot 2}$, or 25 feet per mile.

A similar rise is observable, if we take the section of country from Manchester to Oldham, or from Manchester to Dukinfield. Thus at Gorton the level of the base of the Upper Boulder-clay is 250 feet, and at Dukinfield (as may be determined at the sand-pit near St. John's Church) it is about 480 feet, being a rise of 230 feet in four miles. That there is a similar slope towards the valley of the Mersey from the Cheshire hills is proved by the position of the beds along the brook-courses, as already stated.

The different members of the Drift series rest indiscriminately on the older rocks, which were worn into hills and valleys, or plains, before their deposition (see fig. 3). Thus in Manchester the Lower Boulder-clay rests on the Triassic and Permian beds; but at Heywood, Rochdale, and Dukinfield the older rocks are covered by the Middle Sand; and all along the rising ground of the lower Coal-measures, from Oldham by Staleybridge, Marple, and Disley, the Upper Boulder-clay rests upon, or has been deposited against, the steeply sloping sides of the Carboniferous rocks.

In order to account for the phenomena above stated, regarding the slope of the Drift-formation from the hills toward the plains, and which bears a strong resemblance to a true dip of the strata, I at first supposed that it was due to an upheaval of the country at the close of the Drift period along the old lines of elevation; but Professor Ramsay suggested to me that a more simple explanation might be found in the unquestionable fact that these various beds of clay and sand were deposited over a sloping sea-bottom, and consequently partake of its variations of level. The height to which erratics ascend on these hills is about 1800 feet, as stated long since by Sir H. De la Beche; and from my own observation I can state that there is not a trace of a foreign rock on the tableland of the Peak, which is about 2000 feet high.

The following general section (fig. 3) will serve to explain the general phenomena connected with the relative position of the post-Pliocene and older formations in this district.

Supposed Land-surface in the Drift.—

A very interesting section has been opened in certain beds which I am now about to describe, at the foot of the hill, west of Heaton Mersey. The hill itself is composed of the middle sand and gravel (No. 3); and along its base are large brick-yards excavated in the Lower Boulder-clay

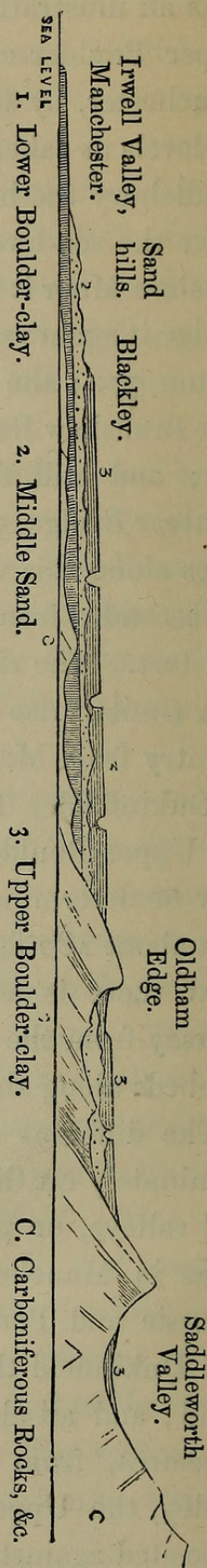
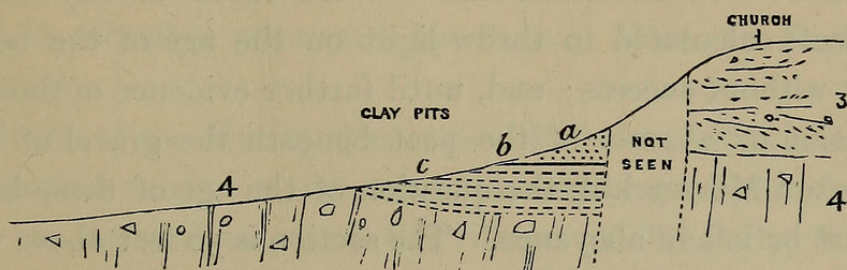


Fig. 3. Section to show the General Arrangement of the Drift-deposits.

(No. 4). At the upper edge of these brick-yards we find the following series, which, when I first visited it, I supposed to represent a land-surface in the Drift, forming the line of separation between the Lower Boulder-clay and the Middle Sand. The section is as follows:—

Fig. 4. *Section at Heaton Mersey.*



- a.* Fine soft sand, 3 feet.
- b.* Bed of peaty matter, and decaying stems and branches of birch, 4 inches.
- c.* Dark, stiff, laminated clay, 6 feet.
- 3. Middle Sand.
- 4. Lower Boulder-clay, with pebbles.

The bed of vegetable matter (*b*) consists of branches of birch in a state of decomposition not much removed from that of ordinary bog-wood. It is about 4 inches in thickness, is overlain by a bed of fine sand (*a*), which I supposed at first to be the base of the middle sand and gravel of which the hill is composed; and below are several feet of a fine, laminated, brownish mud (*c*), without pebbles, which I took to be the uppermost beds of the Lower Till. These beds, however, contain no stones or pebbles, as is usual with the Boulder Clay, and are more regularly laminated than is generally the case with that formation. At the same time, I had no reason to doubt that the whole series belonged to the post-Pliocene group, and that we had here a rare example of a true land-surface between two members thereof.

A few weeks after, however, I again visited the section in company with Professor Ramsay, F.R.S., the Director of the Geological Survey, who, on seeing the beds, gave it

as his opinion that these deposits were not post-Pliocene beds, but "warp," a river mud similar to that of the Humber, which he had recently visited. He also thought the stems of the birch too fresh-looking for so distant an age as the Drift, and that the deposit was an evidence of the former extension of the Mersey much beyond its present limits. We examined the bed for shells or any other objects calculated to throw light on the age of the beds, but without success; and, until further evidence of the extension or absence of the peat beneath the gravel of the Heaton Mersey hill, the question of the age of these beds must be left in abeyance. The section is 50 feet above the present level of the Mersey.

Gravel of the Valley of the Mersey.—The district of South Lancashire affords conclusive evidence of the former extension of the rivers far beyond their present bounds. The river-terraces in the neighbourhood of Manchester have already been described by Mr. Binney* and myself†, and I shall not recur to them here. I wish, however, to draw attention to an old terrace of much wider extent and greater length than any of those in the Irwell valley above Manchester‡. So widely indeed is the country covered by these gravels, that it is not improbable they may have been formed in an estuary of the Dee, when the land was slowly rising from beneath the sea at the last elevation of the country; but on this point, which it would be of so much interest to determine, we are left in doubt by the absence of shells, which I have failed hitherto to detect.

The gravel is generally of a very fine character, evenly bedded, seldom containing large stones, and often divided by layers of fine sand and silt. On the north side of the Mersey it extends as far up as Didsbury, occupying the flat

* "On the Drift-deposits, &c.," Mem. Lit. and Phil. Soc. vol. viii.

† Memoir on the Geology of Bolton-le-Moors.

‡ This terrace I have described at greater length in the forthcoming memoir, "On the Geology of the Country around Oldham and Manchester."

ground along the Manchester road to Fallowfield. From this it trends westward to Hulme, on the south side of Manchester, and is bounded by the valley of the Irwell. It occupies the whole of the flat country between the two rivers, Irwell and Mersey, from Trafford Park to Stretford. At Eccles and Fatricroft it may be found resting sometimes on the New Red Sandstone, sometimes on the Lower Till, and it stretches westward by Barton Moss to Higher Irlam.

South of the Mersey it occupies the level plain, which is a constant subject of remark to all who travel by the railway to Altrincham; and the villages of Timperly, Sale, Ashton-on-Mersey, Carrington, and Warburton are all built on this old terrace. Beyond this I have not traced it westward. It probably disappears at Lymn, owing to the steepness of the banks along the south side of the river. On the north bank, however, it will probably be found between Hollinfare and Warrington. The thickness of this gravel is seldom more than from 6 to 10 feet; and over the greater part of the district described it rests upon the Lower Boulder-clay.

The breadth of this terrace in some places is several miles. As it extends very nearly from Worsley in the north to Altrincham in the south, the breadth is here seven miles. Below this terrace the present river-valleys are hollowed to a depth of 50 or 60 feet; and I have no doubt the land was lower at least by that amount at the time of its formation. The most probable explanation of the origin of this gravel-bed is to suppose that the tides extended as far up as Manchester and Didsbury, and that the waters of the two rivers, having only a very slight fall, often during heavy floods covered the whole plain now formed of the gravel.



Hull, Edward. 1865. "Additional Observations on the Drift-Deposits and More Recent Gravels i n the Neighborhood of Manchester." *Memoirs of the Literary and Philosophical Society of Manchester* 2, 449–461.

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