

coast, were lifted on it by the tides, and, to a certain extent, sea-worn; and that, as pieces of the ice-foot and coast-ice were detached and floated southwards, sub-angular scratched boulders were carried with them, being deposited in the loamy mud, derived from the Triassic plains, forming in the Lowlands of Lancashire and Cheshire. (4) That the climate commenced to ameliorate, the subsidence still continuing, clay was no longer brought down by glaciers to the Lancashire ice-foot, the formation of Marine Lower Boulder-clay ceased, and on its surface, the Middle Drift Sand, derived from the erosion of the cliffs by the sea and of the land by rivers, commenced to be deposited. (5) That subsidence did not cease until the whole country was submerged to a depth of 1,400 feet. (6) That a Glacial climate recommencing, the land rose; that a pause or fresh subsidence took place, the ice-foot again appearing, the Upper Till was thrown down. (7) The land rising, glaciers again occupied the valleys and scooped out the Marine Drift.

V.—ON FAULTS IN DRIFT AT STOCKPORT, CHESHIRE.

By JOHN AITKEN, F.G.S.

(With an Illustration.)

DURING the years 1866 and 1867 considerable discussion took place through the medium of this Journal on the question of the existence of dislocations, or faults, in Glacial Drift. As I believe no communication has appeared since the latter year in these columns on that subject, it may not be altogether uninteresting to your readers if I briefly refer to a clear and unmistakeable example of faulted drift which recently came under my observation at a ballast pit close to the Stockport Railway Station. At the time of my first visit, about three months ago, my object being to search for traces of marine shells in the sand, the several details of the section were exhibited with remarkable distinctness, the action of the weather having brought out the several lines of bedding and fracture as sharply as though they had been produced in a body of compact Sandstone; indeed, so exact was the resemblance in that respect that at a short distance it would have been difficult to believe that such was not the fact. Unfortunately, since that time, a quantity of sand has been removed from the face of the pit, thereby partially obliterating the details; the principal features, nevertheless, were easily discernible a few weeks ago, when I last visited the spot.

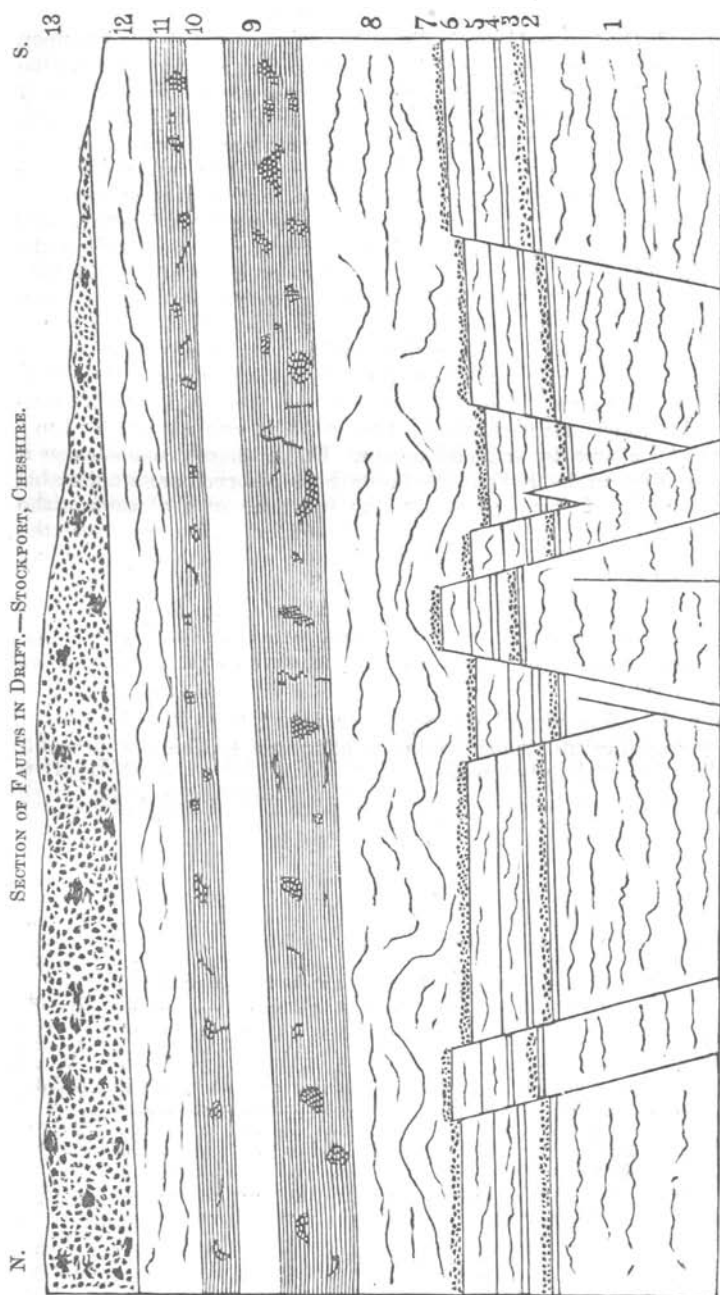
The section has a longitudinal extension of 45 feet, and a vertical depth of about 25 feet, 14 feet of the lower portion being almost entirely composed of fine, sharp, stratified red sand of (according to the classification adopted by Prof. Hull and Mr. Seales V. Wood, jun.) Middle Drift age, conforming very closely as to colour to the New Red Sandstone of the neighbourhood, upon which it rests, and from which it has evidently been derived, and in which are distributed, in considerable numbers, rounded and water-worn pieces of coal, in some places massed together in nests or pockets,

and at others scattered about singly in the sand or gravel. The overlying beds, having an aggregate thickness of about 11 feet, are composed of brown and mottled clay, sand, and gravel. Running along the lines of bedding and faults are thin layers of argillaceous sand, about half or three-quarters of an inch in thickness, which, on account of possessing a greater power of resistance to sub-aerial degradation than the principal body of the sand, give a degree of sharpness and distinctness to the section but rarely witnessed in strata of this character. It is further noteworthy that the faults do not extend through the whole vertical depth of the exposed strata, but are confined to about 9 feet in thickness of the subordinate beds, the bed No. 8 presenting the appearance of arching, or curving, over the elevated conical portion near the centre of the section, as though that division had been forcibly thrust upwards, and partially forced into the overlying bed at a time when it had only recently been deposited, and when, for want of pressure, it had not become sufficiently consolidated to fracture like the rest, but was from that cause in a plastic and yielding state. The supposition that the superincumbent beds of clay, sand, and gravel were deposited at a period subsequent to the dislocation of the subordinate strata, not only fixes the time of its occurrence, but also accounts for the perfectly undisturbed character of these upper beds.

Most of the Drift faults described in the *GEOLOGICAL MAGAZINE* occur in strata resting upon the Cretaceous formation, and it has, with some degree of probability, been suggested that, at least in some of the instances mentioned, the appearance of faulting may have resulted from subsidence of the superior beds into caverns, or hollows, produced in the calcareous beds beneath by the mechanical force of running water, or the chemical action of the acids contained therein. This suggestion, although worthy of the fullest and most favourable consideration, in those instances where the Drift immediately reposes upon chalk or other calcareous rock, easily operated upon by the agents referred to, loses its force when applied to those of an arenaceous character like those at Stockport, which, as is well known, are almost destitute of all calcareous ingredients in their composition.

Whether the dislocations here encountered extend to and also affect the subordinate Triassic rocks, it is impossible to say, as they are concealed from view by other and lower members of the Drift formation; but, if we may judge from analogy, no reasonable doubt can exist that such is the fact; indeed it is difficult, if not impossible, to conceive of any other way in which they can have been produced, under the circumstances here stated, than by a sympathetic action with the underlying rocks.

Whilst writing upon the subject of faults in Drift, I may be permitted to refer to the description of a section of this character given by Professor Hull, at p. 182, Vol IV. of this *MAGAZINE*, which was exposed to view during the progress of the work in preparing the site for the New Town Hall at Rochdale; the origin of which



Vertical depth of Section, 25 feet.

Length of Section, 46 Feet. Dip W.N.W. 8°.

(although Professor Hull declines to offer a decided opinion upon the subject) may, I conceive, be satisfactorily accounted for on the following ground, without having recourse to the supposition of their having been caused by the disturbance of the subjacent Palæozoic strata, an hypothesis which the author seems inclined to favour.

During the time the section was exposed I had frequent opportunities of visiting the spot, when my attention was attracted to the disturbed condition of the beds, the nature of which was described in the notice referred to. The section occurred on the face of what was formerly a steep slippery bank of considerable elevation, at the foot of which the river Roach now runs, and at a place where that river formerly made a considerable bend to the south of its present course: thus giving rise to a sort of obtuse promontory, around two sides of which the water would then flow, and against which it would in times of flood be projected with considerable force, and that too at a time when it was not confined to a particular course by artificial means. Under these circumstances it is more than probable that the faults here observed are attributable to the undermining and destructive influence of the water at the base of the cliff, aided by the percolation of the surface water and the soft loamy and clayey character of some of the beds, causing a series of subsidences or land-slips to take place. The force of this supposition will be rendered more apparent by referring to the explanatory sketch accompanying Prof. Hull's paper, where the strata are represented as being let down by three successive steps in the direction of the river.

Whether this view be accepted or not, I trust it will be found deserving of careful consideration as offering a feasible and probable explanation of the phenomena.

The sketch of the section, given on page 119, although not drawn exactly to scale, is approximately correct.

EXPLANATION OF SECTION ON PAGE 119.

		ft.	in.
No. 1.	Red sand with indistinct wavy lines of bedding	5	0
2.	Argillaceous sand		3
3.	Sand with a thin layer of fine gravel at the bottom, resting on No. 2., containing water-worn bits of coal... ..	1	0
4.	Argillaceous sand		3
5. & 6.	Sand... ..	2	0
7.	Fine gravel... ..		3
8.	Fine sand with irregular discoloured lines running through it	5	6
9.	Stiff brown clay inclosing boulders and pebbles much mottled with green streaks and patches	3	0
10.	Sand, in places mixed with gravel	2	0
11.	Clay, with a few pebbles	1	0
12.	Sand	2	6
13.	Fine Gravel (say 2 to 3 feet thick)	2	6
Total		25	3