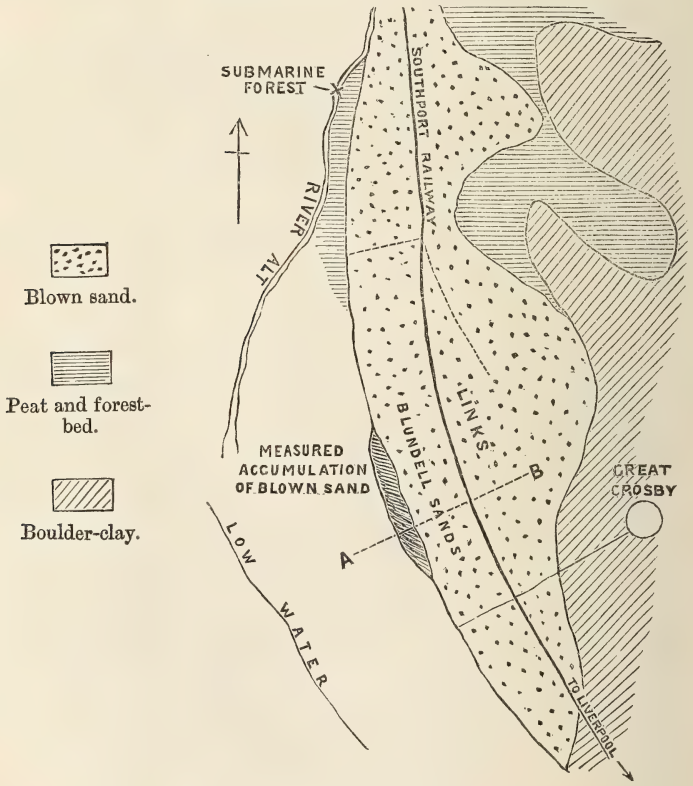
35. *The* Date *of the* last Change *of* Level *in* Lancashire. By T. Mellard Reade, Esq., C.E., F.G.S., F.R.I.B.A. (Read April 6, 1881.)

In estimating geological time the difficulty always lies in getting a reliable unit to measure with. Having surveyed and mapped out, on a scale of 6 inches to the mile, the whole series of Postglacial deposits between Liverpool and the mouth of the river Douglas, I have often asked myself, Can the age of any of these deposits be translated from mere sequence into years? Observation has led me to believe that an approximation may be made in the case of the blown sand; and this, as I will presently show, bears upon the title of my paper.

A reference to the map (1 inch to the mile) and section, figs. 1 & 2,

Fig. 1.—*Sketch Map of the Coast at Blundellsands, near Liverpool.* (Scale 1 inch to the mile.)



and to those accompanying my paper on the Post-Glacial Geology of Lancashire and Cheshire, in the 'Proceedings of the Liverpool Geological Society,' 1871–2, will explain the order and sequence of the deposits; and it will be seen that the last movement of the land in Lancashire was downwards*. Submarine forests at the Alt mouth, the Rimrose brook, the Liverpool and Garston docks show that subsidence has taken place; and (which is perhaps quite as good evidence) sections of stream gullies, cut in the Boulder-clay and filled with recent silt, at levels far below high water, are frequently met with in dock-excavations.

Upon the superior peat- and forest-bed, which is an extension inland of the submarine forests, rests, as on a platform, some 22 square miles of blown sand, in some cases rising 75 feet above Ordnance datum, and estimated by me to be at least 12 feet in average depth.

This deposit is shown in my map, as well as in that prepared by the Geological Survey, by yellow dots; it varies in width at different localities, its maximum being at Formby, where it reaches 3 miles inland. It is quite evident that the whole of this Æolian deposit is an accumulation subsequent to the last subsidence of the land; therefore, if we can calculate the time it must have taken for the deposit to form, we shall be in a position to determine the *least* time that can have elapsed since the subsidence.

The whole of the blown sand has been derived from the shore between high- and low-water marks, but principally from between high water of springs and neaps when the shore is dry. On a windy day it is very curious to see the streaks of sand rushing over the shore, even when it is damp, shining like rays of a lighter colour pencilled over a dark ground. The shore is very flat, being in places more than a mile wide between high- and low-water marks of spring tides; so that the conditions for the generation of subaerial sand can hardly ever have been more favourable than they are now.

In May 1866 I set out a plot of land at Blundellsands, in Burbo Bank Road North, for building-purposes; it had a frontage of 350 lineal yards to the sea, the western boundary being the then high-water mark of spring tides. In 1874, for the purpose of enclosing the said plot, I had to remeasure it to define the boundary, when I found that high-water mark was considerably beyond the western boundary, and that the sand had gained upon the sea. An open wire fence was then put up on the original high-water mark, when measurement showed that there were 15 yards of land in front of it at one end, and 5 yards at the other. The high-water mark of springs had, in fact, receded to that extent. I estimated the deposit of sand that had taken place in the eight intervening years at an average of 10 yards wide along the whole frontage and 2 yards deep. Allowing 1 yard more in depth for sand that may have been

* At Meols, in Cheshire, on the opposite side of the Mersey estuary, was a Roman station; and the land is now only a few feet above high-water; therefore the land cannot have *risen* since the Roman occupation.

blown over the top, which I am convinced is a large estimate, as very little sand blows on to Burbo Bank Road North, the eastern boundary of the plot, we shall thus have $350 \times 10 \times 3 = 10500$ cubic yards of sand deposited in eight years on a shore-frontage of 350 lineal yards—or 3·75 cubic yards per lineal yard of frontage per annum.

Taking this as my unit of measure (and it is an exceptionally large one), I find, for the 16 miles of coast forming the western boundary of the deposit, it will give 105,600 cubic yards per annum as moved by the wind; and dividing the 272,588,800 cubic yards contained in the 22 square miles, 12 feet thick, it will give 2580 years as the age of the whole deposit of blown sand if accumulated at the assumed rate.

Since these calculations were made, I have lately tested their accuracy in another manner. There is another plot in Serpentine Road, having a sea-frontage of 243 lineal yards, and containing about 6500 square yards. Serpentine Road was made from my sections and under my superintendence in 1866; so that I had every opportunity of ascertaining the respective levels. Taking every thing into consideration, I estimate that there has accumulated over its whole surface an average depth of less than 2 yards of sand (very little blows across the road); so I think we may fairly take an average depth of 2 yards as representing the quantity of sand blown off the shore from a frontage of 243 lineal yards. This, extended over fourteen years, gives 3·81 cubic yards of sand per lineal yard of frontage per annum.

It is quite evident that the sand cannot accumulate faster than it sweeps off the shore; but at other points on the coast the sea is

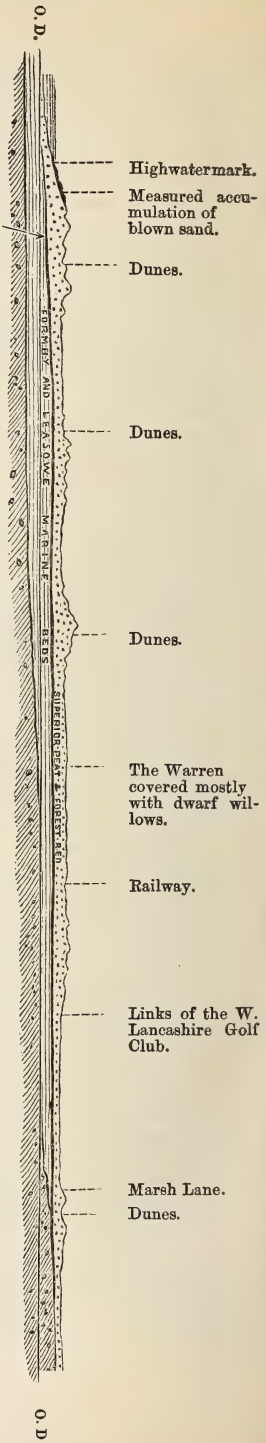


Fig. 2.—*Section along the line A–B in* Fig. 1.

* At the Alt mouth this continues under the Sand-dunes and reappears on the shore as a submarine Forest-bed. (See Map.)

gaining on the land; therefore what is deposited in front of the sand-dunes is again swept away, and all that goes to the accumulation is that which is blown over the tops of the hills or sand-cliffs.

This will also be the case where the coast-line is stationary. Again, the high sand-dunes form a barrier that the sand cannot so readily surmount, the practical effect being that, the bases being swept by the tide, and the angle of repose remaining constant, less sand travels inland the higher they grow. At the mouth of the Alt there is a very extensive bank at low water swept by the north-west wind; but the sand does not accumulate, as it is blown into the river Alt and washed out seawards again. The land on which the Altcar rifle-range is situated has, in fact, as a protection to the river, been gained from the sea by the erection of artificial obstructions, against which the sand accumulates. This accumulation has now practically ceased; and the river and the sea combined are eating into the land by the Crosby lighthouse, and making sad havoc with the submarine peat- and forest-bed.

On referring to the map it will be seen that the blown sand is narrowest at this point, though the conditions are very favourable for its development, had the river Alt not intervened.

If, then, it be conceded that the last change of level in South-west Lancashire was a downward one, I think the facts and calculations I have had the honour to lay before you pretty clearly prove that it did not take place within the last 2500 years.

Discussion.

The Chairman (Mr. Hulke) remarked upon the economic as well as scientific interest of the communication from the proved increase of land in the area.

Mr. De Rance, who had surveyed the district described by Mr. Reade in his paper, could corroborate many of the author's conclusions, especially by the finding of Roman coins on the surface of the marsh land and by a Roman bath only 5 feet above high-water mark.

Prof. Judd stated that Mr. Reade's conclusions were entirely in accord with the most recent researches concerning the supposed changes in the level of the shores of the Firth of Forth since Roman times.

The Author stated that at Hoylake, in Cheshire, numerous Roman remains belonging to a Roman encampment a few feet above high-water mark prove that no appreciable downward movement has taken place since Roman times. He thought the actual period required for the formation of the blown sand was probably nearer 5000 than 2500 years.