Mr. Woodward said the subject was most important to geologists, and he thought that Mr. Taylor had treated it in an able manner. He agreed with the author that the establishment of a proper distinction between the upper and lower beds would make a great difference in the per centage of shells. He also thought that the manner in which the lower bed was shown to be a fluvio-marine or littoral deposit, and the upper decidedly marine, was very important, inasmuch as the latter, perhaps, formed a connecting link between the true Crag and the Glacial series. He had mentioned to his brother, Mr. B. B. Woodward, that Mr. Taylor was about to read a paper on this subject, and he, from long experience with his father, the late Mr. Samuel Woodward, in the geology of the county, was able to confirm Mr. Taylor's views respecting the distinct character of the two beds. Mr. Woodward advised the members of the Norwich Geological Society to devote their attention to the solution of this very interesting question.

The President (the Rev. John Gunn, F.G.S.), then said that he thought the bed of shells in the Whitlingham Tramway belonged to the laminated beds, which, in the "Antiquity of Man," were called fluvio-marine. They overlaid the forest bed on the south side of the Cromer Jetty, and the Norwich Crag on the north side. The forest bed must have occupied a long period of time, during which its soil was first raised above the water in which it had been deposited, continued above it while the forest flourished, and then was gradually submerged; and this forest bed intervened between the Norwich Crag and the upper or marine part of the laminated beds, in which Mr. Gunn supposed the shells to be. He pointed out a fine section of them, near Bishop's-gate Bridge, Norwich, where they lie between the Norwich Crag and the Lower Boulder-clay.

CORRESPONDENCE.

NOTES AND QUERIES IN REGARD TO THE VALLEY OF THE SOMME.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—The valley of the Somme, as described by Sir C. Lyell and Mr. Prestwich, is a long shallow trough, thirty miles in length, about one in average width, and from two to three hundred feet in depth. It has been hollowed out of a bed of "Chalk with Flints."

On the sides there are two level terraces, composed of shingle and sand, with occasional beds of clay. The gravel consists of fragments of rocks, the same as those found in the district at present drained by the Somme. In some places, where the terraces have been opened for industrial purposes, implements of flint have been discovered, as well as the bones of some mammalia now extinct.

Sea-shells are found mingled with the gravel as far up as Menchecourt, twenty miles from the mouth of the river.

In the gravel beds there are sometimes found fragments of rock, with their edges unbroken, as if they had been brought down by floating ice; and there are other evidences which show that these frozen masses must have exerted considerable influence in the formation of the level terraces.

The bottom of the valley is occupied by a bed, which Sir Charles Lyell characterizes as peat, and describes as being from ten to thirty feet in thickness.

Sir Charles Lyell speaks of this peat as having grown on the spot where it is found, and as having required an immensely extended period for its production.

Mr. Prestwich, in his paper read before the Royal Society in 1864, does not speak of peat at all, but calls this bed "alluvium."

QUERY FIRST.—*What is the nature and origin of the bed which occupies the bottom of the valley?*

In England, and more particularly in Scotland, we find extensive accumulations of peat. In some instances, the peat remains in its natural locality. In such cases, the roots and stems of those plants that grow in marshy soil, and by their decay produce peat, are mingled through the whole mass, being of course more abundant in the upper part, which has in consequence a soft and spongy consistence. In other cases the more completely transformed particles of peat, after having been saturated with water, have run down into the hollows, leaving the undecomposed portion of the plants behind. This variety of peat, when condensed and dried, is very tough and hard, and is almost as heavy as coal.

If the peat in the valley of the Somme has grown in the place which it now occupies, we may expect to find a bed of, comparatively speaking, uniform thickness, having but little foreign admixture, the whole mass being intermingled with the remains of the plants that produced it, and these remains retaining the position they occupied when alive. If it is an alluvium, brought down from the higher grounds, we may expect to find beds of solid peat, with very little trace of the plants that produced it, mingled with deposits of sand and mud, and pieces of peaty soil, with vegetable remains lying in various directions. If, as is most likely, some of the peat has grown on the spot, and some has been brought down by the river, we shall find the soil on the banks of the Somme of a very heterogeneous description, containing peat of different kinds, intermixed with mud, and sand, and clay.

A more accurate examination of the bed which fills the bottom of the valley seems to be required before we can determine its nature, or its origin, or the time taken to produce it.

QUERY SECOND.—*Are the terraces on the sides of the valley of the Somme to be ascribed to the effect of river-currents or to the action of the sea?*

Along the coasts of Scotland we find in many places level terraces of recent origin, from ten to fifteen feet above high-water-mark. They are formed of the sand and shingle carried up by the advancing billow, and left behind in those places where the debris thrown up

by the sea is accumulating, and consequently where the land is advancing. Their height above ordinary high-water-mark depends on the height to which the billows rise at spring tides and in storms.

While the advancing billow throws up gravel and sand above high-water-mark, the retreating billow carries back similar material into the deep water. We might, therefore, expect to find level terraces formed under the water, as well as above its level. This is generally believed to be the case, and in that opinion the writer of these remarks formerly concurred; but farther examination shows that the currents that sweep along the shores of the ocean prevent such level formations, and throw up the debris carried down into the deep in irregular ridges and banks. The level terraces, or "ancient sea margins," from thirty to fifty feet above ordinary high-water-mark, though some speak of them as "ancient sea bottoms," seem all to have been formed by the advancing, and not by the retreating billow.

The terraces on the Somme seem to have been formed in like manner by the action of the sea. They are ancient "sea-margins," thrown up above high-water-mark by the advancing billows.

They cannot be ascribed to the action of river currents.

Mr. Prestwich's idea that the Somme at some former time carried to the sea a vastly larger body of water than it now does, is disproved by the fact that all the pebbles found in the valley appear to have been brought from the rocks which are found in the basin which it drains at the present time.

Even, however, if the volume of the river had been as large as that of the Ganges or Mississippi, the force of the stream would not have been sufficient to have brought down gravel. The Somme at Amiens, fifty miles from the sea, is only fifty feet above sea level, and there is no reason for supposing that it was different at a former time. No river current, with so gentle a declivity, as one foot in a mile, could bring down stones and gravel such as are found in these terraces, or could scoop out the hollow between them, as Sir Charles Lyell supposes.

In order to put the question more fully to the proof, let those, who look on these terraces as having been formed at the bottom of the river or frith, point out an instance of any such level having ever been formed under water, in any place exposed to the action either of river or of tidal currents.

We remark further, that if these terraces are the result of water flowing down to the sea, any large stone that may be found in them will have a bank or "tail" of sand behind it, and these tails will *all* point downwards to the sea. Stones also of a flattened shape will be found having an inclination to the sea. If the gravel has been thrown up by the action of the billows no such uniformity of inclination will be found.

QUERY THIRD.—*How was the valley originally formed?*

If we rightly understand the descriptions that have been given of it, the valley of the Somme may be regarded as a long, shallow, flat-bottomed trough. Its formation seems to be unique. Some valleys

have originated in dislocation of the strata, through the action of subterranean forces; but here there is no trace of such dislocation. The valley has been hollowed out of a uniform level bed of chalk. Other valleys have been excavated by torrents from the surrounding hills, but here there is no evidence of any river-current capable of producing the supposed effect. We remark further, that valleys scooped out by river torrents become narrower as they get deeper, and though they may afterwards be filled with gravel or sand, the original channel cut out of the rock has always the character we have ascribed to it. Other valleys are formed by glaciers; but in the neighbourhood of the Somme there is no trace of glacier action, as far, at least, as the accounts given by Sir C. Lyell and Mr. Prestwich show.

If, as we said, we rightly understand the accounts given of the valley, there seems to be but one cause to which its formation can be assigned. That is the action of floating ice, carried backwards and forwards by a tidal current.

If we suppose the Somme, at first, to have flowed into the sea, through some little narrow creek, the ice formed on its surface, at a time when a boreal climate prevailed, must have rapidly worn away the chalk which formed its banks. When the mouth of the river gradually enlarged into a long narrow estuary, that estuary would be filled in a great measure with fresh water, which would be frozen over in winter. The flux and reflux of the tide would be like that which we find in the Solway Firth at the present time. It would produce very powerful currents, and give to the ice on its surface an impetus which a substance so soft as chalk could not resist. If the sides of the depression had been formed of any of the harder rocks, they would not only have been better able to withstand the shock of the floating ice, but the fragments broken off from them would have formed beds of gravel which would have lessened the force of the ice. The abraded chalk would be diffused through the water and carried out into the ocean; the embedded flints only would remain.

Since various considerations have led to the conlusion that a boreal climate prevailed at the time when the valley was formed, it seems no improbable conjecture to suppose that masses of floating ice, with sand and gravel adhering to the bottom and sides, were the means by which the excavation was originally formed.

Yours truly,

JAMES BRODIE.

ON THE ORIGIN OF VALLEYS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—My friend Mr. Scrope, in his article "On the Origin of Valleys," published in your last number (p. 193), has rightly represented me as a convert to his opinions on that subject; but by remarking that I had *at last* acknowledged the correctness of his views, he might lead your readers to infer that I had obstinately maintained an opposite theory, until a very recent period.