VII.—*On a Fresh-water Formation in Hordwell Cliff, Hampshire ; and on the subjacent Beds, from Hordwell to Muddiford.*

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[Read December 7, 1821.]

IN the memoir which I presented to this Society in the year 1813 *, on the fresh-water formations of the Isle of Wight, I mentioned Hordwell Cliff as consisting of the London clay. I had not then had an opportunity of visiting the spot, but depended upon the descriptions of others.

So long ago as the year 1766, a work was published by Gustavus Brander, under the title of *Fossilia Hantoniensia*. It contained remarkably good engravings of a number of shells and other organic bodies, collected (as is stated in the preface) in the cliffs between Christchurch and Lymington in Hampshire ; but chiefly near the village of Hordwell.

Some time since, the agreement observed between those fossils of Hampshire, and those of the London clay found at Highgate and other places, pointed out the identity of the beds from which they were derived ; and it was by the same kind of agreement in the fossils, that I was enabled to show, (in the paper above referred to,) that the northernmost of the vertical beds at Alum Bay, in the Isle of Wight, corresponded generally to the London clay, but more especially to this bed near Hordwell which belongs to that formation ; and, consequently, to establish the relative geognostic situations of the remaining vertical beds at Alum Bay, and also of the alternating fresh-water and marine strata.

But the proof, by which I endeavoured to establish the identity of the beds at Alum Bay and at Hordwell, resting almost entirely on the fossils, it was necessary, in the present advanced state of geological science, to have the additional evidence of other circumstances : and with the view of examining this subject still more closely, I have very lately again visited those places.

* Transactions of the Geological Society, Vol ii. p. 161.

In my former paper I observed, that from the proximity of Hordwell Cliff to Alum Bay and Headen Hill, it appeared to me very probable that some traces of the fresh-water formation, for which Headen is so remarkable, might be found at Hordwell. Indeed Woodward, whose valuable catalogue I have had frequent occasion to mention, speaks of fresh-water shells in a marly stone from Hordwell: but his theoretical opinions with respect to the causes which operated in burying these shells in the earth probably prevented him from examining the order of the beds; and it does not appear that he had been at the spot: nor was the agency of fresh-water in the formation of mineral beds at that time recognised.

I also stated, that I had received from Professor Buckland fresh-water shells sent from Hordwell; and I have seen such shells included in several collections of the Hordwell fossils: one of these, called by Dr. Solander *Helix lenta*, is figured in Brander's work. Notwithstanding these circumstances, however, it does not appear that any of the observers above enumerated were aware of the proper situation of these fresh-water shells; it being generally supposed, that they were found either mixed with Brander's marine fossils, or lying immediately over them without being in distinct beds; much less was it imagined that there existed an extensive and distinct fresh-water formation at Hordwell, such as I am about to describe. I am indebted to the Rev. Dr. Cooke, of Tortworth, for the first notice that traces of this formation were to be seen at Hordwell: but I have reason to believe that a regular examination and delineation of the instructive section formed by the coast has not hitherto been effected.

The portion of the coast of Hampshire, the description of which forms the subject of the present communication, extends from Hurst Castle, on the extremity of a bar in the Solent, to the village of Muddiford, one mile east of Christchurch*. From Hurst Castle to Muddiford is about ten miles. The narrow bar, which joins Hurst Castle to the land, is nearly two miles in length: it appears to have been produced by the rapid current, which, turning round Christchurch Head, and striking on Barton and Hordwell Cliffs, is deflected towards the Isle of Wight, before it enters the Solent in its course to the east. The bar consists of water-worn pebbles of chalk-flints, there called *shingles*: which may have been derived, in part, from the chalk cliffs of Dorsetshire and the Isle of Wight; and partly from a thick bed of diluvian gravel, which forms the upper portion of Hordwell Cliff, and which, continually falling, is washed away by the sea. The tide is very rapid between Hurst Castle and the Isle of

* See the Map and Section, Plate XII.

Wight, and, being thrown on the latter place, it is rapidly destroying the coast : but the north side of the Solent being defended from its action by the bar of shingles, an extensive deposition of mud, that has been carried down by the rivers and streams in this part of Hampshire, has taken place along that shore.

Where the bar of Hurst Castle joins the land, about half a mile south of the village of Milford, the shore rises into a low cliff, which, for a quarter of a mile, consists only of gravel ; but at this spot the original strata appear, dipping a few degrees to the east. The cliff increases in height until it attains an elevation of about two hundred feet, and continues nearly to Muddiford without interruption, except where it is cut through by two streams that flow into the sea. The part properly called Hordwell Cliff, extends from the spot where the original strata first appear at the eastward, just below Milford, to a place called Long-mead End, a distance of a mile and a half. From Long-mead End to a gap in the cliff, occasioned by a stream called Beacon Bunny, is about half a mile, and is called Beacon Cliff. Barton Cliff reaches about two miles and a quarter from Beacon Bunny to Chuton Bunny, where another stream, rather more considerable, comes down. The remaining portion, which extends to within a quarter of a mile of Muddiford, is called High Cliff.

All these cliffs are capped by a bed of gravel, which, in Hordwell and Barton Cliffs, attains a thickness of at least fifty feet.

It is in Hordwell Cliff that the fresh-water formation is to be seen ; the whole of the lower part of this cliff, indeed, consists of it, and not of the London clay ;—which last is found only in Barton and High Cliffs ; and it is in these cliffs that the shells, usually called Hordwell fossils, are found. The fresh-water shells, to be seen in the collections of these fossils, have not been found mixed with those of the London clay, but in a bed entirely distinct.

The fresh-water formation in Hordwell Cliff consists of various alternations of clays and marls. Some of the beds of clay are of a beautiful blueish-green colour, and others are blackish. Thin beds also occur consisting of hard calcareous marl, which appears to be derived entirely from shells of the fresh-water genera *Limneus* and *Planorbis*, of which numerous perfect specimens are to be found in it. A species of *Paludina* (*Helix lenta* of Brander) is also very common in this formation, occurring usually in layers ; together with a great number of a beautiful small *Melania* and two species of bivalves.

In some parts of this bed I discovered also a prodigious number of minute fossil bodies, which, upon examination, are found to resemble the capsules of some vegetable. They are about the twentieth of an inch in diameter, of a

flattened ovoid form, with the surface corrugated, and having a portion of the process by which they were attached still remaining : they are all hollow, and are in general divided, appearing as if they had burst open. They consist in their present state of lignite penetrated by pyritous matter. Fig. 3, Plate XII. represents one of these bodies of the natural size : and at fig. 4 are magnified views of it.

Towards the lower part of these fresh-water beds, there are numerous fragments of lignite, and beds a few inches thick of a substance resembling what the French call *tourbe pyriteux*.

Immediately below this formation at Hordwell, is found a bed of sand from sixty to one hundred feet thick : which appears first about Long-mead End, and may be well observed in the section at Beacon Bunny. This remarkable bed of sand forms one-half of the height of Barton Cliff, and is seen in the upper part of High Cliff, where it thins off and terminates beneath the gravel.

The bed which is identical with the London clay lies immediately below this sand : it commences on the east, at the level of the sea, between Long-mead End and Beacon Bunny, and extends through Barton and High Cliffs : but it is in the upper part only that the fossils are numerous. This part of the bed may be twenty or thirty feet thick, and consists of a very sandy clay of a dark-green colour. Beneath it are some layers of large septaria ; and there the clay is much less sandy, and contains fewer fossils. It is about Beacon Bunny that the fossils are found most conveniently ; the upper part of the bed being easily accessible in that place : as the stratum increases in height, particularly at High Cliff, it is more difficult to reach the green bed. About Chuton Bunny are many large water-worn stony masses, with shells derived from beds in the London clay : and about the middle of the length of this cliff a stratum of sand appears below the clay, from which it is separated by a thin layer of rounded pebbles. This sand is of a dirty white, and contains many fragments of lignite, among which parts of branches, and a few even of the leaves of plants, may be distinguished. From its situation I consider this as the sand of the plastic clay : the fragments of vegetables, also, being very like those which accompany the lignite of that formation at Alum Bay. This bed is suddenly cut off by denudation before it reaches Muddiford, and then gravel forms the low cliff, which extends nearly to that place.

From a variety of reasons, I am induced to consider the fresh-water bed at Hordwell as corresponding to the *lower fresh-water* formation of the Isle of Wight. I have lately found this at East Cowes, at low water, with the same characters as at Hordwell : the beautiful green clay with *Limnei* and *Planorbes* being similar at both places. In my former paper, I mentioned that I

had perceived, in connexion with the lower fresh-water formation, some alterations of beds containing marine and fresh-water shells, and in some places even mixtures of these. These mixtures are to be seen at Cowes; and at Hordwell I met with one specimen of a *Cerithium*: but the examination of this cliff, which is of great height and of difficult access, will no doubt afford traces of the passage to the upper marine formation. The imperfect lignite of Hordwell resembles that of Headen; and the *Melania* of Hordwell is to be met with in abundance in Thorness Bay, Isle of Wight. But it would be tedious to enumerate all the circumstances of resemblance that strike the observer, and which on the spot produce a conviction of the identity of this bed at the two places, very difficult to convey to others. The strongest argument, however, is derived from the subjacent strata: since in the Isle of Wight, a bed of white sand rests upon the London clay; and over this sand is the lower fresh-water formation; with the intervention, in some places, of a bed in which a mixture of marine and fresh-water shells is to be found.

The agreement of this series with that just described at Barton and Hordwell Cliffs furnishes a strong confirmation of the opinion I formerly advanced, with respect to the extent of what I have called the Isle of Wight Basin. And from the great thickness of this fresh-water formation in Hordwell Cliff, it cannot be doubted that it extends to a considerable distance inland; but how far I have yet had no opportunity of determining*

* Since the preceding paper was read, Charles Lyell jun. Esq. has been so obliging as to transmit to me a specimen of shell marl, obtained from pits at a hill called Acres Down, and which is used for manure in the neighbourhood of Lyndhurst; from which it is evident, that the upper marine formation may be traced thus far: this marl consisting entirely of fragments of the same shells as are found in such numbers in that formation in the Isle of Wight.

Section of the Cliff extending from Muddiford to near Hurst Castle.
The Scale of Heights is double that of Lengths.

- Gravel
- Lower Freshwater and Upper Marine Formations
- Sand
- London Clay
- Sand of the Plastic Clay