ON THE PHYSICAL GEOLOGY OF PURBECK.

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*(With Plate XIII.)**[Read 1st May, 1896.]*

IN dealing with the origin of the physical features of the Isle of Purbeck, it is necessary to consider those of the south-east of England generally. For the purpose of so doing I have prepared a map (Plate XIII) showing the river courses in detail, and have placed on it the limits of the Tertiary deposits and of the Upper Cretaceous Rocks, the last-named being selected as forming one of the most important stratigraphical horizons in our Secondary Rocks. The crests of the principal anticlines also are indicated.

These Upper Cretaceous Rocks extend across England in a general north-easterly direction, and with a general south-easterly dip; but their structure is diversified by some important folds, which run nearly east and west. Of these the more important are the London basin, the Wealden anticline, the Hampshire basin, and the Isle of Wight and Purbeck anticline.

The rivers may be considered as consisting of two main lines of drainage running from west to east along the synclines, and of a number of tributaries which flow north and south from the anticlines. Thus the Thames and Kennet pretty closely follow the axis of the London syncline from end to end. On the north there are gathered into this main stream a number of tributaries rising on the back of the Chalk escarpment, amongst which may be included the stream known to geographers, from its superior size, as the Thames, but which for present purposes might be regarded rather as a tributary of the Kennet. This stream, it may be noted, with its contributaries—the Coln, Leach, Windrush, Evenlode, and Thame—rises in the Oolite tract, some distance beyond the Chalk scarp.

On its south side the Thames receives a number of tributaries which rise in the low ground of the Weald, and traverse the bold Chalk range of the North Downs. The reason for this apparently anomalous course has become a classic problem in geology. The Wealden area, for the most part lying low and overlooked on three sides by bold Chalk hill-ranges, was once supposed to have originated as a bay of the sea. It has been shown, however, that its form resulted solely from atmospheric denudation. Originally an elevated area with the structure of an arch it gave birth to a number of streams flowing north and south from the axis of greatest altitude, which then coincided with the axis of greatest upheaval; and though subsequently the crown of the arch was denuded away, and the high area reduced

to a valley, the rivers kept their courses and deepened them simultaneously with the general degradation of the land. As a test of this theory, it may be seen by the map that the main anticlinal axis of the Weald agrees closely with the water parting between the rivers which flow north and south respectively from that area. The agreement is even more striking further west, near Kingsclere, where a valley breaches the Chalk escarpment, but plays no part in carrying the drainage of the district, the streams in fact flowing from it and not to it. Here again the geological structure furnishes the explanation, for the valley coincides with the well-known Kingsclere anticline, by which the position of the water-parting was determined.

The Frome and its tributaries form a system precisely analogous to that of the Thames and Kennet, though a larger portion of it has been removed by the sea. The main line of drainage, as in the case of the Thames, follows the synclinal axis, and though it now enters the sea at Poole, its former course is recognisable in the valley occupied by the Solent. From the north it receives the Stour (which rises in the Oolitic area and thus forms a curiously close counterpart of the Upper Thames), the Avon, which comes down from the Kingsclere anticline, and the various Southampton rivers, while finally the Arun, Adur and Ouse must at some former period have formed tributaries to this main stream. On its south side, there remains a mere wreck of the former drainage area, but enough to give an idea of its configuration. The Isle of Wight, as has been frequently noticed, is divided into three parts by two alluvial tracts, the one running from Freshwater Gate to Yarmouth, the other from Sandown to Bembridge. The former is bordered near Freshwater by terraces of river-gravel, and though it leads out into the sea at Freshwater Gate, its continuation, with corresponding terraces, strikes the land again near Brook, and runs thence for some distance at or near the brow of the cliff. We have here, in fact, a river-valley, with alluvium and terraces complete, but tenanted by no stream, the encroachment of the sea having tapped the waters at their sources. The same description applies to the Sandown alluvial flat; this marsh indicates the former course of a stream, the whole drainage area of which has been swept away, with the possible exception of the ground drained by Shanklin Chine. The Medina, on the other hand, in the middle of the island remains intact. This and the vanished streams above described followed the invariable rule, and, rising in the crest of the Isle of Wight anticline, made their way, regardless of the apparent obstacle formed by the Chalk range, to the main stream in the syncline.

The Isle of Purbeck provides a no less conspicuous example of the same law. It is traversed in its southern part by a continuation of the Brixton anticline of the Isle of Wight, the crest

of the anticline however, as so often happens, coinciding with what is now low ground, while the principal hill-range is formed by the Chalk outcrop farther north. The streams, as elsewhere, rise on the anticline and flow northwards from it straight at and through the Chalk range, taking so little account of it, so to speak, as to have cut two deep gaps through it in close proximity, leaving the conical hill of Corfe Castle between.

Still further south we find small portions of a third drainage system, for the southern water-parting of the Frome basin touches the southern parts of both the Isle of Wight and of Purbeck, and even turns inland west of Purbeck. The small combes south of this parting are the heads of valleys which led down to another drainage system now entirely swept away.

Thus the Isle of Wight became an island through the combined action of the sea and the Frome. The sea, encroaching upon the old estuary of the river, effected the separation on the north, while a tributary to the Frome, we may suppose, had commenced a breach in the Chalk range somewhere between the Needles and Ballard Point. A submergence such as that of which we have evidence in the submerged peats of Southampton Docks, would admit the sea to that breach, and the tide, once given a clear run round the island, would make short work of sweeping out the old alluvia and widening the channels to their present dimensions. The Isle of Purbeck marks an intermediate stage in such an insulation; the tidal estuary on its north side already exists, and a submergence sufficient to admit the sea to the Frome valley round the west end of the Isle of Purbeck Chalk range would bring into existence a second Isle of Wight. The history of the insulation seems to resemble strongly that of Barry on the coast of Glamorganshire.*

All the anticlines I have mentioned have the same general form, namely a steep upward bend of the strata on their north sides, and a gentle descent towards the south. The movements, however, have been more energetic in the extreme south of England than in the central Counties; and while the folding is more complete in the Isle of Wight than in the Weald, it has gone still a stage further in Purbeck and at Ridgeway. The strata, in fact, having there bent as far as they could go, the further strain was relieved by fracturing and overthrusting of a unique character, as I have elsewhere described.† I then assigned these disturbances to two ages, viz. : the intra-Cretaceous folds, which affect all rocks up to and including the Wealden, and the post-Cretaceous folds. Since then Mr. Reid has shown that these later folds themselves belong to more than one age.‡ We may further assume, from the vast discordance between the Trias and Carboniferous in

* *Quart. Journ. Geol. Soc.*, vol. lii (1896), p. 474.

† *Quart. Journ. Geol. Soc.*, vol. li (1895), p. 459.

‡ *Quart. Journ. Geol. Soc.*, vol. lii (1896), p. 490.

South Wales, that there were movements still earlier than the intra-Cretaceous. But at whatever age they recurred, they all seem to have caused folding in a general east and west direction, and their repetition along nearly the same lines, epoch after epoch, must have left the Palæozoic rocks which underlie Dorset in inconceivable confusion.

In the Lower Purbeck rocks a curious rock-structure occurs, the age and origin of which still forms a subject of discussion. The limestones immediately overlying the Dirt-bed assume at times the character of a breccia. They have been broken into angular blocks, which are quite disarranged and now stand at all angles, the whole, however, having been recemented into a coherent rock. This brecciation affects as much as 40 ft. of strata at times, yet the beds beneath and above the broken belt are undisturbed. By Sedgwick and Murchison* the structure was compared to that which occurs in certain Devonian limestones; these rocks are interstratified with shales, and having been subjected to pressure have broken while the shales yielded. Mr. Fisher,† on the other hand, pointed out that the strata above the "broken bands" were not only undisturbed, but that they tended to level up the inequalities due to the breaking, a fact which left him in no doubt that the brecciation took place before the upper strata were deposited. But Mr. H. B. Woodward‡ has lately argued that the structure is connected with the Isle of Purbeck disturbance, and must therefore be post-Purbeck, and probably even post-Cretaceous, but Mr. Fisher's arguments would have to be met before this conclusion could be accepted. Mr. Fisher further suggests that the breaking up was due to the falling in of the tufas consequent on the decay of the mass of vegetation which they had enclosed. It may be noticed also that a brecciated character is not an uncommon accompaniment of tufas of all ages.

In conclusion it may be pointed out that the features of the Dorset and Hampshire coasts are due to the encroachment of the sea on the old drainage area of the Frome, and to the almost complete obliteration of another water-system south of it. It is tempting to speculate on the part once played by this obliterated system, and by others beyond it, but perhaps similar to those I have described, in the formation of the English Channel and consequent separation of England from the Continent. We may call to mind the suggestion that before these changes, and probably at no distant geological period, these various streams formed tributaries of a far more important river which flowed northwards up what is now the North Sea, and of which the Rhine is the diminished representative.

* *Trans. Geol. Soc.*, Ser. 2, vol. v, p. 655.

† *Trans. Camb. Phil. Soc.* vol. ix (1855), p. 566.

‡ *Jurassic Rocks of Great Britain (Mem. Geol. Survey)*, vol. v (1895), pp. 247-251.