II.—CREECHBARROW IN PURBECK.—No. 2.¹

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ADDITIONAL POINTS IN STRATIGRAPHY.

IN my paper published in the Proceedings of the Dorset Field Club (vol. xxiii), I dwelt at some length on certain borehole sections made towards the northern base of Creechbarrow with a view to the discovery of Pipeclay. This course was adopted in the hope that a study of these sections might throw some light on the stratigraphical relations between the Creechbarrow Beds on the hilltop and the Pipeclays lower down, if indeed there are any stratigraphical relations beyond a mere jumble of irregular deposits whose precise orientation can never be disentangled. Whether this latter supposition is the true one or not, the exceptional character of the Creechbarrow Beds, as a local feature, remains the same, even although we cannot decide whether they go under, over, or into the Pipeclay series. Before attempting any further speculation as to the possible stratigraphy of the region I will call attention, at any rate, to its topography as shown in the accompanying figure.

FIG. 1.—Creechbarrow from the north-east, based on a photograph by the late Mr. Laurence Pike.

- A. Summit of Creechbarrow, 637 feet.
- B. The eastern spur.
- C. The northern ridge (approximate dip slope). The hilltop limestone extends along this ridge as far as the 500 feet contour.
- D D. The Purbeck Hill; maximum elevation 654 feet, just behind Creechbarrow.
- E. Blackhills Plantation, about the 300 feet contour.
- F. Spoil-heaps of the clay workings.

North-East Side of Creechbarrow: Additional Particulars as to the Creechbarrow Beds.—From the above figure the topographical relations of the Creechbarrow Beds to the Pipeclay series can be seen at a glance; the former looks down upon the latter. It is

¹ No. 1 appeared in the June number of the GEOLOGICAL MAGAZINE for 1902. It was then intimated that the subject would be treated more fully in the Proceedings of the Dorset Field Club. This has been done, and a portion of the additional matter is now, by the kind permission of the Publication Committee of the Dorset Field Club, reproduced in the GEOLOGICAL MAGAZINE. This portion relates mainly to the lithology and palaeontology of the Creechbarrow Beds.—W. H. H.

Plate XI, illustrating this paper, will appear in the May number with the remaining part of the article.—EDIT. GEOL. MAG.

scarcely necessary to point out that the Purbeck Hill (D D), consisting of Chalk, is depressed by perspective, the highest part of it slightly exceeding the height of Creechbarrow. A word as to the composition of the Creechbarrow Beds seen in this figure may be useful as a sort of recapitulation of what has already been stated. If I give this in the form of a generalized vertical section, it is merely for the sake of convenience, and not to be regarded as absolutely true at any one point.

1. The highest bed of the series is the deposit on the Creechbarrow Limestone. With this must be associated the beds above the 'marl' detailed in the northern section. The thickness of these latter beds is about 13 feet down to the 'main marl,' and they consist of sands, clays, flints, and a thin bed of 'marl.'

2. The next in downward succession is the hilltop, or Creechbarrow Limestone, which is excessively hard at the summit (A), but becomes softer when traced on the dip slope towards the 500 feet contour (the letter C is approximate); in this condition it is known as 'marl,' and may be about 12 feet thick in some places.

3. The beds immediately below the Creechbarrow Limestone are extremely variable, and constitute a stratigraphical crux of considerable perplexity. They certainly differ materially within short distances, and but little analogy can be traced between those on the south side of the summit and those on the north side, which are below the 500 feet contour. On the south side of the summit these beds have been traced in detail with considerable accuracy for about 20 feet vertical, and this must be regarded as the standard section.

On the whole, we may sum up by stating that the beds immediately below the summit Limestone, for a vertical extent of perhaps 30 feet or more, are sandy, with some yellow clay, frequently mangiferous, and are characterized by numerous beds of flints, the beds ranging from 6 inches to 3 feet 6 inches in thickness; loose flints also occur in the sands.

In further illustration of this class of beds I would direct attention to the eastern spur of Creechbarrow (B of Fig. 1). This spur is a conspicuous object from the north-east side, since it breaks the regularity of the conical outline as seen from Furzebrook.

Being desirous of finding some evidence as to the cause of this slight local prominence, I had a special pit sunk on the very top of it, with the following result:—

PIT ON THE EASTERN SPUR OF CREECHBARROW.						ft.	in.
a.	Sandy earth with flints	...	...	...	...	0	6
b.	Flint-gravel	...	...	...	...	3	6
c.	Buff, ferruginous sand with manganese nodules	...	...	...	...	2	6
Total section						6	6

The flint-gravel (b) of this section is the thickest deposit of the peculiar 'gravel' of Tertiary age as yet discovered on Creechbarrow; water was lying in the bottom of the pit, apparently due to a pan formed by surface action. The extent of the opening scarcely

permitted us to ascertain whether there is any bedding in the 'gravel.' The stones are of very unequal size, varying from flints 30 lb. in weight to quite small stones; I did not at the time notice any pebbles. The character of the flints here is just the same as in all the Creechbarrow Beds; the large ones have a partially rounded exterior consisting of white silica thoroughly degelatinized. Some are degelatinized throughout, others have a brown core of gelatinous silica still left; most of them are very brittle and fly to pieces on being struck by the hammer. At present it is not possible to connect this particular bed of flints with those found in the pits near the summit. That there are beds of flints occurring in stratigraphical relation to the sands and clays of this hill is certain, and they probably occur on several horizons. The manganese nodules in the buff, ferruginous sand are very interesting and fairly abundant. I shall refer to them again when dealing with the lithology of the Creechbarrow Beds.

The evidence obtained in this pit on the eastern spur goes to confirm the supposition that the abundance of bedded flints of Tertiary age in the upper part of Creechbarrow has materially assisted the limestone in preserving the softer sands and clays from denudation. Such an observation may be accepted as a general one, applicable more or less to the whole hill. When we come to particulars the limestone is more especially accountable for the summit (A), whilst the unusual accumulation of flint 'gravel' is more directly the cause of the eastern spur (B).

3. *The Buff-coloured Clay.*—Still dealing with the deposits immediately below the limestone and 'marl,' we have seen that, on the northern slope and some distance below the 500 feet contour, the calcareous series rest on a few feet of sands with flint-gravel, and that below this comes a very important deposit of buff-coloured clay (Mr. Bond's clay-pit), which may occur as a lenticular mass, as it does not appear to have any representative if followed in the direction of the eastern spur.

4. The lowest member of what I have termed the Creechbarrow Beds are the 'Sands' underlying the buff-coloured clay. These can be studied at Mr. Bond's sandpit, where the following section may be noted:—

CREECH SANDPIT.

	ft.	in.
a. Clay with rootlets	1	6
b. Clay passing into sands; flints occur, especially towards the base (? unconformity)	5	6
c. Bedded sand	1	3
d. Yellow clay with large flints at base and a pink line ...	1	0
e. Yellow variegated sandy clay with a few small flints ...	1	6
f. Salmon-coloured sand with a black centre line, the coloration probably due to manganese	0	3
g. Very fine white sand with but little true bedding (not bottomed)	9	0
	20	0

N.B.—a and b represent the base of the Creech brickearth or buff clay.

This concludes the description of the Creechbarrow Beds as far as I have been able at present to trace them. If we turn to Fig. 1 we perceive that the convenient obscurity afforded by the Blackhills Plantation helps to conceal their possible relation to the Pipeclay series; all we can say is that, topographically speaking, they occupy the higher ground, and that when we get well below the 300 feet contour the Pipeclay series has possession of the surface.

LITHOLOGY AND PALÆONTOLOGY.

The big Flints.—Before entering upon a detailed description of the Creechbarrow Limestone, there are some other matters of interest which may be considered. The first of these refers to the very large flints which have contributed in no small degree to the maintenance of the fabric of Creechbarrow, and which are such an exceptional feature in the Bagshot beds of this immediate district: their stratigraphical relations may be gathered from the preceding pages. As

FIG. 2.—One of the manganese nodules from the eastern spur of Creechbarrow.
Reduced $\frac{2}{3}$ (from a photograph).

regards the general character and appearance of these flints, they are for the most part of a dirty cream-colour; they are also much degelatinized, and in some cases the exterior is simply a mass of granular silica, very meagre to the touch. They are also extremely brittle when first dug out, though it is probable that exposure to the atmosphere toughens them after a while. In consequence of this brittleness the available fragments do not much exceed 28 lb. in weight, so far as I have seen them, though it may well be that heavier flints than these occur. These flints have split in the bed itself. The surface of those flints which are not much broken has been subject to very little modification from abrasion. Associated with the big flints are flint pebbles and other stones of moderate size, also quartzose grit.

The peculiar fawn colour of these siliceous masses will help to distinguish them from ordinary plateau-gravel or valley-gravel

flints; and the amount of soft and almost pulverulent material which coats so many of them is a further distinction, as this substance could never endure the wear and tear of the gravel-making processes. Without illustration, which would necessitate the employment of colour, it is by no means easy to convey an adequate idea of the peculiarities of the big flints, when freshly dug out of the beds which contain them. Their general appearance leads one to suppose that they had been subject to some corrosive action, and this is especially noticeable where there are any indications which may have been due to organic bodies, such as urchins or sponges.

When these Creechbarrow flints have been rolled down the hillside, and subjected to atmospheric action, the external coating of loose silica is found to have been entirely removed, and the flint itself bleached to a dirty white condition, though the casts of *Pectens* and other fossils still retain traces of iron-discoloration.

FIG. 3.—Part of a calcareous nodule from No. 4 pit. Nat. size.

The Manganese Nodules.—There are considerable traces of black oxide of manganese both in the clays and limestones of Creechbarrow, but the remarkable nodules which I am about to describe have only been found in the yellow sand underlying the great flint bed on the eastern spur (see p. 152). Here the most beautiful botryoidal masses of this black oxide, which is probably the hydrated peroxide, or psilomelane, are common and of great variety in form. The one figured has a length of five inches, and its specific gravity considerably exceeds that of the manganese nodules which are figured in the description of the voyage of the "Challenger."¹ In other respects there is a general resemblance, the chief difference being that in our case ordinary quartzose sand functions as the material caught up by the mineral instead of fine pumice and volcanic fragments, etc., as in the case of those found at the bottom of the Pacific. I have not seen any nodules from the Pacific where the mamillæ are so salient or so rough as those from the east spur of Creechbarrow, which are handsomer in shape, heavier, and present

¹ Deep Sea Deposits, pl. ii.

greater contrast of colours. It is evident that great depth is not absolutely necessary to the formation of manganese nodules, as the Creechbarrow Beds, being associated with fresh-water limestone, could not be other than shallow-water deposits, whilst the manganese nodules from the bottom of the Pacific Ocean were formed in depths between 2,500 and 3,000 fathoms.

The Creechbarrow Limestone.—Perhaps the first stage in the description of this curious rock should be an illustration of the mode of its growth in the associated sands. This may be well studied in No. 4 pit, where there were several calcareous nodules just underneath the irregular base of the great mass of limestone. The one figured (Fig. 3, p. 153) may be deemed characteristic.

Externally there is a kind of skin made up of very closely set calcitic layers, which have a rough exterior and include a few sand grains. The rest of the nodule consists mainly of carbonate of lime with a small amount of very fine mechanical sediment. In this respect it differs greatly from the manganese nodules, which take up a large quantity of the sandy matrix. The concentric character of this concretionary body is well shown towards the exterior, and occasionally in the interior, but the general mass is a rather light porous material with denser nests of calcitic matter here and there. Some of the holes in the more porous parts are suggestive of slender stems round which deposition in the first instance has taken place, and the aspect generally may be described as tufaceous.

(To be concluded in the May Number.)

III.—THE COMPOSITION OF INDIAN LATERITE.

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AFTER the appearance of Mr. T. H. Holland's paper on Laterite in the *GEOLOGICAL MAGAZINE*, February number (pp. 59-69), we can at once give the results of our analysis of Indian laterite, without further introductory remarks. They are as follows:—

I. *Pure Gibbsite from Kodikanal, previously recorded in the Mineralogical Magazine, May, 1902.*

H ₂ O	...	...	...	...	...	33.74
SiO ₂	...	...	...	...	...	2.78
TiO ₂	...	...	...	...	...	.04
CaO	...	...	...	...	...	.20
MgO	...	...	...	...	...	.03
Fe ₂ O ₃	...	...	...	...	...	.44
Al ₂ O ₃	...	...	...	...	...	62.80

100.03