THE

PHYSIOGRAPHY OF CAMBRIDGESHIRE.

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The county of Cambridge is about fifty miles in length from north to south, and its greatest breadth from east to west is about thirty miles; it occupies an area of eight hundred and sixty square miles. The greater part of the county is drained by the river Ouse and its tributaries, of which the Cam is the principal, while the northern part is traversed by a portion of the Nen and its tributaries.

Along part of its course the old Ouse river ran in a direction somewhat north by east from St Ives, past Ely, dividing the county into two portions, of which the northern is almost entirely composed of fenland, while the southern is largely occupied by more elevated ground.

In accordance with its geological structure the county is divisible into three important areas, and two minor ones. The former consist of (i) the chalk tract which lies to the east of the Cam between the southern part of the county and Waterbeach, (ii) the curiously dissected plateau which occupies the south-western part of the county between the valleys of the Cam and Ouse, and (iii) the Fenland of the northern part of the county. The minor tracts consist of the alluvial belts which border the Cam and its tributaries and the ridges of old river gravels; and a small plateau topped by gravels which occupies the country around Fordham, Chippenham, and Newmarket.

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The full significance of the various features will be grasped when the reader has studied the section of this guide which is concerned with an account of the geology of the county, but it is necessary to refer at this point to the general characters of the geological formations underlying the area.

Of the three important areas into which the county is structurally divisible, the first-mentioned only can be said to possess a form which is the direct outcome of the influence of the stratified rocks which underlie it. In the second area the underlying strata apparently exercise little effect upon the character of the surface features. Chalk, Gault clay, Greensand and Jurassic clays alike rise to a plateau-like surface, which for a distance of fifteen miles does not depart from the two hundred and twenty foot contour to an extent of more than ten or a dozen feet. This plateau is much dissected by agents of denudation, and the shape of its contours is distinctly remarkable. The third area, the Fenland, owes its position to the existence of a great thickness of slightly inclined Jurassic clays beneath it, but the actual form and flatness of the area has been determined, firstly by denudation of these clays, probably as the combined effect of subaerial and marine action, and secondly by deposit of silt and by plant-growth.

The more ancient rocks which exist in the county belong to the Jurassic and Cretaceous systems. As the strata dip gently in a direction a little south of east, the older (Jurassic) rocks occupy the northern and western portions of the county, while the southern and eastern parts are occupied by the newer (Cretaceous) rocks. The Jurassic rocks consist chiefly of clays, and are therefore marked, on the whole, by low ground.

The nature of the Cretaceous rocks varies. The lowest group consists of sands; these are succeeded by clays which crop out to the east of the sands, and east of the clays lie the various members of the chalk.

The superficial accumulations which cover the more ancient rocks are very variable. The principal, in addition to ordinary
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surface soil, are Boulder-clay, gravels, sands and loams, and peat.

The drainage of the rivers is to some extent determined by the direction of strike of the strata, but in the Fens many changes have taken place in recent times, and the meandering courses of the river have again and again been altered. The course of the Ouse through the county is, as a whole, that of a strike stream, though the portion between Bluntisham and Ely, known as the Old River, flows in the general direction of dip of the strata. The Rhee, from its source near Ashwell to its junction with the Granta, and beyond this to Bottisham, is also a strike stream. One important tributary from the west, the Bourn, flows in the direction of the dip of the stratum with the Cam near Trumpington. Most of the tributaries, however, flow in a direction opposite to that of the dip of the strata, and drain the chalk tract. The most noteworthy are the Granta, which flows from Saffron Walden, the Lin, from Bartlow, the Lark, from Bury St Edmunds, and the Little Ouse from Thetford. All of these have low passes (wind-gaps) at their head, and may occupy valleys which were once drained by streams flowing in a direction contrary to that of the present streams.

Though the pre-glacial courses of the principal streams were much as now, many minor modifications were produced during and after glacial times, but into this matter we cannot enter here.

We may now proceed to give a brief account of the characters of the principal and minor areas which we have previously defined.

(i) The Chalk Tract. The main tract of Chalk occupies that part of the county which lies east of the Rhee, and of the Cam after the Rhee has joined it. It is bordered on the west by wide sheets of gravel, and its higher hills are capped by Boulder-clay. Several of the hills in the south-east of the county rise above the four hundred foot contour-line, and much of this district is relatively elevated. The district consists

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chiefly of scarps facing a little north of west, and of dip slopes facing south of east. The various divisions of the Chalk form scarps of different degrees of importance, the principal being those of the Lower Chalk, which is well seen at Cherryhinton, and of the Upper Chalk seen near Balsham. The shape of the hills is that of typical chalk downs, namely rolling undulations, and where the Boulder-clay has been removed the vegetation is also characteristic, though the flora of low-growing plants has been greatly modified as the result of cultivation. Until the beginning of the nineteenth century the ground was largely occupied by short turf, but most of it is now under the plough and the character of the original turf is only preserved here and there, as on the Fleam Dyke and the Devil's Dyke. Lines of beech-trees mark the boundaries of the chalk. A good deal of the Boulder-clay land has been planted with trees, and the chalk country as a whole is quite well wooded and is distinctly picturesque. The district, as above noted, is drained by a series of streams flowing in a direction opposite to that of the dip of the strata. Many dry valleys show that the superficial drainage was once more extensive: now, the bulk of the rain which falls is absorbed, and much of it is given out by a series of springs which mark the outcrop of the impervious Chalk-marl at the base.

(ii) The Western Plateau. This is, geologically speaking, the most complicated of the Cambridgeshire districts. It is mostly covered with a thin capping of Boulder-clay, but in places the Boulder-clay is of great thickness. Occasionally the underlying rock is exposed on the low ground.

The district is bounded on the south-east by the outcrop of Gault along which the Rhee flows. It includes the Chalk outliers of Madingley and of the Haslingfield-Wimpole region, with the large tract of Gault to the west of them. The Lower Greensand from Gamlingay to Lolworth and the Upper Jurassic clays to the west of that also underlie this plateau. Most of the rocks are therefore clays, and the character of the country is much the same whether Boulder-clay occurs at the surface
or is absent. An exception to this is seen when the ground is occupied by uncovered Chalk or Greensand, each of which determines the existence of its peculiar flora. Neither, however, exerts much influence upon the form of the plateau, which exists as high land because it forms the watershed between the Ouse and Cam, though the exact conditions under which the plateau structure was brought about have yet to be determined.

The district is flanked on the north-east by a great finger of river-gravel which extends out into the Fen basin along the line of the Huntingdon Road between Girton and Fen Stanton.

(iii) The Fenland. Generally speaking, the county to the north of a line joining Over and Newmarket is occupied by fen. 'Islands' project here and there, as at Ely, Upware, and March, but these form only a very small proportion of the whole tract. The Fenland occupies a wide-spread hollow which was excavated in pre-glacial times, for Boulder-clay is often found beneath the fenland accumulations. Its width is due to the gentle arching over of the belt of Jurassic Clays, the erosion of which has determined the existence of the fenland tract. The floor is probably not a very even surface, but silt deposited by the sea, mud brought down by the rivers, and vegetation growing upon the surface have built up the area to a very uniform plain not more than a foot or two above mean-tide level. The Fens, therefore, in pre-Roman times had become "a swampy plain interspersed with drier places, and with deep morasses," and in the parts near the sea this was liable to be flooded by high tides.

The tract is largely occupied by peat in the south, and by silt in the north: the latter occupies a strip of country about twelve miles in width just south of the Wash, and extends southwards as a great triangular wedge with its apex near Littleport.

The conditions of the Fenland have greatly altered during historic times as the result of human interference. The
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Romans built a series of great sea-banks to keep out the tides, and in so doing interfered with the river outlets, which in course of time became choked with silt, and overflowing their banks rendered the area more of a morass than before.

In medieval times many artificial drainage works were undertaken to improve matters, but most of them were performed in so ill-advised a way that only small areas were favourably affected. In the early part of the seventeenth century a new system was inaugurated, and the natural waterways have since been opened and embanked, with the consequence that pumping has been reduced to a minimum, and the district has been rendered ideal for farming operations.

With the disappearance of the boggy fen many of the characteristic plants and animals have also disappeared or become extremely rare. A small area at Wicken Fen is still preserved in its original state and shows the former character of extensive tracts of Fenland.

As the Fenland has undergone so much change in recent times it is interesting to find a description of the Isle of Ely and adjoining region as it was in the twelfth century in the Liber Eliensis, of which the MS. is preserved in the library of Trinity College. The particular passage quoted below is from a translation furnished by a reviewer in the Zoologist for 1879 (Third Series, Vol. iii., p. 71). "In our isle men are not troubling themselves about the leaguer, but think they may safely be defended by their tiros; the ploughman has not taken his hand from the plough, nor has the hunter cast aside his arrow, nor does the Fowler desist from beguiling birds. And yet something more. If you wish to hear what I have known and have seen, I will reveal all to you. The isle is within itself plentifully endowed, it is supplied with various kinds of herbage, and for its richer soil surpasses the rest of England. Most delightful for its charming fields and pastures, it is also remarkable for its beasts of chase, and is in no ordinary way fertile in flocks and herds. Its woods and vine-
The Fenland

yards are not worthy of equal praise, but it is beset by great meres and fens as though by a strong wall. In this isle there is an abundance of domestic cattle and a multitude of wild animals; Stags, Roes, Goats, and Hares are found in its groves and by these fens. Moreover there is a fair plenty of Otters, Weasels, and Polecats, which in a hard winter are caught by traps, snares, or by any other device. But what am I to say of the kind of fishes, and of fowls, both those that fly and those that swim? In the eddy at the sluices of these meres are netted innumerable Eels, large Water-wolves—even Pickerels, Perches, Roaches, Burbots, and Lampreys, which we call Water-snakes. It is indeed said by many men that sometimes Isicii, together with the royal fish, the Sturgeon, are taken. As to fowls, let us, if it be not troublesome to you, recount those which abide there and thereabout, as we have done with the rest. There are numberless Geese, Fiscedulæ, Coots, Didappers, Water-crows, Herons, and Ducks, of which the number is very great. At midwinter or when the birds moult their quills I have seen them caught by the hundred, and even by three hundreds more or less, sometimes they are taken in nets and snares as well as by bird-lime.

(iv) Minor Tracts. The river banks are usually marked by a strip of alluvium of varying width, which gives rise to a flat ground often flooded in wet weather. This alluvium varies in width. Below Cambridge it passes into the flat of the fenland near Waterbeach.

The ancient alluvia, deposited when the rivers ran at a high level, form terraces more or less parallel to the present river-courses, but often departing from strict parallelism, as will be described more fully in the section devoted to geology. They occur in all the valleys of the present rivers; also in certain now streamless valleys on the Chalk, and as long

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1 The reviewer suggests that this word means salmon, and the suggestion is confirmed by another writer in the same volume of the Zoologist, p. 222.

irregular ridges protruding from the edges of the Fen. They consist chiefly of fragments of flint.

In the neighbourhood of Fordham, Chippenham, and Newmarket a sheet of gravel of uncertain origin caps a plateau between fifty and one hundred feet above the adjoining fenland. Its origin is yet unexplained. It is chiefly of interest on account of its flora. This is specially marked in the old gravel-pit of Chippenham, as noticed by Prof. C. C. Babington. The plants appear to have settled there, owing to the similarity between this gravel and the sandy deposits of East Norfolk and Suffolk, though those deposits have an origin different from that of the Chippenham gravels.

The climate of Cambridgeshire is summed up in the Geological Survey Memoir on “The Geology of the Neighbourhood of Cambridge” as follows:—

“The physical conformation of the ground is (with the exception of the chalk slope) such as to induce dampness of soil and atmosphere; a characteristic which, as regards Cambridgeshire, has become proverbial. It is owing, not to the rainfall which in amount is small, about 23 inches a year, but to the low-lying area being surrounded by higher ground on all sides but one, by the preponderance of ground sloping to the north, and by the prevalence of clay soils.”
THE GEOLOGY OF CAMBRIDGESHIRE.

By W. G. FEARNSIDES, M.A., F.G.S.

The geology of Cambridgeshire, so far as the underlying strata are concerned, is not complicated; the superficial deposits, however, exhibit considerable variety, and their origin is still in many cases a subject for discussion.

The stratified rocks of Cambridgeshire form part of the great mass of secondary strata which extends in an unbroken line from the Yorkshire coast to that of Dorsetshire. In the tract of which Cambridgeshire forms a part, their general strike is nearly north-east and south-west, and as the beds dip gently towards the south-east (at angles which approach horizontality) the older strata lie to the north and west of the county and the newer ones to the south and east. To the north-west of a line drawn from near Littleport to Gamlingay the rocks mainly belong to the Jurassic system; to the south-east of that line to the Cretaceous System.

Complications are introduced by folding, unconformabilities, and the existence of outliers. An anticlinal fold brings up a considerable mass of Jurassic rocks in the neighbourhood of the hamlet of Upware. An important unconformity occurs at the base of the Cretaceous rocks, causing the lower Cretaceous rocks to rest upon different members of the Jurassic System, while a smaller unconformity occurs at the base of the Chalk.
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Several outliers of Lower Cretaceous rocks rest upon the Jurassic rocks to the west of the main line of outcrop of the Lower Cretaceous group, and outliers of Chalk repose on lower members of the Cretaceous System to the west of the main development of the Chalk. The Jurassic rocks, with the exception of a local development near Upware, consist of slightly consolidated clays or muds, while the Cretaceous rocks present a greater variety of sediments. At the base is an iron-stained sand, sometimes compacted into sandstone. This is succeeded by a thick deposit of clay, and at the top is the Chalk. No Tertiary sediments occur in the county, so our knowledge of events during that period depends entirely on the record contained in the rocks of other areas.

The only accumulations newer than the chalk are of post-Tertiary date. They consist of Boulder-clay, accumulated during the 'Great Ice Age,' and of subsequently formed gravels of fluviatile and marine origin, and of the alluvia of the river-valleys and the peat and silt of the Fenland.

For works on the geology of the county the reader may be referred to: (i) the Rev. T. G. Bonney's Cambridgeshire Geology, published in 1875; (ii) F. R. C. Reed's Handbook to the Geology of Cambridgeshire, which appeared in 1897; (iii) The Geology of the Neighbourhood of Cambridge, being the explanation of Quarter-sheet 51 S.W. and part of 51 N.W., by W. H. Penning and A. J. Jukes-Browne, published in 1881; and (iv) The Geology of the Fenland, by S. B. J. Skertchly, which appeared in 1877. The two latter are official publications of H.M. Geological Survey. The list of geological survey maps and sections which illustrate the geology of the county will be found in Mr Reed's bibliography, which forms the appendix to his work on Cambridgeshire geology. This bibliography also gives a very full list of the various books and pamphlets which have appeared at different times, containing references to the geology of the county.

We may now proceed to describe the various deposits of the county in order, commencing with the oldest strata.