

on the one hand, and the "keratophyres" on the other—using the term "keratophyre" in the same sense in which it has been employed in connexion with the Skomer Series.

In conclusion, I desire to thank all those who have assisted me in the course of the work, in particular Dr. H. H. Thomas, to whom I am indebted for a vast amount of kindness and encouragement, and Mr. J. R. P. Penn, of Poyston, Haverfordwest, for his company in the field.

Notes on the Brandesburton Kame, Yorkshire.

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(PLATE XV.)

IN the GEOLOGICAL MAGAZINE for December, 1921, Professor J. W. Gregory has referred to the Brandesburton Kame in a paper dealing with English Kames and Eskers. He points out that further information is required to determine its true nature. The following paper is the result of observations which were made on a visit to Brandesburton in August, 1921. The ridge appears to be a true kame of fluvioglacial character.

The ridge in question has a length of between 3 and 4 miles, and can be traced in Sheets 196 N.E. and 179 S.E. Ordnance Survey 6 in. map. It begins at Gildholm Hill, fully half a mile south of Brandesburton Church, passes 10 degrees north of west through Coneygarth Hill, crosses the Leven-Brandesburton road at Starcarr Gate, takes a north-west direction along Starcarr Hill, turns north at Burshell, and ends just south-east of Hempholme. On the 1 in. map its course is easily traced, as it coincides with the road from Starcarr Gate to Hempholme, the road having probably been made along it owing to the wet nature of the "carr" country through which it passes. "Carr" indicates boggy ground. Trees or tree-stumps mark a considerable part of its course in the field. The trees have been felled, and the kame greatly lowered by former excavations immediately west of Starcarr Gate. The kame is leased out to contractors, and work is in full progress at this part.

The notes in this paper refer only to Coneygarth Hill and the pit immediately west of Starcarr Gate.

Coneygarth Hill is a flat-topped, parallel-sided mound, about 6 feet high and 60 yards broad. It contains several depressions which are probably former pits, and at one point rises to a conical hillock about 30 feet above the rest of the ridge. South of the main ridge two small mounds, the larger 100 yards long, run parallel to it. "George" pennies, 232 years old, have been found by workmen in the excavations, indicating that the hill was probably dug for gravel in the eighteenth century.

MATERIAL OF CONEYGARTH HILL.

Small gravel is seen at the mouths of rabbit-burrows on the flat top; towards the eastern end the ejected material is sandier. A pit on the west side of the hillock shows the following section:—

Small gravel	}	15 ft.
Sand with shell fragments			
Gravel			
Coarse sand with shell fragments and coaly layers			5 ft.
Coarse gravel, mostly subangular			2½ ft.
Small gravel			½ ft.
Loam, hidden by talus possibly			3 ft.
Red clay			3 in.
Brown clay			4 in.
False bedded sand with shelly and coaly layers			2 ft.
Coarse gravel with worn faceted stones of large size (8 in.)			4 ft.
Fine gravel			2½ ft.
Small gravel			½ ft.
Very fine gravel			2 ft.

The thicknesses are approximate.

The section does not persist across the ridge, for the 4 feet of coarse gravel gives place on the right to sand of a uniformly fine character without shell fragments. Also the seam of clay dies out on the right. But the section towards the right edge is obscured by debris.

Analysis of the gravel (pebbles of 2 in. diameter being selected) shows that the great majority are subangular, about 20 per cent rounded and 10 per cent angular. No pebbles bearing striæ were found. The small pebbles (1 in. and under) are generally rounded and pebbles of stratified rock are worn to discs. The pebbles include :—

Limestones, crinoidal, magnesian, cementstone.

Sandstone, white, purple, yellow, and compact white Jurassic.

Flint, black, white, and waxy-looking.

Basalts, compact to porphyritic, fresh to rotten.

Andesites, chocolate coloured.

Quartzites, schists, fine green grit.

Chalk in very small quantity.

Coal and coaly shale.

Fossils including *Gryphæa*, ammonite, belemnite.

I am indebted to Mr. G. W. Tyrrell, F.G.S., of Glasgow University, for identifying the following among the igneous rocks: Quartz-porphyrries, felstone, felspar-porphyry, all probably from Cheviot Old Red Sandstone igneous region, pink granites probably not Scottish, hornblende-schist, hornblendite, augite-porphyry, lamprophyre, aplite, a syenitic rock, and several red and dark-green rhomb-porphyrries. There is also a basalt which strongly resembles an essexite-basalt from Grorud, Norway, but may be an uncommon variety of Scottish Carboniferous basalt. According to the workmen coal is found all through the gravel, and as the section shows also forms layers. Judging from its poor quality it has probably been derived from Jurassic coal seams. Similar layers of coaly material are common in the kames of Carstairs.

STRATIFICATION AND BEDDING.

The section shown by the Coneygarth Hill pit is transverse to the ridge and the looseness of the material causes angles to crumble

away, so that there is little opportunity of observing the dip of the beds. The section, however, gives clear evidence of deposition by water. The coarse gravel has a suggestion of stratification, but all the fine gravels show distinct bedding planes which are horizontal. The sands lie horizontally between the gravels and some show current bedding, particularly the sand immediately beneath the clay. The clay and coaly layers are both horizontal. Tracing the stratification towards the margin, the clay is seen to thin out and droop. Also the beds did not persist, e.g. the 4 feet of coarse gravel passed into a very fine sand without shell fragments and with no false bedding, but it was not possible to observe the junction nor to trace any bed far, as the pit is in the centre of the hillock and the edges are smothered in debris.

Though this pit gives no indication of dip, a trench cut longitudinally in the ridge between Coneygarth Hill and Starcarr Gate shows a very small dip to the west along the ridge and a very gentle inclination towards the margin. This trench shows no sand, but only thin alternations of coarse and fine gravel whose composition is the same as that in Coneygarth Hill.

There is no seasonal banding in the Coneygarth Hill pit, and that it does not occur in the ridge is shown by the absence of alternations of broad and narrow patches along its course, for it remains parallel-sided throughout. The existence of Coneygarth Hill is not due to the presence of any particularly resistant band of gravel, since it is composed of alternations of hard and soft horizontal beds which are scarcely cemented at all.

SECTION IN PIT WEST OF STARCARR GATE.

This pit gives both transverse and longitudinal sections. The longitudinal section shows a small dip to the west along the ridge. The sequence is :—

Small gravel	}	5 ft.
Sand .			
Gravel .			
Fine gravel			
Gravel .	}	4 ft.
Fine gravel and coarse sand interbedded			
Sand			2 ft.
Gravel below.			

False bedding is present, but is not very pronounced. The transverse section shows a fault whose downthrow is towards the margin of the ridge, and gives the above section. The section on the upthrow side is :—

Gravel
Coaly layer
Orange-coloured sand
Clay
Sand

The clay dips towards and is streaked out against the fault. There is no distortion of the beds, but a gentle waviness has been introduced such as might be produced by a slip of material whilst still wet and plastic. Possibly the thinning out and droop of the clay and the replacement of one bed by another in the Coneygarth Hill pit is due to a similar cause, the fault itself being hidden in the debris.

The gravel in this pit has the same composition as that of Coneygarth Hill and a rhomb-porphyry was found here also.

Mammoth bones have been recorded from the Brandesburton gravels,¹ but the writer found no bones, and no shells except the waterworn fragments in the shell sand. Among the pebbles were found an ammonite, a *Gryphæa*, and a belemnite, all well waterworn.

SUMMARY.

1. The direction of the ridge is roughly parallel to the line of the moraine in Holderness as sketched by Carvill Lewis.

2. The material of the gravels is ice-collected, but is well waterworn though not rounded. The bulk of the pebbles are of north-eastern England and Yorkshire origin, and a small proportion of Scandinavian rocks is present.

3. The stratification is horizontal and current bedding is frequent.

4. There is no seasonal banding nor any alternations of broad and narrow parts along the length of the ridge.

CONCLUSION.

From the evidence which I have been able to collect, the ridge is therefore probably a kame of fluvioglacial character. That it is surrounded by "carr" land on *both* sides points to its having been formed in a sheet of water. The parallel sides are probably due to slipping along planes parallel to the length, and this would also explain the existence of the small parallel mounds previously mentioned. The talus produced by the slipping would soon be spread evenly over the floor.

The composition of the gravels indicates that the streams which deposited the kame were fed by Cheviot ice which had probably overridden deposits previously formed by the Scandinavian ice.

In conclusion I must express my great indebtedness to Professor J. W. Gregory, F.R.S., who pointed out the work and was always ready with helpful suggestions.

EXPLANATION OF PLATE XV.

FIG. 1.—The low ridge of the kame is dimly seen in the foreground, runs through Coneygarth Hill, and sweeps round to the right, causing the rise on which the Starcarr Gate houses stand.

FIG. 2.—The section is across the kame. Note the horizontal bedding, and the gravel at the base and top. The sand is seen on the right centre, and the thin clay band lies at the foot of the talus above the centre line of the photograph.

¹ John Phillips, *Illustrations of Yorkshire Geology*, pt. i, p. 22, 1835.



FIG. 1.—CONEYGARTH HILL AND STARCARR GATE.

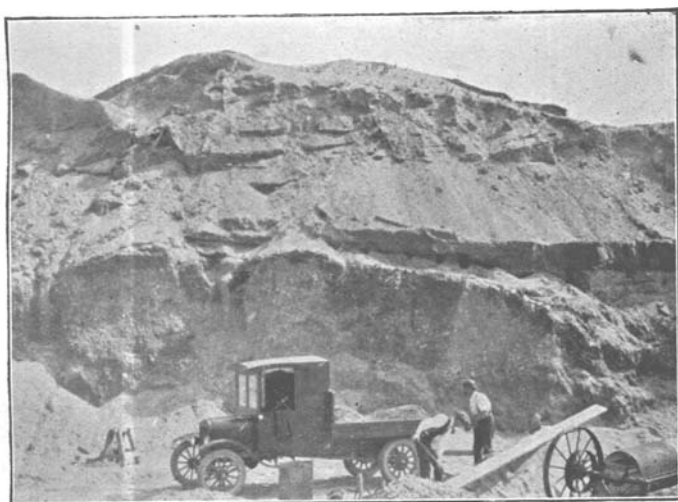


FIG. 2.—CONEYGARTH HILL GRAVEL PIT (SECTION).