

THE GLACIATION OF NORTH CLEVELAND.

BY FRANK ELGEE.

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Thanks to the great work of Professor Kendall in the Cleveland area, glacial geologists are now furnished with a key which will enable them to trace the history of the decline of the glaciers which debouched on to the plains of England during the Ice Age. Even in the area which he has made classic, work still remains to be done in deciphering the records of the various stages in the retreat of the ice from its position at maximum extension until it finally vanished from the district. The following notes, therefore, deal with the glacial phenomena produced during the retreat of the ice in North-west Cleveland, and embrace the Upleatham and Eston Outliers, the Guisborough Valley, and the Cleveland Plain of Stokesley.

The phenomena to be discussed may be conveniently divided into three groups, corresponding chronologically to three positions of the ice margin, viz. :—

1. Phenomena at the period of maximum extension.
2. Phenomena at the foot of the Cleveland Hills during the retreat.
3. Phenomena connected with a halt of the ice on the Plain of Stokesley.

The phenomena at the period of maximum extension have been fully elucidated by Professor Kendall, and are mentioned here so that what follows may be fully understood. There can be little question that he has conclusively established the existence in Cleveland, during the later phases of the Ice Age, of a large glacier that had passed over a part of the Cheviot Hills. The occurrence of Cheviot erratics, of striæ, and, above all, of the lake phenomena, yield evidence in support of this contention. In the area under consideration, all the phenomena go to verify the presence of this glacier, and it may be remarked



GENERAL MAP OF THE DISTRICT DESCRIBED IN MR. ELGEE'S PAPER.

(The portions enclosed by broken lines are reproduced on a larger scale in Plates LII., LIII., and LIV.)

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at the outset that the occurrence of large blocks of Augite Andesite from the Cleveland Dyke, to the south of its outcrop, affords further proof of a northerly ice stream. An exceptionally large boulder of this rock stands in a field just south of the Dyke at Stainton. At the period of maximum extension, the Cheviot Glacier swept right into the angle of the Cleveland escarpment, several small lakes being held up along its slopes, and overflows existed at Gribdale Gate, the head of Bilsdale, Holy Well Gill, and Scarth Nick.* (See Map, Plate LI.)

These overflows were abandoned with a very slight shrinkage of the ice margin, and the impounded drainage would now escape along the lower slopes of the Cleveland Hills, but only one stream appears to have left any traces of the subsequent course of the water. This, the Gribdale Gate overflow, ceased to operate at a level of 747 feet, and therefore, the lake impounded in the hollow of the hills between Roseberry Topping and Easby Moor must have escaped either to the north or to the south. The overflow at the head of Bousdale, half a mile north of Roseberry Topping, discovered by Mr. Kendall at an elevation of 675 feet, indicates a westerly flow, and in all probability this drainage swept round the hills to Kildale, and was joined by the Gribdale Gate waters. No channels are met with proving this until we arrive at the 575 foot contour, at Castle Hill, Easby, where a small valley exists which will be described later.

A further retreat of the ice permitted the extra-morainic drainage to travel at a still lower level. To this stage belongs the deviation of Boosbeck, through the great gorge at Slape-wath, which cuts from 600 feet down to 425 feet or thereabouts. In alignment with this rock gorge is a channel at the foot of Bousdale Hill, near Pinchingthorpe, with a great bank of drift (Grove Hill) in front of it, and cutting, at its outfall near Lowcross House, the 325 foot contour. Still further to the west, at Langbaugh, a well-defined overflow crosses the Cleveland Dyke, and is certainly in alignment with the Grove Hill channel, since the altitude at which it commenced to be eroded is 325 feet, the level of the floor of the Grove Hill Valley. The Langbaugh

* Kendall, Q.J.G.S., Vol. 48, pp. 513-519.

overflow presents some features of interest. Just to the west of, and parallel to it, is a slight trench in the ridge at 325 feet, over which the glacier appears to have readvanced. The overflowing waters then commenced the gap through which the Tame flows, and cut down to 275 feet. At the intake of the channel, on the north side of the Dyke, is a mound of drift at an altitude of 300 feet, in front of which the overflow has clearly taken place. The present stream, the Tame, which well merits its name, cannot have cut the gap, as further to the west is lower country at 275 feet, a clear case of an ice barrier.*

The fall of these valleys is in consonance with Mr. Kendall's observations regarding the overflow at Bushy Dale Wood, on the eastern side of the Boosbeck Valley, "which shows that the main overflow to which it was related was at a low level, and I feel assured that it was into the Vale of York." To summarise the altitudes: Bushy Dale, 600 feet; Slapewath, 600-425 feet; Grove Hill, 450-325 feet; Langbaugh, 325-275 feet.

A retreat of the ice, when Slapewath had been cut down to about 425 feet, enabled the waters of Boosbeck to flow to the sea at Saltburn, and this explains the fact that no dry valleys have been eroded on the northern slopes of Airy Hill, for when the ice-front was standing on that hillside the drainage was travelling down the Guisborough Valley.

A series of channels occurs at the foot of the Cleveland Hills which belongs to an earlier stage than the preceding, and which may, judging from the altitudes, have carried the extra-morainic drainage from the Boosbeck Valley for a brief period. These valleys, however, do not seem to form an aligned sequence, but rather appear to be due to lobes of ice standing on or behind drift mounds, and allowing the drainage of the slopes to sweep between them and the hill sides. The Grove Hill channel is one of these (Plate LII.). Near Great Ayton Station we find a great mound of drift at 450 feet, with a channel between it and the steep hillside. It is nearly 50 feet deep and falls southwards (Plate LIII.).

* The Tame is mostly artificial, consisting of drainage channels for the formerly swampy Guisborough Valley.

The next extra-morainic channel of this kind is one at the foot of Turkey Nab, near Battersby. This, Whitley Hill, has precisely the same characters as the preceding, but probably belongs to a slightly earlier stage, since it is at 500 feet cutting down to 475 feet. Extremely significant is the fact that no overflows of this sequence and the Boosbeck sequence occur between Ayton and Battersby. Yet there must have been a free course for the water round the Castle Hill at Easby, or else it would have gone into Kildale, for which, however, there is no evidence. On the contrary, there must have been an outflow from that valley, of which there is no trace left, for reasons presently to be assigned.

Along the main slopes of the Cleveland Hills, as far as Carlton, no traces of overflows have been detected, yet a considerable body of water must have been held up. At Busby Hall, however, an overflow, though very shallow, crosses the spur there at 425 feet; but north-west of Whorl Hill is a splendid example of this series of channels, cutting from 300–250 feet. It falls to the east, however, and may have been produced at a later stage by a temporary flow of Swainby Beck in that direction. To the south-west of the village, and in front of the great moraines blocking up the entrance to Scugdale, is a shallow, wide trench in the drift, which looks like a glacial drainage channel, but it may owe its origin to Carr Beck, a fact rendered more probable by the course of Swainby Beck, which just crosses the low watershed between these two channels. Its so doing excludes the possibility of its having travelled at any time along the Carr Beck Valley, which must have happened if this had really been an extra-morainic channel.

I have not yet been able to discover any other signs of the Vale of York drainage between the foot of the hills and the course of the Leven, north of which the ice halted for a considerable time and deposited great moraines.

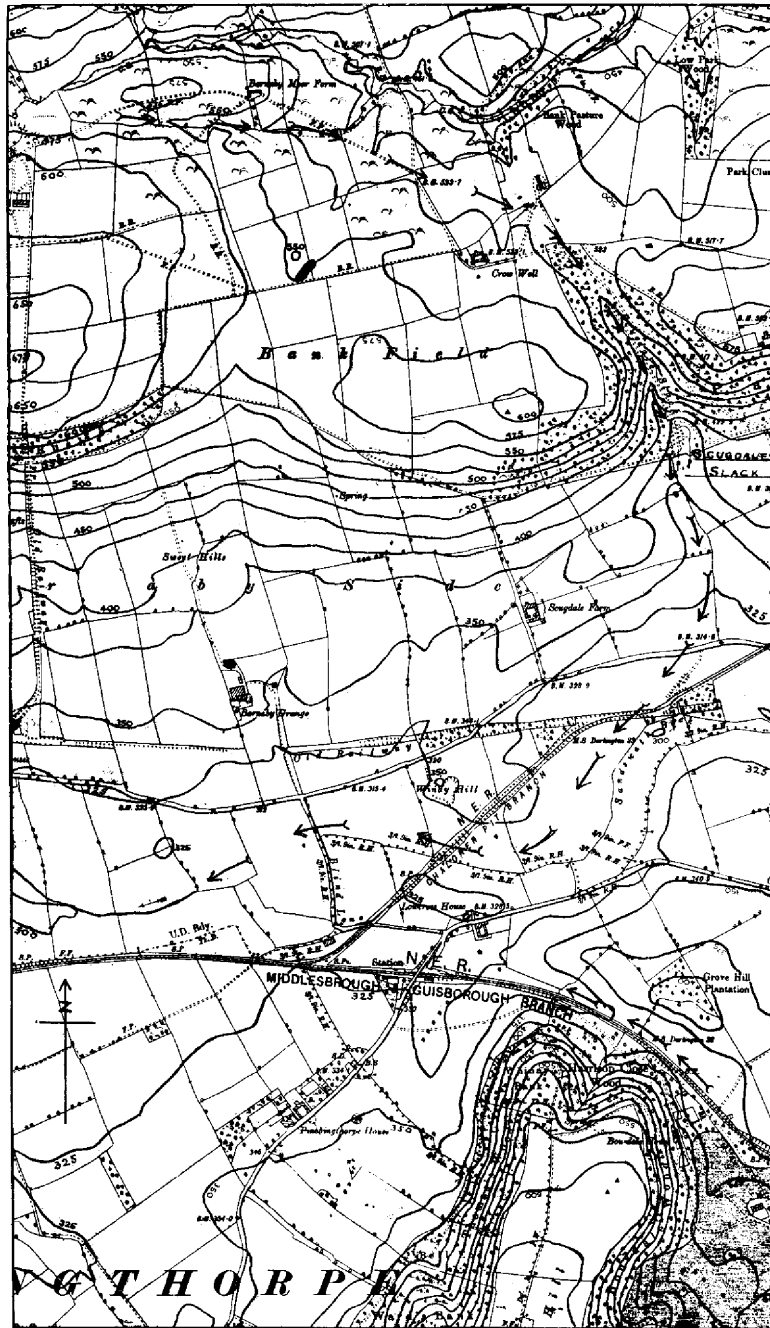
We have now to consider a rather peculiar problem. At the entrance to Kildale, as already remarked, there exist no overflows indicating a line of drainage into the Vale of York.

On the contrary, whatever extra-morainic valleys occur there, prove a flow towards the Guisborough Valley in another direction altogether.

At the entrance to Kildale a low spur, called Castle Hill, projects from the slopes of Easby Moor at an extreme elevation of 600 feet (Plate LIII.). The drift here appears to fill up a small preglacial valley or depression, which exists between the main hill and now forms Sowerdale, and a small outlier of the Sandy Series of the Lias at Burrow Greens Wood, round the very base of which flows the River Leven. Across this spur, overflows, both into and out of Kildale, have certainly taken place, a fact noted by the late Rev. J. Hawell,* who says, "I have recently discovered that there was almost certainly an overflow from the Eskdale Lake at one time into Sowerdale. Anyone looking at Sowerdale will be able to see that the denudation of it cannot have been entirely due to the insignificant stream which now percolates through it."

An examination of the ground showed some peculiar features. Sowerdale itself is about half a mile long and cuts right across the spur, and is divisible into two portions where the path from Copper Hall to High Farm on Castle Hill crosses it. Here is a trench at 575 feet, about 25 feet deep and quite streamless. It falls to the south-east, where it opens on to the steep slopes above the Leven. In the lower portion a spring has produced a small runlet of water, but this has evidently not been the cause of the valley, which is clearly an overflow and seems to have drained the Gribdale Gate area (possibly with the addition of the overflow from the Boosbeck Valley for a brief period) into Kildale, and it is worthy of note that the altitude is almost the same as that of the West Bank watershed (dividing Kildale from Eskdale), beneath the peat, viz., between 580 and 550 feet. The exact level of this watershed is difficult to ascertain with precision, but if we accept the above channel as indicating a flow into Kildale and Eskdale, then the altitude of its floor will give us the elevation of the rocky bottom at West Bank, at the close of the drainage eastwards, that is to say 550 feet.

*Proceedings of the Cleveland Field Club, Vol. II., p. 25.



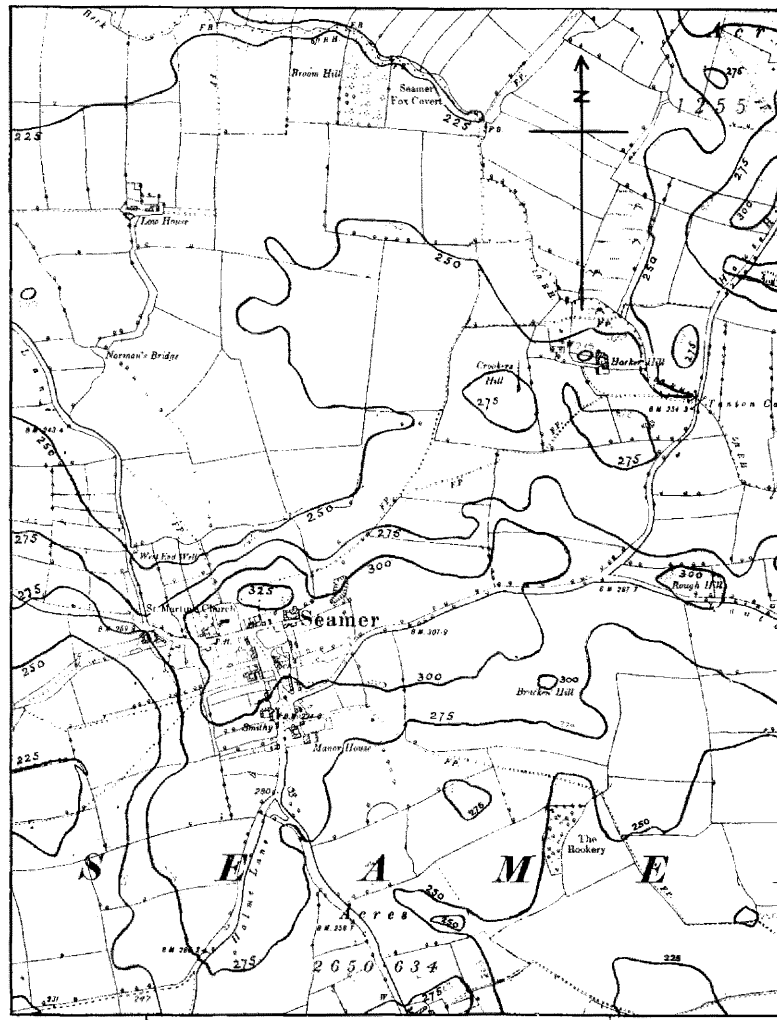
1000 Feet 500 0 1000
1 Furlong 0

SCUGDALE SLACK AND GROVE HILL OVERFLOWS.

Reduced from the Ordnance Survey.

(With the sanction of the Controller of H.M. Stationery Office.)

Proc. Yorks. Geol. Soc., Vol. XVI., Plate LII.



LON 11
1000 Feet 400 0 1000
1 Furlong 0

NEIGHBOURHOOD OF SEAMER, NEAR STOKESLEY.

Reduced from the Ordnance Survey.

(With the sanction of the Controller of H.M. Stationery Office.)

Proc. Yorks. Geol. Soc., Vol. XVI., Plate LIV.

Sowerdale falls to the north-west and is a valley about 150 yards wide at the top, and about 100 feet deep, cutting from 550 to 450 feet. It has very steep sides, apparently composed of drift, and stiff clay is exposed by a very small stream, not 12 inches wide, on its floor. I do not think that this insignificant stream can be regarded as the agent which produced Sowerdale. Elsewhere in Cleveland much larger streams have eroded much smaller channels in the drift, and moreover, the Sowerdale rivulet is practically non-existent in the summer. The upper part of Sowerdale has a very steep ascent to the watershed, the floor of the south-easterly flowing channel above-mentioned. Here, therefore, on the same spur we have two overflows in opposite directions, and one on a very much larger scale than the other.

At first sight it would appear that after Lake Kildale had ceased to drain into Eskdale, it overflowed across the Easby spur and thus excavated Sowerdale. This was the opinion of Mr. Hawell, and he further adds :—“ This water was able to flow out at a lower level between the ice mass and what is now Easby Castle Hill. As the ice gradually shrank, the outflow came to be at a progressively lower level, but still hugged the Castle Hill, and so when the ice had quite gone, the Leven had cut its channel close under the hill.”* This explanation certainly fits the facts and explains the parallel trend of Sowerdale and the River Leven, the latter of which hugs the Castle Hill slope in a most remarkable way. But if the Cheviot ice was the agent in causing these phenomena, where was the escape for the overflowing waters to the north-west, an area covered by the glacier itself ? The overflows could not have travelled round the foot of the hills to the Boosbeck Valley, since the overflows in that area indicate drainage westwards below 600 feet. To reconcile these apparent contradictions is difficult. The overflowing waters may have escaped over or under the ice, but that two opposite drainage lines could be in operation at the same time, along the same hill slopes, one of which escaped under or over the ice and the other did not, appears, to say the least, highly improbable.

* *Op. cit.*

Looking for an outlet in a northerly direction, the Sowerdale overflow could only have escaped into the Guisborough Valley at a time when the Slapewath overflow had ceased to operate and when a free outlet allowed the drainage to escape to the sea at Saltburn. All the phenomena of Skelton Beck are well below 350 feet, and if the ice readvanced and blocked up Kildale again, *after the Vale of York drainage had ceased*, we should have had the impounded drainage cutting across Castle Hill and forming Sowerdale. At a later stage the overflow, now the Leven, escaped in the manner described by Mr. Hawell, since at the foot of Easby Wood it persistently refuses to take a more direct and much lower course towards the south-east, showing the presence of an ice barrier. Hence the probability is that Kildale may have been blocked up for a brief period by a readvance after the coast as far north as Saltburn was free from ice.*

This readvance would also account for the fact that no signs are left of any channels out of Kildale in alignment with the Vale of York drainage system. Mr. Kendall expressly states :—“The ice front must have stood across the Boosbeck Valley until the Slapewath Gorge was lowered below the level of the drift barrier across Boosbeck—that is to say, below 425 O.D. From this clue it is possible to define some of the further course of the stream and consequently of the ice front. It will be remembered that the overflow channel into Eskdale by way of Kildale is at an altitude of 580 feet, therefore it is quite certain that there must have been a line of drainage open into the Vale of York (p. 566).” Now the sequence of overflows connected

* With regard to Sowerdale, Professor Kendall has kindly furnished me with the following note :—“I am very doubtful whether the Sowerdale Valley could be regarded as a lake overflow. The arrangement of the contours does not suggest erosion by a large stream, for it seems too wide and too steep at the head. It is of the type of Bridle Gill (north of Roseberry Common). A stream that could cut a valley of such breadth would have eroded its floor in a broader notch, and have obliterated all signs of the flow towards Kildale. Experience gained in the last two years has made me suspicious of cases of apparent flow in opposite directions through the same channel. It is easier to assume that a transverse watershed or “corrom” has been produced by inflow by a lateral stream, or by some similar means.” Even if we reject Sowerdale as an overflow, the anomalous course of the Leven has still to be explained, so I have let the above-given explanation of its origin stand.

with the lower stages of Slapewath proves that this line of drainage existed. But where are the traces of the drainage out of Kildale corresponding to this state of affairs? The valley of Sowerdale and the course of the Leven indicate no flow into the Vale of York. A readvance would, however, obliterate all traces of the Vale of York drainage from Kildale, and explain, I think, the very curious phenomena of the Castle Hill.

I have looked for traces of the northward flow from Kildale along the Guisborough Valley, but no channels were found. The advanced position of the ice front near Ayton must have prevented the Sowerdale and Leven flows from passing through the Dyke at Langbaugh, as the channel there, if free, would at once have been utilised. Further east along the ridge of the Dyke is a low col at 350 feet, over which extra-morainic drainage must have passed, for a well-defined though small channel occurs here, but the fall of it is so slight that it is quite impossible to say in which direction the drainage has really gone. It must be admitted, however, that the non-occurrence of definite overflows in the Guisborough Valley in alignment with Sowerdale is against the explanation given of the origin of that valley.

Turning now to the Plain of Cleveland, I have to remark that after the phenomena above described had been produced, the ice stood for a long time for about a mile to the north of Stokesley, and a splendid series of moraines and gravel mounds was deposited. The most southerly and most striking of these moraines, evidently marking a halt in the retreat of the ice, runs from near Hilton to the east of Seamer (Plate LIV.). The road from Hilton to Seamer follows the trend of the moraine which, as might be expected, runs in an east and west line. It takes the form of a series of mounds of gravel and sand separated by slight hollows. These mounds have received local names, and, running from west to east, they are:—Boy Hill, 300 feet; the Kirk Bank, at Seamer, 325 feet; Rough Hill, 300 feet; and Hunter Hill, 300 feet. To the south they slope gradually down to Stokesley, but on the north they have a very steep descent to 250 feet, especially north of Seamer, where the ground is very flat and peat-filled. The Kirk Bank is about 75 feet high, and near the church is an old gravel pit so grassed over that no clear section

is visible. A large slab of Old Red Conglomerate and boulders of Cheviot Porphyrite were observed near the top of the pit, whilst rabbit scratchings revealed fine sand.

The flat peaty area north of Seamer extends a little eastwards, where, to the north of Rough and Hunter Hills, three parallel series of mounds can be traced. The first comprises Crooker's and Harker Hills, both at 275 feet. In the latter is a sand pit which yielded a clear section. Below the subsoil occurs a gravelly stratum about one foot thick, with water-worn pebbles and boulders of Porphyrite, Carboniferous and Magnesian Limestones, and Borrowdale Andesite. This gravel passes into ruddy sandy clay with bits of coal, below which is a great mass of sand containing very few, if any, boulders, some broken shell fragments, and a large quantity of coal fragments. In fact, this sand so closely resembles the sea sand with coal on the shore between Redcar and Saltburn, that one is inclined to think that similar coaly sand has been conveyed to the area under discussion by the ancient ice.

Further north, a ridge known as How Hill probably marks another stage of retreat, and stands at 300 feet. Near an old tumulus is a sand pit, but the section is now nearly grassed over. Here finely bedded coaly sand could be seen near the surface in one place, whilst in another was gravel passing down into very coaly sand. The bedding was horizontal, coinciding with the flat top of the ridge. A large block of Carboniferous Sandstone was noted here.

Yet another section occurs in a fourth ridge of drift between How Hill and Spring Well Hill, where gravel at the top can be observed dipping sharply to the east, corresponding with the slope of the surface. The gravel here is ruddy and contains much clay. Many boulders were observed, and they proved how inextricably mixed up the two series of erratics are. A large block of Shap Granite was found alongside Cheviot Porphyrites and Magnesian Limestone, Augite Andesite, and Criffel Granite; whilst on the floor of the quarry were two large boulders of Carboniferous Limestone, one of them showing weathered fossils. Liassic fossils also occurred here, although the drift is mapped as lying upon the Triassic Rocks. The fossils were Lower Lias

forms—*Gryphæa arcuata*, *Ammonites angulatus*, and an indeterminate *Pecten*. They seem to show that the Cheviot ice moved in a south-westerly direction on to the Cleveland Hills at the western end.

At Newby and to the north as far as Marton and Tollesby, the surface is covered with Boulder Clay, which often assumes the form of ridges and mounds, though not on such a striking scale as those just described. In the stream sides a bed of sand occurs in the clay, dividing it into two layers, and near Marton I have found in it striated Magnesian Limestone, Lower Lias fossils and clay ironstone concretions. I do not think that these sands can be correlated with those near Seamer, since the latter have no Boulder Clay above them. The so-called Upper Boulder Clay terminates in a long ridge running from Marton towards Stainton, with a long strip of sand and gravel running along its slopes as far as the village of Eston.

Probably during the deposition of the Stokesley moraines the dry channels on Eston Hill (described in a paper to "The Naturalist," August, 1906) were being eroded, since both features indicate the last considerable halt of the ice in North Cleveland. The ice front would by no means be straight, owing to the form it would assume after contact with the great embayment of the Jurassic escarpment at Greenhow Botton. The drainage from Scugdale Slack, on the Eston outlier (Plate LII.), swept round to the south-westwards along the Guisborough Valley, and a shallow channel can be traced as far as the Langbaugh overflow. It seems probable that though some of the waters escaped through the gap, the rest simply spread over the drift-covered floor.

The results obtained by this survey of the glaciation of North Cleveland may now be summarised as follows :—

1.—The period of maximum extension when the Bold Venture moraine and drift pebbles at 1,000 feet on Newton Moor were deposited, and Holy Well Gill was eroded. (Kendall.)

2.—Period when Gribdale Gate, the Bilsdale overflow, and Scarth Nick were in operation. (Kendall.)

3.—Period when the Bousdale overflow at 675 feet was formed. (Kendall.)

4.—Period of extra-morainic drainage at the foot of the Cleveland Hills during the earlier stages of Slapewath.

5.—Final stages of the Slapewath and Langbaurgh overflows.

6.—Period of readvance at Kildale leading to the formation of Sowerdale and the anomalous course of the Leven.

7.—Period when Scugdale Slack and the Stokesley moraines originated.