

THE GLACIAL GEOLOGY OF BRADFORD,
AND THE EVIDENCE OBTAINED FROM RECENT EXCAVATIONS OF A
LIMESTONE TRACK ON THE SOUTH SIDE OF THE VALLEY.

BY JAS. MONCKMAN, D.Sc.

During the past two or three years the building trade in Bradford has been very brisk, and consequently digging for foundations and drains has been extensively carried on, with the result that large quantities of glacial material have been exposed, some of it in quite unexpected positions.

The largest and most important of these masses is at the foot of the west side of the hill in Great Horton. It extends from Grange Road on the one side to Great Horton Station on the other, and from the Westbrook to the Escarpment of Horton beds.

On the Six-inch Geological Map this is marked as a sandstone outcrop, and in fact it had all the appearance of such, but when the builder proceeded to remove the soil and fill up the valley denuded by the brook, there was no stratified rock, but instead a great thickness of boulder clay. At the north end they removed 12 feet of this, and then dug 10 feet lower to form a drain, but did not get to the bottom. Further south the excavation was not so deep. On the opposite side of the brook there is not much clay, and this rapidly thins out, making it appear that a pre-Glacial valley has been filled up, and afterwards partly worn out again by the present brook.

The workmen, in removing the clay, threw the boulders into heaps and ridges, so that I had a large collection of material moderately conveniently arranged for examination.

The boulders were chiefly sandstones, with abundance of grits of very coarse texture; there were also numbers of red sandstones (fine) and grits (coarse), dark-coloured limestone was common, light-coloured rarer, but still in considerable quantity, ironstones and shales abundant. I obtained about a dozen specimens of Silurian grit, two specimens of banded limestone, and one of chert with shale.

The upper part of this boulder clay was yellowish, and the lower blue. There was no appearance of stratification except at one place, where two different kinds of material were laid together in a rough sort of stratified deposit.

At Lidget Green specimens of limestone were found in a blue clay at and near the corner formed by Legrams Lane and Beckside Lane, where they dug for the foundations of the new premises of the Co-operative Society, also in the excavations a little further along the road towards Bradford (21 Note), while to the north the clay ran out, and to the south sandstones only have been found. (See 3, 4, 22.)

Limestone is recorded by the Geological Survey on the Six-inch Map at a point about one mile above Leventhorpe Mill (S.E. of the Hall).

Blue clay with limestone was found in digging for the foundation of the houses in Burnett Avenue, Manchester Road, (23); it is also found exposed at the sides and above the end of the tunnel Bradford to Low Moor (25).

I have not been able to find limestone south of this line, and Mr. R. T. Dawson, whose work as a contractor has given him opportunities of judging perhaps greater than most men in Great Horton, and whose knowledge of geology and interest in this subject has caused him to make and record observations for a number of years, informs me that there is abundance of grit boulders but no limestone anywhere on the hills near Horton. (See 1, 2, 5, 8, and A.)

Mr. Olliver reports that he found limestones, upon blue clay with local pebbles, and overlaid by yellow clay, at Lady Royd, Thornton Road (33). Lower down the road there appears to be no limestone in the drift (28, 9, 10, 11, 18, 19, B) until we get to Brewery Street (28) and the Town Hall (30), and these specimens probably came up the valley from Shipley, as did also that in East Bowling.

When I found the limestone I at first considered it to be a lateral moraine of about 600 feet elevation. Additional weight was given to this notion by the presence at Leventhorpe, in the

valley extending from the Hall to the Mill, of a large quantity of pebbles and sand evidently deposited in water. Mr. J. E. Wilson explains these and other similar beds by supposing that the ice, by blocking up the outlet in the lower part of the valley, forced back the water until it rose high enough to pass over the lowest part of the ridge at Wibsey Bank, which is about 600 feet above sea level. In this way a lake was formed at Leventhorpe, and sand and pebbles were deposited by the streams flowing down Thornton and Bell Dean valleys.

There is abundant evidence that ice came through Chellow Dean, but so far I have not been able to find limestones in the drift. Mr. Olliver, however, found them at Lady Royd, which is in the line joining Chellow with Lidget Green. All these things appear to show that the ice came through Chellow Dean and crossed over by Lidget Green to Grange Road, and so on to Bowling.

There are, however, points that should be taken into consideration :—

1. Limestone boulders are reported by the Geological Survey at a point about level with Leventhorpe Hall (29), or south of the lake deposits mentioned above.
2. Clay containing sandstone boulders, and pronounced to be true boulder clay by Mr. R. F. Dawson (8), is found on Wibsey Slack at 800 feet above sea level.
3. The hills above Leventhorpe, in the Thornton Valley, have the form of glaciated hills, although their structure would lead one to expect a steep escarpment of sandstone at the top, and a gentle slope for the softer rocks underneath; the outline (as seen from Daisy Hill when looking up the valley) is rounded like a *roche moutonnée*.
4. At Clayton, when the workmen were digging a mill dam behind Benn's Mill, they cut into a clay deposit of great thickness, which I regard as of glacial origin.

These facts appear to show that the ice was at one time higher than it was at the time that the Leventhorpe Lake was formed, and that there were changes of level in the ice (34 and 24),

as indicated by the sand and pebble beds in the clay at Tyersal and at Woodroyd.

The Leventhorpe beds themselves show the same, the upper plane at Leventhorpe Hall being about level with Wibsey Bank, and the lower at the mill with the gap at Laisterdyke.

It appears therefore most probable that the lake was formed when the ice was retreating.

If you refer to the map (Plate XXIV.), you will find that the places where limestone has been found lie on a fairly straight line from a point above Leventhorpe Hall, through Lidget Green, Grange Road, Manchester Road, to Bowling Tunnel and Woodroyd, and this appears to be the end of a track from some place higher up Airedale.

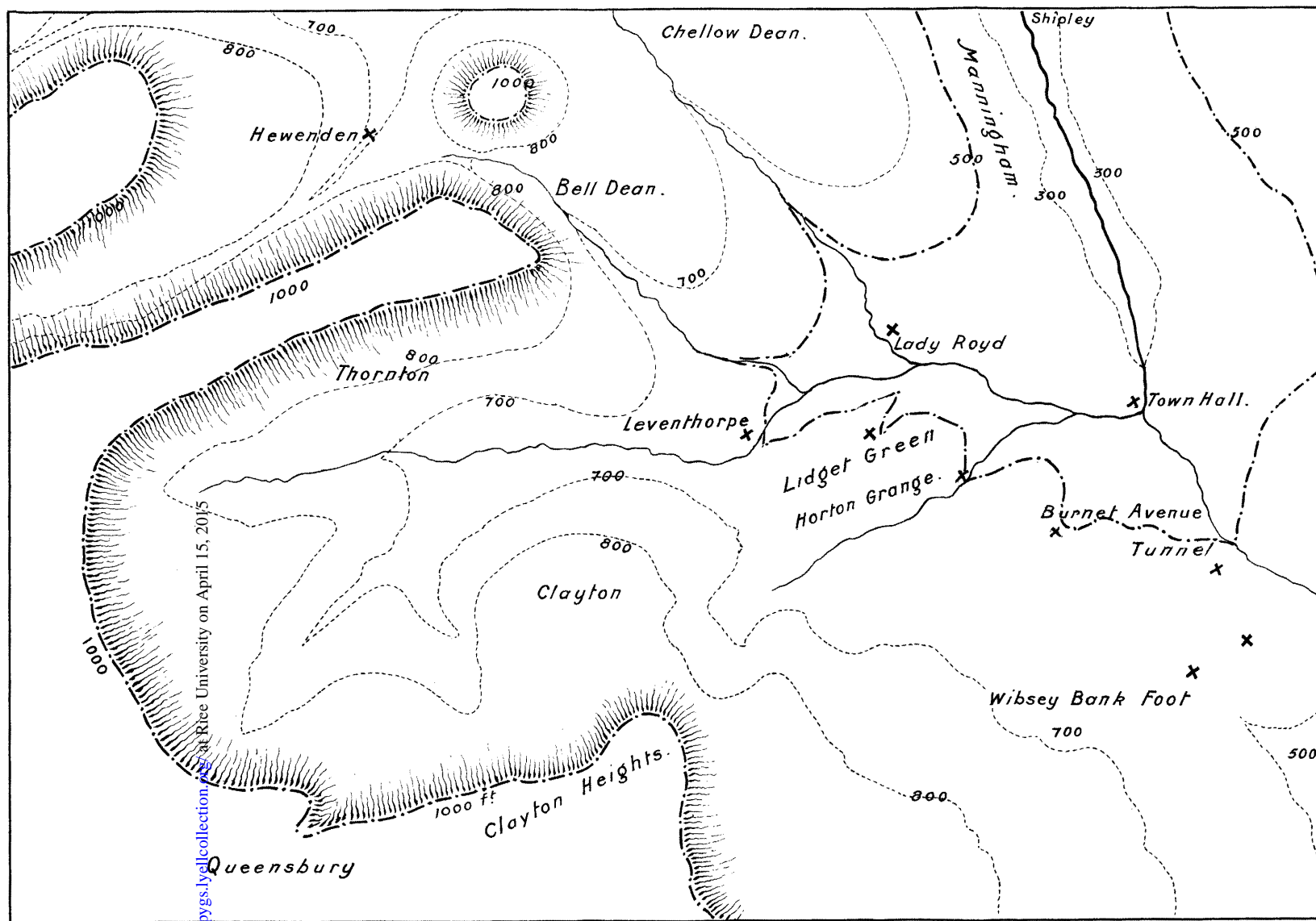
As there is no light-coloured limestone on the south side of the Aire Valley and no Silurian rock, the specimens found at Grange Road must have come either from the north side at Malham or from Ribblesdale.

It is difficult to explain how they could cross the Aire Valley, hence we are driven to the conclusion that the Ribblesdale glacier was forced over the low water-parting at Hellifield, and so down the Aire Valley. The western moraine in Ribblesdale would then become the southern one in the latter valley, and the rocks that would fall upon the ice from the hills on the west side as it passed down by the side of Ingleborough, and those that would be added by the Crummaek Dale ice, would be of the same nature as those found by me at Grange Road excavations.

I am informed by Mr. Howarth that there is evidence near Hellifield that the ice has passed over the dividing ridge.

Since writing the above, I have got some additional indications that the line is continued in the direction suggested in this paper.

I examined the workings at Many Well Springs, and found, with abundance of angular sandstones and grits that were evidently foreign, one piece of encrinital limestone in the clay. Mr. Tatham, who has charge of the farm, showed me a considerable number of pieces of weathered limestone in the walls of the fields. We examined them, and concluded that they could not have been



MAP OF BRADFORD BASIN.

Localities of Limestone Boulders are marked thus, X.

PROC. YORKS. GEOL. AND POLYTEC. SOC., VOL. XIV, PLATE XXIV.

carted on to the land for farming purposes, but were probably from the clay. Many other specimens were found higher up the hill side, but I could not be sure that they were from the clay. This is not so satisfactory as one could wish it to be.

Since that time, Mr. W. E. Holloway led the Bradford Scientific Association over Cowling District, and pointed out a deposit of clay with limestone at the head of Lumb Clough (1,000 feet above sea level), and on the same day the Rev. J. N. Lee showed us an immense deposit in the valley below the village.

More recently, Mr. H. B. Muff has published his researches on the Upper Aire Valley, and he traces a lateral moraine down the south side until it arrives at Denholme, then turns north along the watershed and through the gap at Chellow Dean. (See paper at the British Association, Bradford.)

Later still, Mr. E. E. Gregory and I, in examining the lake deposits at Leventhorpe, have found evidence to show that prior to the formation of the lake the whole district was covered with ice, and that it came down Bell Dean.

Underlying the gravels there is a bed of very stiff blue boulder clay exposed in the bed of Pitty Beck, about 100 yards below the Thornton Road bridge; also a deposit of clay with boulders on the side of the hill (600 feet above sea level) and 200 yards below Pitty Bridge. Here we found one specimen polished and scratched, the striæ running E. and W. or in a line with the valley. On both sides of the footbridge, over which the path from School Green to Clayton crosses the Thornton Beck, we found several limestones (both dark and light), a considerable quantity of gannister, and some very rough grits, some of which contained large quartz pebbles; and in the gravel pit near Thornton Road limestone and chert (rounded and angular) evidently derived from pre-existing glacial drift higher up Bell Dean.

More information is required before a full explanation of the Bradford deposits can be attempted, and the Sub-Committee formed for the purpose will be glad of any aid that can be given to them.

	LOCALITIES.	MATERIAL.	HEIGHT ABOVE SEA IN FEET.	AUTHORITY.
1	In a drain in Cecil Avenue, Great Horton	Sandstone	600	Mr. R. F. Dawson.
2	In a drain in Park Side Road, Bowling	Rough Rock	600	"
3	In a drain between Lidget Green and Paradise Green	Sandy Boulder Clay	550	"
4	At Princeville	"	460	"
5	Opposite Elm Tree Inn, Manchester Road	"	...	"
6	At First Avenue, Killinghall Road	10 ft. Sandy Boulder Clay, 1 ft. tough Blue Clay under it (not bottomed)	...	"
7	Metcalf's Wheel Pit	Clay with Limestone	...	"
8	Wibsey Slack	Sandstone, Boulder Clay	800	"
A	NOTE.—Never found or heard of limestone anywhere in Great Horton or higher up the hill.			
9	Behind Rhodes's Foundry, Thornton Road	Sandstones	350	Mr. W. Parker.
10	In foundations of building on the opposite side of Thorn- ton Road	"	350	"
11	Drains in Thornton Road and in various parts of Heaton	"	320	"
B	NOTE.—Not found any limestone in any part of the valley leading to Thornton, i.e., Heaton, Gillington, &c.			
12	On the north side of the East Brook at Crebbin's Foundry	Blue Clay	...	Mr. Drake.
13	Speight's Mill, Thornbury	"	...	"
14	Windhill Cragg, in a side street off Cragg Lane, near upper Lock on Canal	Striated Rough Rock. Direc- tion of Striae N.W. to S.E.	250	Mr. E. E. Gregory and J. Monckman.
15	Rhumbolds Moor, above keeper's house, on the footpath from Baildon to Ilkley	Grit striated from N.W. to S.E.	1,100	"

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	LOCALITIES.	MATERIAL.	HEIGHT ABOVE SEA IN FEET.	AUTHORITY.
16	Hanson Board School...	Sandstone blocks and flags, 3 ft. x 2 ft. x 1 in. to 2 in. on end, with much sand and one much weathered coral	500 ?	Messrs. Foulds and Forrest.
17	Frizinghall, north of Railway Station	Sand, Sandstone ...	300	Mr. E. E. Gregory.
18	Empire Theatre, Horton Road	Sandstones and Grits ...	380	Dr. J. Monckman.
19	New Street (drainage) parallel to Shear Bridge Road	Sandstones (8 to 10 ft., not bottomed) ...	420	"
20	Behind Grange Road, on east side of the beck as far as the Station, Great Horton	Stiff Clay, yellow on top, blue below, contains Sandstones, Grits, Red Sandstones, Blue Limestone, Light-coloured Limestones, Banded Lime- stones, Chert, Silurian Grits	450 to 500	"
21	Lidget Green, in the digging for foundations for corner shops (Co-operative Society's new place)	Sandstones and some Lime- stones ...	550	"
22	Lidget Green, further N.	Sandstones only ...	550	"
23	Burnett Avenue, Manchester Road	Blue Clay with Limestones ...	550	"
24	Woodroyd Brick Works	Clay with Sandstones and a few Limestones, with a sand and pebble bed interposed	600	Dr. J. Monckman and Mr. C. Smith.
25	Top of the entrance to the tunnel to Low Moor, L. & Y. R.	Sandstones and Limestones...	525	Dr. J. Monckman.

	LOCALITIES.	MATERIAL.	HEIGHT ABOVE SEA IN FEET.	AUTHORITY.
26	Foundations for house at Chellow Dean	Clay with Sandstones	700	Dr. J. Monckman.
27	Excavations in Clay used for Puddle in the Reservoirs	"	700	Mr. W. "Cudworth.
28	Drain in Brewery Street	Clay with some Limestones	500	Geological Survey.
29	One mile above Leventhorpe Mill, S.E. of the Hall	Limestone Boulder	330	Mr. Webster.
30	Town Hall, excavations for the hoist	"		
31	Hewenden reservoir	" One specimen (encrinital) from clay, considerable number of old weathered specimens from walls		
32	Oxenhope	Limestone	677	Dr. J. Monckman.
33	Lady Royd, Thornton Road	Yellow Clay, under which was drift with Limestones, and below that Blue Clay with local Sandstones		Mr. H. B. Muff.
34	Tyersal, near the Board School	Blue Clay with Limestones, with 1 ft. of gravel underneath		Mr. R. M. Olliver.
35	Head of Lumb Clough	Blue Clay with Limestones	1,000	Messrs. Monckman, Foulds, and Forrester.
36	Near Cowling	Clay with Limestones, &c.	500	Mr. W. R. Holloway.
37	Birkhall, Bowling, on the site of the Corporation Gas works	Gannister beds, striated and polished. Direction S.W. to N.E.	550	Rev. J. N. Lee.