NOTES ON EAST YORKSHIRE BOULDERS.

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Our knowledge of the distribution and source of the boulders of East Yorkshire has perceptibly increased during the last few years, and an attempt is made in the following notes to point out and group the more interesting of the facts, both old and new.

BOULDERS TWELVE INCHES AND UPWARDS IN DIAMETER.

Some ten years ago Mr. G. W. Lamplugh counted and roughly classified the larger boulders of Flamborough Head and other selected localities on the Yorkshire coast, and published his results in the Proceedings of this Society. This work has been continued by members of the Hull Geological Society, who have, up to the present time, recorded nearly 4,000 boulders of twelve inches and upwards in diameter. To avoid possible error arising from the moving beach and other causes, only the boulders actually in place in the clays were noted, or such as had recently and obviously fallen from the cliffs. The whole of the coast-line from Spurn to Flamborough has been surveyed in this way, and also portions of the coast north of Flamborough as far as Saltburn. The lists thus compiled have been published from time to time by the Hull Geological Society and by the Erratic Blocks' Committee of the British Association.

The cliffs of Holderness, with the exception of certain post-glacial deposits, consist entirely of glacial accumulations, and therefore afford exceptional opportunities for the study of East Yorkshire boulders; and the following table gives the particulars obtained at four localities where the cliff sections were clear and boulders plentiful:—

TABLE I.

	Boulders Twelve Inches and Upwards in Diameter.	Out Newton (*1 Mile of Cliff*).	Tunstall (*1 Mile of Cliff*).	Aldbrough (*1 Mile of Cliff*).	Mappleton (*2½ Miles of Cliff*).
	Origin.	Per cent.	Per cent.	Per cent.	Per cent.
Rocks from East Yorkshire	Lias	5·6	13·9	14·7	16·0
	Chalk	1·9	2·9	9·7	12·0
Rocks foreign to East Yorkshire.	Other Mesozoic rocks, chiefly sandstones ...	3·7	1·8	3·2	8·0
	Carboniferous limestone ...	37·8	37·6	23·9	24·0
	Sandstones, grits, &c., chiefly from Carboniferous sources ...	12·4	17·9	10·3	20·9
	Basalts	28·8	23·4	34·6	16·0
	Granites, gneiss, schists, &c.	9·8	2·5	3·6	3·1
		100·0	100·0	100·0	100·0
	Actual number of boulders noted	267	274	824	225

From the above table it will be seen that the boulders of East Yorkshire can be divided into two well-defined groups; the first division consisting of rocks from comparatively local sources, and the second division comprising rocks from more distant localities.

(1) LOCAL ROCKS. The coast of Yorkshire north of Bridlington presents continuous sections of the Jurassic and Cretaceous strata, and, as might be expected, these rocks are largely represented in the glacial beds to the southward.

Lias. In south Holderness hard nodular concretions from this formation are plentiful, but large boulders of the softer shales, so characteristic of the lower part of the drift in other places, are rare. Further north, in Filey Bay, between Primrose Valley and Hunmanby Gap, many masses of Lias shale occur embedded in boulder-clay, both in the cliffs and on the foreshore, and were formerly mistaken for Kimmeridge clay in place. Several of the masses in the base of the cliffs are from the

Jamesoni beds of the Lower Lias, while on the beach patches of Upper Lias occur. One of these patches was observed under specially favourable conditions during the summer of 1898. The boulder occurred on the beach forty yards from the foot of the cliffs, and consisted of a patch of black shale twenty yards long by ten yards wide, surrounded by boulder-clay. The shale showed few, if any, signs of crushing, and contained numerous well-preserved fossils, including *Ammonites communis* and *Leda ovum*. Mr. G. Lether, of Scarborough, also informs me that he has seen similar large masses of shale containing Upper Lias fossils in the boulder-clay cliffs situated in the Cliff Bridge Company's grounds, south of Scarborough.

Oolite. Boulders of Oolite are comparatively rare in south Holderness; but as we proceed northwards and approach the neighbourhood of Filey and Scarborough, where these rocks occur *in situ*, Oolitic boulders become exceedingly numerous in the adjacent glacial clays.

Speeton Clay. Mr. Lamplugh has also pointed out that the lower part of the drifts resting on the Chalk around Selwick's Bay, Flamborough Head, is largely composed of re-arranged Speeton Clay.

Chalk. As far as I am aware no boulders of Chalk twelve inches and upwards in diameter have been noted in the drifts north of Flamborough Head. In Holderness they occur in fair numbers, though somewhat unequally distributed, as the following list shows:—

At Barmston ...	... 17	per cent.	of the boulders	are Chalk.
„ Skipsea ...	... 14	„	„	„
„ Atwick ...	... 36	„	„	„
„ Hornsea ...	... 10	„	„	„
„ Mappleton...	... 12	„	„	„
„ North of Aldbrough	24	„	„	„
„ South of Aldbrough	9	„	„	„
„ Thorp Garth ...	4	„	„	„
„ Hilston	3	„	„	„
„ Tunstall	3	„	„	„

At	Withernsea	...	3	per cent. of the boulders are	Chalk.
,,	Hollym ...	...	9	,, ,,	,,
,,	Holmpton ...	...	12	,, ,,	,,
,,	Out Newton	...	2	,, ,,	,,
,,	Dimlington	...	3	,, ,,	,,
,,	Easington ...	...	14	,, ,,	,,
,,	Kilnsea ...	...	7	,, ,,	,,

This inequality in the distribution of Chalk boulders at these different places along the Holderness coast probably arises from the fact (pointed out by Wood and Rome) that the lower part of the glacial series of Holderness contains more Chalk than the upper, and that these basement beds with their higher percentage of Chalk boulders rise only occasionally above sea level.

(2) FAR-TRAVELLED BOULDERS. It will be seen from table No. 1 that, among the far-travelled boulders of the East Yorkshire drift deposits, Carboniferous rocks take numerically the leading position; and the Carboniferous area west and north of the Tees is generally regarded as their place of origin. The group of boulders next in numerical importance to the foregoing is the basalts, the source of which is undoubtedly the Whin Sill. The next, and last, group is that of the granites, gneisses, &c., comprising rocks of widely diversified types, in great variety. Phillips showed long ago that some of these came from the English Lake District, and we now know that there are also Cheviot and Scandinavian rocks among them; but the sources of a large number of these rocks have yet to be determined.

When the lists of boulders obtained in the south of Yorkshire are compared with the lists obtained in the north, they bring to light several interesting facts with regard to the far-travelled boulders. Compare, for instance, the lists obtained at Dimlington and Redcliff, in south Yorkshire, with the lists from Upgang and Saltburn in the north. Before, however, discussing the boulders it is advisable to give a brief description of the localities where the lists were compiled.

(i.) Dimlington is situated on the sea-coast near the southern extremity of Holderness. The cliffs average about

eighty feet in height for upwards of two miles, and are entirely composed of glacial material, chiefly boulder-clay. Here were noted 334 boulders of twelve inches and upwards in diameter.

(ii.) Redcliff is on the north shore of the Humber, near North Ferriby, and is twenty-four miles west-north-west of Dimlington. The cliff continues along the Humber side for two-thirds of a mile with an average height of eighteen feet, and together with the adjacent beach is composed of boulder-clay. The boulders recorded here were 373 in number.

(iii.) Upgang is one-and-a-half miles north of Whitby; the cliff sections are one hundred feet or more in height, and consist largely of boulder-clay. In this neighbourhood Mr. Lamplugh counted and classified two hundred boulders of twelve inches and upwards in diameter, the majority of which were of local origin; the percentages given in the table below are based on his list.

(iv.) The cliffs between Saltburn and Redcar present the most northern exposure of boulder-clay on the Yorkshire coast. These sections yielded 133 boulders of twelve inches and upwards in diameter.

After eliminating all the *local* boulders from the lists, at the above-mentioned localities, the relative proportion between the several groups of *far-travelled* boulders is as follows:—

TABLE II.

GROUPS.	I. Dimlington.	II. Redcliff.	III. Upgang.	IV. Saltburn.
	Per cent.	Per cent.	Per cent.	Per cent.
1. Carboniferous limestones and sandstones ...	55	59	70	73
2. Basalt (Whin Sill) ...	32	30	24	20
3. Magnesian limestone ...	0	0	5	7
4. Granite, gneiss, &c. ...	13	11	1	0*
	100	100	100	100

* Several large boulders of Shap granite were seen in the gardens and about the town, which had probably been derived from the neighbouring drifts.

It will be seen from Table II. that, although the Carboniferous limestones and sandstones, and the basalts, have travelled into our district from practically the same area, the relative proportions of the boulders from the two groups vary considerably from point to point. Thus, while it is probable both groups decrease numerically southwards, the percentages show that the basaltic group increases relatively from Saltburn southwards. The explanation of this seems to be that the large boulders of basalt bear transport better than similar masses from the Carboniferous sedimentary rocks.

In south Holderness the Magnesian Limestone (group 3) is rarely found excepting as pebbles, but these grow in number and size northwards. Large boulders begin to appear north of Scarborough, and at Whitby and Saltburn, as the table shows, they form from 5 to 7 per cent. of the non-local boulders present in the clays. This rock is matched by the Magnesian Limestone found *in situ* at Roker, near Sunderland.

We now come to the boulders of igneous rocks included in group 4, which are shown by the table to decrease both numerically and proportionately northwards. This northward decrease is all the more noteworthy when we remember that boulders of Shap granite and other Lake District rocks, and of the Cheviot porphyrites, all included in this group, increase rapidly in the same direction. This seeming anomaly arises, I think, from the influence of the boulders from Scandinavia. Among the boulders of south Holderness occur very commonly types which agree with certain Scandinavian rocks; the best known of these being the augite-syenite (*laurvikite*) and the rhomb-porphyry. These types, although not by any means unknown in the drifts of North Yorkshire, are much rarer there than in the south. For instance, at Dimlington, in south Holderness, we should find at least one hundred boulders of the above-named Scandinavian rocks to one of Shap granite, while on the other hand at Robin Hood's Bay or Runswick Bay (both near Whitby) the Shap boulders outnumber the Norsemen by twenty to one. Seeing then that the boulders of group 4

increase both in number and variety southwards, and that among them are certain Scandinavian types which are *known* to be much more plentiful in the south of the county than in the north, I think it may be fairly inferred that the unidentified rocks of the group are probably largely from Scandinavia also.

SMALLER BOULDERS, PEBBLES, AND GRAVELS.

Up to the present we are not in possession of even a rough analysis of the smaller boulders and gravels of the East Yorkshire drifts; but the few notes that have been made are of great interest and suggest a profitable field for further investigation. Among the smaller stones and pebbles we find derived fossils of wide range, Carboniferous corals being particularly conspicuous. From the Secondary rocks Lias fossils are perhaps the most common, though in Holderness specimens from the Speeton clay and Chalk are not rare. North of Flamborough Head, fossils and pebbles from the Cretaceous rocks though rare are not unknown, and the writer has seen striated pebbles of hard chalk (six inches in diameter) in the glacial clays at Scalby Mills, two miles north of Scarborough, and smaller pebbles of the same character as far north as Kettleness. It has also long been known that the East Yorkshire boulder-clays, both north and south of Flamborough Head, contain large numbers of black, pink, and green-coated flints, which cannot be matched from Yorkshire rocks *in situ*. In addition to this, a well-preserved Upper Cretaceous belemnite, which Mr. Jukes-Brown recognises as *Belemnitella lanceolata*, is frequently found in the Holderness drifts, yet is unknown to collectors from the Yorkshire Chalk. On the other hand, *Belemnitella quadrata*, which is common in the Upper Chalk of Yorkshire and Flamborough Head, has not yet been noted in the Holderness clays, though sought with care.

It is also worthy of note that among the smaller boulders and pebbles from the boulder-clays and gravels of East Yorkshire the percentage of the far-travelled rocks is much higher than among the larger boulders. There are certain types also

among the smaller specimens which seldom appear as large boulders. Among these is a fairly definite group of rocks, which are known among East Yorkshire collectors as *porphyrites*, and are referred with some confidence to the Cheviot Hills. The evidence in support of this conclusion may be briefly stated as follows:—(1) The erratics seem to match the descriptions of the Cheviot rocks published by Mr. J. J. H. Teall and others. (2) Pebbles of these rocks increase, both in numbers and in size, as we approach the Cheviot district.*

The distribution of both boulders and pebbles would be inexplicable under the supposition that the drift had been deposited in the sea during submergence of the land, but all the facts fall naturally into place if we acknowledge the former existence of ice-sheets covering not only the land but the area now occupied by the sea.

References.

S. V. Wood, jun., and J. L. Rome. "On the Glacial and Post-glacial Structure of Lincolnshire and South-east Yorkshire." Quart. Journ. Geol. Soc., Vol. XXIV., p. 146.

J. Phillips. "Illustrations of the Geology of Yorkshire. Part I. The Yorkshire Coast," 3rd edit.

C. Reid. Geological Survey Memoir. "The Geology of Holderness."

G. W. Lamplugh. "The Larger Boulders of Flamborough Head," Part I., Proc. Yorks. Geol. and Polyt. Soc., Vol. IX., p. 340; Parts II. and III., Vol. XI., p. 231; Part IV., Vol. XI., p. 397.

G. W. Lamplugh. "Drifts of Flamborough Head." Quart. Jour. Geol. Soc., Vol. XLVII., p. 384.

T. Sheppard and H. Muff. "Notes on the Glacial Geology of Robin Hood's Bay." Glacialists' Mag., Vol. IV., Part 2., p. 47.

J. W. Stather. "Notes on the Drifts of the Humber Gap." Proc. Yorks. Geol. and Polyt. Soc., Vol. XIII., Part II., p. 210.

Reports of the East Riding Boulder Committee. Trans. Hull Geol. Soc., Vols. I., II., III., IV., V.

Reports of the Yorks. Boulder Committee. Naturalist, 1887—99.

*This question was carefully investigated during the Yorkshire Geological Society's Meeting at Wooler, and the identity of the porphyrite boulders from the East Riding with the Cheviot rock was satisfactorily established.