Notes on the Geology of Derbyshire.*

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THE object of this paper is to bring before you a few notes on the geology of our county, stating what has been done in it during recent years, and giving suggestions as to what might be done by our Society. In this way members may be guided to take up special lines of work which they otherwise might not think of, for experience shows that much of the valuable geological work done by amateurs has been owing to a suggestion by some geological friend.

Important research has been made from time to time amongst the Barrows and Caves of Derbyshire, and light has been thrown on that period which may be called the borderland of Archæology and Geology. I allude to the late Mr. Bateman's diggings, to the late Mr. Rooke Pennington's work near Buxton, Mr. Mello's at Cresswell Crags, and to Mr. John Ward's work at Longcliffe, articles by the two latter having appeared in our journal. It is much to be regretted that the Bateman collection is in Sheffield Museum, instead of at Derby, our county town. Probably there are many more caves undiscovered which will yield rich results; and the duty of our Society will be to see that such caves as may be discovered from time to time are either properly worked or sealed up until some competent person can have charge of them, so that the whole evidence which they offer of the past may be

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used to the utmost. The great value of Kent's cavern, near Torquay, consisted not only in the quantity and variety of the deposits found in it, but also in the fact that the cave had not been previously tampered with. We should, therefore, try to impress upon people in the county the great importance of guarding such treasures from those who might, through ignorance, help to destroy valuable evidence.

Good work has been done lately on the glacial drifts in the southern part of the county, which the then president of the Geological Society characterised as "a most useful contribution towards the correlation of the drift deposits of the British Islands." In his paper on the Pleistocene succession in the Trent basin, read before the Geological Society in 1886, Mr. Deeley discussed a large number of exposures of glacial drift, and succeeded in establishing a definite sequence amongst the deposits. There is still much work of a similar nature to be done in the county, and it is of that detailed kind that only those living in the district will be able to do it thoroughly. Authorities say that the work in the valleys is easier than that on the hills, and should be attempted first. What has been done is only an instalment of the data required for the solution of an interesting problem, viz., the explanation of the unequal distribution of the drift on opposite sides of the southern part of the Pennine Chain. Mr. Deeley mentions good exposures of drift in clay pits at Spondon and Chellaston, and at the latter place blocks of limestone are to be found scratched and polished by being rubbed against others, owing to the action of ice. But it is not even necessary to leave our own town for observations. Many good exposures have been opened out in excavating for cellars. On Normanton Road, at the top of Hartington Street, a very good section was seen by Mr. Deeley. "Nine feet of boulder clay, consisting of red marl, rested upon a violently contorted bed of sand in the Keuper. The boulder clay had evidently been thrust over the sand by a force acting from west or north." Some streets on the Burton Road were lately cut in the boulder clay, which contained boulders of limestone, millstone grit, rocks from

the coal measures, toadstone, and other igneous rocks I have entered somewhat into detail in order to show that much useful work may be done in the mapping of the drift, if members of our Society will take a little trouble in examining foundations for cellars and excavations in different parts of the town. The position and height above the sea of erratic blocks or boulders might also be reported, so that a boulder map could be made showing the position and character of the blocks, although the number perhaps may not be very great in Derbyshire.

Another example of work done by a resident, is that by Mr. H. T. Brown, on the Permian rocks of the Leicestershire coalfields. From this paper, which appeared in the "Quarterly Journal" of the Geological Society for February, 1889, we find that he re-surveyed the Ingleby and Knowle Hill district on the six-inch map, and showed that the sandstones of Knowle Hill, which are supposed to be of Permian age, are really "an outcrop of lower Keuper overlying Bunter conglomerate, and that the beds owe their present position to the existence of a trough-fault, which has let them down on the east against the coal measures and Permian marls, and on the south-west against the last mentioned beds and Bunter conglomerate." Professor Bonney spoke of the paper as "the cream of a series of observations, such as could only be carried on by one living in the district."

A Yorkshire Fossil-Flora Committee was formed two years ago, in connection with the Yorkshire Naturalists' Union, for working out the horizontal and vertical distribution of the fossil plants. Hitherto little attention has been paid to the distribution of fossil plants, either in space or time, in Britain. A record of the species occurring in the coal measures in Yorkshire, as far as they are at present known, has been obtained, and over one hundred species have been recorded. Of these many are now known to be British for the first time. Such a work, extended over the whole of the Carboniferous rocks of Great Britain, would be a very valuable addition to the Plant Life of former times. One of the advantages of a Society like ours is that, better than an individual, it can co-operate with similar societies in an extensive work of this nature.

I have obtained from the Flora Committee notes for the guidance of those who will help in the investigation of the Carboniferous Flora, and a promise of any assistance that may be required from Mr. Cash, the secretary of the Committee. Our Society might well try and obtain such a record for Derbyshire. The services of geologists in the county, and of engineers and others engaged in mining, might be called to its aid, in noting the position and the seam of coal in which the fossils occur.

In the Geological Survey Memoir of North Derbyshire, are a map and diagram showing the position and directions of a number of measured joints occurring in the Chatsworth Grit of Stanage Edge. The joints have roughly a tendency to arrange themselves parallel to two fixed straight lines, which bear N.E. and S.W., and these are about the directions of the dip and strike of the rocks. The Officers of the Survey mention this in order that local observers may be led to take up the subject more fully.

The same remarks apply to a record of the directions of the dip of planes of current-bedding, and they say that if anyone with time to spare would carry on and complete what is already well begun by Dr. Sorby, much light will be thrown on the question of the method of the formation of the Carboniferous sandstones. In a paper on "The structure and origin of the millstone grit of South Yorkshire," Dr. Sorby concludes "that the materials of the millstone grit in South Yorkshire were derived from the waste of a south-westward prolongation of an ancient Scandinavia, the site of which is now occupied by the North Sea."

There is a strongly marked contrast between the lie of the rocks on opposite sides of the Pennine Anticlinal, and the memoir above alluded to says that, "when a sufficiently extensive set of observations have been brought together, they will doubtless throw light on the mechanics of the upheaval of the range." On the West side the trend is nearly N. and S.; while on the East it is sometimes nearly N. and S., sometimes E. and W., and sometimes intermediate between the two directions. Professor Hall has shown that the Carboniferous rocks of the North Midland counties had their lie given them by two separate upheavals. Further observations may or may not confirm this explanation.

Near Newhaven, Brassington, and Harbro' occur some purple and white fire-clays and sands in irregular hollows in the limestone as much as 100 yards across, and of unknown depth. The memoir states that the presence of quartz pebbles points to a portion of the deposit having been derived from the Kinder Scout Grit, and that a large part of the material is due to the decomposition of chert and sandy or argillaceous limestone. The sand consists almost entirely of quartz; a comparison of the grains with those in the Grit and the insoluble residues in the limestone might throw some light on the subject. In the Longcliffe pit is a lignite, and it might be worth while to look near it for seeds which would determine the plant from which the wood came.

In February, 1888, I heard a paper read at the Geological Society by Mr. Wethered, on "Insoluble residues obtained from the carboniferous limestone series at Clifton." The specimens of limestone were placed in hydrochloric acid, the residue washed, and then examined under the microscope. The residue of the lower limestone shales consists mostly of detrital quartz, with fragments of tourmaline, zircon, and felspar, occasionally associated with amorphous and chalcedonic silica. In the middle limestones the proportion of chalcedonic silica, containing sponge spicules and casts, increases, that of detrital quartz decreases, micro-crystals of quartz, amorphous silica, and less frequently pyrites, tourmaline and zircon occur. Towards the top of the middle limestones the proportion of detrital quartz increases, and the deposition of secondary silica on the grains becomes less marked until the calcareous beds become replaced by the Millstone Grit. Mr. Wethered concluded that the greater portion of the limestone at Clifton was deposited in the form of material not unlike that of the chalk and calcareous mud, now being deposited, in which siliceous organisms occur, and was in fact a Paleozoic chalk. The calcareous organisms he hoped to deal with later. Such a method might be applied to the Derbyshire limestone, and the work would not present much difficulty. Little chemical apparatus would be required, and a microscope magnifying about 40 or 80 diameters, with a polariscope attached, would be sufficient.

Many fossils have been found in the Carboniferous limestone of Derbyshire, and various lists have been published, the latest one being in the Survey Memoir—but nothing has been done, I think, to work out their distribution in the various horizons of the limestone. Mr. Howe, of Matlock Bath, is at present working at the corals of the districts, and will shortly, I believe, publish the results at which he has arrived.*

In the Carboniferous limestones of Derbyshire occur beds of a dark coloured rock commonly called "Toadstone." Its appearance in the field and its microscopic structure prove that the beds are parts of lava streams which flowed from various sources and at various times, while the limestone was being deposited at the then sea-bottom. It has often been referred to, and a few microscopic sections were described by Mr. Allport, but no detailed work on it has been published. During the last three or four years I have been working at it in the field and am now engaged in examining microscopically a large number of specimens. I hope next year to have a paper ready on the lava and beds of fragmental rock, which have been mapped as Green-stone by the Geological Survey.

The main physical features of the county are so closely connected with its geological structure that the one can hardly be considered without the other; and the connection between the geology and scenery should be interesting not only to geologists but to all lovers of nature. Messrs. Fletcher and Ward, in the last volume of our Journal, have, in a popular manner, given examples of the origin of our scenery.

It is of great importance to preserve as many permanent records as possible of the strata passed through in the sinking of wells, making of excavations, railway cuttings, and tunnels, as well as exposures of rocks in valleys, &c. In many of these cases photography comes to our aid. It would be well to work here in connection with the British Association Committee on Geological

* Since the reading of this Paper, Derbyshire has lost, by the death of Mr. Howe, one of its most indefatigable geologists.

Photography for the collection, preservation, and systematic registration of photographs of geological interest in the United Kingdom. Views are desired illustrative of characteristic rock sections, especially those of a typical or temporary nature, railway cuttings, important boulders, localities affected by denudation, or where marked physiographical changes are in operation, raised beaches, characteristic river valleys, escarpments and other landscape features, glacial phenomena, as *roches montonnées*, moraines, and natural views of geological interest. They should be taken under skilled geological direction, and accompanied by certain details. Selections might be made from the numerous photographs of Derbyshire which have been published. Good photographs of the interiors of caverns might be obtained by means of the magnesium flash light. The two new railways which are being constructed in the county, *viz.*, the Dore and Chinley (which passes through the coal measures and grit) and the Buxton and Ashbourne branch of the L. and N. W. R. (which passes through the limestone), will probably offer a field for the geological photographer. The first year's operations of the B. A. Committee have resulted in a collection of 270 photographs of considerable scientific interest.

I hope that these few notes will be useful to those members of our Society who would like to take up geological work. Although we have few, perhaps, who are both willing and able to devote much spare time to this branch of science, yet all may help to some little extent, and our Society may be able to do much in bringing together workers in different parts of the county who are at present unknown to one another.