

On the Occurrence of Cretaceous Fossils in Caithness.

By DAVID TAIT.

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IN the paper published last year in the Society's Transactions "On Egg-shaped Stones dredged from Wick Harbour," the sand-pit at Leavad, situated twelve miles W.S.W. of Wick, was referred to. It was there noted that the sand and sandstone of this pit are unlike any rock of undoubted Old Red Sandstone age in the county, and the remarkable large spheroidal concretions were specially mentioned. It was the writer's opinion then that the rocks there are *in situ* and probably belonged to the Jurassic Formation, and that the very similar egg-shaped concretions which have been dredged from Wick Harbour were perhaps derived from a bed on the same geological horizon near Brora, and have been carried northwards as boulders to Wick, by ice, during the glacial period. The similarity of the rock and the shapes of the concretions at both places render this highly probable.

This year Leavad was again visited and fossils were found in the sandstone in a poor state of preservation, but sufficiently good to determine the horizon of the deposit. This discovery makes a particular description of the sand-pit and its neighbourhood desirable, though it must be confessed that there is some doubt as to whether the rock is actually *in situ* or may be a glacially transported mass.

Leavad sand-pit is situated in the valley of the Little River, a branch of the Thurso River, which flows northwards and enters the sea at the town of Thurso, fourteen miles away. It is eleven miles west of the coast at Wick and eight miles north of the coast at Latheron. It is at an elevation of 300 feet above sea-level, and eastwards of it the ground maintains an elevation of about 350 feet to within a short distance of the sea.

Between Leavad and the coast towards the south, the general height of the ground is from 500 to 600 feet above sea-level. Northwards the ground gradually falls to the shore of the Pentland Firth. The sand-pit is on the east side of the river, and about 220 yards distant from it. The valley is a wide open hollow, covered with heath, and treeless. Old Red Sandstone rocks are exposed on the higher ground on both sides of the valley, and in the river-bed north and south of Leavad. The nearest exposures of Old Red rocks are about 500 yards distant from Leavad sand-pit, the intervening area being covered with peat

and heather. In the streams near at hand boulder-clay containing marine shells occurs at several places.

The pit is about 150 yards long in a north and south direction, and is from 20 to 25 yards wide. The east and west sides are parallel with each other and are formed by walls of sandy boulder-clay, only one or two feet thick with sand on both sides. This is well seen on the east side of the pit. At the working face of the pit at the north end, the pit is about 24 feet deep, and the section seen there is—

1. Peat and subsoil	2 Feet.
2. Sandy boulder-clay	2 „
3. Yellow sand with concretions	20 „

In addition to the two walls of boulder-clay forming the eastern and western limits of the pit, there are three more dyke-like masses seen in section in the working face. These are more irregular than the two outer ones, but they have the same north and south direction. The most interesting of these is the small one in the centre, which tapers in a downward direction to near the bottom of the pit, where it is less than an inch in width. Its form gives it the appearance of filling a crack or break in a solid material. It is composed of dark clay, and contains stones, including quartzite and mica schist, averaging four to five inches in length. The top boulder-clay overlying the sand is coarser in texture and has a larger proportion of stones of local origin, bigger and more angular than those in the boulder-clay dykes.

For many years the Caithness Flagstone Company has carted sand from this pit to use with saws to cut the bituminous, greyish-blue paving-flag so familiar in our cities. The peat and boulder-clay are cleared from the top and the sand is shovelled into carts and taken away. The concretions are left behind and some of the larger ones remain in their original positions on the floor of the pit.

The sand is of a uniform medium grain, and light yellow in colour, and embedded in it are rounded concretionary masses of hard calcareous sandstone which effervesce freely with acid. These concretions range in size from several inches to eight or ten feet in diameter. The larger ones are subdivided by joints into cubical pieces. At their outer margins at some places a passage can be traced from the sand into the hard rock of the concretion. There is little doubt that these hard spherical masses of sandstone are concretionary structures, and that the sand in which they are imbedded is a more easily decomposed portion of the same sandstone which has had its binding material removed by weathering.

Just below the depth to which at present the pit is worked the

sand is saturated with water. Excavations made in the floor of the pit almost immediately fill with water and the sides fall inwards. This renders it impossible to work it to a greater depth than at present without the aid of pumps.

At the present working face there are no signs of the termination of the sand. That the sand extends some distance beyond the limits of the pit is proved by a small exposure of the same material on the bank of the stream 220 yards to the west.

About one mile due north of Leavad, at Tacher, sand and sandstone of the Leavad type may be seen in the bank of the little stream close to the cottage. During a visit to this place after a heavy fall of rain, the channel of the stream was found to be composed of boulder-clay, at a lower level than the sand and sandstone in the bank. It may also be stated that at this place, but on the opposite side of the stream from the cottage, there are several overgrown diggings from which sand like that of Leavad is said to have been at one time obtained.

It is reported by men who have worked in Leavad pit that a considerable number of years ago, by means of pumps and drainage, the sand was worked eight to ten feet deeper than the present depth of the pit. No change in the character of the material was observed, nor was there any indication of the bottom of the deposit being reached. This eight or ten feet added to the depth of the pit at the present time (20 feet) gives a depth of about 30 feet of sand without the bottom being reached. The sand and sandstone seen by the side of the river to the west is twenty to thirty feet below the level of the bottom of the pit. If this be added to the 30 feet in the pit it gives a total of about 50 feet as the probable thickness of the sand.

The fossils were obtained from the hard concretionary sandstone; no trace of them was noticed in the sand. They are not conspicuous, being small and of much the same colour as the containing rock. Minute fragments of shells are common throughout the sandstone, but the more perfect specimens occur in nests or pockets. Minute rod-shaped bodies occur which may be sponge spicules. The greater number of the determinable fossils are lamellibranchs; the remainder are gasteropods and cephalopods. The cephalopods have enabled Dr G. W. Lee, who has kindly examined them, to say that they are of Lower Cretaceous age and have a Neocomian facies. This opinion has been confirmed by Dr F. Kitchin. The cephalopod genera collected are—*Desmoceras* (?), *Craspedites*, *Hamites*, and *Crioceras*. A complete list will be published in the "Summary of Progress of the Geological Survey" for this year (1908).

The junction between the Cretaceous rock of Leavad and the



FIG. 1.—Leavad Sand Pit. General View.



FIG. 2.—Leavad Sand Pit. Near view of working face, showing sand, two sandstone concretions, and fissure containing boulder clay with boulders of Highland metamorphic rocks.

Old Red Sandstone below is nowhere seen. Though the thickness of the Leavad rock and its horizontal extent lead one to think that it is *in situ*, lying unconformably on the Old Red, there are facts in the glacial phenomena of the district which point to the possibility of its having been pushed up on to land out of the North Sea or carried northwards from Brora.

Numerous papers have been written by C. W. Peach on the fossils found in the boulder-clay of Caithness, and later than these an important one on the glaciation of the county, by Messrs B. N. Peach and J. Horne.¹

In these it is made clear that the ice moved in a north-westerly direction over the county, from the Moray Firth to the north coast. Boulders of Jurassic and Cretaceous rocks containing characteristic fossils are common in the boulder-clay, so that the rock at Leavad may be a very large boulder.

Near Cruden Bay in Aberdeenshire, across the Moray Firth, 170 miles to the S.E. of Leavad, Cretaceous fossils have been found at Moreseat, in a similar exposure, and also in the same kind of rock. Here, as at Leavad, the relationship of the Cretaceous rock to those underlying has not been satisfactorily made out. Several papers have been read on the rock and fossils of Moreseat, the latest being one by A. J. Jukes-Browne in the Report of the British Association for 1897.

Perhaps it is more than a coincidence that both localities are situated at an elevation of 300 feet above sea-level, and are at a somewhat similar distance from the coast.

Sir Archibald Geikie, in his "Scenery of Scotland," page 162, says, "The sea in which the chalk was laid down must have spread over at least the lower part of the country, for the land in the western parts of Argyllshire, to judge from the height at which the chalk occurs there, must have been not less than 1500 feet lower in level than at present." On page 141 he says that "rocks belonging to the Cretaceous system undoubtedly at one time covered considerable areas on both sides of the Highlands. . . . Enormous numbers of flints, and also less abundant fragments of chalk, occur in the glacial deposits of the counties bordering the Moray Firth. These transported relics show that the chalk must have been in place at no great distance, if indeed it did not actually cover part of Aberdeenshire and the neighbouring counties."

The Cretaceous rocks of Leavad supply further evidence in support of this view.

¹ *Proc. Roy. Phys. Soc. Edin.*, vol. vi. p. 316.