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XLI.—*The Greensand Fossils from Drift-Beds at Moreseat, Cruden, E. Aberdeenshire, with Exhibition of Specimens Collected.* By DAVID J. MITCHELL, Schoolhouse, Burnhaven, Peterhead.

(Read 15th April 1897.)

THE estate of Moreseat is situated in the parish of Cruden, in the district of Buchan, East Aberdeenshire. It is about 500 feet above sea-level, and five miles west of Buchan Ness.

The existence of the Greensand deposit there was known in the early part of the present century. Dr Ferguson of Kinmundy says: "The fact of its existence was first communicated by the late Dr Knight of Marischal College, Aberdeen, to the late Dr Thomson of Glasgow College." The late lamented Hugh Miller, in his "Sketch-book of Geology," page 113, also mentions the Greensand formation.

It is part of an extensive Cretaceous deposit in Cruden and in the adjoining parish of Slains.

The deposit in Slains, which was examined by Dr Jamieson, Waterton, Ellon, has, on the authority of Mr Searles Wood, been relegated to the "Crag."

The Greensand formation was more fully brought to light under the following circumstances. The late Mr Johnstone, proprietor of Moreseat, made an excavation at his farm-steading for the purpose of putting in a water-wheel to drive a new thrashing-mill.

In the material excavated, pieces of fine light-coloured sandstone (a most uncommon rock in the district) were found. These sandstone fragments, on closer examination, revealed the presence in them of fossil-shells.

This deposit was examined by the late Dr Longmuir, Aberdeen, who wrote a paper on the subject.

The Greensand rock has been aptly described as consisting of "Calcareous sand, visibly stratified, of grayish hue and containing comminuted shells."

One of the fossil specimens got in the rock from the water-wheel excavation was the cast of a large Ammonite. The Greensand bed was found about 9 feet below the surface of the soil. Dr Ferguson of Kinmundy knew of the Greensand at Moreseat, through having noted its existence while attending lectures at college. Before he began his investigations, the bed

above mentioned was beyond reach, as the water-wheel had been put in and the hole filled up. The spare excavated material was utilised for the purpose of top-dressing and levelling some of the fields on the farm.

Dr Ferguson found the most of his specimens in a ditch, while it was being made for the purpose of fencing a newly reclaimed field. This ditch was about 400 yards north-east from the farm-steading. He examined it about the year 1850. He got the Greensand beds at about from 1 to 3 feet below the surface. The deposit extended for fully 100 yards. He had an excavation of about 7 feet deep made. The section of this, as described by Dr Ferguson,¹ "presented irregular layers of unctuous clay of a dark-brown colour and soapy feel, and so tough and adhesive as to render it a work of considerable difficulty to dig it out. Interstratified with this clay were thin layers of a compact sandstone. These layers of sandstone were not continuous. They graduated into each other, thinned out, disappeared, and reappeared most confusedly. They were very much inclined, dipping towards the south. The whole mass had the appearance of having been drifted, although from the nature of the matrix and the state of preservation in which the shells were found, it does not appear as if it could have been transported far. The sandstone is tough and soft when newly dug, but hardens on exposure to the air, and becomes light-coloured in drying. When wet it presents a mottled appearance, the colour being greenish; when dry this almost disappears. The exterior surfaces were often quite reddened with iron. Many of the remains are casts and are on the outer surface of the fragments of sandstone, as well as in the interior of the masses. Of the remains themselves flattened spatangi are most abundant." Dr Ferguson sent his collection of specimens to Jermyn Street for examination, and the best of them are at present in the Museum of Practical Geology.

The experts, Messrs Salter and Baily, examined and identified the specimens. Their opinion was that the species represented, indicated the rock was of the Upper Greensand Age, and that it was a drifted deposit.

Some of the species were new. One was named *Cyprina Fergusoni*, in honour of the finder, Dr Ferguson. Mr Salter wrote a paper on the fossils, describing them and giving reasons for his conclusions. It appeared in the Quarterly Journal of the Geological Society, vol. xiii.

He based his conclusions as to the age of the rock (viz., Upper Greensand) on the occurrence in it of such fossils as

¹ Paper by Dr Ferguson on "Chalk-flints and Greensand," vol. iii. pt. 2, Transactions of Buchan Field Club.

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Galerites castanea, *Arca carinata*, *Pinna tetragona*, and especially of *Thetis major*.

He regarded the discovery as most important and further said: "There are many points of interest connected with the former extension of Cretaceous rocks from Sweden over the northern part of Britain which must receive illustration by the recording of such facts as those." In a note appended to Mr Salter's paper Dr Ferguson gives it as his impression that the deposit is not *in situ* but drifted, but that it could not have come far.

Mr Salter questions the possibility of the soft sandstone withstanding drifting, had it been from any of the known similar deposits in England (the farthest north of these being in Cambridgeshire). He thinks rather that it must have come from some place in the vicinity of its present situation. About two years ago Dr Ferguson, in his retiring address as president of the Buchan Field Club, described his experiences and work. Thereafter I visited Moreseat with some other gentlemen in quest of the interesting deposit. My interest in it was aroused when, in a concluding paragraph of his paper, Dr Ferguson said: "I am not aware that any new facts have been elicited as regards the topics (Chalk and Greensand) which have been our subject to-night, and I feel that the question altogether is one involved in considerable darkness, and that it is vain to attempt generalisation upon it, till the local geology has been far more accurately examined and determined. It is a matter well worth the while of the members of your club to investigate."

The deposit had been practically untouched since Dr Ferguson had worked at it.

All the excavations previously made, from which specimens had been got, were unavailable, as they had been filled up.

The first find was a small fragment of Greensand, which was picked up on the edge of a ditch, about 400 yards north-west of the farm-steading, and about 500 feet above sea-level. The ditch had been previously cleaned, and the Greensand thrown out. Having been left for a considerable time exposed to the influence of the atmosphere it was quite dry and brittle, and broke quite easily. In it was found a small bivalve fossil.

A little to the north, and at a greater elevation, an extensive deposit of fine sand similar to that found commonly on the sea-shore, is to be seen. This is most likely an old sea-beach.

Where the Greensand was picked up an excavation was made in the bottom of the ditch, which here was about 3 feet deep.

The same order of things as described by Dr Ferguson was discovered. There was the same dark brown soapy clay. Mixed up with this clay were numerous nodules of Greensand, appar-

ently drifted, as they were much worn and rounded. The pieces of rock found, were carefully broken and examined for fossil remains with some success.

Enough was seen to justify a speedy return visit for farther examination and discovery.

This excavation was frequently revisited, enlarged, and deepened. It proved to be the most important of the several sinkings made, both as regards the quantity of Greensand and its richness in fossils.

The section presented various aspects. Near the top there were the much worn and rounded pieces of Greensand mixed with the clay. These soon disappeared, giving place to layers of the rock, which at first appeared to be solid masses separated by clay. The layers, however, on examination, were found to be in a very shattered condition, which only became apparent when they were handled. They were at various angles, but the general dip was towards south-east. They all gradually thinned out and disappeared. The presence of pebbles of quartzite and granite was noticed for some time, but at the lower part of the excavation they had disappeared, although the Greensand layers and the clay continued right to the bottom. The depth reached would be about 9 feet below the surface of the surrounding fields. The lowest shattered layers were extremely rich in fossils. It was necessary to exercise considerable care in removing the broken pieces from the layers, as very often casts of shells and spatangi were got between the fragments, lying quite loosely. These undoubtedly would have been lost if a spade had been roughly or carelessly used. Instead, the clay surrounding the layers was removed with an old knife, and the pieces of rock and fossils carefully laid aside. Some of the best fossils found were lying loosely between the shattered fragments. In fact, the lines of fracture in the rock generally occurred where there were fossils. The excavated rock was next washed to get rid of the adhesive clay. It was then allowed to dry for some time, and was in consequence more easily broken for minute inspection. Each bit of any size was split carefully and examined for fossils. The results were sometimes very discouraging. The largest pieces were not always most productive of specimens, and contiguous masses were often very dissimilar in their yield of fossils. Generally the rock was easy to manipulate, being soft and fragile while wet, and free and crumbly when dried.

About twenty yards farther north up the same ditch another hole was dug, which yielded similar results. The digging here was a work of considerable difficulty, and the place was in consequence abandoned.

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Some fragments of Greensand were one day picked up on the edge of another ditch, alongside the accommodation road which runs westward over the farm. This spot was south-east of the first excavation. A hole was dug in the bottom of the ditch. Here the Greensand had every appearance of solid rock, but like that in the first excavation it was much shattered, although the fragments in this case were considerably larger. The rock layers dipped at an angle of 30° under the road, whither they could not be followed. The yield of fossils was poor. Most of the pieces of rock were almost destitute of remains, and were harder and closer-grained than in the former pits. The large masses were quite angular, shewing few signs of tear and wear from drifting, and apparently they could not have been carried far.

Several other holes were dug at random in the fields north of the mill-pond on the farm, and numerous specimens of the rock were met with, generally at no great depth under the surface, showing the deposit extends over a considerable area. Many pieces were got along the sides of other ditches in the fields.

The last important excavation from which some of these specimens were obtained, was in the bottom of the mill-pond. Here a hole about 5 feet square and $4\frac{1}{2}$ feet deep was formed. A yellowish clay of a most tenacious character was first encountered. It was exceedingly difficult to dig. Under it the dark-brown greasy-looking clay already referred to was again met with. The Greensand pieces got here were, in the upper part of the section, quite red with rust, and in the lower part of it, quite black. When washed and dried, they were found to be as hard as iron, and hardly breakable. Worst of all, they were poor in their yield of fossils.

These several excavations were the result of oft-repeated visits and much toilsome digging.

A thorough examination of the surface of the higher grounds to the N., N.W., and W. went to show that no Greensand fragments were visible in these quarters as there were farther to the south.

The rock examined by me yielded fully 400 specimens of fossil remains, in the form of casts or impressions. That examined by Mr Insch, of Peterhead, produced similar results.

My collection of fossils was first submitted to Professor Nicholson, of Aberdeen University, with a view to their identification. He advised me to have them examined by an expert in Mesozoic Palæontology. Through the kind offices of Dr Milne, King Edward, and of Professor Judd, my collection and that of Mr Insch, Peterhead, were, with the consent of Sir

Archibald Geikie, examined by Messrs Sharman and Newton, experts in the Museum of Practical Geology, Jermyn Street, London. The result of their painstaking labour has been embodied in a most interesting note, which was published in the Geological Magazine, in June last year.

Their conclusions are most gratifying to the recent investigators, in so much that they indicate that our labour has been not altogether in vain.

As has already been mentioned, Mr Salter concluded from what he found in Dr Ferguson's collection that the deposit therein represented was a rock of Upper Greensand Age.

Messrs Sharman and Newton say: "The specimens sent are all in the condition of internal and external moulds, in a light-coloured, fine-grained sandstone, and although slight differences may be noticed in different pieces of the rock, they are all so similar that one can scarcely question their having been originally derived from the same bed. Notwithstanding this, the fossils clearly indicate *more than one horizon*."

They next notice the similarity of the recent specimens to those of Dr Ferguson in the Museum of Practical Geology in London.

After a scientific description of the fossils, in the concluding paragraph of their paper, they say: "While the *Echinocyphus difficilis*, *Micrabacia coronula*, *Galerites castanea*, and *Pectunculus umbonatus*, indicate an Upper Greensand fauna, the *Ammonites Crioceras*, *Trochus pulcherrimus*, *Astarte-striato-costata*, *Trigonia vectiana*, *Cardium Raulinianum*, *Arca Raulini*, *Plicata placunea*, and *Lima Dupiniana*, point even more strongly to a Lower Greensand Age."

"It would seem, therefore, that the faunas which in the South mark the distinct horizons of Lower Greensand, Gault, and Upper Greensand are, here in Aberdeenshire, included in one bed of nearly uniform character throughout. However that may prove to be, it is clear that these Drift Specimens have been derived from beds where a large part of the Cretaceous series of strata occurs, not only Upper and Lower Chalk, and Upper Greensand, as pointed out by Salter, but also beds of Lower Greensand or Speeton Clay Age."

"What relation these beds may have to the Lower Cretaceous of Sweden, or to the Neocomians of Heligoland and North Germany, which are now occupying the attention of Dr Danes and Professor von Könen, it will be of interest to know; but this must await future investigation."

By these recently identified fossils the district of Buchan is now proved to possess a more complete series of Cretaceous horizons than was formerly known to be the case.

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The work of investigation is still going on, and we are hopeful that ere long, with more complete information, a satisfactory solution of this most interesting geological problem will be arrived at.

Two years ago the British Association gave a grant of £10 to a committee, consisting of Dr Jamieson, Ellon (chairman); Mr A. Jukes Brown, London; and Dr Milne, King Edward (secretary), to help to determine the age of certain rocks belonging to the Cretaceous age at Moreseat, Aberdeenshire.

The work was delegated to Mr Tocher, secretary of the Buchan Field Club, and myself. In the spring of last year the money was expended in sinking a shaft 6 feet in diameter through the deposit. The depth of the excavation is 30 feet, and it is slightly to the north of our first excavation in the ditch and at a higher elevation.

It was hoped that the rock might be found *in situ*, but the result has been quite otherwise.

The shaft passes through clay all the way down. Greensand fragments and then layers are abundant near the top, but gradually get fewer and finally disappear altogether as the excavation increases in depth.

The fossils found in the Greensand from this excavation are in the hands of Mr A. Jukes Brown, who has not yet reported on them, but doubtless something interesting will result.

The full report of the work of the committee as carried out by us will be read at the next meeting of the British Association.

The excavation, I think, seems to prove that the Moreseat Greensand deposit is a drift and not rock *in situ*.

If that be so, how came these beds, and whence?

I am afraid that we can only theorise on that question.

Various ideas strike one. The bed might be the result of drift from some deposit in the vicinity, but no such formation is known to exist.

It might have been drifted from the basin of the Moray Firth, the western and southern shores of which shew evidence of an older series of rocks than Greensand. There are evidences in drift rocks at and around Moreseat that the ice-drift passed thither from the Moray Firth districts.

There is a great probability that the western drift of ice over Northern Europe brought the deposit in question with it from beds (cretaceous) *in situ* somewhere out in the North Sea, towards the east of Moreseat. These beds(?) might be a prolongation towards the west of the Cretaceous series in Scandinavia and Western Europe. That this theory is the correct one might be proved from the fact of the existence of the Crag

deposit in Slains, which is farther to the south than Moreseat, and more distant from the Moray Firth basin.

It is hoped that the Fellows of the Edinburgh Geological Society may be able to prove to their satisfaction which of the hypotheses advanced is the correct explanation of the presence here, in Aberdeenshire, a district where granite is the prevailing rock, of the interesting Cretaceous drift deposit which has been the subject of this paper.

The following list of fossils found at Moreseat was compiled by Messrs Sharman and Newton, and appears in their paper in the Geological Magazine of June last, which see for the scientific description of the fossils.

MESSRS SHARMAN AND NEWTON'S LIST OF FOSSILS (CRETACEOUS)
FROM MORESEAT, ABERDEEN, SHOWING RANGE OF THE SPECIES.

Mitchell Collection.	Insch Collection.	Ferguson Collection.		Lower Greensand, Speeton Clay, etc.	Gault.	Upper Greensand.	Chalk.
		F.	<i>Celenterata.</i> <i>Micrabacia coronula</i> , Goldf.	—	—	×	×
			<i>Echinodermata.</i>				
		F.	<i>Ananchytes</i> (Holaster),	—	—	—	—
		F.	<i>Diadema</i> ,	—	—	—	—
		F.	<i>Discoidea</i> ,	—	—	—	—
M.		F.	<i>Galerites</i> (<i>Echinoconus</i>) <i>castanea</i> , Brong.	—	—	×	×
M.		F.	<i>Enallister</i> (<i>Toxaster</i>) <i>Scoticus</i> , Salt,	—	—	—	—
			<i>Echinocyphus difficilis</i> , Ag.	—	—	×	×
			<i>Annelida.</i>				
	I.		<i>Serpula</i> ,	—	—	—	—
			<i>Polyzoa.</i>				
	I.		<i>Entalophora</i> ?	—	—	—	—
			<i>Brachiopoda.</i>				
M.	I.	F.	<i>Rhynchonella compressa</i> , Lam. (?dimidiata),	—	—	×	—
M.	I.		<i>Rhynchonella sulcata</i> , Park,	×	×	×	—
M.	I.		<i>Terebratula</i> ,	—	—	—	—
M.	I.		<i>Waldheimia hippopus</i> , var <i>Tilbyensis</i> , Dav.,	×	—	—	—
			<i>Lamellibranchiata.</i>				
M.			<i>Arca Raulini</i> ? D'Orb.,	×	?	—	—
M.	I.	F.	<i>Astarte</i> (<i>Venus</i>) <i>Striato-costata</i> , Forbes,	×	—	—	—
M.	I.		<i>Avicula Simulata</i> , Baily,	—	—	—	—
M.			<i>Crasatella</i> (probably),	—	—	—	—
M.			<i>Cardium Raulinianum</i> , D'Orb.,	×	×	—	—
M.			<i>Corbula</i> ,	—	—	—	—
M.	I.	F.	<i>Cucullæa carinata</i> , Sow.,	—	×	×	—
M.	I.	F.	<i>Cyprina Fergusoni</i> , Salt,	—	—	—	—
M.	I.		<i>Exogyra</i> ?	—	—	—	—

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MESSRS SHARMAN AND NEWTON'S LIST OF FOSSILS—*continued*.

Mitchell Collection.	Insch Collection.	Ferguson Collection.		Lower Greensand, Speeton Clay, etc.	Gault.	Upper Greensand.	Chalk.
			<i>Lamellibranchiata—(continued).</i>				
M.			Gervillia (near to rostrata?)	—	—	—	—
M.			„ solenoides, DeFr.,	x	x	x	—
M.	I.		Goniomya, sp.,	—	—	—	—
M.	I.		Inoceramus,	—	—	—	—
M.		F.	Lima Dupiniana, D'Orb.,	x	—	—	—
			„ semisculata, Sow.,	—	—	x	—
M.	I.		„ (near to abrupta),	—	—	—	—
M.		F.	Limopsis texturata, Salt.,	—	—	—	—
M.	I.		Lucina ? sp.,	—	—	—	—
M.			Nucula,	—	—	—	—
M.			Ostrea ?	—	—	—	—
M.	I.		Panopæa,	—	—	—	—
M.			Pecten orbicularis, Sow.,	x	x	x	x
		F.	„ (probably the P. corneus of Nils, not of Sow.),	—	—	—	—
		F.	Pectunculus umbonatus, Sow.,	—	—	x	—
M.		F.	Pinna tetragona, Sow.,	x	x	x	—
M.	I.		Plicatula placunea, Lam.,	x	x	—	—
M.	I.		Spondylus,	—	—	—	—
M.	I.		Trigonia vectiana, Lyc.,	x	—	—	—
			<i>Gasteropoda.</i>				
M.			Actæon,	—	—	—	—
	I.		Cerithium aculeatum, Forbes MS.,	x	—	—	—
	I.		Phasianella (near to eroyna), D'Orb.	—	—	—	—
M.	I.		Trochus (pulcherrimus), Phil.,	x	—	—	—
		F.	„ (small elongated form) [? pulcherrimus],	—	—	—	—
M.	I.		Trochus (conical species),	—	—	—	—
M.		F.	Dentalium cœlatum, Bailly.,	—	—	—	—
			<i>Cephalopoda.</i>				
M.	I.		Ammonites Mortilleti, P. and De Lor.,	x	—	—	—
M.	I.		„ Speetonensis (cf. Payeri, Pav.)	x	—	—	—
		F.	„ Selliguius, Brong. ?	—	—	—	—
	I.		Belemnites,	—	—	—	—
M.	I.		Crioceras Duvalii ?, Lev.	x	—	—	—