

V.—*Recent Geological Changes on the Moray Firth.* By THOMAS D. WALLACE, F.R.S.A. Scot., Head Master, High School, Inverness.

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Introduction.—The purpose of this paper is to localise and describe certain physical features now to be seen in and around the Moray Firth. Before doing so it will be necessary to state clearly the exact area included in the following observations. That arm of the German Ocean usually known as the Moray Firth, is naturally divided into three distinct parts, as follows:—

1st. The most westerly portion, extending from Beaully to Kessock Ferry at the mouth of the Ness, is called the Beaully Firth or Beaully Loch.

2d. The second and middle portion is occupied by the Inverness Firth, and extends from Kessock Ferry to Fort George.

3d. The Moray Firth proper extends from Fort George to the German Ocean.

The whole is bounded on the north by the counties of Ross and Cromarty, and on the south by Inverness, Nairn, Elgin, Banff, and Aberdeen shires.

Area of Observations.—This paper is confined to the Beaully and Inverness Firths, and the south shore of the Moray Firth proper as far as Port Gordon. It takes up the geology of the shore where it was left in the "Geology of Rathven and Enzie," read before the Society (May 1880). It may be interesting to remember that the district under consideration includes the whole of the northern boundary of the "old province of Moray," which included forty-five parishes, and extended along the south shore of the Moray Firth from Beaully to a little beyond the mouth of the Spey.

Shores.—There is a remarkable contrast between the northern and southern shore of the firth. The former is with few exceptions high and rocky, and broken by Munlochy Bay and Cromarty Firth. The latter is with as few exceptions almost entirely low and flat, over which flow the rivers Beaully, Ness, Nairn, Findhorn, Lossie, and Spey.

History.—The history of this area is full of interest to the antiquarian and the archæologist. Although some doubt whether the Romans ever penetrated so far north, there is every probability that they did. If they circumnavigated the island; as they sailed into the mouth of the Moray Firth, the shores of Caithness, Sutherland, Cromarty, and Ross would appear to them

as an island or the shores of another country, and they would naturally sail westwards, hoping to find open sea all the way. The Romans visited these parts not as settlers, but as explorers, and hence the scarcity of Roman remains. From history, tradition, and archæological finds, the old province of Moray must have been the scene of frequent incursions of the Danes and Northmen. But history is not our object here, and therefore we must forbear, and conclude with one interesting fact in its modern history, namely, that on the shores of this firth were born Hugh Miller and Sir Roderick Murchison, whose names will always be cherished with the highest veneration by every lover of scientific research.

Author's Motive in Publication.—Considering it to be the duty of every member of any scientific society to gather facts from which to form theories, and explain phenomena, and not to waste time gathering those facts which will support only those theories already formed without sufficient data, has alone induced me to lay before the Society the following facts, obtained by personal observation and from trustworthy information.

Beaully Loch.—This loch, which measures 10 miles long by $2\frac{1}{4}$ miles at its greatest breadth, is extremely pretty when viewed at high tide, and illuminated with all the glorious hues of a northern summer sunset, gilding Ben Wyvis and the Ross-shire hills in the back ground. Its shores, which are low, are well cultivated and sparsely wooded, afford here and there sites for several prehistoric as well as historic strongholds. Standing on eminences guarding the eastern entrance are the vitrified forts of Craigphadrick and the Ord of Kessock. The Gallow Hill, the grim monument of a former civilization, overlooks the baronial pile of Redcastle. On a well-defined portion of the 90 feet terrace which overlooks the western extremity of the loch, stands the house of Tarradale, the birthplace of Sir Roderick Murchison.

Name of Loch.—The River Beaully, like the Forth, Clyde, and others, may have originally formed and imparted its name to this great estuary. A branch of the river still retains the name Varrar, which it bore in the days of Ptolemy, and gives its name to one of the loveliest of our northern glens. The Vara Arstuarium and Sinus Vararis are names applied to this firth by those authors who have had occasion to mention it in the Latin tongue.

Physical Features of Loch.—The loch is very shallow, so shallow indeed that at low water a boat can with difficulty be navigated through its tortuous channels. The bed of the loch may be described as an extraordinary accumulation of sand banks with two well-defined channels between them, and which are kept open by the River Beaully, and the ebb and flow of the

tides, which are very strong. The sand banks vary in form, according to their positions to the different currents.

It receives the waters of the Beaully River, Moniack Burn, Alt-na-Cardiach, Bunchrew Burn, and the waters of the Caledonian Canal. All these, flowing for considerable distances over the Old Red Sandstone area, supply the loch with the accumulations of sand referred to above.

Terraces.—In and around this loch there are many evidences of geological changes. On the north shore there are extensive and well-defined portions of the 90 feet terrace. At Kessock Ferry, which is the outlet of the lake, along with the fragments of the 90 feet terrace, are associated portions of other terraces of various heights and dimensions. All these rise seawards; that is to say, they are higher at their eastern extremities than their western. It is a little difficult to account satisfactorily for this seaward elevation.

Changes.—When the sand and mud, which are carried down by the streams into the loch, are met by the flowing tide, which, as has been said, runs very strongly in the narrow channels, they are thrown back and diffused over the sheltered bays and deposited through the quieter waters. This will ultimately raise the bottom of these bays, or in other words continue to make them shallower. While this must be the inevitable result of the present operations, it is also evident from facts now to be stated, that there has been a very extensive overflow or rise in the level of the sea upon some of these shallow bays. I have read and heard it frequently stated that the Beaully River, anciently called the Farar, once flowed as a river through the entire length of the "Moray Firth." "Although this might be in general presumed to have been the case, its application in any one particular may still be difficult. It requires no common exertion of the mind, even in idea, to represent this country before the excavation of the Moray Firth, when the highest lands of Birnie were continuously conjoined with the Sutherland hills, and no sea intervened between Duncan's Bay and Peterhead; but that the Varrar, receiving the waters which now constitute the Ness, Nairn, and Findhorn, in its course meeting with the Spey also on the south, and the Conon from the north boiling in rapid eddies around the Knock of Alves, rolled in one vast volume along the side of the hills of Enzie and Cullen, and discharged an immense cataract of extremely turbid water far eastward into the German Ocean."

Cairns.—From minute personal observation, evidences of this condition of things seem to exist in the Beaully Loch. From the mouth of the Ness and along the channels in the loch there is a series of cairns. Some of them bear special names, others do not, Cairn Airc (the Monument of the Sea) is at the mouth of

the Ness, Cairn Dhu (Black Cairn) with another nameless one are on a sand bank. Further up the loch and near to Redcastle there is another large one with several smaller ones. These are considerably within high-water mark, and "from the urns that have been found in them" they must have been used as sepulchral mounds. As it is not at all probable that the primitive builders of these mounds would have buried their dead within high-water mark, the sea must have overflowed what was dry land when these people inhabited the shores of the firth. Again, as they would be originally placed at a considerable distance from the water's edge, our ideas are carried back to the period when the estuary terminated with the influx of the Ness at least, and the course of the Beaully alone winded along the margin of the vale.

This change may be accounted for in several ways, but we would suggest in passing that it may not be owing to any actual upheaval or depression of the land, but probably to the different alterations of the area of the firth.

At the depth of 30 feet below the Tarradall terrace, which is a portion of the 90 feet terrace, a deposit of hazel and alder twigs, leaves, and fruit have been found. This points to the growth and fructification of the trees previous to the deposition of these gravels. From the quantity of mussel and other shells, including the oyster, which are found in these gravels at Wester Lovat, and at the back of the schoolhouse at Beaully, it is evident they are of marine origin as far as their present arrangement and stratification are concerned. This shows conclusively that no change has taken place in the climate of the north of Scotland since the deposition of these gravels.

Changes in River Channel.—There are also most interesting and well-defined evidences of many changes in the channel of the Beaully River.

1st. Previous to cutting the gorge out of the Old Red Conglomerate at the celebrated Falls of Kilmorack, the river evidently flowed in a straight line from the top of the gorge towards Beaully.

2d. After leaving this channel it flowed past the Established Church Manse at Kilmorack, along the line of the present road to Beaully, which passes the manse.

3d. The most recent change which has taken place was when the river changed the course in one night, at a place below the "Falls of Kilmorack," which led to a lawsuit between the Bishop of Ross and the Bishop of Moray for possession of the land. The river when in flood still fills a portion of this channel.

4th. Another channel may be traced through Moniak Moss (now drained) in the parish of Kirkhill, into the firth to the east of Clunes Railway Station. The church and manse of Kirkhill

stand upon the high ground which divides this old channel from the present course of the Beaulieu.

Inverness Firth.—The Inverness Firth extends from the mouth of the Ness to Fort George, a distance of $8\frac{1}{2}$ miles. Its greatest breadth is $3\frac{1}{2}$ miles. The shore on the north side is high and consists of Old Red Conglomerate, which comes down in many places to the water's edge. Munlochy Bay opens through this shore for a considerable distance inland. From Kessock to Fortrose fragments of terraces of various heights and dimensions are here and there to be met with, having a tendency to rise a little towards their eastern extremities. There are terraces on both sides of Munlochy Bay exhibiting the same features. These terraces form sites for the villages and mansion houses along the shore, as at Kilmuir, Avoch, and Fortrose.

Terraces.—The south shore is bounded by the 90 feet terrace, which rises to 117 feet as it nears the hills. Following this terrace from Inverness eastwards, it slopes gently down towards the low lying lands of Nairn and Moray shires. It can also be traced westward to Fort Augustus, Fort William, and Ballachulish. Its presence on the north shore of the Moray Firth has already been stated. It is cut through by the Ness and various streamlets which flow into the firth. Inverness is built partly on it, and a magnificent view of the surrounding country can be obtained from its highest parts. The terrace consists of gravel, sand, and boulder-clay, exhibiting all the different features of current bedding. Screetown Burn is cutting its way back from the sea towards the farm of Stoneyfield with marvellous rapidity, displaying on both sides very fine sections of boulder-clay. This cutting is 5 or 6 yards wide at the lower end, and narrows to a few feet at the upper, and is about 25 or 30 feet deep. The stones in the clay are all smoothed and rounded, but owing to their extreme hardness no decided striæ are to be detected on them. During heavy rains the stream carries down great quantities of this clay and sand to be deposited on the shore, in delta shape, through which its waters find their way to the firth by different channels.

Bays.—There are three bays on the south side, Culloden Bay, Petty Bay, and Campbelltown Bay, which are covered only at high water. Their low water marks may be roughly described as straight lines drawn from the eastern to the western points of the bays.

Petty Bay is shallow and muddy, and on its south shore lies a large boulder which was, on the night of the 20th February 1799, removed seawards about 260 feet. The stone marked the boundary between the lands of Culloden and the Earl of Moray, and many are the explanations given of its removal. Some say it was done by an earthquake; but the general opinion seems to

be that a large sheet of ice, having frozen fast to the stone, was the means, with the help of wind and tide, of changing its position. In this bay there was once a tide mill, remains of which are still to be seen.

Oyster Deposits.—Formerly oysters must have been plentiful in all these bays, as can be proved by the numerous deposits of shells under the sand and mud. At the mouth of the Millburn near Inverness, and in fact all along the shore, there are great deposits of oysters and other shells. In 1758 there were oysters in Petty Bay. But forty years after that they are reported to have disappeared. They are still in the firth, and smacks from England come to dredge for and carry them away to southern markets.

Clay Deposits.—There are several deposits of very fine clay in and around the south shore, which seem to have been deposited in hollows or pools through quiet waters. The deposit at Culloden Tile Works is interbedded with fine sand, and is about 11 feet thick. It shows fine bedding, but is almost destitute of stones; as yet no shells have been found in it. The strata exhibit undulations, which could not have been the result of pressure, but simply of the clay deposited on an undulating surface, probably indicating the contour of the smoothed rock underneath. The different beds which dip and thin off towards the north might be accounted for by different periods of deposition, between which the beds of sand would be laid down by currents. A deposit of blue clay is to be seen at different points on the shore, and one near Fort George may be here mentioned which contains shells in great abundance.

Changes at Campbelltown.—Between Campbelltown and the fort the sea is gaining on the land, or rather on the deposits of gravel which the sea has at some former period laid down here. On the north side of the fort the sea is gaining very rapidly on the land. These are to be accounted for by the action of the currents from the west and north-west, which are the combined results of the wind and ebb tide. The material carried away from the Campbelltown side of the fort is deposited on the point to the west of the fort, while that taken from the north side of the promontory is carried eastwards to assist in the accumulation of land on Whiteness Head. Between the fort and the carse wood there are three ridges of gravel (similar to those at Lossiemouth), extending for about 3 miles long and 12 yards apart. Between Fort George and Nairn there is perhaps the most remarkable reclamation of land to be seen on the whole shore. The present tenant of the farm of Ellismore—Mr M'Pherson—says that seventy-six years ago, when his father was a boy on the same farm, the tide in one hour rose over the land as far as 1000 yards from the present high-water mark.

During this high tide his grandmother took to bed with six lambs to save herself and her pets from a watery grave.

Whiteness Head.—About fifty years ago high-water mark was 300 yards farther inland than the present, and within the last twenty-five years there has been a gain of over 100 acres of land along the shore. The whole of Whiteness Head consists of a series of sand banks which are dry at low water, and the outer one is seldom covered even at high water. To all appearance the whole of Whiteness Head will very shortly become the property of the farmer, by the natural accumulation of sand heaped up by the north-west and north-east tides.

There is another agent in the same locality working hard to bring about the same result, namely, a tongue of land extending from opposite the fisher town of Delnies, westwards towards Fort George for a distance of about $1\frac{1}{2}$ miles. This accumulation has been formed within the last sixty years, and consists largely, if not entirely, of gravel, pebbles, and shingle scooped out by the north-east current striking on the shore to the west of Nairn. The action of the sea is so much felt at this latter point that it is sought to be counteracted by artificial walls. Once this tongue of land extends as it is rapidly doing to Whiteness Head, the sea will be shut out from hundreds of acres that can be speedily turned to agricultural purposes.

Nairn.—On the south side of the town of Nairn, on the bank of the river, is the Castle Hill where stood the royal fort of which the Thanes of Cawdor were hereditary constables till the year 1747. The constabulary garden is still distinguished as an article of the valuation of the estate to the extent of £3, 10s. Scots. At a very remote period of antiquity the castle was situated near to the shore, upon the influx of the river, which, similar to the Spey and Findhorn, then flowed half a mile farther westward than its present termination. There were some persons alive in 1798 who remembered to have seen at spring tides vestiges of its foundation, at present a considerable way within the bed of the ocean.

Culbin Sands.—The sand hills of Culbin stretch from the mouth of the Findhorn to Nairn, a distance of 9 miles. This used to be one of the most fertile parts of the proverbial "Granary of Moray." When other parts of the surrounding country were uncertain in their yield of crops, the Baron of Culbin had nothing to fear. Notwithstanding its former fertility, there is now nothing to be seen but a wide waste of constantly shifting sand. After strong west winds some of the soil is frequently laid bare, and the furrows left by the plough previous to its devastation, are distinctly to be seen; and what is in some respects more interesting, the tracks of cart wheels as they had crossed to and from the shore. Valuable

relics of prehistoric days are picked up in several places from which the sand has been blown. These seem to be chiefly on the old banks of the Findhorn or on the old sea beach. Remains of shell mounds or "kitchen middens" are to be seen, with split bones, deer horns, flint arrow-heads, coins, bronze keys, fragments of pottery, hooks, nails, copper fastenings, and beads made of vitrified glass. Remains of the same ridges of gravel, so often mentioned in this paper, are also at times laid bare by the wind.

Before this accumulation of sand the annual rental of the Barony of Culbin has been computed to be £6000. In the year 1694 or 1695 the estate was almost entirely overwhelmed, or at least to such an extent as to cause in July 1695, Alexander Kinnaird, the proprietor, to petition to be exempted from paying the public dues, because, as he said, the best part of his estate was destroyed "so that there was not a vestige to be seen of his manor place of Culbin, yards, orchards, and mains thereof, and which within these twenty years were as considerable as many of the county of Moray."

Theory of Sand Hills.—Whence all this sand? is one of the most interesting questions in connection with this and other similar accumulations on the south shore of the Moray Firth.

While sand is no doubt carried down to the sea by the rivers which enter the firth, yet one greater source seems to me to be the washings of the shore, combined with the westerly flow of the tides. This is especially the case between Nairn and Fort George, where hundreds of acres of pure sand have been and are still accumulating. Then in Burghead Bay the same washing is going on and the sand carried westwards by the tide. This sand is thrown up on the shores, dried in the sun, and its fine particles raised by the wind and carried inland.

Findhorn.—The present village of Findhorn is said to be the third that has been built. The first was 6 miles to the westward of the present one, and is now covered up completely by the Culbin Sands. The second was to the north-west of the present village, and had to succumb to the same enemies that had overwhelmed its predecessor. What is now the north end of the village was the south end, in the recollection of the very oldest inhabitants. "A slip or ridge of ground along the shore on the western side of the River Erne appertains to the parish of Kinloss (1798) and to the estate of Muirtown. About a hundred years ago (1698) the river flowed westward nearly 6 miles converging with the shore. When the river gained its present direct course, this ground, by the water stagnate in its former bed, became an island, for many years affording secure pasturage for sheep and cattle; but by the drifting of the sand this ancient channel is now filled up, so as to be an island only

during high water, divested of much of its accommodation, and the pasture greatly injured by the overspreading sand."

"Prior to the year 1701 the town of Findhorn, regularly built, stood upon a pleasant plain, a mile north-west from its present situation, and now the bottom of the sea. The eruption, though completed in one night and by one tide, had long been apprehended, and the inhabitants had gradually withdrawn. It is probable that the drifting sand accumulated by the united power of wind and tide, dammed back the river, forcing open its present course, and overwhelming the village."

Burghead Bay.—At that time a pretty level moor stretched in a right line along the shore from Findhorn to Burghead, for the distance only of 5 miles. The encroachment of the sea in a semi-circular bay has made the distance now by land a little more than 10 miles. The inhabitants of Findhorn were in a great measure supplied with fuel from this moor, the cutting up of which might have been the cause of the encroachment. On this moor near the shore stood a conical mound evidently artificial, about 40 fathoms high. It was called the Douff hillock, and afforded a view of the firth and the whole country round. An old man living in 1798 had gathered berries among the heath round its base. Many roots and trunks of trees were then found in the moor, and a few are still dug in the Moss of Hatton, confirming the truth of the tradition that a forest once occupied what is now the bottom of the sea and the downs between Findhorn and Duffus.

Changes.—The sand banks afford a feeble barrier to the power of every storm from the north, by which they are themselves forced further on the shore, and banks of peat earth are thereby discovered 6 or 8 feet below the sand. Within the flood-mark of the bay of Findhorn, where the estate of Muirtown borders with West Grange, in the year 1787, pretty extensive beds of peat earth were discovered, deemed such a treasure at first as to excite a lawsuit, as on the records of the Sheriff Court, between the landlord and his tenants, even for the duration of the current leases; but after the commencement of the litigation it was found that this fuel had such an offensive smell, and such corrosive power on kitchen utensils of copper and iron, as to be absolutely improper for any domestic purpose. This peat was found at a depth of 2 or 3 feet under the sand, not in a continuous bed, but in detached banks, as if covered by sand when formerly used, in a period beyond the remembrance of the passing generation.

At the present day, while the bay between Findhorn and Burghead is gradually sinking, so that the traces of the old forest have almost entirely disappeared, the land at Findhorn is accumulating. This is accounted for by the action of the tides and currents in the bay. The chief current is from the north-

east, which strikes upon the shore between the Mill Burn and the Bessie Burn; but is strongest in the neighbourhood of the latter, and carries the gravel and sand along the shore westwards to Findhorn.

Findhorn River.—The same action is filling up and altering the mouth of the Findhorn. So much so is this the case that not many years ago there was a sand bank in the mouth of the river which formed a passage between it and the shore, called the "Ee" (Eye), through which ships used to pass. This "Ee" is entirely filled up now, and what was formerly an island of sand is now connected with the Findhorn shore.

The present village of Findhorn is, in the mean time, in no danger of sharing the fate of its two predecessors.

Between Findhorn and Forres there is a large bay about $3\frac{1}{2}$ miles long and 4 miles broad, entirely covered by the tide at high water, but left dry after the ebb, with the River Findhorn flowing through it. It receives the Findhorn River, Forres Burn, and the Kinloss Burn, all of which carry down (especially the Findhorn) mud and sand in great quantities.

There are only two boulders in this bay, one of granite and the other of gneiss, which must have come from the south-west.

Burghead.—Burghead stands upon a bold headland of Upper Old Red Sandstone, surrounded almost by the sea, and considered by some to have been an island. To the south of Burghead there is a great accumulation of sand hills, composed of blown sand, which extend westward as far as Nairn.

Much has been written with regard to the origin of Burghead. Some maintain that it is of Norse origin, and others bring forward proofs to establish its Roman origin. Its geological history is equally interesting. The headland consists of a portion of the famous reptiliferous sandstones of Elgin, covered by an artificial deposit of earth and stones. The sandstone exhibits fine examples of the usual current bedding; one section shows the direction of the chief currents to have been from the south, with others from the north, and masses of pure quartz pebbles terminate the wave or current. The hard rock is interbedded with soft ferruginous sand. There are numerous examples of sun-cracks in the cliff overhanging the sea on the "head." The cliff indicates clearly the sea-level at a former geological period, for at the height of 30 feet above the present high-water mark there is a bed of gravel 3 feet thick, containing a deposit of marine shells covered by 3 feet of black peaty soil, which is capped by an artificial layer of 4 or 5 feet thick. The latter was probably at one time much thicker.

On the authority of people still living, the sea is rapidly encroaching on the land, to the west of the "head," but slowly receding on the east. About one hundred and fifty years ago

the children of Burghead used to be able to pass from there to Findhorn on the stumps of the trees of the submerged forest. Burghead Bay measures in a straight line to Findhorn little more than 5 miles, and $1\frac{3}{4}$ miles from this line to the shore at the widest part. The shore for $1\frac{3}{4}$ miles, to the Mill Burn, consists of sand hills, and from thence to Findhorn of accumulations of gravel ridges, about 8 or 10 feet above the present high-water mark. The bay itself consists of sand, covering an extensive peat moss, with the remains of the old forest resting on a deposit of blue clay.

Changes on "Head."—It is evident from the deposit of shells on the "head" that high-water mark was at some former time 30 feet higher, or that the land was 30 feet lower than at present. The land then rose, leaving the greater portion of the old province of Moray a marsh, with the Hill of Alves, Rosisle Hill, and other high lands as islands. Gradually moss grew and trees sprang up into a forest. Then another submergence took place, and this moss and forest were covered with a deposit of gravel to the depth of 8 or 10 feet. Then the land began gradually to rise *into its present position*, and the action of the waves and currents to eat into, and carry away the gravel, and lay bare the forest.

Gravel Ridges.—On the authority of people now living, great changes have been, and are still taking place. The sea is rapidly encroaching upon the land. The old road to Forres used to be within the present high-water mark. Again, the sea is cutting into the gravel banks, and washing and rearranging the gravel in ridges on the shore, in a similar manner to those ridges already referred to. The tides from the north-east are gradually conveying this gravel and sand towards Findhorn, and working the changes before mentioned. These old gravel ridges, which extend from Hatton to Findhorn, are about a mile in breadth, and are as bare and entire as the day they were left by the tide.

They are of various heights, and measure from crest to crest 3, 4, 6, 8, 12, 14, and 20 yards.

About $2\frac{1}{2}$ miles to the south of Burghead there is a farm called "Buthill," which some say is a corruption of "Boathill," and is pointed out as the place where the ferry landed or embarked passengers from Rosisle and Burghead. This is open to question; but the following can be relied on:—"Near the eastern end of the Duffus Valley there is a place called 'Ardivot' (the Hill of the Boat). A gentleman still in the neighbourhood has seen persons who crossed by this boat."

Lossiemouth.—The village of Lossiemouth, as its name implies, stands at the mouth of the Lossie, on a flat sandy plain very little above sea-level. Near the mouth of the river, and situated

on an elevated rocky peninsula called Coulard Hill, stands the thriving village of Branderburgh. A little to the west the beautiful little village of Stotfield is situated on a grassy slope, facing the firth.

The changes that have taken place in this locality in recent times are something wonderful. The old harbour of Lossiemouth, which was opposite the site of the present railway station, is now in ruins, having fallen a helpless prey to the violence of the north-east currents which constantly beat against it. The old harbour of Stotfield is also in utter ruins, and has almost entirely disappeared under the sand. While making the harbour at Branderburgh, all the rubbish was thrown into the sea. This has been carried westwards by the tide and deposited in a ridge along the shore above high-water mark, as far as the mine at Stotfield. This ridge is from 10 to 12 yards wide at the base, and from 5 to 6 feet high at the crest.

Coulard Hill.—The Coulard Hill is composed of the Upper Old Red Sandstone, which has proved highly fossiliferous. Upon this sandstone there is a deposit of flinty rock, which is known as the Cornstone of Elgin, and which may be seen on the shore from Branderburgh to Stotfield, and has proved at the latter place to be highly charged with galena and several of the allied minerals.

Lossiemouth Lead Mine.—The following is a short account of the mine and some of the minerals, supplied by one of the gentlemen in connection with it.

"White Sandstone or Freestone with Galena intimately associated."—I have traversed this deposit and discovered what appears to be a true fissure vein, having a mean bearing to the south-west and north-east, entering the strata at about an angle of 80°, with a well-defined footwall to the north-west, and, as usual in such cases, very wide on the top, carrying good ore for nearly half a mile in length. As to its continuing so large and rich down to any great depth remains to be proved by exploration. I have found the ore in this rock at a depth of 45 feet from the surface.

"Red Sandstone."—Of this rock the Skerries opposite the mine are composed. There are several ridges, the lines of which can be distinctly seen at low tide. They are parallel, lying east and west, and those points which are always seen are the highest points of some of the ridges. Opposite the shaft there is an outcrop of silicious spar, highly charged with galena, in fact I broke therefrom a rock of ore, over a ton, four-fifths of which was galena. Here also I may mention, two lodes form a junction. At such points we invariably find master-lodes very rich, and all lodes, however insignificant, take a decided favourable change where such occurs. This is a point of great importance

to the precious metal miner. Here also, at this particular point, we can more clearly notice the junction of the lodes imbedded between the white and red sandstones. This fact I consider the leading cause of the deposit being so large, 169 feet wide. We have therefore the lodes forming a junction as well as the white and red sandstones merging into each other. Each rock appears, and particularly the red, to be metamorphosed at first sight, while on closer examination it will be seen that their close firm texture is owing to their being highly charged with silicious matter.

"Galena and Silicious Spar.—This mineral is most abundant here. It occurs in smallest quantities in the very hard and almost pure silicious rock. I have frequently observed in other localities where we have the true crystalline rock, the lodes are always richest. The ore in this locality contains 75 per cent. of metal, together with 3 or 4 ounces of silver to the ton of mineral.

"Phosphate of Lead.—This is a very rare variety of lead ore. It usually occurs crystallised, solitary, or in groups, forming hexagonal prisms with basal planes, often modified by faces of the hexagonal pyramid. It usually contains about 70 or 80 per cent. of metal.

"Galena and Blende, or Zinc-Ore.—This is a very common and faithful associate of lead-ore, occurring crystallised and amorphous, forming the rhombic dodecahedron, octohedron, &c., often hemihedrally modified, and frequently twinned, the forms being often difficult to determine.

"Mundic or iron pyrites, with silicious spar. Very common.

"Carbonate of Lime.—Crystallised or calcareous spar. Lustre often more or less shining, between vitreous and pearly colour; very various, usually more or less transparent and double refractive, often associated with galena.

"Galena with copper frequently found associated, especially in deep mines.

"Gossan.—This mineral is principally composed of spar and iron, frequently found on the top of rich metallic lodes, and where any quantity exists, there is usually a good deposit of mineral. The gossan itself usually carries silver ore in the form of very fine sand, in which case it is sent off to the smelter just as it comes out of the vein. Gossan seldom holds down deeper than 20 fathoms or so, when some other lode takes its place, with a rich course of ore continuing."

Buckie to Covesea.—There can be no doubt that the waters of the Moray Firth from Buckie to Covesea, which is a distance of over 20 miles, are receding from the land. This is not caused by the mass of land rising, but by the sea banking itself out with the aid of the wind. Some of the present old inhabitants of Stotfield say, that within their memory, spring tides used to

flow in on a level piece of ground immediately under the village. This is now green sward upon a very slight covering of vegetable soil overlying shingle. Within the last six years several acres of shingle have been formed on the beach, which has been gradually filled up with sand blown from the shore during ebb-tides. The formation of the beach between Branderburgh and Stotfield would naturally have caused the sea to overflow the flat land to the east of Stotfield, but this has been prevented by the sand accumulating in this bay and thus banking out the water.

Lossiemouth to Kingston.—From Lossiemouth to Kingston at the mouth of the Spey great changes may be seen taking place daily. Travelling from Lossiemouth to Kingston, 6 miles of pure sand are first got over, which, when dry, is very liable to be drifted by the wind. It is generally carried southwards and formed into enormous banks, which if not covered with bent would be constantly shifting. These 6 miles are succeeded by 3 or 4 miles of pure shingle, which at their widest part are from three quarters of a mile to a mile. This shingle is continued in one great bank as far as Portgordon. The village of Kingston is built not only on it but of it. Their gardens consist of earth that was from time to time brought as ballast in the numerous ships which used to visit its busy harbour.

River Spey.—The changes at the mouth of the Spey are very remarkable, although they have proved most disastrous to the inhabitants of this interesting little village.

The Spey in flood is a very dangerous neighbour. This was painfully true in 1829, when so much damage was done to life and property. The amount of debris carried down in that year must have been enormous. As a proof of its carrying powers, when the bridge of Fochabers was carried away by the flood of 1829, some of the largest stones were found at the sea in the mouth of the river. Twenty-six years ago the mouth of the river was fully half a mile to the west of its present mouth. The place is marked by a solitary house on the beach. At the same time a new mouth was cut for it about 200 yards from its present mouth eastwards, which is now also filled up with gravel. So rapidly is the river again seeking westwards, that in the months of June, July, and August of this year (1880) it had gone fully 20 yards to the west, so that the tendency of this as of all the other rivers on the south shore is to go westwards. In the opinion of several persons who have given attention to this subject, the Spey once flowed through the valley now occupied by the Great North of Scotland Railway between Elgin and Rothes. The Spey is no doubt the cause of the accumulation of gravel on the shore between its mouth and Lossiemouth. The gravel carried down by the river is cast upon the shore by the

action of the strong westerly tidal wave. There is now a delta at the mouth of this river, which is gradually filling it up as well as the harbour, where twenty or thirty years ago many ships could lie at anchor. The land along the right bank of the Spey from Fochabers seawards is very flat, and bounded by an irregular line of high terrace which runs from Fochabers to Portgordon. On the left bank the land is high, corresponding to the terrace on the right. At Garmouth it deflects to the west, and may be said to end with the Black Hill, an enormous accumulation of sand and gravel.

Loch Spynie.—Mention might here be made of the Loch of Spynie and the Lossie. History tells us that the loch continued an arm of the sea down to 1397. "It is proved from the chartulary of Moray," says Mr Young in his "Parish of Spynie," "that Spynie was a town and harbour inhabited by fishermen; who sailed from Spynie to the sea, and that boats and nets were kept by the bishop, Alexander Bar, in the lake for catching salmon, grilises, and other fish, and that he and his predecessors had exercised all acts of navigation therein." This loch, which was more than 3 miles long and 1 broad, is now drained, and the sea is at a considerable distance from it. Perhaps the most extraordinary ridges of gravel on the whole shore of the firth are to be seen between this loch and Lossiemouth; but they must be seen to be thoroughly understood.

Conclusion.—In conclusion, attention is directed to the following facts:—

First. All the rivers that have been mentioned in this paper at no distant date entered the firth at points considerably to the west of their present outlets, and they are again tending in that direction.

Second. Some of these rivers have not only changed their mouths but their channels for considerable distances.

Third. All around the shore of the firth there are beaches or terraces of different origins and of different dimensions.

Fourth. In some places the sea is gaining upon the land, and in others the very reverse is taking place.

Fifth. These accumulations are almost entirely confined to the south shore.

These and many other interesting facts demand attention, and raise questions which we cannot here wait to answer.

The author hopes at some future time to be able to return to this subject, when he will supply any additional facts that may have been overlooked, and give what seems to him to be the explanation of some of the more interesting features.