NOTICES OF THE NEWER PLIOCENE DEPOSITS IN SCOTLAND AND THE WESTERN ISLANDS.

Entering Scotland by the well-known locality of Gretna Green, evidences of the former level of the sea are noticed in the Statistical Account of the parish of Gretna,* and also in the adjoining parishes of Dornoch† and Ruthwell.‡ Lochar Moss rests upon marine beds. I suspect, however, that part of them has been silted up in modern times, as vessels and anchors have been discovered in them. In the county of Kirkcudbright there are elevated shelly beds, on the east side of St Mary's Isle,§ and in several places the fossil shells are used for manure.‖ In Wigtonshire there are extensive tracts full of them.¶ At Cassincarie, in the parish of Kirkmabreck, there is a bed of littoral shells, at an elevation of 18 feet.** On the west coast of Scotland, these deposits can be observed in Loch Ryan,†† and in the Bay of Ayr. The Rev. Mr Landsborough of Stevenston, in a letter to me, thus notices the elevated beds in his parish :—

"There is a cave at Ardeer-house ; the rocks which form the walls are evidently water-worn. This cave is near the base of the eastern termination of a ridge, which, with some breaks, is continued from this to Largs, which I am convinced was once the bounding barrier of the sea. Owing to the mining operations that are going on,

* New Stat. Acct., Dumfries, p. 263.
† Stat. Acct., vol. ii. p. 18.
‡ New Stat. Acct., Dumfries, p. 220.
§ Stat. Acct., vol. xi. p. 30.
‖ Ib. vol. xv. p. 62.
¶ Ib. vol. xiv. p. 473, and vol. iv. p. 139.
** Information from the Rev. Dr Lawrie.
†† Stat. Acct., vol. ii. p. 48.

we have every proof of it in this parish. Betwixt the terrace and the sea, in sinking a coal-pit, they generally have to dig through from 18 to 25 feet of sand, before they come to the stratum of clay in which the shells are found. They occur in the churchyard, at an elevation of 55 feet. The quarry where I found the shells is from 15 to 20 feet above the level of the sea at high water. The ridge at the church-yard consists of coarse gravel and sand. The shells found at the quarry were nearly all littoral."

In the account of the parish of Ardrossan, we are informed that " There are many reasons that lead us to conclude that a considerable portion of the lower grounds of this parish were under the dominion of the sea. Sub-fossil sea-shells, such as are at present found on the shore, have been found in gravel pits, and in the earthy banks of Stanley-burn, as far up as Kirkhall. They have been also found in a section of the Castlehill, pretty near the summit," &c.*

In the adjoining parish of Kilbride, the ancient sea-cliffs noticed by Mr Landsborough rise to the height of 300 feet, and continue parallel to the present coast line of the frith of the Clyde, nearly through the whole of the county of Renfrew. Whilst there are corresponding ones in the islands and opposite shores of the counties of Argyle and Dumbarton, above Dumbarton the high lands recede, and the river Clyde now flows through what must have at one time been the bottom of an extensive inland sea, of which Loch-Lomond, with its tributary valleys, formed a branch. In every part of the coasts of Argyleshire, the ancient cliffs form a marked feature. Dr Thomson† observes that, " on the west coast of Lorn, from Dunstaff-

* New Stat. Acct., Ayr, p. 194.

† Outlines of Mineralogy and Geology, vol. ii. p. 187.

nage to Gallochin, an extent of about eight miles bears unequivocal marks of having been elevated, at no very remote period. A considerable portion of this coast consists of pretty steep rocks, the summits of which are elevated 300 or 400 feet above the level of the sea. These rocks show clearly that they have at no very remote period been washed by the sea, at a height certainly more than 30 feet above the present high water mark." On the west coast of the county of Inverness, Glengarry informs me that he observes the ancient cliffs and terraces abounding with sea shells; and at Lochalsh, in the same county, a sub-marine forest has been observed.*

Similar indications of change of level are to be met with in the islands. At Ballaugh, in the Isle of Man, Mr Forbes found them in beds of gravel and sea-sand several feet below the surface, but a greater number above the level of the sea, and from one to two miles inland. These contain sea-shells, bleached, but often tolerably perfect. They all appear to belong to the present era, with the exception of a Nassa allied to the *N. macula*, but with the spine less produced, the body short, much more ventricose, and the longitudinal ribs fewer. It is named in the catalogue *N. Monensis*. I have already noticed the occurrence of elevated marine deposits in Bute and Cumbra. I have also observed them in Arran and Inchmarnoch. In the Geological Transactions† Captain Vetch gives an account of sea-worn terraces in the Island of Jura. I am indebted to the Rev. Mr Cameron of Kilchoman for the following account of similar phenomena in Islay. "A large extent of surface has been added to this island, in

* Communicated by the Rev. Wm. M'Lean to the Rev. Wm. Smith of Inverary. See his account of a submarine forest in Tiree.—*Edin. New Phil. Journal*, 1829.

† Edin. New Phil. Jour., second series, vol. i.

consequence of the change of level. When the sea stood at the former level, Islay must have consisted of a cluster of isles. What at one time was under the dominion of the sea consists now partly of arable land, partly of banks of rolled stones, about the size of six-pound shot, partly of downs formed of broken sea-shells, clay-slate, and quartz, so minute as to be blown about by the wind—partly of morasses and fresh water lakes round the head of Lochindaal. The former sea-line is as well defined as it is in Rothesay Bay, or any part of the banks of the frith of Clyde. Islay House, with its garden, and a good extent of its ground, stands over the plateau left by the retiring of the sea. In various parts of the island, whatever form the surface of this plateau has assumed, I have found on digging, sea-sand mixed with shells of the species that still abound in the various inlets; in the parts of it converted into morasses, large oaks are to be found, which appear to have been growing on a bed of clay and sand incumbent on a bed of sea-sand and sea-shells.

The range between the traces of a former high water mark, and the present low water marks of spring tides, is, I would say, not under 40 feet, and I would almost venture to call it 45 feet. The west side of the parish presents a line of about twenty miles to the unobstructed flow and swell of the Atlantic, and it is to this line the above measurement is applicable."

In the Island of Mull the same terraces are observable, and the same marine remains are to be found. In Lismore there is a bed of shells composed of all the varieties to be found on the coasts, which has formed a concretion nearly as hard as the limestone rock which surrounds it about 7 or 8 feet above the ground.* In Tirey, the

* Stat. Acct., vol. i. p. 494.

Rev. Mr Smith has described a sub-marine forest, and in Skye Dr MacCulloch notices a series of terraces on the shore, "exhibiting precisely the same appearances which characterise the terraces that line the alluvial valleys through which active rivers have cut their way," and which, of course, owe their origin to the same causes which have in other places produced like effects.

In the Orkney Islands, submerged forests have been observed, and on the north coast of Scotland, the Earl of Caithness informs me that near Scotland's Haven there is a bed of oysters 40 or 50 feet above the sea level. His Lordship has also observed on the north-east coast, a littoral deposit between Wick and Duncansbyhead, about a quarter of a mile inland.

The ancient terraces extend from the ord of Caithness to Banff.* At Tain, Mr Jardine tells me that he found marine shells 60 feet above the sea. At Kiltearn, on the north side of the bay of Cromarty, there is a bed of shells at the height of 30 feet,† and at Dingwall, at the head of the bay, one of blue clay full of shells, in which, at the distance of three miles from the sea, there was found one of the vertebræ of a whale at an elevation of 12 feet.‡ At Inverlochy in the county of Ross, and along the shores of Moray firth, this deposit is observable.§ There is a raised beach near Kinnairdshead,‖ and at Peterhead, Dr Buckland observed shells at the height of 60 feet.¶ In the counties of Kincardine, Forfar, and Fife, there are many notices of the elevated marine beds, in the Statistical Ac-

* Agricultural Journal, Dec. 1836, p. 431.

† Stat. Acct., vol. i. p. 283.

‡ Trans. R. S. Edin., vol. x. p. 105.

§ Information of Sir T. D. Lauder, and Stat. Acct., vol. xiii. p. 21.

‖ Stat. Acct., vol. vi. p. 2.

¶ Jameson's Edin. Phil. Journal, vol. xii. p. 314.

counts. There are also numerous indications of them in the Lothians and Berwickshire, for an account of which I refer to Mr Maclaren's lately published work on the Geology of Fife and the Lothians, in which he gives a full and interesting account of the proofs of a rise in the bed of the Forth;* and in the paper of Mr Milne on the Mid-Lothian and East-Lothian coal-field,† much attention has been paid to the raised marine beds in this part of the Island. Mr Milne states that "he walked along the whole shore from St Abb's Head, round by Dunbar, North Berwick, Aberlady, Cockenzie, and Newhaven, to Queensferry, and traversed the greater part of the Carse district from Falkirk to beyond Stirling," and every where found traces of a change in the sea level. In his report on the Geology of Berwickshire,‡ he notices indications of a change of the sea level of about 100 feet. I have thus traced these deposits round Scotland—they occur in every one of the maritime counties, indicating changes of level in every part of the northern division of the Island. I have no doubt that marine beds belonging to the newer pliocene extend also throughout England and Ireland.

* P. 228.

† Transactions of Royal Soc. Edin. vol. xiv. p. 334, &c.

‡ 4th Report Brit. Association, p. 636.