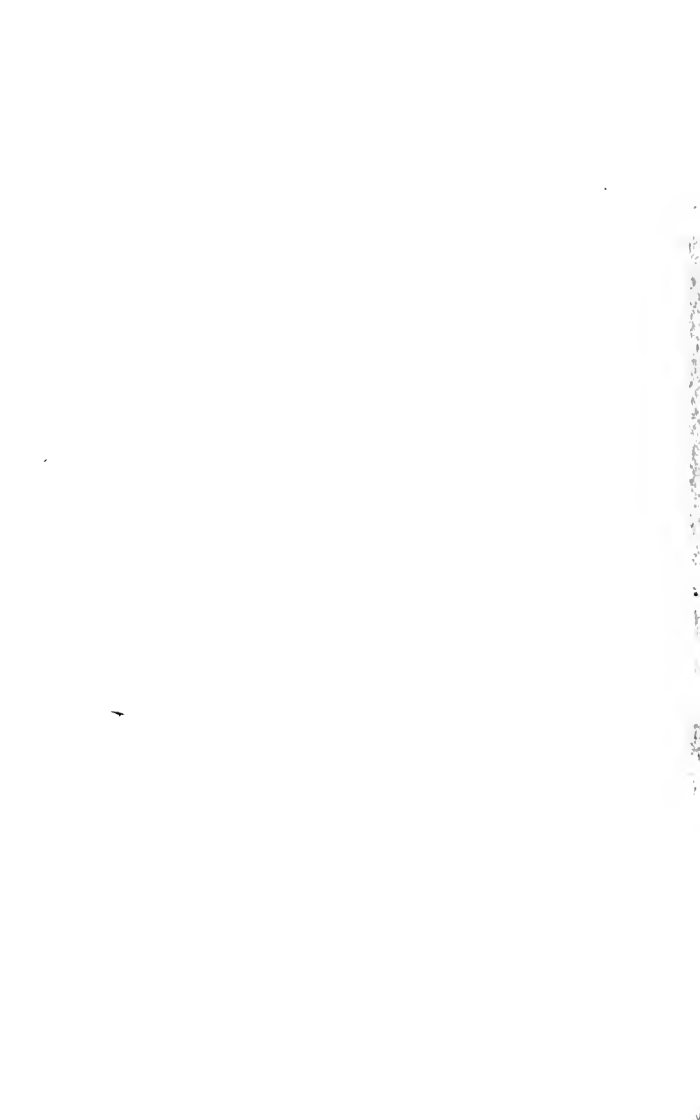


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Robert C. ...



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THE PARALLEL ROADS OF LOCHABER.

"NA CASAN."—THE BENDS.

So much has been written and said by distinguished observers during many years, about certain terraces in Lochaber, that little need be said about the "Parallel Roads" by way of introduction. Three terraces in Glen Roy, (Gleann Ruaidh, the Glen of the Red, river) are marked at an average height of 1,148, 1,067, and 855 feet above the present sea level. One at 855 feet is marked both in Glen Roy and Glen Spean, of which Glen Roy is a branch, and one is marked at 1,165 feet, in Glen Gloy, which is a branch of the Lochy, and belongs to the Great Glen. It is divided from Glen Roy by a "Col" 1,172 feet high. These waters meet in Loch Linne. The country people named these terraces "Na Casan;" the bends; because they curve about the hill sides like contour lines on the ordnance map, and wind like a river. The "roads" are not flat on the top. The surveyors give an average between highest and lowest, and allow 17, 11, 15, 12 feet. The slope on the terrace, is far less than upon the rest of the hill side: the soil there is better, the vegetation is richer, and deer and cattle prefer to graze upon the terraces and to walk along them, and so they wear footpaths on the grass "roads." The steep bare treeless sides of deep narrow sheltered glens shew the forms of opposite and parallel "bends," and their colour sets off their form, from a distance. But a stranger in a mist might walk up a hill-side and cross the whole series without notice. When snow falls three terraces grow conspicuous, and these are so remarkable at all times in Glen Roy, that "the bends" could hardly escape notice, a name, and a legend. But many other locally marked parallel terraces in the same glen at other levels seem to have escaped notice altogether. All who have described the conspicuous three in Glen Roy, agree that they are beaches formed at old water levels, but authorities differ as to the water. Are these sea coasts, or lake shores? If lake shores, how were the lakes dammed? Why were they dammed thrice, at three successive levels in one system of glens, at 1,148 1,067, and 855 feet, and once in a neighbouring glen at 1,167?

These are the chief facts noticed and questions undecided, about which a great deal has been written and said by many distinguished geologists during many years. Mr. Milne Home has abstracted the debate in a late pamphlet, which I had the advantage of reading at Roy Bridge, after seeing the "Bends" for the first time in September, 1877.

Lakes.—In the Lochaber system of glens are large lakes dammed by rock barriers, or by drift. Their waste waters are wearing their dams, cutting drains in them, lowering the water level, and leaving beaches at old lake shores on the hill side. In other places in the same glens lakes have been drained by the well-known process which is going on at Moy, at the west end of Loch Laggan. River courses, drains, broken dams, and old lake shores remain to show plainly where drained lakes stood, in Glen Spean above the waterfall, and above Spean bridge: in Glen Roy, at Braonachan (drizzle field), and elsewhere. A higher lake level is strongly marked along the shore of Loch Laggan, 819 feet, which is being drained, and it corresponds to the flat top of a terrace of stratified shingle at "Moy." Through it the river Spean has cut a drain. The name means "a plain," magh, genitive maigh. The "plain" is at about 850 feet above the sea level, and it is opposite to a river which comes from Loch Ghuilbin, where is another "plain" of like stuff:—a dam of detritus at about 1,200 feet above the sea level. Lakes, lake shores, and dams, associated in the same hollows with far higher beaches, naturally suggested larger and deeper lakes, higher and bigger dams, in Lochaber. Accordingly the first observers thought of lakes. But there was a difficulty about the needful dams at the places required to account for lake beaches at 1,167, 1,148, 1,067, and 855 feet. To account for the Glen Roy lake a dam is needed about Roy bridge, at least as high as the Scotch water parting between the Spean and the Spey at one source of the Roy. That is at 1,151 feet at the "Col," and corresponds nearly to the highest beach mark in Glen Roy, 1,148. The dam must have been as wide as the distance between the opposite contour lines of 1,200 feet, which are nearly three miles apart above Roy bridge, and it must have been about 900 feet deep, where the rock foundation now is 300 feet above the sea. Because of existing dams of detritus at about 850 and at 1,200 feet at the end of Loch Laggan, Loch Ghuilbin, and Loch Treig, another such dam might have existed as high as 1,200 feet at Roy bridge, on the same drainage system, but no remnant of such a dam of detritus is there. A rock dam is above the waterfall in Glen Spean with glacial marks upon it, and with a river drain cut through it, but there is no rock dam at Roy bridge. Measured by the high level beach, a theoretical Glen Roy lake was about 10 miles long, and overflowed eastward into the Spey Glen instead of westward into Glen Spean, but there is no remnant of a dam to account for that lake shore about Roy bridge. Other dams are needed to hold the lake at the high level. It seemed to me that high terraces are faintly visible in Glen Spean above the bridge, far outside of Glen Roy on the face of "Meall nan luatha." The needful dam in that case must have been out about the river Lochy where there is no such dam nearer than the American coast.

Ice Dams.—Failing dams of rock or of drift, like those which hold Loch Laggan, Loch Ghuilbin, and Loch Treig and those which formerly held lakes in Glen Spean and Glen Roy, and remain broken ruins; ice dams were suggested, like the dam which holds a lake in Switzerland. They were suggested by Agassiz, who was a Swiss.

It is supposed by the supporters of this explanation for high level

beaches, that a large glacier flowing westwards from Strathmashie through Loch Laggan and down Glen Spean to Roy Bridge, after flowing about 20 miles, was at least 900 feet high in Glen Spean, and blocked the mouth of Glen Roy in flowing towards Lock Linne. When it burst or dwindled it still was thick enough to account for lower beaches which run back into Glen Roy and its branches, and which correspond to "Cols" at 1,075, and 848 feet, according to the survey. To account for a lake, to account for a beach at 855 feet in Glen Spean, which occurs in Glen Roy also, at 855, a smaller glacier is supposed to have survived the rest, and to have crossed the mouth of Glen Spean, where it is three miles wide, between contour lines marked by the survey. That theoretical ice dam came out of "Coire 'n eoin," the bird's corrie, which is on the south side. It came from a narrow water parting 3,000 feet above the sea, at Aonach Mòr, and it flowed eight miles northwards to the opposite hill face, Meall nan luatha, the knob of the ashes, where a conspicuous terrace ends above Spean Bridge, at 855 feet above the sea, as is marked on the map. That theoretical lake then was 22 miles long, and overflowed eastward at the Scotch water parting, between the Spey and Spean, at Strathmashie, at 848 feet, a level which nearly corresponds to the beach mark at 845 feet, 22 miles away opposite to Spean Bridge. But these nice measurements are difficult to find on the ground, and many terraces are visible which are not marked on the inch map. Snow wreaths now outlast the summer in the shade of the high steep slopes on the the south side of Glen Spean; they suggest a surviving glacier, and marks of a glacier are upon rocks high up in Coire 'n eoin, where the snow lies now. In fact glacier marks do abound in Glen Spean also, and in all the glens in Lochaber, and all over Scotland. During a Scotch local glacial period, which preceded the formation of drift which rests upon glaciated surfaces of rock, there was enough ice to make dams large enough, to hold lakes deep enough to account for the beaches which are conspicuous facts in Lochaber. But these drift beaches stand upon glaciated rocks, so they are later than the big glaciers. The ordnance maps of the district shew the most conspicuous parallel roads, and the sites selected for dams to account for them by lakes. The principal facts and measurements are accessible, and it is easy to reach the ground. I went there in the end of September, 1877, and got the ordnance maps afterwards in Edinburgh to study at leisure. I believe that I have said enough to state the facts of the case and the problems involved.

Raised Coasts.—For the latest news from the ice world I have read the last Arctic Blue book. I found no mention of fresh water lakes dammed in by ice, where ice now is thick enough to make dams a thousand feet deep, or more. But there is mention in the Blue book of coast lines with shells on them parallel to each other, and to the existing sea coasts on the western side of the local glacial period which now covers Greenland with an ice sheet as wide as the land.

In "Lyell's Principles of Geology," 9th edition, 1853, which happens to be the edition which I have studied since 1855, at page 21, is a map recast in 1847, to shew areas in Europe which had then been proved by "marine organisms" to have been sea bottoms *at some time or other* since

the beginning of Eocene geological time. In that map are marked great part of Orkney, the vallies in which are the Caledonian Canal, the Forth and Clyde Canal, the Edinburgh and Glasgow Railway, the Bridgewater Canal, and other great works, where much digging had given opportunity for discovering buried shells. The east coast of England from the Wash to the Isle of Wight, the Thames Valley, great part of both sides of Scandinavia, nearly the whole of Central Europe, the source of the Volga, the base of the Caucasus, Constantinople, Lombardy, the south of France, and most of the banks of the chief European rivers have been sea bottoms at *some time or other* since Eocene times began. As that is proved, Eocene sea coasts were somewhere higher than Eocene marine organisms while they lived. That follows of course, and Eocene sea margins may still remain somewhere. It follows that all finds of marine organisms of later date, from those of the dawn period down to the youngest oyster spat last spawned also prove seas, sea bottoms, and sea coasts at a higher level than the shells, unless the contrary is shown. Mussel spat on the sands of the Wash at low tide prove that higher "high water mark" which is "the sea coast." It bounds existing geography and divides marine geology from that of the land. It passes through all zones of climate between the two poles—Arctic and Tropical,—and rises and falls with the tide. But I have seen mussel spat carted off the Wash sands to manure fields. Only if found *in situ* do shells prove that a coast was somewhere at a higher level when these shells lived. A multitude of sea shells found *in situ*, at distant points, all round high land mean a raised sea bottom, and require a raised sea coast at some higher level to bound the sea, which surrounded an island. At page 132. Sir Charles Lyell tells in 1853 how Sir Roderick Murchison had found sea shells of existing species in a *strait* which divided Wales from England, and how Mr. Trimmer had found recent sea shells at 1,392 feet above the present level of the sea, on Moel Tryfan, a Welsh hill near the Menai Strait. That is proof of a raised sea bottom, a raised sea coast, and an island. The frequent rise and fall of land, and a late rise equal to 1,392 feet, had been proved 24 years ago according to "The Principles of Geology."

In 1869 that principle condensed in an aphorism was quoted by Sir Roderick Murchison. "In Siluria," page 549. "*Stability of the waves; mobility of the land.*"

All that I have been able to learn about raised coasts and sea bottoms by reading and by observation does but confirm that which is taught in this aphorism. Land waves roll under the tidal wave of the sea, raising and sinking vast areas slowly and imperceptibly. I learned to look for coasts on hill sides, and I have seen many since 1830, when people about me spoke to me of such things. Sir Charles Lyell saw the parallel roads in Lochaber in 1825; in 1841 he supposed them to be sea margins. He never saw them again. In 1863, in his "Antiquity of Man," he accepted the lake theory of ice dams. He took it on trust that no other terraces were in Lochaber besides those mapped, that one only is in Glen Spean and that none are in Glen Spey. (Page 257.) The views of Mr. Darwin are stated on the same page by Sir Charles Lyell. He also states the opinion of Robert Chambers on page 258,

and the chief arguments in the Lochaber debate in the rest of the chapter. In 1865, at page 123, Vol. II, "Frost and Fire." I described terraces, about the eastern end of Loch Eriicht, like terraces in Norway and Sweden. These I supposed to be Scotch sea margins, at about 1,400 feet. On these grounds I thought it probable that the parallel roads were also raised sea margins, page 127, but I never saw them till 1877, and never ventured to join in this debate till now.

Parallel Coasts and Shells.—I had seen "terraces" in many parts of the world before I went to Lochaber. I lived upon a shingle terrace in Islay, and was familiar from childhood with raised sea margins at low levels. In 1849 Robert Chambers, at Alten, in Norway, told me the general result of his examination of Norwegian terraces. I saw these Norwegian raised coasts repeatedly afterwards, and the corresponding drift flats, slopes, and steps in Sweden, and in Finland. I had followed these "parallel roads" round the north cape of Europe to Archangel, and I had crossed the broad steps from the Polar basin to St. Petersburg, and from Archangel to Astrakhan. I had seen drift terraces along the shores of the Caspian and Black Seas, on both sides of the Caucasus, on the shores of the Mediterranean, and at the base of the Alps in Lombardy. I had seen terraced drift on the Atlantic and on the Pacific coasts of North America, and drift flats in Canada and the States far inland, where they are proved to be sea bottoms. I had seen terraces in Japan and China, in Ceylon, on the coasts of the Red Sea and the Mediterranean, and drift flats at Suez, where are beds of sea shells. The rising and sinking of the earth's crust and the sea mark left at a coast had become for me essential parts of geology, long before I went to Lochaber. Those who gave a Gaelic name to "the bends" never thought of the sea. I knew that the sea had been higher or the land lower elsewhere. I went to Kingussie on the 24th of September, 1877, with this proposition:—*If these "parallel roads" be "sea margins" like marks ought to be found at like levels on both sides of the watershed, east and west, north and south of Lochaber.*

Raised Sea Margins.—One fact ascertained and published by Robert Chambers in 1849 is, that Norwegian raised beaches are not perfectly parallel to the curve of the surface of the sea at the coast. The land in rising has bent like a bow on meridians. A late rise was general along the west of Europe, and probably affected the whole European area, but the land rose unequally and with periods of repose. During long pauses waves and ice broke out shelves and drilled sea caves in rocks at levels which correspond to conspicuous terraces of drift, which occur everywhere in sheltered corners along the whole Norwegian coast. In some sheltered nooks in fjords, a whole stair of terraces records a whole rise above, below, and between three conspicuous beach marks. These register periods of rest long enough for much work to be done at a slow rate, at the so called "destructive plane of the sea." The further north the plain is these raised "sea margins" in Europe. I suppose that an ice foot, like the ice foot on the opposite Atlantic shore, helped to mark the sea level upon Scandinavian hill sides. I had seen thousands of miles of "parallel roads" which are raised sea coasts, before I went to look at the beach marks in Lochaber.

Beach Marks.—The mark of an old water level hardly needs description. A "beach" may be seen on various scales, but the same in pattern on the banks of any puddle, pond, mill dam, or lake, or streamlet, or river where the water has sunk; or on the sea shore between tides. If shells are associated with a beach the shells decide whether the water which made the mark was or was not part of the sea. In Scandinavia sea shells have been found associated with beaches from the sea level up to terraces, which makes it certain that these and higher contour lines are raised sea coasts. I have seen terraces in Norway at 4,400 feet, and erratics near these terraces, which are on hill sides far above the high plateau of Scandinavia, near the head waters of many large rivers which flow from high ground near the summit level of the Norwegian railway, which was opened on the 12th October, 1877. It passes over the Dovre fjeld near Røraas, which is 2,175 feet above the sea. (See "Frost and Fire," 2nd issue, Vol II., p. 578.—*Times*, November 7th, 1877.) About that high region in Scandinavia, at Røraas, at Dombaas, and elsewhere, are drift terraces. They seem to be the geological equivalents of drifts about the summit levels of Scotch mountain railways, where they pass "cols" in high rock grooves which would be straits if the sea were 1,500 or 2,000 feet higher on the hills where they now stand. The Norwegian drifts about Dovre consist of stratified sands and gravels, laminated clays, and boulder clays which cover rock surfaces, glaciated from the watershed downwards. The level of Mr. Trimmer's shell find, 1,392 feet, has not yet been passed, but these new railways have opened new hunting grounds for those who hunt after "marine organisms" upon high hills.

Sea shells are not found everywhere at old sea margins or on old sea bottoms. If exposed to weather shells are destroyed, if buried and so preserved, they must be dug up before they can be seen. But shells having been found, the rest of a terrace needs no further proof beyond form and position with reference to the coast. The "terrace" which contains sea shells, and follows the sea coast at a higher level, is a raised sea margin from end to end. Such terraces, one above the other like seats in an amphitheatre, follow the whole sea coast of Norway from end to end. Two of them are especially conspicuous, and whole stairs of them occur here and there. They are not continuous. A cliff has fallen, or a river has cut through, or the rain has washed away the record locally. But enough remains to make three old coast lines on the steep Norwegian side of Scandinavia conspicuous facts. The absence of the sea mark at a Cape does not prove the absence of the sea locally, or require a lake in a glen to account for the record where it is better preserved. Shells, form, level, and position, with reference to the coast line, prove that a beach was a sea beach; and a coast a sea coast, and that drift at lower levels was marine drift, so far as shells are found in it. Recent sea shells, associated with caves, cliffs, scarped hills, drift, stratified sands and gravels, and with terraces at low and at high levels have been seen and found all along the Norwegian coasts. They have been found in Caithness and elsewhere in Scotland; about Macclesfield and elsewhere in England; in Lombardy, and elsewhere in Europe. The high record has only been fully read at a few spots, but any beach

mark up to the limit at which sea shells have been found in Europe may be a sea beach, unless the contrary is shewn. But most of this was unknown when the parallel roads were first noticed.

South of Lochaber.—Most of the drift in Cheshire looks like water drift, and it has been attributed to a "glacial sea" by the geologists who surveyed the district some years ago. Macclesfield may be taken as a central position in Britain. Near Macclesfield, at about 500 feet above the present sea level, an erratic block of Porphyry was found. It weighs 40 tons, and it took 1½ horses to drag it down to the park where I saw it. It is striated, and grooved by ice, and smoothed by water. The nearest place from which it can have started is in Cumberland. I have seen stones like it at Elfvdal, in Sweden, where vases are carved out of erratics, and far up in Kemi, Lapland, at the head of the Gulf of Bothnia. The Macclesfield erratic proves glacial action there. On the opposite Atlantic coast of Labrador great ice rafts and ice bergs are floating on their way from the Arctic basin, and from the hills of Greenland, and there also are raised coasts, drift terraces, with marine shells in them, made of stuff like the Cheshire drift. Close to the place where the Macclesfield erratic was left, the rest of the drift consists of beds of stratified sands and gravels, between boulder clays, upper and lower. Many of the stones in the Cheshire drift are glaciated. I have found them myself repeatedly, and they are mentioned in the memoir of the geological survey. Many of these drift stones are foreign to the district, their form commonly is that of glaciated stones rolled in water. Mr. Sainter, of Macclesfield, a keen observer, has been watching for more than twenty years at a place where much digging has gone on in drift, about the building of houses, the construction of roads and railways, about the making of a park and a cemetery, and the burial of the dead. He first found sea shells at Macclesfield. He has, as he tells me, himself picked recent sea shells out of upper and lower boulder clay, and middle sands and gravels near Macclesfield. Geological surveyors, and many other skilled observers have also found shells there since they began to look for them. They have collected about sixty species, and many of them represent living British forms. The highest level at which sea shells have yet been found in drift on the Macclesfield hills is 1,200 feet. In Wales they have been found at 1,392. It is therefore proved by shells that any beach mark which can be traced in that part of Britain up to 1,400 feet may be a sea beach, corresponding to the raised coasts of Scandinavia, which are to the north of Lochaber.

Lack of Shells in Terraces.—The shell negative has no value. These Macclesfield shells were found only because a keen observer happened to have opportunity. Hill men have no opportunity, and do not seek after sea shells on hill tops, or believe in their existence when found. It has been suggested to me that Macclesfield people ate shellfish at the "Cat and Fiddle" and left the shells there. That which is *new* commonly seems to men *untrue*, and the notion of living upon a raised sea bottom still is a new idea to the majority of Europeans.*

* The *Macclesfield Courier and Herald* of the 20th October, 1877, reports the opening of the Macclesfield Scientific Society. The president, Mr. Sainter, in thanking

Raised Coasts in Cheshire.—Because of the shells it is certain that a sea level extended from “Cloud End” to the Macclesfield hills, but nobody seems to have noticed the coasts. The eastern profile of Cloud End is like a raised coast. Looking southwards from Capesthorpe, with a good glass and a good light, walls on the western slopes of the Macclesfield hills are seen to outline horizontal shelves which correspond to the coast profile on Cloud End. On this large scale an old coast is visible to practised eyes taught to look for sea marks by sea shells. But till attention is directed to these forms by the fact otherwise proved, form alone would not suffice to prove coast lines on the Cheshire hills. I have been visiting Cheshire for the last 40 years, but I never saw these high coasts till I looked for them in October, 1877. I do not now pretend to date them geologically.

Between the Macclesfield Hills and Wales numbers of isolated hills are scarped and broken like Cloud End, and these were islands in fact, because of the Welsh and Macclesfield shells. Alderley Edge, Beeston, and many other hills in the region, have old sea marks on their sides which I have often noticed. Above Macclesfield, at about 900 and 1,300 feet, are steeper escarpments which are visible from a distance. They are like raised sea coasts which I have seen elsewhere, and because of the shells they certainly have been sea coasts. I made a sketch from the west of the town where I could see the coast marks plainly southwards. Sea shells prove the presence of the sea without drift terraces, and sea coasts are visible long after drift marks have been destroyed. The absence of drift terraces does not prove the absence of the sea locally, for drift terraces are not to be seen above Macclesfield where shells are buried. On a fine day, on the 23rd of October fresh from Lochaber, and armed with fresh knowledge gained from Mr. Sainter, I drove from Capesthorpe, which is 300 feet above the sea, through Macclesfield and up the hills to the “Cat and Fiddle.” I knew that I was driving from a low water level to a high raised coast, as surely as if the tide had ebbed that morning, some 1,200 feet. I fully expected to arrive at beach marks when I got to an old coast; but I saw nothing like the familiar forms of terraces in driving up and down twelve miles. I did not happen to see any section of drift; I did not find any shells though I sought them. I found nobody on the ground who had the remotest suspicion that he lived upon an ancient sea bottom. Nevertheless, Cheshire is a sea bottom, for the sea ebbed from the shells which were found near the “Cat and Fiddle” to the estuary of the Dee. The hill pastures are as bare and treeless as the sides of Glen Roy; the fields are fenced, and the walls outline the whole country so as to show contour shelves, if there were any to show. On the ground I could see no terraces, where it is certain that the sea

Professor Dawkins for a lecture on recent discoveries of fossils and works of men's hands in caves, said that the debris of about sixty species of sea shells had been found from 1,200 feet downwards; from 700 feet above Macclesfield to 130 feet lower than the site of the town. Many of these “marine organisms” are of living species, identified and named by experts. They were found within the area which has been a strait according to Lovell's map of 1817, and the authority of Murchison, confirmed by later geologists. Mr. Timmer and Mr. Sainter helped to spread the knowledge of a truth which still is new, and seems to be untrue accordingly.



margin has passed down the whole width of Cheshire in ebbing 1,200 feet to its present coast. South of Lochaber a rise of land is demonstrated, but without sand terraces.

North.—North of Lochaber in Sutherland, and at Achnasheen in Ross are wide terraces of stratified gravel which dam lakes near the water parting. Read with Macclesfield, Welsh, and Scandinavian shells they prove that the sea was at Achnasheen where Loch Roisg is about 630 feet above the sea, to pack drift as it is packed at Loch Laggan and Loch Treig in Lochaber. Terraces in that region are well marked at about 700 feet. North and south of Lochaber it is proved that land rose, and rose at least 1,200 feet south and 700 feet north of Lochaber.

West.—West of Lochaber a rise in land is proved. In Islay beds of cockle shells are in the low land which separates Loch Gruinart from Loch in Dàl. Terraces of shingle carry the sea level much higher. On the coast are lines of cliffs with caves in them, which caves contain sea sand and rolled stones. How high the record extends in Islay I cannot yet say, but some rise is proved by a conspicuous mark. At Iona is a beach called Port a Churaich (the port of the canoe) where Saint Columba landed. There a series of beaches extends far inland from the sea level up to about 50 feet. Rolled stones there are typical of the work done by the full force of Atlantic waves. In Mull is "Mackinnon's Cave," and in the cave are large rolled stones of the Iona pattern at about the same raised level. Above the western coast of the Island of Jura, high up on hill sides, I cannot yet say how high, are numerous raised beaches, large deposits of big rolled stones of the Iona pattern, packed as they are on the beach, on which waves beat now. These are called "Muirchlach" (seas of stones). There are so many of them that a popular myth makes the number of "stone seas" equal to the number of lakes in Jura. By such piles of stones the sea level is carried high on the hills in Islay and Jura. The record is as plain as the record of last tide at Port a Churaich. There is no great difference between the raised tide coasts of Jura, and those at the Arctic basin north of Norway. Further inland Loch Seil is dammed by stuff like the dam of Loch Laggan. About half way up Loch Seil are strongly marked terraces of shingle. In the dam or near it shell beds have been found near Loch Muidart, at about 30 feet above the present sea level.* Shells and shingle terraces prove that Loch Seil was a firth, in which the tide ebbed and flowed as it does now in Loch Muidart, before it became a lake. The highest level marked by the shingle terraces that I saw in Loch Seil this year corresponds to the level of the "Col" which separates Loch Seil from Loch Eil. That carries the record of a rise of land into the jaws of Glen Spean. At Fort William are recent sea shell beds raised about 10 feet above high water mark. To the westward of Lochaber from the outer islands to the Spean some rise of land is proved by the very same marks which proved it southwards at Macclesfield, and northwards up to the North Cape of Norway. The question remains, was the latest rise in Lochaber great enough to account for the beach marks?

* Mr. Burrell, architect, Fort William, is my informant as to the shell beds.

East.—To the eastward a rise of land is proved along the east coast, equal to the rise on the west, by shells, anchors, boats, whale's bones, caves, cliffs, and terraces. "The 40 feet beach" is an accepted geological fact, which goes round Great Britain and Ireland, and proves that the whole land has risen so much bodily. Far higher coasts are now acknowledged facts in modern British Geology. Above Dalwhinny, near the highland line is an isolated hill-top called "Geal charn," white cairn. On the map it is marked 3,005 feet. There, or thereabouts, I found several large erratics many years ago. They differ from the rock on which they rest. Unless they were carried there by the same ice power which left an erratic at 500 feet above the sea at Macclesfield, these stones need some explanation which I cannot give. I have coloured the Ordnance map to shew the distance from these erratics to the nearest points of equal height. The nearest large blocks of land higher than 3,000 feet are about 18 miles away to the north-eastward, and 24 to the south-westward, at the Cairn Gorm range, and Ben Nevis. I think it probable that the last rise of land in Britain was general, and some rise as much as 3,000 feet. At about the same level I found more erratics on the shoulder of Ben Wyvis, and in Rossshire, above Loch Marce, and about Fannich. I have found erratics above 4,400 feet in Norway. I suppose that some rise along the whole European coast was as great, or possibly may have been as great as the depth of the ocean now is. About 1,800 feet down, and distant a mile horizontally, just below the erratics on Geal Charn, is Loch Ericht, dammed in by flats of drift, and with shingle terraces near the middle of it, like those in Loch Seil. It lies in a deep rock groove, across the watershed, at 1,153 feet according to the survey, and at the level of the highest side of the highest of the parallel roads in Glen Roy; 1,153 feet, which is distant about 17 miles. But that is the level of the shells in Wales and Cheshire. On the 29th of September in crossing from Kingssie by rail to Edinburgh, barometer in hand, I noted a marked terrace in Glen Truim, at about 1,000 feet. At about 1,200 feet is a great flat towards Loch Ericht, and drift flats in all directions, towards Lochaber, and between rounded tops of bare glaciated rocks. The level of shells at Macclesfield corresponds to drift terraces, and the materials are the same in Scotland and in Cheshire. There is great abundance of boulder clays, sands and gravels in that Scotch region, about the level of the highest of the Lochaber terraces on the *Eastern slopes of Scotland in the Spey basin*, and about Loch Ericht. Descending towards Perth, I noted a series of terraces and flats of drift, and like records of water work corresponding roughly to the Lochaber terraces, and succeeding each other down to the sea level. Something like "the parallel roads" of Lochaber, and something to prove the presence of the sea at 1,200 feet, and a rise of land which took in the whole area of Britain, does in fact appear all round Lochaber, north, east, south, and west of the district, far from it and near to it. It seems to me certain that Lochaber has been submerged like the rest of country, and rose with it, so the parallel roads may be sea coasts.

Round Lochaber.—The latest available published abstract of official geological information as to finds of recent shells at high levels in drifts



and in boulder clays is, as I am informed on high authority, in "The Great Ice Age," by Mr. James Geikie: second edition. In that able work I find mention of the finds of Mr. Trimmer and Mr. Sainter, to the South of Lochaber. Between pages 162 and 171 later finds are mentioned which surround, and which cross Scotland between the Firths of Forth and Clyde. Recent shells have been found according to Mr. James Geikie, who is himself a Geological Surveyor of experience and repute.—

In Galloway, Wigtonshire, and Ayrshire: up to	-	168 feet.
At Campbelltown in Ceantire	- - - -	180 "
In Arran	- - - -	?
In the Island of Lewis	- - - -	171 "
In great part of Caithness	- - - -	?
In Aberdeenshire	- - - -	?
In Berwick	- - - -	?
At Oakshall Hill near Paisley	- - - -	?
About the River Endrick, where is the Forth and Clyde Junction Railway, near a Col which is 130 feet high;		
at	- - - -	320 "
At Chapel Hall, near Airdrie, within a mile and a half of Woodhall House, at or near a Col or divide be- tween Forth and Clyde; at	- - - -	526 "

Up to 526 feet the "Raised sea margins" of Robert Chambers seem proved, and the "Principles of Geology" are confirmed. This geological evidence seems to me to prove a recent sea, like the Atlantic on the opposite coast, which I saw in 1864 and described in 1865, in a book called "A Short American Tramp." It seems to prove that great part of the Scotch Lowlands are raised sea bottoms, and that higher sea coasts surrounded Scotch hills which were islands. The ordnance map of the region between Greenock and Dunbar, the Clyde and the Grampians, has the shape of a dried strait like the strait of Belle Isle, in which light and heavy, and very thick masses of ice ground, and are moved to and fro by whole currents, and by tides. I am now convinced that I lived in my youth, before the railway "period," in the dried sea strait in which shells lived, which were buried soon after they died near Airdrie. Most of them are "broken shells." So are most of the shells in soundings on charts on the banks of Newfoundland. Shells are "rare" in boulder clay; so they are on the sea beach in Labrador where ice scrapes. It seems from Mr. Geikie's store of facts, that no shells have yet been found in Scotch drifts, at levels higher than those which indicated "a strait" when Sir Charles Lyell revised his map in 1847, thirty years ago. Trimmer, Sainter, and Smith, of Jordan Hill, who first found shells in boulder clay in Scotland long ago: still are first in the mountain hunt, after recent "marine organisms." An American geologist topped them all at 3,000 feet on Snowdon, but his find was pronounced to be Silurian when I quoted him in 1865. So he was put out of the race.

I have found perched blocks at 3,000 feet upon isolated Scotch tops. Since then other observers have found horizontal striation at 3,500 feet in Scotland, and to that thickness the "ice sheet" required by

advanced glacialists attained during "The Great Ice Age." I have myself found Scotch "terraces" which I suppose to be "sea margins" up to the level of shells, which experts have admitted to be recent, and genuine, at 1,200 and 1,300 feet in England and Wales.



Mr. James Geikie accounts for the Lochaber terraces by "*ice dams*," and follows with the followers of Agassiz. To his excellent work I refer for his views, while I refer to my own works for mine, and to the latest Arctic Blue Book for facts, by which to explain records of glacial action. An ice sheet must have behaved like an ice sheet, however old it may have been; glaciers always behave as such, and the sea is the same sea which packed drift in Lawrentian times. On the other side of the Greenland "ice sheet" are *parallel raised sea coasts*, up to 1,000 feet, with recent sea shells in them. There also are *high horizontal striations*, ruled parallel to ice rafts, which do in fact rule parallel grooves at the water line, wherever the ice planing engine works. It is working now on the other side of the Atlantic opposite to Lochaber in the Labrador.

In this Lochaber debate I wish to give my own opinion for its worth, and to add my facts to the common stock. Hitherto whatever may have become of my opinions my facts have stood testing since 1865. I will now try to tell what I found in and about Lochaber in 1877.

THROUGH LOCHABER, SEPTEMBER 24th, 1877.

Kingussie.—I approached the parallel roads by way of Kingussie. There, on the north side of the Spey Valley, is a hill called "A chreag Bheag," the little crag. It rises to 1,593 feet, and the town is 736. On the 24th of September I walked up 857 feet to the cairn, to see if I could find anything at a promontory there, on the east side of the watershed, about the level of the parallel roads of Lochaber on the west side, like a coast. Like all other rocks in the district the top is glaciated, but much weathered. Below the bare rock are "terraces," made of rolled stones; exactly like those which now are mossgrown on the raised beach at Port a Chruich in Iona, and on far higher beaches on the hill sides of Jura and Islay. Two terraces are well seen from the railway station, outlined by walls. I had remarked them long ago near a wood. They extend along the north side of the Spey, and can be seen from the railway on both sides of the Spey glen, so far as I have looked. Their levels correspond roughly to those of the chief terraces in Lochaber; they are on the east side of the water parting, and higher than the Col at Strathmashie, which is 848 feet, whereas terraces on both sides in Glen Gloy, and at Kingussie, are between 1,100 and 1,200 feet, which also is about the level of terraces at Loch Eriocht upon the watershed of Scotland, and the level of the Macclesfield and Welsh shells.

I made an eye sketch of the country ahead from the top of the little rock, and I have since taken the following measurements from the inch survey. At Kingussie the horizontal distance from the 800 feet level to the 900 contour line is 800 feet, which gives a rise of 100 feet in 800. Within that distance are two conspicuous steps, a third is higher in the wood out of sight from the station.

Opposite to them at about a mile and a half, the 800 and 900 levels are close together, where I saw the likeness of an opposite coast. It is 12 horizontal miles to Strathmashie along the Spey Glen. The road is between the 800 and 900, contouring all the way. There the 800 contour line is cut off, but the 900 feet level goes through, and that "plane" which is parallel to the curve of the sea goes on westward to Labrador. The River Pattack comes in between the 800 and 900 levels, and the course of it is about as long as that of the rest of the Spey above the fork, some 12 to 14 miles. In short the coach road from Kingussie to Spean Falls runs for nearly 30 miles upon natural terraces, between the levels of 800 and 900 feet. Where the road descends from 800 to 300 there the natural terraces are seen at 855 feet going on above towards the ocean. Throughout this trough a cross section is like one made through the middle of a trencher. The flats in which the Spey winds rise from 700 up to 800 in six miles, and the Spean flats sink less in 10 miles. The sides are between the levels of 800 and 900, and 1,000 feet; they are terraced drift, and they are generally a mile apart. But a section across the glen of the Pattack is not like  but like . That "trencher" section is characteristic of all the glens which cross Scotland from the Tweed up to Loch Ericht. There is no such section to be found in the Himalayas, so far as I have explored these mountains. They abound in North America, where I have been, up to the level of 6,000 feet. They abound in Scandinavia.

In Lochaber.—I went to Lochaber with some knowledge of glacial marks to look for the tracks of ice dams, or for the remains of dams of detritus; and to look at the chief Col in the system; and this is the result of an inspection of the ground. In driving between the Spey terraces, from Kingussie to Strathmashie, after sailing about the Western Isles for a month in a yacht, the look of the land suggested to me a narrow strait. Besides marked drift terraces on both sides, I saw cliffs. One cave at least is in the cliff. It is known because Cluny MacPherson hid there after the 45. At the watershed I saw the familiar shapes of mounds of drift, which I have always found at Cols which have been shallows in sea straits. I have seen like hills of drift in passes in North America and elsewhere, many a time. When I got the ordnance maps I assumed the contour line of 1,000 feet as a probable sea level, and coloured all below that line blue. I took that level from Spey terraces which I saw, and from rolled stones which I found at Kingussie. The result comes out as a narrow strait joining the Spean and Spey glens at Strathmashie, where the water parting now is 848 feet above the sea. With the sea at 1,000 feet the strait would be 152 feet deep and more than half a mile wide. A tidal race would flow through it like the race in the Pentland Firth: or the race between Jura and Scarba, which is like a great river, and is notorious as "Coire Bhreacain," the whirlpool. It would be like the race between Skye and the main land, or any other narrow place in the Western Isles where tides flow swiftly. Rivers are at Strathmashie to wash drift into the strait; and the race would pack the drift along the shores of the strait, and terrace it. On the ground it is



hard to make out where the rivers divide. The Puttack and another flow northwards side by side to Strathmashie. There they part. One goes on to Speymouth, the other turns suddenly back in a loop amongst sands and gravels, and goes west to Loch Linne, where are sands and gravels in sea straits at Lochiel and at Loch Leven. Strathmashie would be good hunting ground for shells.

Local Names and Soils.—In Strathmashie are woods growing upon drifts. Where bare rock is close to the surface trees will not grow. Names often describe the soil. The "Roy" is red in floods because it is washing red drifts. All round Lochaber and in it, plantations are marked about the contour lines of 1,250 and 1,000 feet, and names describe sands and gravels. The map shows that drift abounds along the great glen, about Glengary and Glerquoich, at Loch Arkaig and Loch Eil, and Loch Linne, and Loch Leven, always about the level of the Lochaber terraces and those of the Spey Glen. The same is true at Inverness and in Morayshire, and all round a high block of land, which is surrounded by a contour line of 1,000 feet, and would be an island with hills in it 2,000 feet high if the sea were 1,000 feet higher. I suppose that the island was a gathering ground for glaciers which flowed into the Great Glen, and into the Spey Glen, and the Spean. That is the hoary mountain, and its name is "Monadh Liath." I suppose that woods grow upon drift terraces. In fact, plantations, fences, contour lines, and the levels of the parallel roads often coincide at about 1,200 feet. Plenty of woods grow at higher levels where there is soil and shelter, so this is not a question of simple elevation, and cold climate.

Summary.—I have tried to sap up to the Lochaber problem gradually with all the knowledge that I am able to bring to bear upon it from the outside. I went to the Col from Kingussie with a water level at something like 1,200 feet, which gives a strait at Strathmashie about 350 feet deep, and nearly a mile wide, according to the survey. I have tried to show that the Lochaber terraces are not exceptional phenomena requiring some exceptional local cause to account for them, but that they correspond to raised beach marks, proved to be sea coasts, at Macclesfield by shells, and all the way to the North Cape by good geological proofs, which amount to a demonstration. It is demonstrated that land has risen on the whole west coast of Europe, and that great part of it has risen at least 1,200 feet. It is probable that the land rose from three to four thousand feet at least, through a glacial sea, like the cold sea on the opposite coasts of Labrador. When the land had risen high enough to shunt the Arctic current, I suppose that the cold climate was shunted with the cold stream to the opposite side of the Atlantic, where it remains.

In driving along Loch Laggan I noticed shelves at higher levels, upon the hills on the south side; and I suppose that these are coasts. On the 26th of September, with Sergeant Fraser, instructor of militia, for guide, I drove up Glen Roy to look at "the parallel roads." They are not so well marked as the pebble terraces at Kingussie, nor are they so conspicuous as terraces are in Norway, and elsewhere. They are not shelves worn in the rock, as two old high sea

coasts are above the Norwegian Coast. So far as I examined them the Glen Roy terraces are shelves of loose drift, with large stones resting upon them, like the stuff between high and low water mark at the present sea level in Scotch firths; for example, in Loch Linne, Loch Leven, Loch Muidart, and Loch Fyne, 15 feet of difference between "highest" and "lowest" may measure the ancient tide. Most of the rock surface is buried under drift in Glen Roy, or worn by the river, but where it shews on the hill sides it is glaciated, though much weathered.* Streams have cut sections through the drift which covers the rock, and is terraced. It consists of sands and gravels. Some of the beds are nearly horizontal in one direction, but dip towards the river. At some places the upper series of beds rest unconformably upon lower beds, which dip at a higher angle steeply towards the bank of the main stream. It seemed to me on the ground that sand and gravel, and angular stones, were washed off the hills by rains and streams, into water; or, possibly on to ice frozen upon the surface. Ice does now form on narrow sea lochs in Scotland. The stones of which Inverary Castle was built were partly carted over Loch Fyne on ice during a severe winter. On the opposite coast of Labrador the sea freezes regularly, I could not hope to add anything material to knowledge gathered in the glens by two generations of able observers, during 60 years, so I went to the site of the supposed dams. I clearly saw a great many faint horizontal shelves, besides three which have been noticed, because they are better preserved than the rest. Glen Roy is terraced from top to bottom, and streams are rapidly destroying the whole series. They are best seen when the sun's rays shine parallel to the slope of the hill.

Dams.—A great many fresh water lakes in Scotland are held in by dams, and are at the ends of salt lochs. Loch Guirn, on the west of Islay, is banked off from the Atlantic by a low dam. It is a shallow lake, and it was a shallow bay when shells lived which are buried near it. Loch Baa, in Mull, is banked in by a mass of shingle, with large blocks of stone in it. The rocks are glaciated in the direction which a glacier would take in flowing seawards from the watershed. I believe the dam to be a moraine washed by the sea. It is about a mile wide at least, and clay is under the shingle. Terraces are upon the lake shores, and shingle on low cols and notches in the rock, which I suppose to be coasts. These sea marks extend down Loch na Ceall, the loch of the cell, and are plain on islands in that sea loch. The raised beach is inside of Mackinnon's Cave. No shells have been found thereabouts, but the sea filled the hollow in which Loch Baa now is held by a low flat of shingle with large stones in it, resting upon clay. Loch Seil certainly was a branch of Loch Muidart, because sea shells have been found thirty feet above the present sea level. The dam is shingle on clay. Loch Maree, in Rosshire, is held at its present level by a shingle dam, which I suppose to be another moraine washed by the sea which made the 40 feet beach. There must have been a lake above Spean bridge before the drain was cut in which the

* November 2nd, 1877. Sergeant Fraser has found "glacial scratchings" in Glen Roy, near where the river flows. That fills Glen Roy with a local glacier, I suppose, and disposes of one dam.

river now flows, unless the sea made a strait for the river. Lake shores or sea margins are clearly marked in Glen Spean at low levels, on the slopes of "Aonachan."^o That is a mound of glacial debris capped with gravel, and I took it to be a large moraine which made a dam when the glacier melted in Spean Glen. But in that glen, land has in fact risen at least ten feet, because of sea shells at Fort William. So the Aonachan terraces probably are sea coasts up to 600 feet. The flats between Aonachan, and the Spean falls, at about 300 feet above the sea, would be good hunting grounds for shells of the period of 500 feet sea level, which is proved at Chapel Hall, near Airdrie. A bed of recent shells is under Corpach Moss, according to a letter from Mr. Clerk, of Kilmallie, Nov. 5th, 1877. At Spean Falls is a rock dam. Were land now to rise there would be a dam of rock at Counal ferry, and Loch Etive would become a deep fresh lake as soon as the rivers had washed out the salt. Now a tidal race flows out and in over the rock dam, with all the force and turmoil of Lachine Rapid on the St. Lawrence. The drift is chiefly found outside. There would be a rock dam at the Baile Chaolais ferry, and the upper ends of Loch Leven would become a lake by the same process, if the land were to rise. A great mass of terraced shingle about Corran and Corpach in Loch Linne might be taken for the remains of a dam of detritus, to account for sea margins by lakes at the upper end of Loch Linne and of Loch Eil. Loch Lechy and all the lakes which now are joined artificially by the Caledonian Canal, have large dams of stratified shingle at their ends. Glen Gloy belongs to that system. Glen Gloy has "parallel roads" in it, at 1,165 feet, and it is said that there also are lake shores. The dam is wanting at the mouth of Glen Gloy, and there is no remnant of it in Loch Lechy or in Loch Linne. If the great glen were full of ice, there might be an ice dam at the mouth of Glen Gloy. If there were dams in Loch Linne, and at Inverness, and elsewhere, all the lakes in the great glen might join in one, but the sea at 1,000 feet higher, or the land a thousand feet lower, would account for terraces in Glen Gloy and Lochaber, and in Glen Spey without local dams. The American coast would be the dam. Dams of drift are at both ends of Loch Erich, and they are like the rest of these dams, which are at all levels up to 1,153 or 1,209 feet. So far as I know these dams, either they are the lips of rock basins, or they are moraines washed by water. They are made of boulder clay capped with stratified sands and gravels. With so many dams at so many levels, it was natural to account for the Lochaber terraces at first by dams like the rest. But there is no remnant of a dam of this kind large enough to account for the beach marks in Glen Roy by a lake held by a dam of detritus. Nevertheless distinguished geologists still believe in lakes dammed by "detritus," which dams have been somehow removed.

Straits.—The sea is always building dams in "Cols" which are within reach of the sea. The nature of Straits or Sounds I have learned amongst the Scotch islands. The outer Hebrides extend from 56° 15' N. Lat. to 58° 30'. Sounds between the islands are in fact "Cols"

^o Aon—one. Aonach—a solitude; a lone hill. Aonachan—lone hillock.

crossing a long ridge of high rocky hills. Tides flow eastward and westward through these sunken Cols. The lowest are deepest; the highest in the series are north and south of Benbecula, and these are passable on wheels at low tide. In them I have seen that which happened at the watershed of Scotland, if that ridge of hills has in fact risen.

The Benbecula fords are flats of stratified sands which fill a rock groove, and that "plain" ends steeply, seaward, at both ends east and west. The plain is terraced like Moy. There always is a channel in the plain deeper than the rest of the Sound. In it the last of the ebb, and the first of the flood flow swiftly like a narrow river eastward and westward. But when the highest ridge in the lowest hollow in each "Col" comes up through the ebbing sea, swift flowing suddenly ends, as if a sluice were shut. The Sound changes into a couple of sea lochs, divided by a "*dorlaing*," or isthmus, and the water ebbs quietly. There is no scour, and the sand sinks and takes the shape at which sand rests on a slope under water. Whatever scour there may be afterwards is northwards and southwards outside, instead of eastwards and westwards. While the Sound is above water, and is an isthmus of drift upon a Col, land waters flowing north or south are caught in the channel made by the sea in flowing east and west. In these sea-made channels, land water would necessarily continue to flow east and west if the Col were to rise above low water mark ten feet, or fifty, or a thousand or three thousand, or as high as the Himalayas. In that same range of islands are numerous "*Tarberts*," low narrow necks, over which boats are drawn from sea to sea. On them can be seen land waters flowing east and west through drift plains and deepening the channels in which they flow as other streams work between tides on the Fords. These Tarberts certainly were sounds in the outer Hebrides. The River Seil is constantly washing drift into Loch Muidart from a dam, which was a Sound before the land rose fifty feet. The land waters keep a channel open in the strand of Loch Muidart when the tide is out. The scour of the tide keeps a shallow channel open at the narrows, and that channel is continued under water to the open sea, where the sand banks of Loch Muidart end steeply, because water suddenly shoals. Vessels entering have to keep to the channel or ground upon the steep side of it. Were that sea bottom to rise, the land waters would necessarily flow seawards in the channel which the tide has scoured. On a rock at the narrow straits is "*Cuisteal Tioram*," Dry Castle. A "*Dorlaing*" joins it to the mainland. It is a raised sea bottom between two tides. One flows past like a wide river, in and out of the upper loch; the other rises and falls quietly in a shallow bay. The narrow isthmus is terraced on both sides, the slope equals the rise and fall of tide; a plain is at the foot of the terraces, and the terraces are beaches. But the plain of the sea bottom on one side ebbs dry, while the other side is some feet lower and never ebbs dry. The narrows of Loch Muidart at low tide are like the fords at Benbecula at high tide. If the land were raised and converted into a Tarbert, the sand would be a dam, like the dam of Loch Seil, and very like the stuff which dams Loch Laggan at Moy, and is washed in at the

head of Loch Laggan by landwaters, from drift deposits at the Col at Strathmashie. The nature of a tidal sound explains low level terraces in Glen Spean. They occur on both sides of the river, between the contours of 300 and 600 feet, where the contours of 500 feet are about 4,000 feet apart. That gives a strait 200 feet deep, three miles long, and four-fifths of a mile wide. The 500 feet level would send the sea up to the waterfall in Glen Spean. I suppose that land waters followed the channel, which tides scoured as tides scour at Baile Chaolais in Loch Leven. The Spean now flows on rock above the waterfall, and between Roy Bridge and Spean Bridge, and numerous side streams have also cut down to the rock, through drift terraces, along which the road has been made. If, as I suppose, the tide has ebbed three thousand feet, that which happens daily in the outer Hebrides must have happened at all "Cols" which have risen. The Sound which was deep at Strathmashie at 1,250 feet, was a "ford" at 845, and a "Tarbert" at 500. There was a swift race through it when it was like the Sound of Barra; when it got like the sound of Benbecula there was still a rush till the ebb fell; when it became a "Dorlaing" land waters split upon it, and flowed as they flow now east and west, towards two opposite sea lochs. When the sound was finally blocked, the tide rush was transferred to the narrows, which were about Spean Bridge at 500 feet. Now tidal sounds are at the end of Lochiel, in Loch Linne, in Loch Leven, in Loch Muidart, and out in the sounds of the outer Hebrides, where the action of the sea at "Tarberts," "Dorlaings," and sunken "Cols" may be studied by those who care to learn practically. Sea charts shew that all narrow Scotch lochs are terraced just under low water mark; and these terraces are built by land waters and by the tides and the waves of the sea.

Sounds and Dams.—The Dubbloch—black lake, at Inverary, is a rock basin much silted up by a river, and dammed off from the sea. The water is brackish, because the sea flows in through a narrow sound, spanned by a bridge. At half tide the Sound is a small river equal to the land water supply. In that tidal lake herrings and trout live together. If the land were to rise a few feet the land waters would expel the sea fish, and freshen the brackish water.

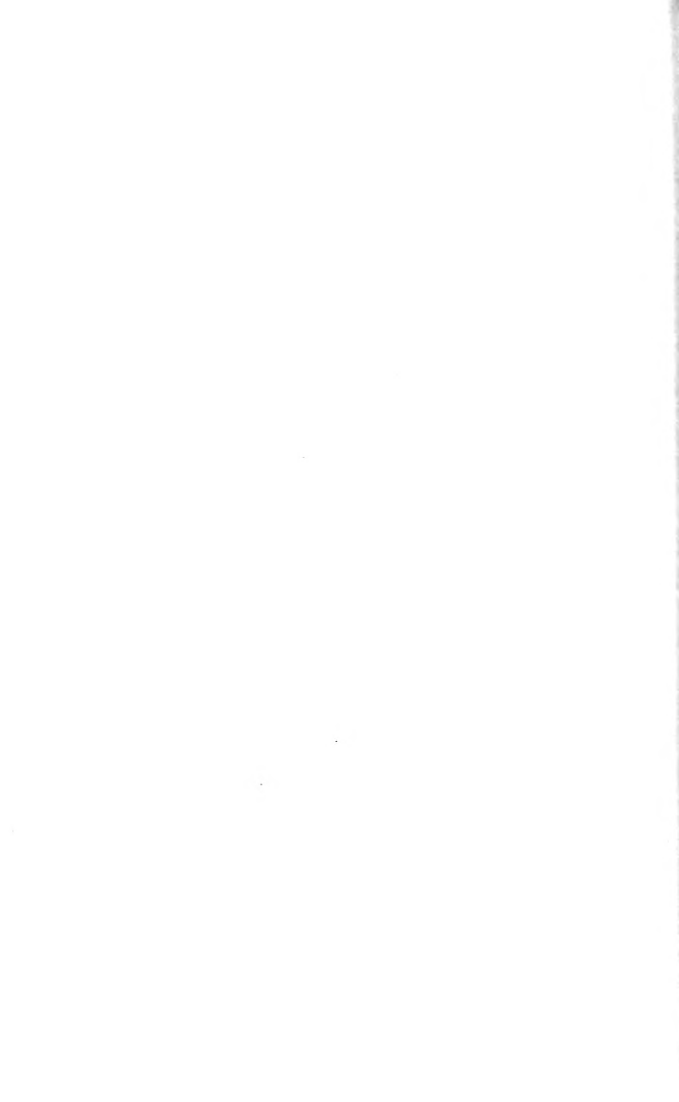
Near Rosneath, the "Gare Loch"—short lake, is a deep rock basin. At the "Row,"—Gàlic Rudha, a point, is a sound 800 feet wide at low water mark, and 2,000 at high water mark on the survey map. The "points" make a broken dam and a "Dorlaing." They are terraces of stratified rolled shingle, sand, and mud, and the longest point is at the mouth of a rivulet, which rolls shingle down from the hill. The terraces are like the rest, in Loch Muidart at the sea level, in Loch Seil about thirty feet higher, at the mouth of Glen Spean up to 500 feet, at Moy at 819 to 850 feet, at Achnasheen at about 700 feet, in Loch Erich at 1,153; and the manner in which the "Points" are growing is plain. Within the "Row" the Gare Loch is five miles long, and about a mile wide. An area of five square miles of sea water as deep as the rise of the daily tide flows through the sound like a broad swift river, and it spreads the drift brought down by the land water, and terraces it in the sea. The tide runs at about 10 miles an

hour at times. Were this land to rise again as it has already risen, bodily, according to the raised coast which is next above the existing beach, the land waters of this drainage basin would flow out of it, in a river some six or seven miles long, like the rivers at Inverary. It would flow between coasts, which are already terraced by the wide deep strong tidal stream, which scours through the dam at "Row." The top of the terrace which now is between high and low water mark, has a slope equal to the rise of spring tide in a distance of 1,200 feet. The top would seem to be a "plain" if the sea were not there to prove the contrary. The bar of shingle would be very like a Kame—"Cenm," or footpath, which geological phenomenon is not easily explained by any other theory known to me.

Loch Lomond is about 20 miles long, and is in a third rock groove. Between it and the Clyde "the Leven Water" (Gaelic, "Lighe" water; Irish, "Li," the sea; English, "Lee" and "Lea") flows upon a larger dam like the Point at "Row." The dam is about five miles long, and the sides are terraced by sea coasts about half a mile apart on the map. They are conspicuous on the ground. These were "coasts" because of sea shells found at higher levels than Loch Lomond up to Airdrie at more than 500 feet above the sea, which is the level of terraces in Glen Spean. Loch Lomond certainly was a sea firth, and the water of Leven certainly flows at the bottom of an old "Sound," terraced like the "Row" in the Gare Loch by the scour of the tide in the narrows. The river Endrick accounts for part of the dam at Dumbarton, and is the larger equivalent of the streamlet north of the Row. In these regions it is geologically proved that the sea flowed through a strait between the Forth and Clyde. From existing facts and records which have been read, records which have not yet been read in Lochaber may be deciphered. By them I make out the Col at Strathmashie to be a *sound* of late date, geologically, but older than human history.

The Clyde is but a larger stream of land waters aided by the tide in a firth, and divided from the Forth in a dried strait. It is now building a dam of detritus under water, and awash, from Dumbarton towards Rosneath point. Rosneath Bay is rapidly silting up. Were it not for the scour of the tide under water which keeps a channel open to the Clyde, the mouth of the Gare Loch would soon be blocked with a silt dam. That sea bottom will be a wide "moor" if the land goes on rising. Through that "plain" the Clyde, the water of Leven, and the land water of the basin of Gare Loch, will flow between terraced sea coasts, they will join at forks, and work as streams do in the Clyde Haughs, in the Carse of Stirling and the Carse of Gowrie; in the Thames Meadows, and in the vallies of the Spey and Spean.

The Valley between the Forth and Clyde Firths was a strait, because of sea shells in it found near Airdrie in drift. It was a "sound," with tides flowing through it east and west. The ordnance map shews the form of a hollow through which some great engine worked eastward and westward, and minute examination of the ground has shewn me that ice worked in the rock groove, and left clear undeniable records all the way from North Berwick to Arran. I have seen the straits of Belle Isle on the opposite Atlantic Coast, crowded with frag-



ments of heavy ice moved by a whole tide, and by a great ocean current, and my opinion is that the present state of that long sound, accounts for records in Scotland, in a hollow of nearly the same size. The drift shells are broken in Scotland. Great "islands of ice" are surely big enough to account for broken shells. Raised coasts surely need nothing but the sea to account for them. The Dubh Loch, the Gare Loch, Loch Lomond, and the valley of the Forth and Clyde are but raised straits of different sizes, and I hold that the valley of the Spey and Spean is another Scotch strait of the same kind as the Sounds of the outer Hebrides. Sea shells have already been found at 1,200 feet in Cheshire, and at 500 feet in Lanarkshire; I venture to predict that they will be found in Lochaber when they are sought for there.

Glaciers.—It is perfectly certain that great glaciers filled all the Scotch glens. Their marks are preserved by drift which covers the rock, and they are seen where the drift has been removed. From Strathmashie to Fort William a glacier filled Glen Spean. Fresh glaciated surfaces in it abound to prove the fact. They do not end in Loch Linne. They cross Andnamurchan, and the Isle of Mull at Knock, and Loch Baa. The top of the granite quarry in the Ross of Mull is polished like a marble chimney piece, where protected by boulder clay; and the rest of that region is all glaciated. Near Fairhead in Ireland, near the lighthouse, are large erratics on chalk. Clear marks of enormous glacial action cross Ireland, and are on high tops in Connemara at 2,000 feet, and go southward out of the sea loughs in the south-west.

Moraines.—On the sides of these loughs are great lateral moraines, terraced by the sea, resting upon glaciated rock surfaces, like those which are in Glen Spean. On getting to Roy Bridge, my attention was speedily drawn to a hog-backed mound which is in the middle of Spean Glen. The "parallel roads" follow the hills above it, and may be likened to the prongs of a pitchfork where they fade away above Spean Bridge. The points are about four miles apart at 845 feet, but many fainter terraces are visible thereabouts at other levels.

The highest point of "*Aonachan*" is 613 feet. I went expecting to find it a moraine where the rock is 300 feet above the sea. On that rock I expected to find glacial marks, to shew the direction in which ice moved. The mound is made chiefly of deep moraine stuff with many large polished boulders in it, covered with rolled gravel and peat, where I could get at it. I have coloured it by the contour lines which shew the shape of the mound. It is terraced down to the river and on both ends. It is about five miles long, and a mile wide, and it stands lengthwise in the rock groove which held the Spean Glacier, pointing to the shell beds at Fort William. It seems to be the moraine of the Spean glacier, washed and terraced by the sea, because it is capped with rolled gravel outside. It is not the moraine of the glacier which came out of Coire 'n eoin into Glen Spean, for it does not come out of that hollow. It is not part of a dam which crossed Glen Spean, but a hog-backed long terraced mound which lies along Glen Spean, and turns into Loch Linne following ice grooves, which go on thence to Cape Clear.

Glacial Striae and Glacial Periods.—I have been seeking ice marks for a great many years in many countries, and reasoning and writing about "Glacial Periods" ever since 1865. All that I had to say on the general question in May, 1877, I sent to the Geological Society of London.—(See their proceedings) After a good deal of searching about burns which have cut through drift down to rock, I found a glaciated rock surface near a road under gray boulder clay on the north side of the river Spean, opposite to the northern prongs of the parallel roads which fade away above Spean Bridge. The place is close to the site of the supposed ice dam which is mapped E.—F. The direction of movement recorded upon the rock corresponds to the flowing of a glacier down Glen Spean, and is nearly at right angles to the supposed direction of the glacier which blocked Glen Spean by crossing it according to the lake theory of ice dams. I found nothing at all in the glacial record to support the ice dam theory, and gave it up on the spot. I could find no remnants of any other dams either between the prongs of the pitchforks of parallel roads in Glen Roy or in Glen Spean. I gave up dams of detritus, and ice dams, and freshwater lakes on the spot where I found the glaciated rock surface under clay. It seems to me impossible that sandy terraces should be left on steep slopes while a dam of detritus four miles long, and about 500 feet deep was swept out of Glen Spean, and out of sight. The marine theory remains to account for the parallel roads of Lochaber, and for all similar water marks in that region up to Loch Erich and the level of the Macclesfield shells, which is 1,200 feet. I suppose that all the drift below that level is marine at the surface, though locally arranged by land waters since the land rose. I take these Lochaber beaches to be the equivalent of Norwegian coast lines, and of drift flats in Sweden and Finland, and in Scotland about the same levels. The chief three beaches probably record the same pauses in the rise of land, which are recorded by three raised coasts in Norway. As in Norway so in Lochaber a whole series of fainter horizontal terraces can be seen in favourable lights. The Lochaber hill sides are marked horizontally from top to bottom, but rains and streams are washing off these beach marks, great and small, faint and conspicuous. The Lochaber parallel roads will be destroyed in time, as drift terraces have been destroyed above Macclesfield where shells are buried.

(Vote in the debate). After seeing Lochaber my opinion is that the parallel roads there are parts of the same coast lines which are marked at Kingnsie, on the opposite side of the Scotch watershed. I think that they are all raised sea margins, like others which I have seen elsewhere in the world during many years of wandering; and like those on which I lived in my childhood and hunted deer in the Western Isles of Scotland.

The complicated machinery of dams required by the lake theory seems to me unnecessary and insufficient to account for the facts which I noticed. Eastern dams would be needed in the Spey Glen to account for terraces at equal altitudes on both sides of the Col at Strathmashie. As I could find no traces of dams at either end of the hollow, in the Spey or in the Spean, I set the dwellers in Lochaber to hunt for sea shells in the drift.

EVIDENCE.

Seeking — Till shells are found in Lochaber drift, my case will not be fully proved. None had been found at high levels, up to the date of my visit in September, 1877, but so far as I could discover very few of the many experts who visit the country for a short spell, and none of those who live there, habitually look for sea shells in drift.

"Bad seekers are bad finders," and those who do not search are worse still unless they are lucky. Unless a man knows what to seek or where to look he is not likely to find. On asking a gentleman about "parallel roads" this year, he answered as if the roads meant were the coach roads through Lochaber. Till Mr. Sainter found his shells nobody looked for them about Macclesfield. Everybody wants gold, and many people migrated to places where gold had been got after 1848. But nobody in Sutherland looked for gold there, because nobody expected to find it. A native returned from digging gold at the Antipodes, sought for gold at home and found it there in 1869. Attention being roused, other skilled diggers flocked to Helmsdale. Experts knowing what to seek and where to look, and how to work; all got gold; as good seekers got good shells at Macclesfield when they sought. The people of a Sutherland fishing hamlet went to the "diggings" with fish creels, intending to gather gold, as they were wont to gather mussels and cockles on the strand. They were bad seekers for lack of experience, and they went home when they saw that gold is easier earned by fishing. The good seekers also went away after finding experimentally that Sutherland gold dust does not pay for digging. It would not pay to seek jewels in the Strand habitually, but they have been found there. A friend bought sapphires in the East where they are dug out of river gravels, and he brought them to England. He carried them through London to have them cut. Somewhere in the Strand they dropped through his pocket. Hundreds, probably thousands, of bad seekers passed the treasure, but one good seeker only who knew what to seek for and where to look retraced his steps, and picked his rough sapphires up one by one in the Strand. Those who seek fossils when others dig in the Thames Valley, find the teeth of elephants in drift with many layers containing works of human art, from flint weapons up to the feet of living Londoners who tread over them all without knowing of them or caring about them. So it is generally. People who live in a country, are "bad seekers and bad finders" of anything outside of their daily experience and way of life because they do not attend to much else; they "mind their own business." For all that has been said and written many educated Scotchmen never heard of the Parallel Roads of Lochaber. But country folk notice anything that is conspicuous and is before their eyes continually, and they generally describe it by a name. The Lochaber people named "the bends," because they seem to twist about in Glen Roy. They named "*The Plain*" at the end of "*the lake of the hollow*," because *Moy* is a plain, and Loch Laggan is in a hollow. They named a hill face between Loch Ghuilbin and Loch Treig, "*Sliabh Lorgach*." Lorg means a spoor or track, like sheep paths or hares' runs, which commonly follow horizontal contour lines on hill sides. Where the people gave a descriptive name, there surveyors have

marked horizontal shelves, and lines of stones for a distance of about three miles. These "tracks" which attracted the notice of the people who gave Gaelic names to Lochaber topography, rise far above the Spean parallel road, which attracted the notice of geologists at 845 feet:—to more than 2,000 feet. There a hill top, above terraced slopes, is crowned with rings upon the map. Shepherds and deer stalkers saw that the hill is "*lorgach*," and described it by a Gaelic name. Surveyors mapped these "tracks;" and I saw them from the coach road in Glen Spean, only because I was on the look out for raised coasts, and accustomed to see them in Norway. On the north side of the Spean, opposite to "the hill of tracks," is "*Meall Clachach*," "Mount Stony." It is a stony mound. "*Rough burn*" correctly describes, by an English name, a hollow in which a great many very large stones are ranged in parallel sweeps, up to about 1,200 feet on the map. These parallels equal the level of the highest of the "parallel roads" now mapped in Lochaber. To my eye these high marks seemed conspicuous in "*Rough burn*," and on the opposite hill face, which is a little to the west of "the plain" at Moy. The local names and the survey map confirm the impression left by the places seen in passing. There certainly was a glacier some four miles long in *Rough burn*, to mark the rocks, under the drift, through which the existing river has cut deeply, since glacial drift was terraced by lakes or by the sea, I saw these ice tracks from the coach, only because I had seen glaciers and moraines, and knew what to look for. The next burn and corrie eastward are named "of the Cave" *Na uamha*. I know nothing of the cave. A cave commonly is a sea mark, and this may be one worth exploring, but because artificial subterranean structures are called "caves," this name will not suffice alone. These Lochaber hollows north of the Spean lead up to a narrow hooked ridge of ground higher than 3,000 feet. It is six miles long and very narrow. About 12 miles away from that high ridge beyond Loch Laggan, and beyond a ridge with tops on it above three thousand feet, and beyond Loch Erich erratics are on "*Geal Charn*" at 3,000 feet. It is said that erratics are common upon isolated tops in this region. Because I have myself found many in Scotland, I set the dwellers in Lochaber to seek for erratics on the highest tops. If they know what to seek for, and where to look, they will be more likely to find missing links in the chain of evidence which is needed to bind sea coasts in Norway firmly to the parallel roads of Lochaber; and to the higher marks which I noticed there, and afterwards found upon the survey map. I hear from Lochaber a rumour that shells have been found upon neighbouring hills. If that rumour proves true there will be an end of a debate which has gone on for 60 years and still continues. I expect to hear of erratics on the highest tops when the weather is fit for searching.

This paper is printed for circulation amongst people who have opportunities to set them to seek by calling attention to the possibility of finding sea shells upon high hills, and big stones upon the highest. I shall be greatly obliged for any information which may help to settle a question which is important for geologists.



Seekers and finds.—The people who are most likely to hit upon sea shells on Highland hills are herd boys and surveyors, the makers of sheep drains, and shepherds, and keepers, and deer-stalkers. These generally have keen powers of observation, and are anxious to learn and willing to exchange knowledge. Those who are most likely to turn up sea shells in flats, and lower grounds, are peat casters, drainers, road contractors, and farmers, who are reclaiming new land, and working it. After rain, things dug up, or ploughed up, are easier to see. The sides of burns, which cut through flats of sand, gravel, and clay, are good places. Fishers on the Spey, the Spean, the Roy, the Lochy, the Ness, the Findhorn, or any such large river, may hit upon drift shells, or bits of them washed out of boulder clay, or sands and gravels, especially after floods. Quarry men moving the ‘cap’ often expose sections and rock surfaces protected by the cap. Men who patrol railways may often find things washed from cuttings, and from embankments made of stuff dug out of cuttings. A great many colonists, returned to the old country, understand ‘fossicking,’ which is another word for ‘practical geology applied to practical mining.’ A great many sailors who hunt seals and whales in the ice world have facts, which others lack. Many soldiers have served in far off lands, and can tell what they noticed. I shall be greatly obliged to any of my countrymen, into whose hands this paper may fall, for any information which will help to settle the Lochaber debate. It is a debate about a Highland question, and Highlanders may settle it by exchanging knowledge, and by keeping their wits about them while they work, as the mason, Hugh Miller, did; and the Scotch naturalist, Thomas Edwards, who was a shoemaker. Like them a discoverer may find ‘mare’s nests’ at first, and may be ridiculed by slower wits. The practice of manuring peat land with shell sand may lead to error, or may be quoted to account for real marine deposits. Many have found mica, who thought they had got gold, but many have got gold nevertheless by ‘fossicking.’ Lake shells will be found where many lakes have been drained, and snail shells where snails live. But sea shells have been found under the beds of lakes, which have been drained, and ploughed, since the sea left the place, for land waters to cover in their turn, and in their turn to leave the land as dry as land is in Lochaber. A good finder may settle the debate about the Parallel Roads of Lochaber once for all. I wrote this for pastime; I print for circulation amongst the classes who may best help one of their kind. Allaban-ach, a wander-er.

Parallel Coasts and Ice Groves.—I am now writing for readers who may not have read geological works. The first ‘Principle’ of the science as I understand it is to learn facts from nature.

Learn what is now going on upon the world, in order to learn what has gone on upon the world.

Read records which are now being written, in order to be able to read records written by the same engines directed by the same will, and stored up from the beginning of the world in the book of nature. Go to the sea to learn the nature of coasts. Gather facts there, and reason upon them, as far as may be. But do not take it for



granted that all coasts are exactly like your own at home. "Coral strands" and "Icy Mountains" are beyond your sea horizon. By way of illustration I will quote one famous proof of the rising and sinking of land at a coast. Facts and reasoning together proved the case, and mere facts carried the author of the *Principles of Geology* a long way through geological records. He overcame the strong prejudice which still prevails against believing in the "mobility of the land;" and in "Raised Coasts;" and in "Sunken Lands," about which folk lore has so much to tell all over the world in support of geological truth. A view of the Temple of Serapis in 1836 is the frontispiece to the "*Principles of Geology*," 9th edition. Six years later, in 1842, I saw the temple. After 31 years absence I saw it again in 1873, made a sketch of the pillars, and bought photographs at Naples. I could see no change of level in that lapse of time. But sea water was about a foot deep on the pavement in 1828 and I found two feet four inches at the base of a pillar, November 12, 1873. There has been little change of level in 45 years. But changes of level at some time during the united lives of about sixty-two generations who have lived and died since the Christian era are proved thus:—

1st. The Temple certainly was built on dry ground, at the base of a bank like the raised cave beach of Britain. 2nd. It sank 23 feet at least into the sea, with many other buildings along the shore of the bay, because certain shells which bore holes in limestone, bored holes in the marble pillars. There are the holes, and the shells are in them, and they are sea shells of living species. 3rd. The Temple pavement rose to near about the existing sea level. The pillars lean a little towards the sea according to measurement. They seem upright. The pavement slopes a little. The whole story, and its application to the mobility of land is told in chapter xxii., page 493. of the famous work of Sir Charles Lyell, of which the first edition was printed in 1830. It is a work of authority in 1877.

According to this kind of proof there has been no great change of level in Scotland since the last churches were built near the sea; since cathedrals were built at Elgin and at Iona; since "Pictish towers" were built near Dunrobin in Sutherland, and in Glen Elg; since pillars, cairns and circles of "standing stones" were set up in Orkney, in Lewis, and in Tiree. No late marks of the sea are about Scotch buildings of which some probably are far older than the famous temple of Serapis near Naples. I know of nothing made by men to suggest any late notable change of level in Scotland, above the level of 40 feet, less or more, where is a notable coast line with caves in it, to prove that the sea worked there for a long time, and before men built between that cave beach level, and the present high water mark.

The chief records of history are comprised within the map of lands which have been under water at some time or other since Eocene times; and many of the oldest known are close above the present level of the sea. The Pyramids are dated B.C. about 1500, and all Egypt lies low, near a place where beds of recent shells prove that the canal is made through a "Tarbert," which was a sound.

Beach marks upon hill sides, and horizontal ice grooves, are like the register upon the marble pillars at Naples. They are like beaches

between tides. They are scales engraved by the sea, upon a scale which has now been measured by the Ordnance Survey. They are like a tidal scale at the end of a pier, or a scale of feet at the stem and stern of a ship. All register or mark the relative position of a water level *at some time*, present or past, with reference to things above water and under it. If a ship cants, or rises or sinks forward or aft; or if an iceberg cants or rolls; or if a block of land, small or great, sinks or rises unevenly, the levels recorded on the scale are not parallel to the actual water line. Large areas of the earth's surface have sunk and risen many times so as to bring the sea level to the same marks over and over again, evenly or unevenly. Monadh Bhreac, the Brindled Mountains, the Grampians, may have been coasts when coal was peat, or was growing. They certainly have been coasts since Eocene times, according to authority. They were coasts when the Forth and Clyde firths joined about Airdrie. But they may have canted like a ship or an iceberg, or a sunken pier, or a leaning river gauge; or like the marble pillars at Naples; or like Scandinavia. Accurate measurement by experts like Robert Chambers and the Ordnance Surveyors settle whether sea beaches on hill sides are "parallel," and so ascertain whether land rose evenly, or how it rose. Shells only can decide for geologists whether a beach is a sea beach. When I write of a general rise of Scotland equal to 3,000 feet, I mean a rise since great stones, erratics or Allaban-aich were planted upon Monadh Bhreac, Monadh Liath, and Monadh Ruagh at 3,000 feet.

When I speak of a rise equal to horizontal lines scored by ice upon the sides of high tops: I mean a rise since these rock surfaces were scored horizontally by ice passing along the mountain scale which had not been measured by the Ordnance Surveyors, when I first found such marks long ago, and wrote about them in 1865.

Sealers and whalers will understand what I mean. When I speak of a late rise equal to 1,200 feet, I mean a rise since shells lived at Macclesfield of the families which people British seas—Cockles, mussels, oysters, screws, periwinkles, limpets, ladies ears, buckies, cowries, and others which are known to fishers as "Maorach"—bait. I saw all these in Mr. Sainter's collection, on the 24th of October.

When I speak of a rise equal to the highest of the Lochaber parallels, I mean a rise so late in geological time that land waters which have cut deep V grooves in the sands and gravels above Roy bridge, have not yet washed out the whole of a record which is written chiefly in sand, in Lochaber. The sea never has retouched flat sand terraces and furrows cut through them which now remain as they were shaped by waters at and below the level of 855 feet. Look to the sea for the facts. Holes dug in gathering bait at low water, get filled when the tide flows, and disappear in a few days. Look at a burn to see what it does to sand beaches near the sea, above and below high water mark. The burn makes a mark, the sea wipes it out every tide. Coasts marked on boulder clay, and moraine stuff, like stuff by the way side between Kingussie and Spean Bridge, and in fields upon Aonachan, may have been up and down many a time. The sea has covered Lanarkshire up to 500 feet, and the rocks still are covered with clay. Hard tough greasy stuff is not easy to wash away. Plenty of it is in

the sea now, and is little changed by tides. Because the sea was at Airdrie it probably was at "Tom an t-èirne" --the watchfire mound on the top of Aonachan; say at 500 feet. Below that level I saw no sand terraces in Lochaber, down to 300 feet. Land may have sunk and risen many times since the sea was at 855 feet, at 500 feet, or at 300. It has sunk and risen elsewhere many times since the Christian era; and many times since the beginning of this century. Land is sinking and rising still. I have felt it move under me during an earthquake in Japan, and the Oban people felt it move under their houses this year as they declared. That Scotch earthquake being a new idea to many, was by many supposed to be untrue. Thereupon somebody described the capture of "the sea serpent" at Oban, and was immediately believed because it was "in print," and because the sea snake is an ancient myth familiar to all the world. He is Shesha Naga in India and Dreagan in Glen Nevis, but his bones are wanting in Geology, and he is a myth.* Between the raised caves and the storm beach level, the land may have sunk and risen many times. It has elsewhere. Even Gaelic names often seem to record the presence of the sea far inland. Mr. Clark, of Kilmallie has given me a list of such names in his neighbourhood, and I know many elsewhere. All records of the presence of the sea, high and low, seem to me very old historically, though later than the last time when glaciers flowed off Monadh Liath through all the glens. It was found last month by Sergeant Fraser, that ice left its mark in Glen Roy and scored the rocks near the river. The sands buried the old marks and preserved them; the river dug out the records of ice. Upon these scored rocks rest thick beds of sands and gravels, on which is the 855 parallel road. On these grow woods. In them men smelted iron and left piles of slag. Manifestly the sea was not at the smelting hearth in Lochaber when it worked; nor was it at the lower smelting hearths beside the River Ewe; nor was it in Glen Elg, when the ancients built their towers before Scotch history begins. Nor was the sea at standing stones out in Lewis, about which a thick peat moss had grown since pre-historic men set up pillars, and left them to puzzle antiquaries. Such pillars are set up along the overland route to Cape Comarin. When I speak of "raised sea coasts" and of "horizontal ice grooves;" at high levels on Scotch hills above a thousand feet, I mean something beyond measure older than any of these very old records from the Parallel Roads downwards, though later than the last "Scotch glacial Period," during which Scotland was like the sealing grounds over in the Labrador as I suppose, and was sunk as rocks are off Newfoundland, against which "floes" and "pack" drive in the Arctic current from the Polar basin down to Cape Race; and thence float onwards to lat. 37° North in the Atlantic. Ask any sailor who has been sealing what the sea coast is like over the sea and beyond the sea horizon of the Scotch coast. The works of pre-historic builders reach nearly to the storm beach level in Scotland. I suppose that the builders of

* Nov. 16. Mr. Clark tells me that a sea cave is in Glen Nevis to which is attached a legend of "a Dragon and a Piper." We are all said to be "Allaban-aich," who wandered from Central Asia. The Dragon myth pervades the world, and all the caves in the Himalayas are supposed to be haunted by gigantic serpents, and dragons with many heads. Many West Highland stories are current still in India, and many of our customs are Hindoo customs, in particular the Highlanders of Sikkim play the pipes.

stone circles found the sea near about the present coast when they reached it. They may have found it a long way westward, at a far lower level, in "*the land under the waves.*" Many western caves, like the blue grotto at Capri near Naples, now are just above the sea level at the mouth. They probably mark a coast which has gone *down* since the caves were made. There are sunken peat mosses, and sunken forests under the sea, and they are records as plain as the record built by Tiberius who lived about the beginning of the Christian era, and built a palace, of which part is deep in the clear sea which now fills the blue grotto, close up to the roof at the mouth. "The mobility of the land" means sinking as well as rising, and that is at the very foundation of the science of geology, as I have learned from books, and by wandering about the world for many years, reading the book of nature for myself and striving to understand it so far as my powers can reach.*

The Lochaber debate has already lasted for sixty odd years. We may go on debating for several more generations, unless we get new facts. But some Lochaber lad will settle it if he can point out a place where geologists can seek and find sea shells, which experts will admit to be genuine finds, like those of Mr Sainter at Macclesfield. They reach 1,200 feet, and are about the level of the pass above Gleann Glas Choire, and Allt Glas Choire—the glen of green grove, and the streamlet of the green Corry—out of which somebody made that "Glen Glaster," for which I vainly inquired of a deer-stalker whom I met at Moy on the 25th of September, 1877.

"I know every glen in this country," he said in Gaelic, "and there is no Glen Glaster."

This part of the paper is written for men like him, used to seeking and finding—for "Clanna nan Gaidheal," agus na "Abaraich."

J. F. CAMPBELL.

NIDDRY LODGE, KENSINGTON, LONDON, W.,

November 22, 1877.

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* November 17, 1877.—While correcting proofs I have had the great advantage of reading a copy of Mr. David Milne Home's paper on "The Parallel Roads of Lochaber;" an "author's copy," from the transactions of the Royal Society of Edinburgh, Vol. XXVII., 1876. In it are facts gathered on the spot, and out of books by the distinguished author who also gives his own explanations. I find mention of many "erratics" perched high upon isolated tops, including "Geal charn," at 3,000 feet. I find mention of horizontal strata on rocks up to 3,055 feet, including some which I described in 1865. I find mention of strata at low levels in Glen Spean, which pass athwart the foundation of the ice dam on the line of "Coire n' coin." E. F. on the map. They are E.W. instead of N. S., as they ought to be to make the ice theory hold water. I find mention of many "parallel roads" in many parts of Scotland. I had the advantage of hearing Professor Tyndall's lecture, and of seeing him work his clever model to illustrate his theory of ice dams. I am led to expect a reply to Professor Tyndall from Mr. Milne Home. My own attempts to explain my store of facts are in "Frost and Fire," published 1865; in "A Short American Tramp," 1865; in "Something from the Gold Diggings of Sutherland," 1869; in papers in the Quarterly Journal of the Geological Society, May and November, 1873, and November, 1874; in "My Circular Notes," 1876; in *Nature*, June, 1876; in the Journal of the Asiatic Society of Bengal, January, 1877; in a paper now before the Geological Society of London, since May, 1877, and in this paper, which I may hereafter finish and publish. I only want facts just now.

NOTE.—On the 21st, Mr. William Stone, F.G.S., of 42, Watergate Street, Chester, read a paper on drift shells found by him in West Cheshire, and exhibited his collection to the Geological Society. They seemed fresher than shells of the same kind, found at higher levels above Macclesfield.

