where each sort are found, and the other remains found along with each, may throw some light on the subject; and those who have the means of doing this will, we trust, give the matter their best consideration.

## NOTICES OF MEMOIRS.

### I.—Notes for a Comparison of the Glaciation of the West of Scotland, with that of Arctic Norway.

By Archibald Geikie, F.R.S., etc.

[Proc. Roy. Soc., Edin., Jan. 15, 1866].

In June, 1865, the author, accompanied by two of his associates in the Geological Survey, Mr. W. Whitaker and Mr. James Geikie, made an excursion to Norway, for the purpose of examining the glacial phenomena of that country, and to search for any facts that might help to throw light upon the history of the glacial period in the British Isles.

The close resemblance between the general outline of Scotland and Scandinavia is well known, and this depends upon a close similarity in the geological structure of the rocks, and a coincidence in the geological history of the surface of the two regions. Norway from south to north, is almost wholly made up of metamorphic rocks, not all of the same age, yet possessing a general similarity of character. In like manner, the west of Scotland, from the Mull of Cantyre to Cape Wrath, is, in great measure, built up of gneiss, schist, slate, quartz-rock, granite, and other metamorphic rocks, quite comparable with these of Norway.

Besides the external resemblance due to the lithological nature of the rocks, beneath there is a still further likeness dependent upon similarity, partly of geological structure, and partly of denudation. Many of the Scottish sea-lochs have had their trend determined by lines of strike or of anticlinal axis, and the same result seems to have taken place in Norway. In other cases, the lochs and glens of the one country, and the fjords and valleys of the other, cannot be traced to any determining geological structure, but must be referred to the great process of denudation which has brought the surface to its present form.

No one can attentively consider the maps of the countries between the headlands of Connaught and the North Cape without being convinced that the endless ramifying sea-lochs and fjords, kyles and sounds, were once land-valleys. Each loch and fjord is the submerged part of a valley, of which we still see the upper portion above water; and the sunken rocks and skerries, islets and islands, are all so many relics of the uneven surface of the old land.

No feature of the Norwegian coast is more striking than the universal smoothing and rounding of the rocks, which is now

recognized as the result of the abrading power of ice. Every skerry and islet, among the countless thousands of that coast-line, is either one smooth boss of rock, like the back of a whale or dolphin, or a succession of such bosses rising and sinking in gentle undulations into each other. Such too is the nature of the rocky shore of every fjord; the smoothed surface growing gradually rougher, as it is traced upward from the sea-level, yet continuing to show itself, until at a height of many hundred feet, it merges into the broken, scarped outlines of the higher mountain sides and summits. In short, the whole surface of the country, for many hundred feet above the sea, has been ground down and smoothed by ice.

An excursion was made, by the author and his friends, to the glaciers of Svartisen; starting from the island of Melo (a steamboat station), which lies a little to the north of the Arctic Circle, the party proceeded up Holands Fjord to Fordalen. This hamlet stands at the mouth of a deep narrow valley, on the line of the terrace, which here runs along the crest of a steep bank of rubbish covered with enormous blocks of rock—an old moraine thrown across the end of the valley. At the head of the valley a small glacier descends from the snowfields of Svartisen. There could be no better locality for studying the gradual diminution of the glaciers, and for learning that it was land-ice that filled the Norwegian fjords, over-rode the lower hills and mountains, and went out boldly into the Atlantic and Arctic Seas.

Leaving Holands Fjord, the party took the steamer at Melovaer, and proceeded northwards, halting at the island of Skjaervö (lat. 70°), in order to make an excursion across the Krenangen Fjord, and up the Jökuls fjord, to see the glacier which reaches the level of the sea. The sides of the Fjord are icemoulded and striated, in the direction of the inlets, and its islands are only large *roches moutonnées*.

Several other fjords were visited by the party. In fine, the excursion into this northern part of Scandinavia furnished abundant proofs that the glaciation of the west of Norway was produced by a mass of land-ice, of which the present glaciers are the representatives It likewise confirmed, in a most impressive way, the conclusion which has gained ground so rapidly within the last few years, that the glaciation of the Scottish Highlands, as well as of the rest of the British Isles, is in the main the work, not of floating bergs, but of land-ice.

---

## II.—Report on the Auriferous Drifts and Quartz-Reefs of Victoria. — Observations on the Probable Age of the "Lower Gold Drifts."

By Alfred R. C. Selwyn, Director of the Geological Survey of Victoria.

THE attention of the Geological Survey has latterly been directed to the very important question of the age, and probable auriferous or non-auriferous character of what are called the "Lower drifts of Victoria," and from the facts observed, the following conclusions have been arrived at :—

First.—That these particular drifts are clearly antecedent in date to the upper and middle marine Miocene beds, under which they have now been traced, and, therefore, that they are far older than the lowest Pliocene gravels, to which age the deep-lead gravels of Ballaarat, the White Hills of Bendigo, and other similar rich gold-bearing gravels have been referred.

Second.—That they do not probably contain gold in paying quantity, because, as I believe, they are derived from the abrasion of quartz veins, that themselves contained little or no gold, and that were probably formed by forces in operation as long prior to those which produced the gold-bearing veins, as the denudations, producing the barren Miocene gravels, were prior to those which gave rise to the Pliocene productive ones.

I will now briefly state the facts which have led to these conclusions.

During the progress of the Geological Survey, deposits from a mere capping, to over 300 feet thick, have been met with in several localities, from sea-level to an elevation of 4000 feet. These consist of beds of clay, sand, "cement" or conglomerate, gravel, and large boulders,—the gravel and boulders, much water-worn and rounded, and composed either of quartz, quartz-rock or hard silicious sandstone. They rest on the ordinary slates and sandstones (Silurian) of the gold-fields, and are often in the vicinity of rich gold-bearing quartz-reefs.

Till quite recently I have considered these deposits to be true Older Pliocene gold-drifts, or of the same age as the rich lower drifts of Bendigo, Epsom, Ballaarat, Castle-maine, and other gold-fields, all of which drifts they very closely resemble, both in lithological character and geological position. Holding this opinion, I have hitherto been at a loss to explain why they had in no instance been found to contain gold in paying quantity. Numerous shafts had been sunk and levels driven in them in the most likely places in various localities, both by miners and by the Geological Survey parties, with a view to develop their supposed auriferous contents, but always with the same unsuccessful result.

In the neighbourhood of Steiglitz especially, they occur in close proximity to rich quartz-reefs; and the more recent alluvial deposits near the same reefs are also auriferous, while every attempt, and many have been made, to find paying gold in the older gravels either on the hills or in the valleys, has proved unsuccessful. The connection of these old unproductive Miocene gravels of the Steiglitz gold-fields, with the lower gravels of the Golden Rivers, Tea-tree Creek, the Upper Moorabool, Parwan Creek, Bacchus Marsh, and Ballan, has not yet been fully mapped out; but the preliminary examination recently made has, I believe, clearly established that they all belong to the same Miocene period; and, if so, I venture to predict, they will all prove equally unproductive. At the Tea-tree Creek, and all along the valley of the Moorabool, what I believe to be the true Older Pliocene gold-gravel has been worked, and it rests directly on what I now term the non-auriferous Miocene gravel,

without the intervention of the marine beds or of the older basalt, both so well shown lower down the same valley.

The section near the Golden Rivers is:—

1. Upper basalt-rock, about 25 to 30 feet.
2. Pliocene gravel, about 50 to 60 feet.
3. Miocene gravel, etc. ("false bottom of miners"), gravel, sand, clay, and boulders, with fossil-leaves and wood; about 400 feet.
4. Silurian slates, etc.

The section on the Moorabool, west of Steiglitz, is:—

1. Basalt, upper, 49 feet.
2. Sandy Pliocene grit, 10 to 15 feet.
3. Upper coralline limestone (Miocene), 13 feet.
4. Older basalt, enclosing bands of hard compact limestone with fossils (Miocene).
5. Sandy limestone, with fossils, 30 feet (Miocene).
6. Rounded quartz pebble-drift, and hard silicious conglomerate rock, with fossil wood, lower part a gravel and boulder drift, 90 feet.
7. Silurian slate and sandstone with quartz veins.

No. 6 of this section represents No. 3 of the Golden Rivers, 3, 4, and 5 being absent in the latter. The thicknesses given are only approximate, and of course vary in different sections.

In support of the theory I have advanced respecting the non-auriferous character of a set of what I believe to be the older quartz-veins, and from which the Miocene gravels have, probably, in great part, been derived, I would mention a fact well known to all experienced quartz-miners, viz., that in many districts numerous large lines of reef occur that are entirely barren, though in close proximity to others affording handsome returns. These reefs present no peculiar features either in external character, general appearance, or mode of occurrence, that would enable an ordinary observer, unacquainted with the reefs of the district, to distinguish them. They are, however, I believe, recognised without much difficulty by the practical quartz-miner.

Now unless there really is, as I suggest, some marked difference in the time, and also in the conditions under which these different reefs were formed, it is difficult to explain why one reef should be richly auriferous, while another, in close proximity, is entirely barren, if formed at the same time and under similar conditions. In attempting to reconcile these facts, I have arrived at the conclusion, that there must be two, if not more, distinct sets of quartz veins—that the older ones were formed prior to the Miocene period, and are barren; and that the newer ones were formed after the close of the Miocene epoch, and before the Pliocene, and are productive. The former have furnished the material for the barren Miocene gravels; and the latter have furnished the material for the productive Pliocene gravels.

Victoria, *May 4th*, 1866.