

of the Kawaka Watershed, and round the eastern slopes of the Waimea South Hills, by way of Stony Hill, Duffer's, and Greek's, to Callaghan's, all within the Kapitea Watershed.

In the upper basin of the Kapitea and Little Kapitea Creeks almost the entire area of drainage by these streams is occupied by morainic matter, slightly modified over particular areas, or by beds of silt deposited in lakes fed by glacier-streams. These moraines and other glacier deposits were, within the Kawaka and Kapitea Watersheds, mainly, if not wholly, due to the Arahura Glacier, which, finding little or no relief to the south and south-west, pressed with great force to the north-west and north, and in the latter direction came in collision with a portion of the Teremakau Glacier. These phenomena of the action of ice in the northern part of Westland, during the glacier period, have been fully described elsewhere;* and more than a rapid sketch of the areas covered by these deposits need not be given in this place. The Arahura Glacier, driven to the north, was met by one great branch of the Teremakau Glacier, and thus the Loop-line Hills are on one side formed of materials brought forward by the Arahura Glacier, while on the other, the northern side, the material is due to the action of the Teremakau Glacier. Yet the Arahura Glacier reached forward into the watershed of the Teremakau River, a little to the seaward of where was the terminal moraine of the Teremakau Glacier. As regards the gold-bearing character of the Arahura moraines there can be little doubt, as otherwise it would be required in some other way to explain the presence of the gold over the entire watersheds of the Arahura River and Kapitea Creek, and part of the Teremakau Watershed near Dillmanstown. Perhaps such alternative explanation would be the more reasonable if it assumed this as being due to the denudation of the Pliocene gravels where they occur in this part of the district, since if gold be denied to the glacier-drifts, it must also be considered absent from the river-gravels that, having the same source, simply by a little time preceded the deposit of the moraines, such river-gravels being in great part merely glacier matter rounded and carried forward from terminal moraines that in course of time were overridden by the further advance of the glaciers.

On the northern side of the Teremakau Valley no moraines appear to have reached further to the westward than within the limits of a line drawn from the mouth of the Greenstone Valley across Fuchsia Creek, where that is crossed by the Greymouth-Greenstone Road, and thence by way of Maori Creek (in the New River Watershed) to Stillwater and Maori Gully, within the Grey Watershed. At all of the places mentioned there is unmistakable evidence of the presence of morainic matter, but slightly if at all modified by the action of running water. How far glaciers reached down the Arnold Valley is not easily determined, but probably to abreast of, or even further west than, the points reached in Stillwater Creek and Maori Gully.

No clear evidences of the presence of ice has been detected on the No Town Hills, and it is only to be inferred that the line of furthest ice extension crosses Nelson Creek somewhere above Hatter's Terrace; nor has the line of limit been clearly made out further to the north till reaching Orwell Creek. Here the presence of ice is unmistakably made clear by the occurrence of vast angular blocks of rock scattered over the tops of the hills between Napoleon Hill and the saddle leading from the left branch of Noble's into the head of Duffer's Creek. More to the north every trace of moraine in the low ground has been destroyed by the action of the Big Grey in the formation of the succession of terraces described under the previous heading. Yet, in the different gullies cut into the "Old-man bottom," in Adamstown and Antonio's Flat Creeks, large boulders are found suggestive of the agency of ice as a means of transport from their original matrices and localities to the hill tops, whence they have rolled into the gully bottoms.

No modern ice-action appears ever to have taken place in any part of the Paparoa Range, otherwise the morainic material has been carried completely forward into the Grey Valley, so as to come under a reconstructive process by means of running water, or, on the west coast side, bodily into the sea. As far as this latter assumption is concerned, as older deposits of a loose or incoherent character are preserved in many places that must have been passed over by ice in its passage to the coast-line, we may assume that no such ice-sheet ever existed. In the Upper Buller Valley the only evidence of glacier action is the moraine stretched across the Maruia, seven miles below Walker's Home Station. This is unmistakable in its character—the general character of the material, the hummocky outline of the surface, and the large far-transported blocks of rock, still perfectly angular, amply testify to the fact.

(b.) *River Deposits formed prior to the Advance of the Glaciers.*—At Ross the deposits in the flat are partly reconstructed glacier material, and partly river-gravels that were deposited prior to the advance of the glaciers. The various alternations of these beds are well seen in the workings of the Ross United Company's claim, and there can be no doubt that the greater area of the Ross Flat towards the sea contains the like deposits.

In the country between the Totara and Rimu it is uncertain if any of the gravels seen along the road-line do underlie the glacier deposits, but along Back Creek and in the face of the terrace overlooking the low grounds of the Hokitika, it is abundantly demonstrated that river-gravels underlie the glacier deposits. These old river-gravels are auriferous, and form what is now the principal source of gold in the immediate district.

River-gravels under the morainic hills are probably present at the western margin of Commissioner's Flat, Kanieri. In the glacier deposits of the Kanieri Forks there are considerable developments of gravel at places; in other places almost none. In the Arahura, Kawaka, and Kapitea Valleys very little has been done to prove the existence of gravels under the glacier-drifts, or, where gravels have been observed, to prove them gold-bearing. It is at Kumara where the river-gravels under the morainic deposits of the Dillmanstown Hills occur fully displayed, and where they have most extensively been worked. It would appear that these gravels on the Kumara field are the great source of the gold. They in the various workings pass under the morainic hills of Dillmanstown. Over Kumara and Larikins Flats these gravels were overlain by others of a similar nature, derived from the denudation of the adjoining glacier deposits, and it was a matter

* Mines Reports 1893, pp. 163, 164.