

ART. LXXXIX.—*Notes on the Valley System on the Western Flanks of Mount Cook.* By S. HERBERT COX, F.C.S., F.G.S.

[*Read before the Wellington Philosophical Society, 30th September, 1876.*]

THE following observations were made by me during a trip in January last to the West Coast, south of Hokitika, on work connected with the Geological Survey, and are placed before the Society with the permission of Dr. Hector.

The points to which I wish to call attention in this paper are more specially connected with the West Coast Glaciers rising in the vicinity of Mount Cook, pointing out the position of the snow-fields from which these derive their origin; this being of special interest, as showing the disconnection which exists between the older crystalline range and Mount Cook proper.

I intend on a future occasion to read a paper before this Society on the glaciation generally of the West Coast, and simply bring the present facts before the notice of the members as a ground-work for further remarks in the future.

Mr. McKay and I arrived at Gillespie Beach on the 22nd January, having come up overland from the Abbey Rocks, where we had been landed by the "*Waipara*" on its way from Jackson Bay.

We had previously settled in our own minds that we would go inland from this point to the Fox Glacier, and endeavour to get back on to the main range, and also see with what prospect of success an attempt to ascend Mount Cook from the West Coast was likely to be attended. I do not think we were ever sanguine enough to fancy that we could ascend the mountain ourselves under the circumstances in which we were placed, and if we ever did indulge such an idea for a moment we had abandoned it before reaching Gillespie Beach.

However, we wished to get as far back as possible, our object being, if practicable, to reach the junction between the older crystalline rocks and the overlying Maitai slates; and accordingly having hired a pack-horse, and prevailed upon a man who had been to the glacier often before, and knew the fords of the river well, to accompany us, we started on the morning of January 25th, arriving at the foot of the glacier the same night.

When Mr. Fox visited this glacier, and indeed until comparatively recently, the river headed from the northern side, and the passage from one side to the other was readily accomplished. Now, however, the river heads from almost the southernmost boundary of the terminal face, and to cross the glacier is a matter of considerable time and difficulty, the result being that, having been obliged to leave the pack-horse a mile or so below

the glacier, and having had to swag our things from this point, we arrived too late, and were too heavily laden to make any attempt to get to the southern side to camp as had been our original intention, so we pitched our tent at the foot of the northern spur.

The elevation of the terminal face of the glacier above the sea by aneroid measurement I found to be 660 feet.

From the northern edge of the Fox Glacier a spur rises very abruptly to an elevation of about 5,000 feet, and separates the Francis Joseph Glacier from the Fox, the summit of this spur in the summer time being only capped with patches of snow.

On the southern side of the Fox there is another spur-range, which attains a somewhat greater elevation than that to the north, the highest point being, by aneroid measurement, about 6,500 feet above the level of the sea, the general elevation of the spur being about 5,500 feet.

The next morning we started on our way across, and found considerable difficulty in getting over owing to the manner in which it is crevassed, involving many journeys backwards and forwards up the glacier, in addition to which, in three separate cases, we had to cut steps in the ice to ascend or descend as occasion required.

We got across eventually, and spent the day in examining the rocks which occur in the Conical Hill and in travelling for a distance of perhaps two miles up the southern lateral moraine.

On the southern side of the terminal face of the glacier is a hill called the Conical Hill, on the southern side of which a stream runs, delivering its waters into the Cook River and rising from the glacier about a mile above its terminal face, also deriving a good deal of its water from mountain torrents which fall from the spur-range to the south of the glacier.

Up this creek we went until getting into the lateral moraine; and at a point about $1\frac{1}{2}$ miles up the glacier came to one of the before-mentioned mountain torrents.

We went some little distance up this, and found that, although rough climbing, it was quite practicable to ascend it, at least as far as we could see, so we decided to try this direction for our ascent of the hills next day. We returned to our camp that night, and the next morning started with daylight, having by this time become more familiar with the way across the glacier, which we crossed in about half-an-hour, and then pushed on to the before-mentioned stream. Up this we started, and made pretty good travelling for some time, ascending along the bed of the creek to an altitude of 4,000 feet, a considerable amount of the travelling requiring the use of our hands far more than feet. When we reached this elevation we left the bed of the creek, and, after a rough scramble, got on to a slope covered with

alpine plants, which were at this time in full flower, and by eleven o'clock we were on the summit of the range.

On the northern slopes of this spur little or no snow rests, but on crossing the crest of it a large snow-field is seen at an elevation of 5,300 feet above the level of the sea, and *sloping eastwards*.

This field is surrounded on all sides by turretted peaks, which rise as bare patches above the snow, and at one point only could we see an outlet, viz., at the S.E. edge, from which point the Balfour Glacier is fed.

The Fox Glacier trends away to the N.E., at a point about two miles above its foot, to an extension of this snow-field, lying to the westward of a dome-shaped mountain, which we took at this point for the dome of Mount Cook, but whether correctly or not, I am unable to say. The Francis Joseph glacier heads from the northern part of the same snow-field.

The ridge of the spur to the south of the Fox Glacier follows the trend of the Fox Glacier itself; that part of the snow-field, from which the Balfour is fed, thus widening out to considerable proportions, as shown on the diagram, but I had neither the means nor the time to determine the exact extent of this accurately, and am only able to shew it relatively to other points, which have been fixed by topographical surveyors; however, it extends continuously over the dome.

Beyond this snow-field, in a S.E. direction, there is a deep valley separating it from the main range, which, as far as I could determine, is the valley of the Balfour Glacier, and its elevation above sea level cannot be more than from 2,000 to 3,000 feet, a dense bush being seen on the western flank of the main range, which rises abruptly from this valley.

The northern branch of the Weheka or Cook River rises from the Fox Glacier, the middle branch from the Balfour Glacier, and the southern branch—which, according to all accounts, is not an ice river—in all probability has one of its sources in a valley at the foot of the main range in the direction of Mount Cook; the main source, however, heading from Mount Sefton, as is evidenced by an account I got from a digger at Gillespie Beach. It appears that this man wished to get from Gillespie to the Mackenzie country, and thought he could effect a pass at the head of the southern branch of the Cook River, the elevation of the main range there being considerably less than at most points, but very broken and rough. With this end in view, he went up to the head of the south branch, and, as he says, completely lost himself. However, he kept on rising till he got, as he imagined, to the summit of the main range, and then commenced to descend, ultimately finding himself in the bed of the Karangarua River, which brought him out at its mouth, about ten miles from where he started, showing that the southern branch of the Cook River saddles with the Karangarua, at a point to the Mount westward of Sefton.

It will be seen then from the above:—

- (1.) That the principal drainage of Mount Cook is to the S.E., by way of the Hooker and Great Tasman glacier; but at the same time it is highly probable that a large quantity of snow from the main range is carried down to the West Coast by the Wataroha, which falls into the sea north of Okarito.
- (2.) That a snow-field of very considerable proportions lies to the westward of Mount Cook, not, however, having any immediate connection with it.
- (3.) That this snow-field stretches back to the Dome, to the eastward of which the River Wataroha, in all probability, takes its rise from an, as yet, unknown glacier, and consequently that, from Mount Cook, the line of water-shed must retreat to the eastward.

It will further be seen that the Francis Joseph and Fox Glaciers are fed from this snow-field irrespective of Mount Cook, and that the Balfour Glacier derives the greater portion of its ice, at all events, from the same source, but that it may also, to some extent, be fed by avalanches from Mount Cook, which mountain would also perform, in a large measure, the function of condenser for the whole field.

We spent some hours on the snow-field, and then commenced our descent, and, not being satisfied with the way we had come up, thought it better to try the spur for some distance, and then to get into another creek, which, from our point of observation, appeared to rise by easier gradients. We were decidedly unlucky in our choice, having great difficulty in ever getting to the creek at all, and, after reaching it, I counted 36 waterfalls that we had to descend before reaching the edge of the glacier, and we only arrived at our camp when it was quite dark, having had to cross the glacier with very little more light than that afforded by the moon, and having had considerable experience of what Mr. McKay described as the "Boulder Hornpipe."

Before closing this paper, I wish to call attention to a few points of interest, which have come under my notice, with respect to the present glaciers.

In the year 1870, Dr. Haast made the height above the sea of the terminal face of the Francis Joseph Glacier, 705 feet, and of the Fox Glacier, 702 feet.

In 1868, Mr. J. R. Hackett made the height of the Francis Joseph Glacier 640 feet above sea level; and when at the Fox Glacier last January, I found the elevation of the terminal face to be only 660 feet above the level of the sea.

Dr. Haast, in describing his topographical map of the Southern Alps for the Royal Geographical Society, mentions the fact that the Tasman Glacier had advanced about half a mile during the time which had elapsed between his visits there in 1862 and 1870; and in an earlier report on the West Coast, he has also given the height of the Francis Joseph Glacier above the sea at 750 feet. These variations appear to point to the advance of the glacier during the past few years; and the absence, at the foot of the Fox Glacier at least, of any terminal moraine of consequence, adds further proof of the truth of this hypothesis.

ART. XC.—*On the Reptilian Beds of New Zealand.* By A. MCKAY.

[Read before the Wellington Philosophical Society, 4th November, 1876.]

IN March last, I received instructions to proceed to the Amuri Bluff for the purpose of making further collections and a measured section of the north-east face of the bluff. In my official report I confined myself to a statement of the facts observed by me; and now, with the permission of Dr. Hector, I contribute my views in the form of a paper to the Society.

Before doing so I propose to shortly sketch the progress of the geological exploration of the Waipara and Amuri Bluff beds, as the views held as to the age of these vary considerably.

In 1861 a notice of the first discovery of saurian remains, at the Waipara, by Mr. T. H. Cockburn Hood, was given by Professor Owen in a paper read before the British Association, from which it is to be inferred that he considered the fossils to indicate a jurassic age for the formation period.*

In 1864 Dr. Haast, in a paper dated, June, 1869, states that he examined the Waipara beds, at which time he considered the saurian beds to be of lower tertiary age.† In the same year Mr. John Buchanan, of the Geological Survey Department, examined and made collections from the Amuri Bluff beds, considering the Amuri limestone and overlying marls at that place as lower tertiary.‡

In the same report, from an examination of Mr. Buchanan's collections, Dr. Hector was enabled to classify the beds as below:—

Cretaceo-tertiary formation.

A—Chalk marls, the upper parts of which are now known as the grey marls; the lower as the Amuri limestone.

* Proceedings of the British Association, 1861.

† "Trans. N.Z. Inst.," Vol. II., p. 189, 1866.

‡ "Geol. Reports," 1866-7, p. 39.