absence of an underclay beneath the coal-seams, such as is generally found below European and American coal-beds, and in which the roots of *Stigmariæ* and other plants are to be found. According to the observations of Mr. Draper, the coal now being worked at Vereeniging, by Messrs. Lewis and Marks, has a soft layer of whitish clay underlying the coal; but, as if to prove the futility of applying general theory to each particular case in South African geology, this underlying clay is apparently a decomposed sheet of dolerite, which had intruded below the coal, and, in many parts, penetrated into it, changing the coal into coke in the neighbourhood of the intrusion, and giving it more the nature of anthracite throughout its area. The endeavour to establish a geological horizon for the coal-beds in South Africa has not hitherto led to much practical result. We have Professor Seeley's recent opinion that coal must not be looked for below the strata containing the remarkable characteristic fossil reptilia. Further, we have Mr. Stow's original deduction that coal would be found from 70 to 150 feet below the silicified tree-stems which he traced over a large area in the north of the Cape Colony, and over a still greater extent in the Free State, and which he termed the forest zone. . . . . Mr. Stow's prediction that the coal would be found to crop out on the north-west of his forest zone has since been abundantly verified at the Vaal River. Nothing like a true Carboniferous system has yet been made out for South Africa; and though ferns, such as *Glossopteris*, have been found, this and some others are looked upon as survivals of Carboniferous plants into Jurassic times."

After some observations on the Coal-beds in the Stormberg and at Lake Nyassa, of the same Karoo series, Dr. Exton concluded with an exhortation to geologists to lose no opportunity in elucidating the many interesting and, indeed, most important problems lying at their feet in the subterranean strata, and before their eyes in the many and varied escarpments of hills and mountains around them.

II.—Glacial Progress. By Captain Marshall Hall, F.C.S., F.G.S.

[From the "Alpine Journal," No. 128, May, 1895.]

SINCE the appointment of the Sub-Committee upon Glacier Observations[1] sufficient time has not yet elapsed for many exact data to have come to hand, with one very brilliant exception—that of New Zealand.

Amongst the explorers of the Southern Alps are men not only mountaineers, but who are also greatly interested in these problems, shrewd observers and efficient officers of the New Zealand Survey. We have the novelty of new excursions, combined with the determination of a series of positions upon which to found future measurements, and all this in mountain ranges till recently scarcely known. The writer will give a summary of this work (with great conciseness, the result of instructions he has received). In the

[1] Geol. Mag., 1895, March Number, p. 144.

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absence of key maps, he omits tables, which would not be understood without diagrams of the various localities.

In the year 1892 an exploration was made in the hopes of finding some practicable route for a road from the west coast, Middle Island, New Zealand, across the main range to "The Hermitage." Although this object was not completely attained, materials for a survey of the country were collected, and a map by Mr. C. E. Douglas, explorer, Westland, is published in the Report for 1893 of the New Zealand Surveyor-General, as also a sketch of the geological formation of Copland District and sundry inspiring views of glaciers and peaks. Messrs. Douglas and Cuttance describe the Copland, Lyttle, Strauchon, and Cuttance glaciers amongst other features of the scenery.

In the Report for 1894 Mr. Douglas gives an account of a survey of the Westland Alps, with the assistance of Mr. A. P. Harper, from November, 1893, to April, 1894. On this expedition a satisfactory triangulation was carried up several glaciers. In the case of Franz-Joseph Glacier, points in its neighbourhood and on the ice itself were determined in sufficient number to afford data for estimating its future movements and bulk. This will serve as a typical glacier on the north-west side of the range. Its "snout," 692 feet only above the sea, is but four miles distant from the beach, in lat. 43° 25′ 30″ S., and long. 170° 10′ 58″ E. It has made great winter advance and summer retreat. Débris from lateral ranges have lodged in crevasses of the higher layers of ice, which further down have become the lower layers, the upper ice pushing over the lower,—as is exemplified in photographs to be found in the library of the Alpine Club—showing itself in alternate clear and dirty ice. The upper ice overlaps and breaks off at the terminal face, as also shown in the photographs. Other illustrations and maps will be seen in the Survey Report for 1894, together with a text full of interest. Over one matter the writer has been much exercised. Mr. A. P. Harper gives, at page 77, a table of rates of ice movement during his stay. An average of his figures at different stations gives the daily rate as 154·2 inches. But five other entries are so different, being 5″, 30″, 53″, 23·6″, and 7·28″, that to strike a mean of these figures would evidently mislead. They refer to distances from the sides of the glacier. At page 73 Mr. Douglas makes a statement of considerable interest to students of ancient glaciers. He says: "In valleys containing large glaciers I have always found four tiers of terraces, or old ice-lines, as if there had been four distinct periods. These lines keep a wonderfully regular distance from each other, and their inclination is very uniform, from, say, 4000 feet to 600 feet or 700 feet. . . . . The larger the valley the more gentle the slope."

Mr. T. N. Brodrick, C.E., sent a paper, accompanied with four maps, to the writer. The most important part of Mr. Brodrick's work is a triangulation and survey carried up the Mueller glacier, during which were determined, not only the position of stones on the ice relatively to stations on the huge lateral moraines, but the distance and bearings of many such blocks *from each other*. These

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positions were first fixed on March 29, 1889, re-determined November 14, 1890, and again December 3, 1893. The measurements so far showed (what has been found elsewhere) that the sides move more slowly than the centre; that the ice moves more slowly as it approaches the terminal face; that the current is varied by surrounding circumstances, such as bends of the glacier and, probably, the unevenness of its bed.

Its daily rate is not constant; a comparison of the rate for 1889–90 with that for 1890–93 shows a decrease of speed during the latter period. Here we ask, how as to *bulk* in those years? Fluctuations of the terminal faces of the Tasman and Mueller glaciers have been constantly remarked, but changes have not lasted sufficiently long to show if the ice be retreating or advancing. Captain Hutton, F.R.S., President of the New Zealand Alpine Club, states that about 1882 the Mueller glacier reached over the Hooker River to the side of Mount Cook, and sheep were taken over on the ice. Traverses were made of the terminal faces of the Tasman in November, 1890, and of the Mueller in March, 1889, and November, 1890. Mr. Brodrick says that the Hooker River so modifies the contour of the Mueller that the experiment has failed to demonstrate short changes satisfactorily, though these traverses will no doubt be of interest in the future. During a recent period all the Canterbury glaciers appear to have been in retreat, but latterly, and for a number of years, to have been stationary.

There is no evidence of ploughing up the earth and leaving it in ridges, and falling stones are in great measure stopped by lateral moraines, and do not reach the ice. Mr. Brodrick gives tables of rates of motion, and one of the areas of six glaciers, together with that of the sources of supply, as regards *névé*.

REVIEWS.

THE SEISMOLOGICAL JOURNAL OF JAPAN. Vol. IV, 1895 (corresponding to vol. xx of the "Transactions of the Seismological Society): Edited by Prof. J. MILNE. pp. xxi + 367.

Contents: A Catalogue of 8331 Earthquakes recorded in Japan between 1885 and 1892, by Prof. John Milne, F.R.S., F.G.S.

MANY of the preceding volumes of this well-known series may have possessed a wider interest, but few, if any, are of greater value, or will more profoundly influence the progress of seismology, than that which is now before us. This evidently is a work which is neither to be "tasted" nor "swallowed," nor even to be "chewed and digested." It is intended for those who make books, not for those who read them. It will be the parent of many papers. For in these somewhat unattractive-looking pages are gathered materials for the harmonic analyzer and facts for the student of terrestrial evolution. Only the labour is required, and that will soon be forthcoming, and we shall know something about the laws which govern the distribution of earthquakes in space and time, at any

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