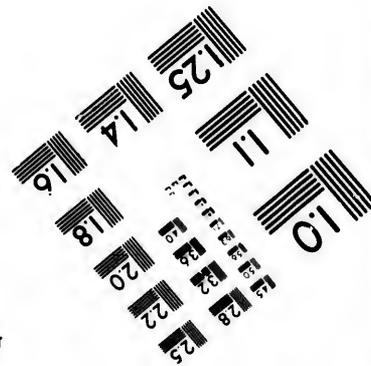
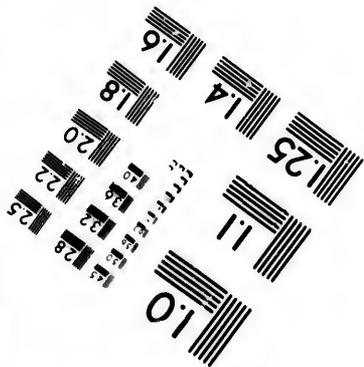
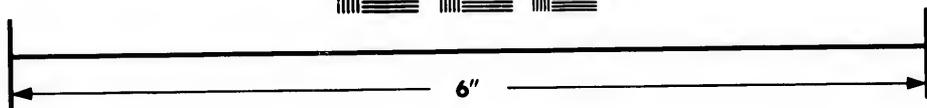
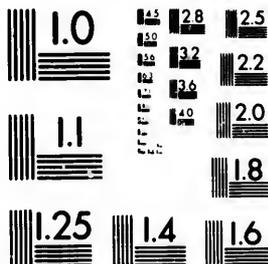


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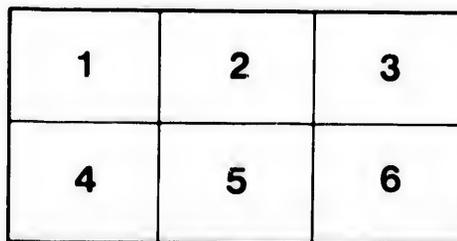
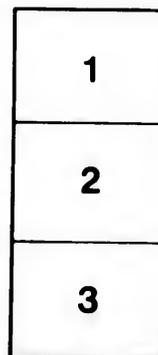
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GLACIATION OF BRITISH COLUMBIA.

[*Extracted from the* GEOLOGICAL MAGAZINE, August, 1888.]

TRÜBNER & CO., 57 and 59, Ludgate Hill, London.

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RECENT OBSERVATIONS ON THE GLACIATION OF BRITISH
COLUMBIA AND ADJACENT REGIONS.

By GEO. M. DAWSON, D.Sc., F.G.S.,
Assistant Director, Geological Survey of Canada.

PREVIOUS observations in British Columbia¹ have shown that at one stage in the Glacial period—that of maximum glaciation—a great confluent ice-mass has occupied the region which may be named the Interior Plateau, between the Coast Mountains and Gold and Rocky Mountain Ranges. From the 55th to the 49th parallel this great glacier has left traces of its general southward or south-eastward movement, which are distinct from those of subsequent local glaciers. The southern extensions or terminations of this confluent glacier, in Washington and Idaho Territories, have quite recently been examined by Mr. Bailey Willis and Prof. T. C. Chamberlin, of the U.S. Geological Survey. There is, further, evidence to show that this inland-ice flowed also, by transverse valleys and gaps, across the Coast Range, and that the fiords of the coast were thus deeply filled with glacier-ice which, supplemented by that originating on the Coast Range itself, buried the entire great valley which separates Vancouver Island from the mainland and discharged seaward round both ends of the island. Further north, the glacier extending from the mainland coast touched the northern shores of the Queen Charlotte Islands. The observed facts on which these general statements are based have been fully detailed in the publications already referred to, and it is not the object of this note to review former work in the region further than to enumerate the main features developed by it, and to add to these a summary of observations made during the summer of 1887 in the extreme north of British Columbia, and in the Yukon basin beyond the 60th parallel, which forms the northern boundary of that province.

The littoral of the south-eastern part or "coast strip" of Alaska presents features identical with those of the previously examined coast of British Columbia, at least as far north as lat. 59°, beyond which I have not seen it. The coast archipelago has been evidently involved in the border of a confluent glacier which spread from the mainland and was subject to minor variations

¹ Quart. Journ. Geol. Soc. vol. xxxi. p. 89. *Ibid.* vol. xxxiv. p. 272. Canadian Naturalist, vol. viii.

² Bulletin U.S. Geol. Survey, No. 40, 1887.

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in direction of flow dependent on surface irregularities, in the manner described in my report on the northern part of Vancouver Island.¹ No conclusive evidence was here found, however, either in the valley of the Stikine River or in the pass leading inland from the head of Lynn Canal, to show that the ice moved seaward across the Coast Range, though analogy with the coast to the south favours the belief that it may have done so. The front of the glacier must have passed the outer border of the Archipelago, as at Sitka, well-marked glaciation is found pointing toward the open Pacific² (average direction about S. 81° W. astr.). It is, however, in the interior region, between the Coast Range and the Rocky Mountains proper and extending northward to lat. 63°, explored and examined by us in 1887, that the most interesting facts have come to light respecting the direction of movement of the Cordilleran glacier. Here, in the valleys of the Pelly and Lewes branches of the Yukon, traces were found of the movement of heavy glacier-ice in a northerly direction. Rock-surfaces thus glaciated were observed down the Pelly to the point at which it crosses the 136th meridian and on the Lewes as far north as lat. 61° 40', the main direction in the first-named valley being north-west, in the second north-north-west. The points referred to are not, however, spoken of as limiting ones, for rock exposures suitable for the preservation of glaciation are rather infrequent on the lower portions of both rivers and more extended examination may result in carrying evidence of the same kind much further toward the less elevated plains of the Lower Yukon. Neither the Pelly valley nor that of the Lewes is hemmed in by high mountainous country except toward the sources, and while local variations in direction of the kind previously referred to are met with, the glaciation is not susceptible of explanation by merely local agents, but rather implies the passage of a confluent or more or less connected glacier over the region.

In the Lewes valley, both the sides and summits of rocky hills 300 feet above the water were found to be heavily glaciated, the direction on the summit being that of the main (north-north-west) orographic valleys, while that at lower levels in the same vicinity followed more nearly the immediate valley of the river, which here turns locally to the east of north.

Glaciation was also noted in several places in the more mountainous country to the south of the Yukon basin, in the Dease and Liard valleys, but the direction of movement of the ice could not be determined satisfactorily, and the influence of local action is there less certainly eliminated.

Of the glacial deposits with which the greater part of the area of the inland region is mantled, it is not intended here to give any details, though it may be mentioned that true Boulder-clay is frequently seen in the river-sections, and that this generally passes upward into, and is covered by, important silty beds, analogous to

¹ Annual Report Geol. Surv. Canada, 1885, p. 100 B.

² Mr. G. F. Wright has already given similar general statements with regard to this part of the Coast of Alaska, American Naturalist, March, 1887.

the silts of the Nechaco basin, further south in British Columbia, and to those of the Peace River Country to the east of the Rocky Mountains. It may be stated also that the country is generally terraced to a height of 4000 feet or more, while on an isolated mountain-top near the height of land between the Liard and Pelly rivers (Pacific-Arctic watershed) rolled gravel of varied origin was found at a height of 4300 feet, a height exceeding that of the actual watershed by over 1000 feet.

Reverting to the statements made as to the direction of the general glaciation, the examination of this northern region may now be considered to have established that the main gathering-ground or *névé* of the great Cordilleran glacier of the west coast, was included between the 55th and 59th parallels of latitude in a region which, so far as explored, has proved to be of an exceptionally mountainous character. It would further appear that this great glacier extended, between the Coast Range and the Rocky Mountains, south-eastward nearly to lat. 48°, and north-westward to lat. 63°, or beyond, while sending also swollen streams to the Pacific Coast.

In connection with the northerly direction of ice-flow here mentioned, it is interesting to recall the observations which I have collected in a recently published report of the Geological Survey, relating to the northern portion of the continent east of the Mackenzie River.¹ It is there stated that for the Arctic coast of the Continent, and the Islands of the Archipelago off it, there is a considerable volume of evidence to show that the main direction of movement of erratics was *northward*. The most striking facts are those derived from Prof. S. Haughton's Appendix to McClintock's Voyage, where the occurrence is described of boulders and pebbles from North Somerset, at localities 100 and 135 miles north-eastward and north-westward from their supposed points of origin. Prof. Haughton also states that the east side of King-William's Land is strewn with boulders of gneiss like that of Montreal Island, to the southward, and points out the general northward ice-movement thus indicated, referring the carriage of the boulders to floating-ice of the Glacial Period.

The copper said to be picked up in large masses by the Eskimo, near Princess-Royal Island, in Prince-of-Wales Strait, as well as on Prince-of-Wales Island,² has likewise, in all probability been derived from the copper-bearing rocks of the Coppermine River region to the south, as this metal can scarcely be supposed to occur in place in the region of horizontal limestone where it is found.

Dr. A. Armstrong, Surgeon and Naturalist to the "Investigator," notes the occurrence of granitic and other crystalline rocks not only on the south shore of Baring Land, but also on the hills at some distance from the shore. These, from what is now known of the region, must be supposed to have come from the continental land to the southward.

¹ Notes to accompany a Map of the Northern Portion of the Dominion of Canada, East of the Rocky Mountains, p. 57 R., Annual Report, 1886.

² De Rance, in *Nature*, vol. xi. p. 492.

Dr. Bessels, again, remarks on the abundance of boulders on the shore of Smith's Sound in lat. $81^{\circ} 30'$, which are manifestly derived from known localities on the Greenland coast much further southward, and adds, "Drawing a conclusion from such observations, it becomes evident that the main line of the drift, indicating the direction of its motion, runs from south to north."¹

It may further be mentioned that Dr. R. Bell, of the Canadian Geological Survey, has found evidence of a northward or north-eastward movement of glacier-ice in the northern part of Hudson Bay, with distinct indications of eastward glaciation in Hudson Strait.² For the Northern part of the Great Mackenzie Valley we are as yet without any very definite information, but Sir J. Richardson notes that Laurentian boulders are scattered westward over the nearly horizontal limestones of the district.

Taken in conjunction with the facts for the more southern portion of the Continent, already pretty well known, the observations here outlined would appear to indicate a general movement of ice outward, in all directions, from the great Laurentian axis or plateau which extends from Labrador round the southern extremity of Hudson Bay to the Arctic Sea; while a second, smaller, though still very important region of dispersion—the Cordilleran glacier-mass—occupied the Rocky Mountain region on the west, with the northern and southern limits before approximately stated.

I have refrained from entering into any detail at this time in respect to the glaciation of the northern part of the Cordillera belt, as it is probable that within the year we shall be more fully informed on the subject, as the result of observations to be expected from Mr. R. G. McConnell of this Survey. Mr. McConnell is now on the Mackenzie River, which, as well as the Poreupine branch of the Ynkon, within the Arctic circle, it is intended that he shall examine during the summer.

¹ Nature, vol. ix.

² Annual Report Geol. Surv. Canada, 1885, p. 14 D.D.; and Report of Progress, 1882-84, p. 36 D.D.

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