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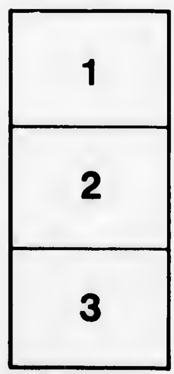
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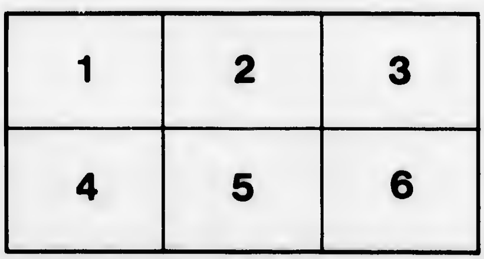
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The

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## THE GLACIERS OF NORTH AMERICA.

By Prof. ISRAEL C. RUSSELL, University of Michigan.

There is a popular impression that for the proper study of glaciers one must visit Switzerland. A tramp through that country is instructive and highly enjoyable, I freely admit, but in this paper I wish to show, among other things, that an American need not leave his own continent in order to gratify his taste for mountaineering and glacier study. We are greatly indebted to the many explorers who have climbed the Alps, for observations and theories concerning the nature and origin of glaciers, and are also under lasting obligations to European students for a vast amount of information concerning the time when much of the northern hemisphere was buried beneath vast ice-sheets, but for the study of both existing glaciers and the records of the Glacial epoch, North America furnishes an abundance of material. Before reviewing the present status of our knowledge concerning the glaciers of North America, let us endeavour to obtain a clear idea of what a glacier is, even at the expense of repeating what may be regarded as elementary information.

Suppose a climatic change should occur of such a nature that the snow falling over the surface of New England each winter should not be entirely melted during the succeeding summer. If the remnant left over from one year to the next were a foot thick, in a thousand years the land would be buried beneath a thousand feet of ice. The covering would be mainly ice, and not snow, except in its superficial portion, for the reason that the summer melting would lead to the saturation of the snow left unmelted, and when cold weather came it would freeze. Consolidation of the lower portion of the accumulation would also result from pressure. A cubic foot of ice weighs about 57 lbs. At the bottom of an ice-sheet 1000 feet thick the pressure would be 579 lbs. to the square foot. Now, since ice, in common with many other solids, behaves like a plastic body when subjected to sufficient pressure, a thick layer will tend to change its shape of flow under the influence of gravity. Without attempting to discuss the vexed question of the causes of glacial motion, I may say, as a result of accumulated observations, that an ice-sheet a thousand feet thick over New England would acquire motion and flow in all directions, the motion being greatest where it was favoured by the slope of the land. Such a bed of ice as we have built up in fancy is what is termed a glacier; that is, a glacier is a body of ice formed by the consolidation of snow, which flows by reason of its own weight.

The climatic change which would permit of the formation of a glacier over New England would be a lowering of the mean summer temperature to such a degree that the snow falling each winter would not be melted during the succeeding summer. In other words, a change in the mean summer temperature to about 32° would be required.

Such climatic conditions as we have assumed are not in violation of the laws of nature. There are numerous localities on the Earth's surface, ranging from the equator to the poles, where snow accumulates from year to year.

Mountains under the equator in Africa and South America, 18,000 feet or more in height, are snow-capped throughout the year. The lowest limit of snow at the season of greatest melting is known as the snow-line. That is, the snow-line is the lowest limit of perennial snow. As one travels either north or south from the equator, the snow-line descends lower and lower, and finally reaches the level of the sea in high latitudes. The conditions favouring the formations of glaciers are met with, then, in any region where the land rises above snow-line. We find, on examining such regions, not considering minor conditions, that glaciers originate above the snow-line, and, descending below it, melt away.

The places where perennial snow is possible outside the polar regions are on high mountains. The snow falling about lofty peaks accumulates most deeply at the heads of valleys and in great amphitheatres, and flows from these gathering grounds as streams or rivers of ice. These ice-rivers frequently descend, not only below the snow-line, but in numerous instances well below the highest limit of tree-growth or the timber-line. These long, narrow, river-like streams of ice were first studied in the Alps, and hence are known as "alpine glaciers."

Some alpine glaciers not only descend below the snow-line and traverse valleys bordered by luxuriant vegetation, but reach the plains adjacent to the mountains and spread out as nearly level ice-sheets. When several alpine glaciers expand in this manner and unite on a plain, a lake-like ice-body is formed. Such ice-bodies differ in many ways from their feeding ice-streams, and it is convenient to designate them by a separate name. Their occurrence about the bases of mountain ranges has led to the suggestion that they be termed "piedmont glaciers."

Glaciers also originate on plateaus and plains, where the winter's snow is not completely melted, as in the hypothetical case of the origin of a glacier in New England. The climatic conditions favouring the accumulation of perennial snow over broad plateau-like surfaces occur at the present time only in high latitudes. Under the conditions named, the ice flows in all directions from the central region of accumulation, unless local topographic influences prevail. These accumulations of ice are, in certain typical instances, of broad extent. The areas covered by them are, in fact, comparable with continents, and we term them "continental glaciers." At the present time a continental glacier covers nearly the whole of Greenland. In the southern hemisphere, the climatic conditions favouring ice-accumulation on low ground again occur, and we have the antarctic ice-cap, with an area approximately equal to that of North America, and an estimated thickness in the central part of many thousands of feet.

Glaciers of any of the three types I have mentioned, that is, the alpine, piedmont, and continental, may enter the sea. When this happens, the ice usually breaks off and floats away as bergs. On account of the well-marked characteristics of glaciers which terminate in this manner, it is convenient to have a general term by which to designate them, and we call them "tide-water glaciers."

Investigations carried on in North America by various explorers, have shown that we have many hundred, and possibly several thousand, glaciers of the alpine type. Two characteristic examples of piedmont glaciers are known in Alaska, and Greenland furnishes a typical example of continental glaciers. Several of the alpine glaciers of Alaska end in the sea; the great Malaspina glacier, the type of piedmont glaciers, also touches the sea for a few miles at Icy cape, near Mount St. Elias, and the Greenland ice-sheet sends thousands of bergs afloat. We have, in fact, many magnificent examples of tide-water glaciers.

America thus furnishes characteristic examples of all the types of glaciers now known, a statement that cannot be sustained in reference to any other continent.

All the glaciers of North America, not considering for the present those of Greenland or the arctic archipelago, are confined to the Cordilleran region, adjacent to the Pacific coast. We there find a belt of snow-capped mountains over 3000 miles long, and from 80 to 100 miles broad in its widest part, in which glaciers are of common occurrence. This great belt of shining mountains is curved so as to be rudely crescent-shaped. The extreme southern end of the crescent is in east-central California, and its north-west extremity on the larger of the Aleutian islands. At its ends this curved belt of snow and ice is broken into detached glaciers of small size, situated at high elevations among overshadowing peaks; but in its broadest portion, in the neighbourhood of Mount St. Elias and Mount Logan, the snow-line descends to within about 2000 feet of the sea, and hundreds of ice-streams come down to sea-level, and a score or more meet tide-water.

The most southern glacier in North America, so far as known, with a p ‸ble exception of perennial snow and ice about the summit of Popocatepetl in Mexico, occurs amid the most lofty peaks of the High Sierra, in Eastern California. In that region there are several peaks, such as Mount Lyell, Mount Ritter, Mount Dana, etc., which attain elevations of over 13,000 feet. These splendid summits are white throughout nearly the entire year, but in late summer, when seen from the southward, they seem to be completely bare of snow. On their northern sides, however, in the shelter of great cliffs, small snowfields may be seen from a distance at the season of greatest melting, but if one visits these snow-banks as they appear to be from a distance, he finds them to be actual glaciers. They are small, but present many of the characteristics of even the largest ice-streams of the alpine type. The larger, the one on the north side of the summit peak of Mount Lyell, is not over a mile long, but on traversing its surface one finds very many of the features common to true glaciers. There is an upper region of snow, or a *névé*, and a lower region of compact banded ice. Crevasses, glacier-tables, moraines, etc., as well as striated rock surfaces adjacent to the ice, are all present. Nothing is lacking, in fact, to make this and several other ice-bodies of the High Sierra, strictly counterparts of typical alpine glaciers, except the river-like form characteristic of the larger glaciers of Switzerland.

North of High Sierra, for several hundred miles, glaciers are absent. In fact, in the Sierra Nevada proper no glaciers occur except those mentioned above, in the highest and most rugged portion of the range.

Mount Shasta is a volcanic mountain with a double summit, standing west of the north extremity of the Sierra Nevada, and distinctly separate from that range. This splendid peak, rising in its solitary grandeur to a height of about 14,500 feet, is white with snow through the year, and from its summit gives origin to five glaciers. The largest of them, an ice-stream of the characteristic alpine character named Whitney glacier, in honour of Prof. J. D. Whitney, of Harvard, has a length of a little over two miles, and is from 1000 to 2000 feet wide.

The general line of elevation marked out by the rugged summits of the Sierra Nevada, is continued northward by the scarcely less imposing Cascade mountains. The Cascades also have a high central region in West Central Washington, where several peaks attain an elevation of 8000 feet or more. The snow-line is there lower than in California, and the climate far more favourable for the accumulation of perennial snow. In this, the High Cascades, as they may be termed, there are scores of glaciers, some of them of what may be termed respectable size, but as yet they are unexplored. From the summit of Glacier peak, in Northern Washington, the writer has counted fifty veritable glaciers, and somewhat extended explorations in that region have shown that fully two hundred glaciers still exist there.

An outstanding watch-tower of the Cascades on the east, and separated from the crest of the main range by a belt of 20 to 30 miles of rugged country, is afforded by Mount Stuart, 9470 feet above the sea. This lone summit, rising spire-like from a group of encircling foothills, commands a most magnificent and far-reaching prospect of the Cascade region. Standing on the summit of Mount Stuart, or, better still, on the apex of some one of its score or more of supporting peaks, having elevations of about 7500 feet, the eye ranges over a region containing many objects of magnificence. To the south-west rise the snowy domes of Mount Hood and Mount Adams. Apparently near at hand, especially on the wonderfully clear days following storms, although some 70 miles distant, stands Mount Rainier, beloved of all the friends of nature who have ever seen its glorious summit. Below the gleaming snowfields, sheathing all the higher portions of this the finest single mountain in the United States, south of Alaska, there are several ice-streams which descend far into the encircling forests. More will be said in what follows of these fine glaciers.

What especially attracts the eye of the geographer who stands on the summit of one of the rugged foothills of Mount Stuart—particularly when the sun is rising above the distant cloud-like mountains of Idaho, or when only the summit of Rainier is aflame with the rosy light of the after-glow—is the generally even sky-line of the Cascades. On looking westward, one beholds what seems a vast plateau, rising gradually from far to the east of his station, like a great smooth surface swell of the sea, and attaining its maximum height along the sky-line to the west, about 7000 feet above tide. The plateau referred to, or, what is more nearly the case, the great elongated flat-topped dome, appears to have a smooth surface, because the valleys are in shadow, or filled with purple haze, and their presence lost to view. Mount Rainier stands on the Cascade plateau, and similar to it in position are Mount Hood in Oregon, Mount Adams, Mount Baker, and Glacier peak in Washington. Each of these commanding summits, once aglow with volcanic heat, is now glacier-crowned. From each peak long tongues of ice, forming typical alpine glaciers, descend in all directions, and in several instances invade the dark coniferous forests with which the lower slopes of the mountains are clothed.

The finest of these series of radiating glaciers clusters about the summit of Mount Rainier, 14,526 feet above the sea, and flows far down its rugged sides before melting away. In this cluster there are at least ten glaciers which descend below timber-line. These are bordered by pine and spruce trees, and flow between precipitous banks decked with gorgeous alpine flowers. The larger of these very characteristic glaciers, named in honour of S. F. Emmons of the U.S. Geological Survey, one of the first explorers to climb the great peak, is about 7 miles in length, and approximately a mile broad. Examples of all the typical features of the glaciers of Switzerland are here illustrated. Few glaciers in any country can show finer ice-cascades, crevasses, moulins, glacier-tables, moraines, etc., than are encountered by one who climbs Mount Rainier.

Alpine glaciers, in many ways typical of their class, occur in the elevated valleys of Montana. Still finer ones may be reckoned by the score in the central ranges of the justly famed Canadian Rockies. As the great Cordilleran belt is followed northward, the ice-streams descend to lower and lower levels, and finally in the southern extremity of Alaska, a few miles north of Fort Wrangell, they enter arms of the sea and become tide-water glaciers.

Travellers who have ascended Stikine river, which rises in British Columbia and flows west across South-Eastern Alaska, have described several fine examples of alpine glaciers, which descend from lateral canyons and encroach on the river itself, thus adding a unique attraction to its marvellous scenery. It was in the neighbourhood of the Stikine that Muir discovered a large lake, held in a lateral valley by a glacier which crossed its mouth. Glacial lakes of this type are common in the more extensively glacier-covered region to the north.

After sighting the floating ice discharged by Hotlum glacier, or the thunderer, just referred to, the tourists who visit Alaska by the usual ute leading through the land-locked waters separating the many islands i British Columbia and South-Eastern Alaska from the mainland and from each other, see several glaciers above the dense forests fringing the coast, but none which reach tide-water are met with until Taku inlet is traversed, and the magnificent ice-cliffs of Taku glacier meet their astonished gaze. Taku glacier has its source far back in the mountains, in a region as yet entirely unexplored, and flows seaward through a deep rock-walled valley as a veritable river of ice nearly a mile broad. Where it enters the sea the ice stands in sheer cliffs of the most marvellous shades of blue and white, about 200 feet high. The ceaseless onward flow of the glacier is counterbalanced by the breaking away of great masses of ice from its terminus. These fall from the face of the ice-cliffs in avalanches, whose thunder is sent back in deep-toned reverberations from the surrounding mountains. The ice set free, after centuries of imprisonment, floats away as gleaming bergs.

The visitor to the wild Alaskan shores, who derives his first tangible ideas of a tide-water glacier from the one at the head of Taku inlet, will say, I think, that nothing could be at the same time more exquisitely beautiful and more awe-inspiring. If, however, his wanderings are to be continued westward, I would bid him wait.

The sail up Lynn canal, the route so many fortune-hunters are now following on their way to the Yukon goldfields, reveals scenes of wondrous beauty. Forest-covered shores, with many bays and inlets, overshadowed by rugged precipices, leading upward to snow-covered mountains, are the elements that in various combinations make up the ever-changing panorama bordering Lynn canal on either side. In the valleys between the ragged and serrated mountains there are scores of glaciers, some of which descend steep precipices and form beautiful ice-cascades. When the mists shroud the mountain-tops, these broken ice-falls seem cataracts of foam descending from the sky. The number of glaciers along Lynn canal can scarcely be realized by one who traverses that great inlet, once a river valley, but now flooded by the sea; but let the tourist climb some of the rugged peaks which command a far-reaching view over the deeply sculptured land, and every valley will be found to be partially ice-filled. On one occasion, from a peak about 3000 feet high near Dyea, I counted forty alpine glaciers, and a change in position of a few rods brought still others into view.

None of the glaciers on Lynn canal actually enter its waters, but a number come down to within a few hundred feet of sea-level. The most conspicuous of these is Davidson glacier, which expands on emerging from a deep high-grade valley, and forms a delta-like ice-mass fringed with a dense belt of spruce trees.

The reader who has patiently followed our lead thus far, perhaps needs to be encouraged by the statement that we are only on the border of the glacier wonderland. Scenes far more marvellous than any previously seen await the traveller who sails westward along the sublime Alaskan coast.

The next indentation of the land west of Lynn canal is Glacier bay. On entering Glacier bay from Icy straits, one sees before him a broad inlet, studded by fleets of gleaming bergs or packed with floating ice, so as to call to mind the accounts given by explorers of the borders of the arctic ocean. The head of the bay is beyond the reach of vision as one enters it, but far beyond rise white mountains of marvellous splendour. The highest of these is Mount Fairweather, which, although as yet not accurately measured, is over 15,000 feet high, and, with the exception of its steepest cliffs, is ice and snow covered from base to summit.

About the head of the inlet several large glaciers reach the sea, and break off in towering cliffs of ice. The largest and best known of these, named in honour of the discoverer of Glacier bay, John Muir, the well-known writer, drains an area of 800 square miles. A score or more glaciers of the alpine type there unite their floods of ice, which is forced out through an opening between rugged mountains about a mile broad, and breaks off in a manner characteristic of tide-water glaciers. The splendid palisade of ice in which the glacier terminates is from 250 to

300 feet high. The depth of water from which it rises is about 700 feet, making the thickness of the glacier at its terminus 1000 feet. From these shining cliffs, huge masses of ice, sometimes reaching from below the water's surface to the crest of the palisade, break away with a deafening roar, and topple over into the sea. During warm summer days these occurrences are repeated every few minutes, and in fact at such times the echoes from the neighbouring mountains are seldom silent. The scene beheld from the deck of a vessel anchored a mile from the terminus of Muir glacier is impressive, and will be long remembered by all who have feasted their eyes upon it; but still more wonderful scenes await one who climbs a neighbouring peak, and has in view the hundreds of square miles of rugged mountains from which the glacier derives its many tributary ice-streams.

Looking down on the glacier from a commanding station for the first time, one is filled with awe and wonder at the vastness of the panorama before him. The rough broken ice, with shining pinnacles separated by profound crevasses of the deepest blue in the central part of the stream just before it makes its final plunge into the sea, reveals the line of most rapid movement. The rate of ice-current is there about 7 feet a day during the summer, but is less in winter.

Turning from the ice-cliffs and rugged surfaces above them, and looking northward, one sees a broad valley, the bottom of which seems a nearly level pavement of ice. The way in which the mountains rise out of this ice-sheet shows it to be of great thickness. Not a tree is in sight, and not a trace of vegetation in all of the broad wintry landscape, except the exceedingly brilliant alpine flowers at one's feet. Far to the north rise white-robed peaks. Each valley between them is occupied by an ice-stream. One can count a score of separate glaciers, which unite to form the broad ice-field in the main valley.

Several other glaciers of the same general character as the Muir enter Glacier bay, and many more descend nearly to tide-water, but melt away before being able to add their contributions to the countless bergs that whiten its waters.

West from Glacier bay, the mountains which rise directly from the beating surf of the Pacific to great heights are bare and desolate, but in brilliant weather shimmer in the sunlight like burnished silver. Snow and ice fill every ravine and valley, and thousands of domes and precipices are sheathed in crystal. For 250 miles the coast-line is unbroken save by one small inlet, not easily accessible to ocean-going vessels. The next opening in the land is Yakutat bay, about 60 miles eastward of Mount St. Elias. The head of this inlet forms a long narrow waterway, which bends about the bases of the mountains like a broad river. Entering this land-locked estuary are four glaciers of the type of those discharging into Glacier bay. One of these, named in honour of Gardiner G. Hubbard, for many years president of the National Geographic

Society, is larger than Muir glacier, and ends in a mighty palisade of ice, which is even more magnificent than those we have just left in our fireside wanderings.

To the west of Yakutat bay there is a plateau of ice some 20 miles broad, which intervenes between the base of Mount St. Elias and neighbouring mountains and the Pacific. This ice-sheet at sea-level is fed by a number of large glaciers of the alpine type which flow down valleys in the mountains to the north, and has an area of about 1500 square miles, and its surface is, in general, about 1500 feet above the sea. This ice-sheet is strikingly different from any of the glaciers thus far considered. It has no gathering ground or *névé* fields of its own, but is supplied by ice-streams in much the same way that a lake at the base of a mountain range is fed by torrents. The ice-sheet in question has been named the Malaspina glacier, in honour of one of the earliest explorers of the Alaskan coast. As stated on a preceding page, it is the type of a class of ice-bodies termed piedmont glaciers. One of its most novel features is the presence of a forest growing on the dirt and stones which conceal the ice. Many square miles of dense vegetation have at least 1000 feet of ice beneath them.

At one place the Malaspina glacier enters the sea, and, breaking off, forms the finest tide-water glacier in the Alaskan region. This is the only locality on the west coast of North America where a glacier meets the surges of the open ocean.

From nearly everywhere on the ice-sheet at the base of Mount St. Elias the precipitous southern slope of that great peak is in sight. The mountain rises 16,000 feet above the broad glacier encircling its southern base, and has an altitude of 18,100 feet above the sea. The vast avalanches that rush down its southern slope illustrate on a grand scale the manner in which mountain peaks rising into regions where melting is unknown, are freed of their accumulations of snow. The avalanches feed the glaciers not only with snow and ice, but contribute to their freight of stones and dirt as well.

Mount St. Elias and its giant neighbour Mount Logan, 19,500 feet high, and, so far as now known, the loftiest summit in North America, rises from the most thoroughly glacier-covered region on the mainland of the continent. From the northern slope of Mount St. Elias, at an elevation of 14,500 feet, the highest point reached by the present writer in 1891,* the country to the northward, as far as the eye can reach, presents a vast succession of snowfields, with here and there a bare peak or crest too steep to allow snow to rest upon it. In this great gathering-ground hundreds of alpine glaciers have their birth. The largest yet discovered is the Seward glacier, the principal tributary of the Malaspina, which is about 50 miles in length, and about 3 miles

* In 1897 the summit was reached by the Duke of the Abruzzi's party.

broad in the narrowest part. The *névé* region just referred to has a general elevation of about 8000 feet, with hundreds of mountain peaks towering far above that horizon, and extends from the region about Lynn canal and glacier bay, westward past St. Elias and Logan to the vicinity of Copper river. This is the broadest portion of the crescent-like belt of glaciers and snowfields which follows the Cordilleran mountains from Central California to the Aleutian islands. To the west of Mount St. Elias the snow-line again rises, the snowfields become less and less extensive, and the glacier shrinks back farther and farther into the shelter of the peaks and mountain crests.

In Alaska and British Columbia, to the north of the mountains near the border of the Pacific, perennial snow is absent, and glaciers are unknown.

A journey from the High Sierra in Central California northward along the Cordilleran mountains would furnish hundreds, and probably thousands, of examples of alpine glaciers, and illustrate every phase that such glaciers present. In addition, the only known examples of piedmont glaciers would be found near the base of Mount St. Elias. To enlarge our studies of the glaciers of North America, and to add an example of a continental glacier to our list, a review is necessary of the work of explorers in Greenland and on the islands to the west of Baffin's bay and Smith sound. The greatness of this field, however, will preclude more than a brief outline of the facts known concerning it.

The area of Greenland, as stated by Peary, is about 700,000 square miles, and of this area about 600,000 square miles are buried beneath a glacier of the continental type. The central part of this covering is 8000 feet, and over, above the sea. As described by Nansen, Peary, and others, it is in reality a vast *névé* field, or gathering-ground, from which there is an outward flow in all directions. Throughout many hundred square miles in its central portion, the surface of the snow is unbroken by mountain peaks. The only feature that meets the eye of the hardy explorer is a seemingly boundless plain of snow. In travelling from the interior towards either the east or west coast, as has been shown, especially by Nansen's highly successful journey in 1888, one would at length see island-like summits of mountains, termed nunataks, projecting above the generally level snow surface. On a nearer advance to the coast, the nunataks would become larger and more numerous. Within sight of the Atlantic, or of Baffin's bay and the water connecting with it, strips of rugged land many miles in length form the actual coast. The central ice-sheet, many hundred and possibly seven or eight thousand feet thick, does not flow away from the central area of accumulation equally in all directions, but the outward drainage is influenced in a marked way by the topography of the land. The ice is drained off through the valleys, forming stream-like glaciers simulating alpine glaciers in some of their features. A continental glacier is thus a reservoir for the supply of lobes of ice and of well-defined ice-streams extending out from its border. Some of the streams draining the Greenland ice-sheet are from 10 to 30 miles broad. One of them, the Humboldt glacier, which flows west into waters leading to Baffin's bay, is reported to have a breadth of 45 miles where it enters the sea. This and other ice-streams on the Greenland coast are tide-water glaciers, and the largest of this class in the northern hemisphere. The bergs set adrift in Baffin's bay are reported to rise, in some instances, from 200 to 300 feet above the sea's surface; as they float with only about one-seventh of their mass above water, some idea of their immense size, and of the magnitude of the glaciers which gave them birth, can be realized. It is the bergs from this great factory, principally on the west coast of Greenland, that reach the Grand Banks and endanger trans-Atlantic commerce.

The tongues of ice extending out from the vast central gathering-ground in Southern Greenland, but melting away before reaching the sea, end in low frontal slopes in much the same manner as do alpine glaciers similarly situated in Alaska. In Northern Greenland, however, as has been carefully recorded by Chamberlin and others, the glaciers which end on land terminate in precipitous, and even in some instances in overhanging, escarpments 200 feet or more in height. These glaciers end on the land in cliffs of ice quite as steep as those found at the extremities of tide-water glaciers in more southern regions. The reason for this remarkable feature of the extremities, and also of the borders, of glaciers in the far north has not been clearly explained, although Chamberlin has made the suggestion that it is owing to the low angle of incidence of the sun's rays. The direct rays from the sun, as well as the reflections from the sea surface, reach the ice in nearly horizontal planes, and not at high angle as in more southern latitudes. Whether this is a sufficient reason for the peculiarities referred to, however, remains to be determined.

Remarkable glaciers discovered on Grinnell Land by the Greely expedition have been described by Lieut. Lockwood, as ending in great walls which could be traced across the land for many miles. One of these escarpments of ice is termed the "Chinese Wall," but it is a wall only when seen from the south, being the margin of a plateau of ice. The brief accounts brought by General Greely and others from the far north, although not as satisfactory as could be wished, are sufficient to show that many things of extreme interest to glacial students there await study.

We have now passed the existing glaciers of North America in rapid review, and can judge to some extent of the richness of this continent in objects of special interest to the student of glacial geology. It is safe to say that the mountains of the Cordilleran system hold thousands of glaciers of the alpine type, ranging in size from the great Seward glacier, probably the largest of its class known, to the small ice-bodies of the High Sierra. There are also two piedmont glaciers known, one the Malaspina glacier, briefly described in this paper, and a second on the coast to the west of the Mount St. Elias, and named Bering glacier. This second example, however, has only been seen from a distance, and no white man, so far as I am aware, has ever set foot upon it. Of continental glaciers, the one in Greenland is the only example in the northern hemisphere, unless the recently discovered ice-sheet of Franz Josef Land should prove to be of this type.

Space will not permit of a comparison of the glaciers of North America with those of other regions, but it is safe to say that no other continent affords such a variety of ice-bodies, or in such numbers.

It might be said that it is unfortunate America should have so much ice, but this is a matter which may be considered in two or more ways. The moderating influence of glaciers on climate, their conservative action on water-supply, etc., are frequently far-reaching and beneficent. To the geographer and geologist, glaciers are of more than passing interest, not only as illustrating the intricate working of the laws of nature at the present day, but for the reason that they furnish the key for unlocking a most interesting and instructive chapter in the Earth's history. But for the study of existing glaciers, the records of the Glacial epoch would still be a sealed book.

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