The Mountains and Glaciers of Prince William Sound, Alaska

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At the northern apex of the Gulf of Alaska where the coast of the North American continent swings around from a northwest to a southwesterly direction is a large protected body of water known as Prince William Sound.¹ It resembles a great inland sea dotted with islands and extended in three directions by long inlets and fiords. Everywhere the land surface rises abruptly from the water for the sound itself occupies a depressed portion of a former mountain range whose summits are now represented by the numerous islands.

On all four sides of the sound are mountains covered with snow most of the year and harboring glaciers of almost every type and description. These peaks attain elevations of from five to six thousand feet on the large islands to the south; from six to seven thousand feet on the mainland to the east and west; and over twelve thousand feet on the north. In the latter direction is the real alpine paradise of the region. Here are the highest summits of the western part of the Chugach Range which bends around the northern side of the sound in one of the most rugged and spectacular mountain systems to be found on the continent. It includes more than a score of 10,000-foot peaks, of which at least four are over 12,000 feet. The highest of these is a beautiful snow summit 13,250 feet high, which rises among a group of high mountains eleven miles from the head of College Fiord.² It is in such a locality that one finds some of the finest fiord and glacier scenery of the whole world.

Since my first glimpse of this region from a passing steamer in 1925, it had been my hope to spend some time there, free to go where I wished among the fiords and inlets. Two features made especial appeal: first, the main peaks of the Chugach Range of which little was known, and second, the great glaciers

¹ Named by Capt. James Cook in 1778. Later it was also known as Chugach Gulf.
² Name given by the Harriman Alaska Expedition in 1899 which also named the glaciers of this fiord after American colleges and universities.
which flowed from them into the northern waters of Prince Wil-
liam Sound. Although their ice fronts had been accurately studied
between 1899 and 1914, practically no data had been obtained
since, so a visit promised some interesting and perhaps startling
disclosures.

An opportunity presented itself late in the summer of 1931
when quite unexpectedly I found it possible to return to Alaska
for a period of six weeks. A small gas boat was chartered at
the town of Cordova in the southeastern part of Prince William
Sound and with little delay our small expedition set off on its
cruise to the various glaciers of the inlets to the north. Our
vessel was the Virginia owned and expertly run by the brothers
Rex and Ronney Hancock of Cordova with Charley Lillygren
as assistant pilot. Completing the party was Andy Taylor who
a few months before had been with the successful Ladd-Carpe
Expedition to Mt. Fairweather. Then a month later we were
joined by Sherman Pratt and Jack Wood, both of New York,
who spent the last two weeks with us.

Our work was confined mainly to the actual study of the ice
fronts, which involved occupying former photographic and meas­
urement stations, map-making, and general observations. No
purely mountaineering ventures were undertaken although on
several occasions it was found necessary to make fairly extensive
climbs up the glaciers for views of the surrounding country. The
party, however, was neither equipped nor organized for any
major ascent and the lateness of the season made the attempt
of such an undertaking quite inadvisable.

MOUNTAINEERING HISTORY

The history of mountaineering in this part of the Chugach
Range is a short one. The writer knows of no major peak that
has been climbed or whose ascent has ever been attempted. The
only recorded mountaineering expedition to visit this region was
that of Miss Dora Keen in 1914 which climbed eighteen miles up
the Harvard Glacier to explore its upper reaches and to search
for a pass leading across to the north slope of the range. After
more than three weeks of constant work relaying up the glacier
the party was stopped by tremendous ice-falls at an altitude of
6,100 feet.
However, other than strictly mountaineering parties have visited the upper portions of some of these glaciers. In 1898 over 4,000 prospectors and some United States Army detachments journeyed across the Chugach Range to the interior of Alaska by way of the Valdez Glacier route. This led up the Valdez Glacier to the snow fields at its head and then descended the northward-flowing Klutena Glacier, a total distance over the ice of twenty-four miles. There was naturally much suffering among the ill-prepared men, for the hardships were great, and several fatalities occurred; but gold was ahead and, therefore, mountaineering technique and proper precautions were for the most part forgotten. Later, in 1911, veins of gold and other minerals were found in the mountains north of Prince William Sound and almost immediately several hundred prospectors began exploring the country. During the next few years the upper sections of several of the big glaciers were visited in what later turned out to be a highly impractical search for these precious metals. The snow-fields at the head of the Columbia Glacier were reached at this time and one party is reported to have made the long trip northward across the range to the Matanuska Valley district. Actually several mines were established up the Columbia, Shoup, and Valdez Glaciers, but the difficulties of approach over the ice were in most cases too great so in the end few of them were financially successful.

Thus one may summarize the mountaineering activities in this region as having been entirely confined to glacier travel, during which it seems probable that prospecting parties have attained elevations of 7,000 and possibly even 8,000 feet. However, the ascent of any major peaks by them or anyone else has never been recorded and is extremely improbable.

PEAKS AND GLACIERS

Many of the high peaks on the crest of the range and its southern slope have been triangulated from distant points and, as a result, the main features of the glaciers hereabouts have been determined, but the details are still very imperfectly understood.

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3 For references see note at end of paper.
4 Information from Chris Peterson of Valdez, Alaska.
5 For references see note at end of paper.
Except for the foregoing, a large part of the main range, including practically all of its northern slope, is still unmapped and the altitudes of the peaks and the main topographic features are unknown. Large glaciers flow northward into the Matanuska Valley and it is assumed that they all rise near the center of the range, in some cases forming "through" glaciers with those flowing south into Prince William Sound.

A discussion of the different mountains can be undertaken only in the briefest and vaguest manner. Several fine peaks exist between the head of the Valdez and the Columbia Glaciers but this portion of the range is little known and one can only guess their height to be from 7,000 to 8,000 feet. Up the Columbia Glacier there are several mountain groups with peaks rising to altitudes of 10,000 feet. These, however, are mostly unmapped and but one or two are named. The difficulties in getting to them are not great beyond the necessity of packing fifteen to thirty miles in from the coast over the intervening glaciers where in the early spring sleds can be used to advantage. To the west of the Columbia, around the upper basins of Yale and Harvard Glaciers stand the highest peaks of the range. Their bases can be reached by traveling up these long gently sloping ice-streams but the cascading tributary glaciers issuing from the upper snow-fields and the peaks themselves render further progress extremely difficult. This factor serves to make the ascent of most of these peaks from the south side a formidable undertaking even in spring when glacier travel is at its best. In the case of the peaks situated on the watershed, which includes several of the highest summits, there is practically nothing known of their northern slopes. What routes of ascent there may be on that side can only be conjectured, but it is the writer's opinion that the climb from that direction should prove more practicable than from the south. The best preparation would be to fly over the region in order to make careful notes of the topographic details and the possible routes of approach and ascent.

The mountains on the northwest side of Prince William Sound between College Fiord and Passage Canal which include the prominent summits which rise above Harriman Fiord⁶ should afford

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⁶ First explored and named by the Harriman Alaska Expedition.
some excellent mountaineering. Several of these peaks, notably Mt. Muir (7,640 feet) and Mt. Gilbert\(^7\) (9,550 feet), rise so near the water's edge that the difficulties are confined to the actual ascent of the peaks. A further advantage is that there are one or two passes through this part of the range which make it possible to reach the northern slopes while maintaining a base of operation on the shore of the inlets to the south.

The numerous glaciers issuing from the southern front of the Chugach Range and terminating in or near the waters of Prince William Sound are of special interest. In complete contrast to the conditions found in Glacier Bay 400 miles to the southeast, where the ice-fronts have been retreating fairly steadily for over a century, the glaciers of Prince William Sound are now in many cases more advanced than has been the case for a very long time. As a result, we often find luxuriant forest growing in very close proximity to the glaciers, forming a magnificent contrast of color and enhancing many times the beauty of their tidal fronts.

The chief ice streams enter the northern side of the sound where from Valdez Glacier on the east to Harriman Glacier on the west there are eleven active tidal glaciers and many more large and small that terminate on land. The giant of the whole region is the Columbia, flowing from unexplored parts of the Chugach Range as a broad river of ice three to six miles wide and fully thirty-five miles long. Its terminus is seven miles across. For two and one-half miles fronting on Columbia Bay extends a magnificent active ice cliff which, owing to its accessibility, is enjoyed by most of the summer passengers on the steamers plying the southwestern Alaska route.

To the west of the Columbia are long fiords and inlets seldom visited and yet so close to the regular routes of travel that but a day's trip on a small boat is required to reach any one of them. Here are glaciers one to two miles wide and up to twenty miles in length flowing down through tremendously deep valleys hemmed in on either side by towering peaks whose summits and slopes are almost completely covered with magnificent hanging glaciers.

\(^7\) Named after John Muir and G. K. Gilbert of the Harriman Alaska Expedition.
To undertake a study of the glaciers of this region should appeal to mountaineering enthusiasts who desire to combine additional work of a practical and useful nature with a moderate climbing holiday. Serious climbing in Alaska requires a better equipped and organized party than in the Canadian Rockies or the Alps, owing to the greater scale. This makes it hard for the average mountaineer to work successfully among the really big peaks of the country. But Prince William Sound offers a happy compromise in its opportunities for glacier observation and for climbing accessible lesser peaks.

The actual technical knowledge and preparation required for the observations need not deter the amateur, for very valuable work can be done by simply photographing from designated stations the various ice fronts so as to show their positions in relation to nearby landmarks. Comparison of these pictures with earlier ones taken from the same spot, indicates the changes in the position or condition of the ice fronts. Furthermore, at certain glaciers, it is possible to recover old monuments from which accurate measurements of the advance or retreat of the termini can be made.

The need of observations may be realized when we recall that between 1914 and 1931 no careful studies were made of the Prince William Sound glaciers, although a few of the ice fronts were visited and photographed. For the remaining glaciers of this district the only clue to their recent behavior is the physiographic evidence which in most cases is inadequate and far less satisfactory than if regular observations had been made at about five-year intervals. It was a desire to reconstruct this past history of the various ice fronts and to record their exact positions and conditions in 1931 that prompted the writer's expedition. The intention was to study all the glaciers of Prince William Sound, but owing to the detailed nature of the work and the short amount of time allotted, it was found necessary to omit those on the west side of the sound. These and most of the glaciers of the southern coast of the Kenai Peninsula, therefore, still remain unstudied since 1910. A similar situation exists in the case of the important ice tongues entering Disenchantment Bay and Russell Fiord in the Yakutat Bay district. Like the Prince William Sound
glaciers they were carefully studied early in the century but no record of their behavior since 1913 seems to be available.

The study of glacial fluctuation involves considerably more than merely recording the oscillations of the ice fronts. Among other factors, it includes a detailed record of meteorological conditions at the glaciers and fairly complete knowledge of the size and configuration of the glacial basins. Another important factor is the temperature of the water into which the glaciers discharge, for if this increases or decreases it would immediately affect the ice fronts and would probably cause a change in their positions. These and many other branches of the study have as yet hardly been approached and their importance can be but vaguely surmised.

Future observations of the Alaskan glaciers are by no means assured for they will have to depend very largely if not entirely on voluntary work. However, the chances of systematic study are greatly increased by the recent formation of a Committee on Glaciers as part of the Section of Hydrology of the American Geophysical Union. It is recognized that, in addition to its scientific value, the subject possesses considerable economic importance. Already a collection of photographs of the North American glaciers is being made as a permanent pictorial record which will be added to from year to year as newer pictures are secured. Further, it is hoped to issue a yearly report of all glacier studies. Active work for the present will consist of helping to organize new research through governmental agencies or private enterprise. As an example, the Forestry Service has recently been enlisted to conduct annual observations of about twenty large glaciers in southeastern Alaska. Work in other sections will be more difficult to organize but at any rate a new element of systematization is being introduced which should produce more valuable results than has heretofore been possible.

OBSERVATIONS MADE IN 1931

Space permits but a brief summary of the observations of the recent oscillations of the glacier fronts visited by the author in September and October, 1931. For clearness the glaciers will be discussed in the order of their positions beginning at the eastern side of Prince William Sound and proceeding along the coast toward the west.
Valdez Glacier retreated about 1,240 feet between 1914 and 1931—an average of 73 feet per year. There may be a slight margin of error in this figure as the old monuments have been partially destroyed in the intervening seventeen years and are, therefore, difficult to identify precisely. The recent history of the glacier is, therefore, one of retreat amounting to 1,948 feet since 1901, broken as far as known by only one short spasmodic advance of a few hundred feet about 1906.

The terminus of Shoup Glacier has not materially changed position since 1898, but its appearance has been altered from that of an active discharging tidal ice cliff to a sloping inactive front scarcely reaching salt water even at high tide.

Columbia Glacier

Columbia Glacier, the largest and longest ice stream in the Prince William Sound region, has a lobate terminus of about seven miles in length.

At the west margin of the terminus we find that the ice retreated about 800 feet between 1892 and 1899. Then an advance set in about 1908 which by 1911 amounted to over 1,700 feet. A slight retreat appears to have followed until sometime soon after 1914 when a further advance of about 100 feet occurred. A retreat then set in which continued till 1930 or 1931, followed by a slight advance which was in progress in September of the latter year. The ice front at that time stood 900 feet back of its most advanced position since 1914 and about the same distance in front of the 1899 position.

Near the center of the ice terminus where the ice rests on the northern extension of Heather Island there have been various oscillations corresponding very closely to those of the west margin. A retreat occurred between 1892 and 1905, then by 1908 an advance set in which in 1910 had amounted to 742 feet. After 1914 a further advance of fully 200 feet occurred. The subsequent retreat has amounted in this part to from 200 to 250 feet, but again as at the west margin, there was a distinct advance observed in progress in September, 1931.

Immediately east of this, along the so-called eastern ice cliff the recent retreat has amounted to from 1,500 feet near the
west margin to 2,500 feet at the east end. The eastern land terminus has fluctuated in a very similar manner to that of the other land fronts and its recent retreat has amounted to from 400 to 800 feet.

**Glaciers of Unakwik Inlet**

The small glaciers of this inlet are all in a state of retreat, but the one large ice stream, Meares Glacier, has been advancing for some years. After what the writer interprets as fully a two-mile advance between 1898 and 1905 the ice front has since come forward several hundred feet more. Every observation has shown this terminus to be progressively further forward than the last. Meanwhile it is clear that only the northern tributary is contributing this forward impulse and that the eastern tributary is at present shrinking and its terminus would probably be retreating if its position were not influenced by its neighbor.

**Glaciers of College Fiord**

The center of the ice front of Yale Glacier has remained in the same position from 1898 to the present day. However, the east margin advanced about 750 feet between 1899 and 1910 and several hundred feet more since that date. Recently there has been a slight retreat of the east and west margins from their most advanced positions.

Harvard Glacier has been observed to be steadily advancing in recent years. From 1899 to 1905 there was little change at the east margin, then an advance set in which by 1910 exceeded 700 feet. Little change took place until after 1914 when an advance of from 1,300 to 1,400 feet took place at this point. This was still in progress in 1931. The west margin has also advanced but probably not to as great an extent.

The termini of the four large cascading glaciers on the west side of College Fiord have behaved somewhat differently in the last twenty years. Smith Glacier experienced a considerable increase in volume after 1914 and has since then shrunk to less than its former size. Bryn Mawr Glacier advanced about 500 feet between 1905 and 1909 and continued this till after 1910. Another advance occurred after 1914 followed by a retreat of 1,500 to 2,000 feet which by 1931 placed the ice front several
hundred feet back of its 1899 and 1905 positions. Vassar Glacier has probably experienced oscillations similar to those observed at Smith and Bryn Mawr Glaciers but on a smaller scale for its lower portions are so covered with moraine that the ice is too well protected to respond quickly to delicate readjustments. In almost direct contrast to these is Wellesley Glacier which although advancing in 1910, had retreated again by 1914 to a point back of the 1899 and 1905 positions. By 1931 part of the ice front had again come forward and occupied a more advanced position than previously observed.

**BARRY GLACIER**

Between 1899 and 1914 the front of Barry Glacier experienced the most spectacular retreat of the region. During these fifteen years there was a retreat of over three miles which caused one tributary glacier to become an independent ice tongue and all but freed another. Since 1914 there has been little change in the position of the terminus but photographs taken in 1925 suggest that the glacier was smaller in volume that year than either in 1914 or 1931.

**GLACIERS OF HARRIMAN FJORD**

Serpentine Glacier retreated about one-quarter mile between 1905 and 1909, then during the next five years there was little change in the position of its terminus. Between 1914 and 1931 there was an additional retreat of about 1,000 feet along the east margin and about 2,000 feet at the west margin.

Baker Glacier, a very small hanging glacier, is interesting because of its relatively great oscillations, for although less than two miles in length its terminus advanced about 1,000 feet between 1909 and 1914. A subsequent retreat had by 1931 restored the ice front to its position of 1905.

The tidal terminus of Surprise Glacier retreated about one and one-tenth miles along its southern margin between 1899 and 1909. Since then its position at this point has remained unchanged, but between 1914 and 1931 there has been a retreat of about 2,000 feet near the center of the ice front.

Cataract Glacier, a small steeply cascading ice tongue, advanced between 1909 and 1914. In 1925 the volume of ice had greatly decreased but the terminus still reached tidewater. In 1931,
THE CHUGACH MOUNTAINS AND PRINCE WILLIAM SOUND

Sources: U. S. Government maps; sketch map of Harvard Glacier by Dora Keen, 1917; observations by the author, 1931
however, the conditions were reversed, for the volume of ice was
greater than in 1925 but the terminus had retreated to dry land.

The oscillations of Roaring Glacier have been determined
very largely by the condition of the ice block fan at the base of
the cliffs overhung by the terminal portions of the glacier. This
fan was present in 1899 but absent in 1905. It had reformed by

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1910 and had greatly increased in size by 1914, but in 1931 was again of small size. It is probable that in this glacier the increase or decrease in size of this ice block fan indicates whether the glacier is tending to increase or decrease in volume—a condition

Glacier Studies

Maps
Map of Copper River District, Scale 1/500000, Alaska Road Commission, 1929.

Photographs

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which in the case of most glaciers is measured by the advance or retreat of the terminus.

Harriman Glacier retreated on its east margin about 1,050 feet between 1899 and 1909 while the west margin experienced practically no change. An advance then set in which by August, 1910, amounted to more than 1,050 feet on the east and 700 feet on the west. This advance was observed to be in progress in 1914, 1925, and 1931, during which all parts of the ice front appeared to have come forward at least 600 feet during those twenty-one years.

Toboggan Glacier, being a valley glacier terminating on land, has lent itself to very specific measurements. Between 1905 and 1909 there was an advance of the terminus to a point 400 feet beyond the 1905 position followed by a retreat of 652 feet. From 1909 to 1910 there was a further retreat of seventy-five feet, and from 1910 to 1931 the total retreat was 832 feet—an average of nearly forty feet per year.

CONCLUSION

The results of these observations indicate that with several notable exceptions there has been a fairly steady retreat and shrinkage among these glaciers during the last decade or decade and a half. That this is not a part of a widespread retreat which has been in progress for a long period of time is proved by the fact that within the last thirty-two years nearly half of the more prominent glaciers of this region have extended their fronts over terrain not occupied by ice for at least the previous one hundred years. This is conclusively shown by the position of mature trees and forests close to the termini of these glaciers. Further light on the relationship of these fluctuations to those observed among other glaciers or to any possible climatic cycle can be revealed only by more observations during the next few decades.