

GLACIER SURVEY
ROCKY MOUNTAIN NATIONAL PARK

1938

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1936 Glacier Studies
Rocky Mountain National Park

Introduction

Initiated in 1932, annual glacier surveys have been made in Rocky Mountain National Park through the year 1936, with the exception of 1936. In 1937 the survey was so reported as to cover the two-year interval from 1935 to 1937.

Andrews and Tyndall Glaciers have been selected for these studies due to accessibility, and better adaptation for measurement.

Method of Measurement

Desiring only data concerning the actual fluctuations forward or backward in the terminus of the glaciers, those setting up the survey devised a simple and roughly accurate system that lends itself to quick checking. Fixed stations, with related points for checking the positions of the fixed station from which actual measurement is made, were established. Measurement is made along ground slope from the front station to the nearest ice.

In 1937, it was found that the station for measurement at the foot of Tyndall Glacier had shifted out of position from that at the time of the 1935 measurements. By checking with reference points which may or may not have been absolutely stable, but which were evidently in about the same position, the movement of the points for measurement was calculated, and corrections made in the measurement figures. In 1938, measurement of stations indicated that no further shifting had taken place.

In the report for 1937, a thorough discussion of the difficult conditions for measurement at the front of Tyndall Glacier was presented. It is not, therefore, necessary to review that discussion here. Suffice it to say that the figures for Tyndall Glacier will always be subject to question in view of changing conditions there.

At Andrews Glacier in 1938, it was found that a persistent apron of snowbank on either side, particularly on the shaded south side of the glacier front, obscured the position of the actual ice. The only thing that could be done with reference points as they are set up was to make the measurements on the same line to the nearest ice, or rather, to the nearest points of snow overlay, and call the calculation based thereupon the "apparent advance". The conditions at the north side of the glacier terminus indicated a definite forward movement, which, to the naked eye, without previous station for measurement, would appear to be about 20'. This conclusion was based upon memory of conditions in 1937, and comparison of 1937 photographs with conditions as observed in 1938. Looking to a

better condition for measurement that should be effective for some

years, barring an entirely unexpected recession, a new station was established on an apparently stable boulder near the north edge of the terminus, from which measurement forward to the actual ice front can be made with facility. This new arrangement is diagrammed and discussed in the section dealing with Andrews Glacier.

1938 Glacier Survey Party

On September 21, 1938, the party for glacier study made the annual measurements on Tyndall and Andrews Glaciers.

Weather

Changing, the early hours before about 10 a.m. were fair. Increased cloudiness between 10 a.m. and noon brought squalls and in spite of "cotton" snow at the elevation of 11,000 to 12,000 feet. In mid-afternoon, the stormy conditions lifted, although overcast, hazy skies prevailed until sunset.

Party

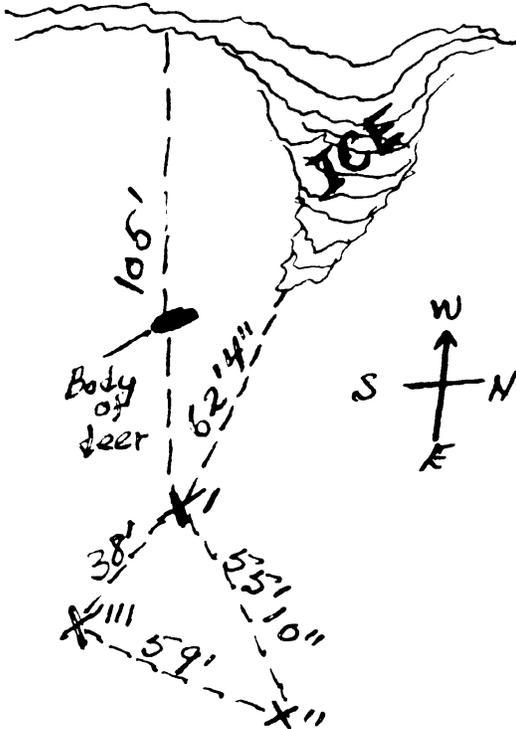
The party consisted of Dr. Carol Wegeman, Regional Geologist, National Park Service, Omaha, Nebraska; Chief Ranger J. Barton Hershler, Rocky Mountain National Park; and Park Naturalist Raymond Gregg, of Rocky Mountain National Park. Chief Naturalist Earl A. Trager of the Washington office of the National Park Service, and Mrs. Trager accompanied the survey party as far as Tyndall Glacier. The trip was made by horseback to the top of Flattop mountain. From here the party descended to the foot of Tyndall Glacier, climbed back out to the top of Flattop, and continued southward across the peneplain to the head of Andrews Glacier. After descending over Andrews Glacier and making measurements, the party returned to the Bear Lake road via Loch Vale.

The Measurements

1. Tyndall Glacier

Comparison of conditions at Tyndall Glacier with conditions in 1937, based on memory and study of 1937 photographs immediately showed a considerable growth in volume of the glacier. The large bergschrund normally present at the head of the glacier was not in evidence, and the snow overlay at the collecting head was evidently deeper than it was in 1937, when ice was visible up to the bergschrund rift. At the foot of the glacier, the ice, or what appeared to be ice, as best as it could be distinguished from snow overlay, was somewhat forward of the 1937 position. On the south edge of the glacier, the snowbank around the walls connecting with the "chute" on the south of the main body of the glacier had increased to a marked extent.

There was clear blue ice visible at a number of points in the interstices of the morainal and ablation debris on the flat "apron" between the pitching slope of the main body of ice and the recessional ridge in front of the glacier. It is quite apparent, as pointed out in the 1937 report, that there is much stagnant shade ice in the base of the morainal material. Therefore, as in previous measurements, the figures here merely indicate the nearest point of advance of ice or compacted snow overlay to the fixed point on the inside of the recessional moraine east of the apparent "glacial front".



TYNDALL GLACIER

in the month of August, 1938, was the snow melted away to reveal the body. It was in an excellent condition of preservation. Coyote tracks in blood and on snow near the body accounted for the consumed hind quarter, and ravens seen at the spot accounted for the partial consumption of the stomach and intestines. Otherwise, the flesh was dried and solid. The antlers were in autumn or winter condition, with velvet fully shed, and the condition made evident that they had been exposed to weathering too long to have been antlers stripped after the summer growth of 1938.

In making measurements from Station X', the nearest ice was sighted, and a tape measurement made. This was 62'4". The line was northwesterly from Station X'. In 1937, a line almost due west reached the nearest ice at a point 196'9" from Station X'. A measurement along the same angle in 1938 reached nearest exposed ice,

Persistent snowbanks filling concave depressions on the north walls of the gorge formed by the glacier were in evidence in 1938, where complete absence was noticeable in 1937. The largest of these was some 70' in diameter, roughly circular.

An interesting sidelight was the finding of a carcass of a mule deer buck, lying in the ablation debris south of the visible "snout" measured. Photograph of the deer is included with this report. It was quite evidently the victim of a fall into the gorge during the autumn of 1937, since its body evidently could not have been embedded in solid ice and avoided discovery in the autumn of 1937, when measurements were made. A reconstruction of events is as follows: The deer, during October snowstorms wandered out into the snow cornice at the head of Tyndall Glacier, lost footing, and hurtled down the precipitate face, becoming buried in snow at the base of the glacier. Only late

which was obviously compacted snow overlay, at a point of 105' from Station X'. The practice in past years apparently has been to mea-

sure from the fixed station to the nearest ice without regard to an angle. This, of course, means that the figures are deceptive as far as the actual condition to total increase in volume, or decrease in volume, is concerned. The figure set up in the table below is figured on the basis of the nearest-ice measurement of 62'4", although a much shorter indicated advance would be calculated if measurement to nearest to nearest ice on an established angle from Station X' were used. This comparative measurement is indicated in the sketch above, as well as the shorter line used in computing the apparent advance in the following table. In 1937, a correction of 5'2" was necessary to compensate for shifting of Station X', making total distance for comparison with previous readings, 201'11". The actual measurement of 196'9" made in 1937 is used in arriving at the apparent advance in the glacier year 1937-1938.

Measurements and comparison with previous figures are as follows:

<u>Station X' to</u>	<u>Ice</u>
1938	62' 4"
1937	196' 9"
1935	38' 6"
1934	72' 5"
1933	63' 4"
1932	30' 8"

Apparent advance 1937 to 1938: 134' 5"

Apparent net recession since 1932: 26' 6"

2. Andrews Glacier

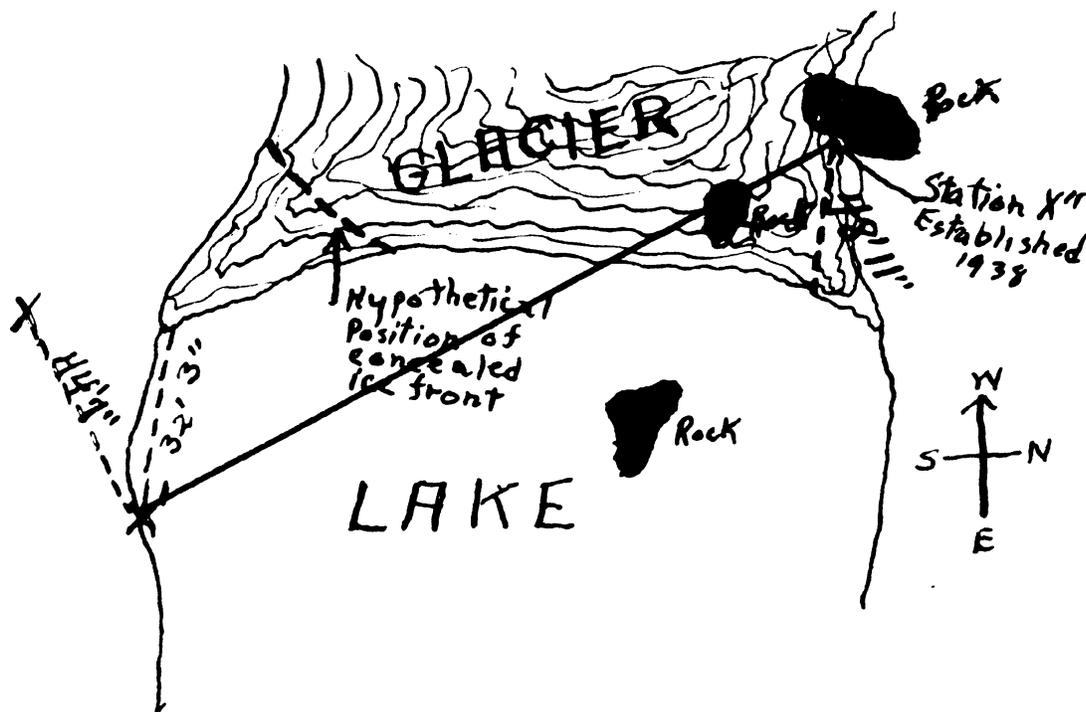
Study of photographs from 1937 at the time of the 1938 survey, together with the memory of members of the party, indicate that there was considerable enlargement of Andrews Glacier, particularly as concerns growth of surviving tributary collecting snowbanks along its margins, particularly along the south wall of the gorge. A picture made from the walls immediately at the head of the glacier shows very little difference in the level of the ice at the point of contact with the new lateral moraine along the north edge of the glacier, but this is an exposed position, and snow overlay had completely melted, exposing the down-sweeping accretion bands in the glacial ice. However, the extending upward on the headwalls of accumulated snow was evident, and the line of break from the gradual slope of the upper end of the glacier to the steep pitch to the terminus was apparently somewhat forward of this position in 1937, due to the heavy snow-pack over the upper part of the glacier.

In spite of the snow overlay giving the appearance of very marked advance, the actual ice at the center of the glacier prob-

ably did not move forward from the 1937 position more than some twenty-five feet. However, the presence of a large fixed boulder in the lake in front of the glacier gives a good marker for comparison

of position, and examination of the terminus good solid glacial ice at the front where the ice protruded into the lake. The level of the lake was much higher than in 1937, perhaps 18" to two feet. There was no evidence of an exposed mud delta in front of the glacier snout. However, the lake was milky in color, although probably less so than during the last season in 1937. Photographs for comparison are included in this report.

An interesting difference noted in 1938 was the complete absence of ice tables. Probably the heavier snow overlay prevented differential melting around surface rocks, as was the case in 1937. Another difference was in the emergence of stream channel carrying surface water along the north edge of the glacier. In 1937, this stream flowed in a deep channel to a point where the glacier is constricted into a narrow channel extending down to the terminus, and at this point dropped to the bed, emerging at the snout. In 1938, this stream emerged at a point about 150' above the terminus, flowing out to form an apron of glacial mud, strongly resembling a mine dump in form.



ANDREWS GLACIER

As mentioned on page one of this report, Station X' was found to be difficult of use for reference in determining actual advance when late survival of overlay along the south edge of the ice front conceals the actual position of the ice. The only thing that can be done is to measure to the nearest "ice", which was, in 1938, apparently merely a snowbank auxiliary to the glacier itself. In addition, it was found that Station X' was all but submerged in the

water of the lake at its higher snow level. Further rise of ten inches or more, possible before overflow at the outlet confines the maximum rise, would make Station X' useless. For comparison in such

case, and to give a better indication of actual movement of the true ice front, as long as it remains within some 50 feet of its present position, a new station, X" was set up on a boulder that is in an apparently stable position at the north edge of the glacier, and measurement made from that point to the edge of the ice at its contact with the water of the lake, where it broke abruptly to a square-faced front. An eight-line through a marked position on a rock surrounded by the ice to Station X' from Station X" will serve as future reference on the relative stability of the boulders along the north edge of the ice which have been selected for possible use in future measurements. (See above sketch.)

In 1938, the same line followed to the nearest ice was used for measurement, the nearest edge of the snowbank falling along this line, or close to it. The distance, on direct line, with tape extended across the surface of the lake, was 32' 3". Measurements and comparison with previous figures are as follows:

<u>Station X' to</u>	<u>Ice</u>
1938	32' 3"
1937	96' 10"
1935	66'
1934	139'
1933	58' 10"
1932	43' 7"

Station X" to Terminus
(On direct line to center of outlet of lake)

1938 48' 11"

Apparent advance 1937 to 1938: 64' 7"

Apparent net advance since 1932: 16' 4"

TEMPERATURE AND PRECIPITATION

As in the report for 1937, temperature and precipitation readings are computed as averages of the readings at the U.S. Weather Bureau Cooperative Station on Fall River, and readings at the Grand Lake ranger station. This is done to give an average of conditions which vary considerably between the west and east slope of the continental divide. While the glaciers lie on the east side, the heavy prevailing winds from the west contribute heavily to the condition of the glaciers by the amount of snow drifted over the continental divide into the gorges containing the glaciers. Hence, snow conditions on the west slope are equally as pertinent to those on the east slope, and are used to obtain an average condition. Inasmuch as the same readings are taken annually for

use, relatively the same conditions will prevail at the glaciers, which are not situated for feasible weather data measurements. Readings for the glacier years, Oct. 1937 through Sept. 1938 follow

<u>Month</u>	<u>Mean Temp.</u>	<u>Snow</u> <u>Depth</u>	<u>In prec.</u>	<u>Total Precip.</u>
October 1937	42.3	2.5"	1.89	1.89
November	30.5	17.2"	1.40	1.40
December	24.3	16.3"	1.15	1.15
January 1938	20.6	14.2"	0.90	0.90
February	23.6	10.5"	0.64	0.64
March	32.5	28.0"	2.09	2.09
April	35.6	20.8"	2.28	2.28
May	43.5	5.7"	1.21	2.21
June	53.7			1.92
July	58.2			1.81
August	58.5			2.27
September	<u>50.0</u>			<u>3.30</u>
For Glacier Year 1937-8	39.4	115.2"	11.56	21.86

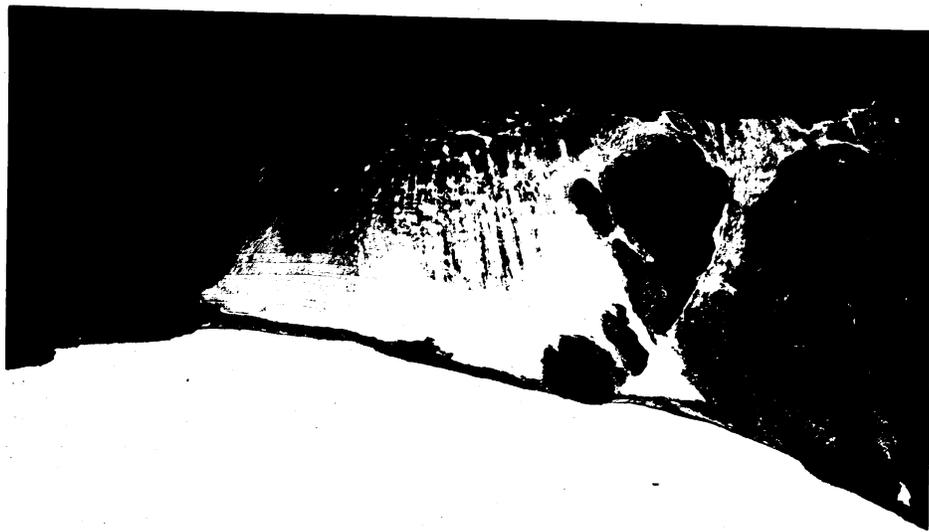
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Tyndall Glacier
from Flattop Mt., 1932



Tyndall Glacier
Flattop Mt., 1933



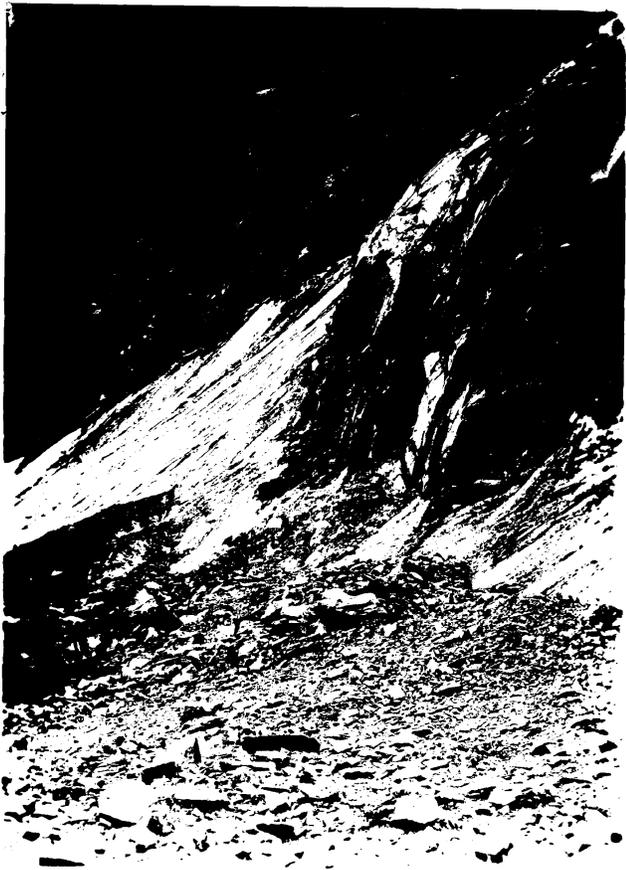
TYNDALL GALCIER

General view, taken from Flattop Mountain at point directly north of Jude Pool, looking west toward the glacier. Photograph taken September 31, 1936.



TYNDALL GLACIER

Photographs made in 1938, showing the lateral contacts of the glacier with the surrounding walls and debris, for future comparisons. Left photograph shows the "funnel" and the south edge of the glacier, looking from the north wall, with the new lateral in the foreground. Right photograph shows the north edge of the glacier, looking from Station X'. Note the antlers of a buck deer showing left of lower center. Measurement for 1938 was made from point of camera to nearest ice marked "A".



TYNDALL GLACIER
Looking south from
north lateral moraine
showing relative po-
sition of south limb
or snowbank of the
glacier.

Upper photo, 1937

Lower photo, 1938





TYNDALL GLACIER

Looking south across the headwalls of Tyndall Glacier, comparing conditions in 1937 and 1938. Upper photograph, 1937, with opened bergschrund, and greatly dissipated snowfield. Lower photograph, 1938, with bergschrund not evident, and much higher level of snow accumulation in evidence.





TYNDALL GLACIER

Looking down from above, showing location of terminus. Positions A, B, and C are identical rocks to show comparative position of ice and snow overlay. Upper photograph, 1937. Lower photograph, 1938.



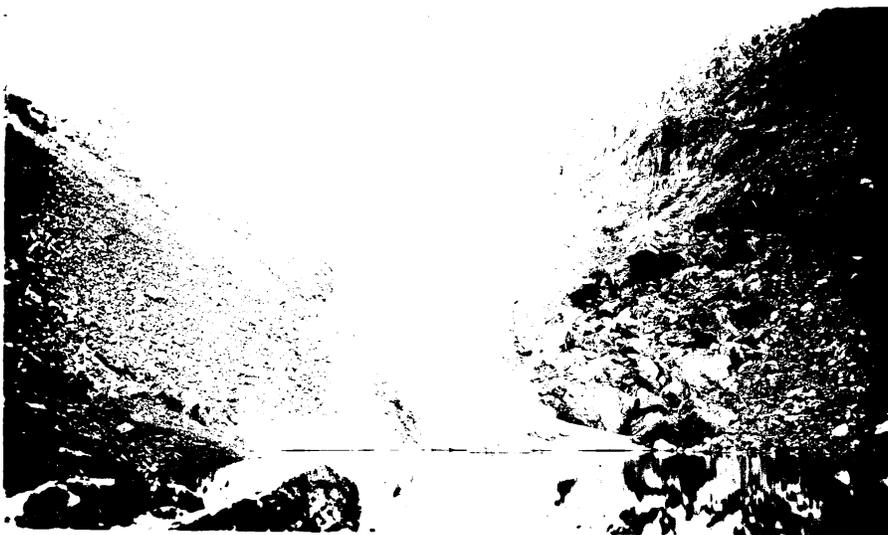
Tyndall Glacier
Carcass of mule deer found
at foot of Tyndall Glacier
in 1938. Apparent victim of
fall during snowstorm during
late fall of 1937, melted
from snow overlay at glacier
front early in autumn of 1938.
Lower photograph shows po-
sition of carcass with
relation to terminus of
glacier (looking west).
Lower shows state of
preservation.





ANDREWS GLACIER

Entire glacier as seen from east end of the lake immediately below and east of the glacier. Upper photograph, 1937, Lower photograph, 1938.





ANDREWS GLACIER

Looking across the terminus of the glacier, from north to south. Points A, B, C, and D are identical rocks, showing relative position of the glacier front. Water level is indicated by comparison of the rock in the lake. 1937 photograph shows surface-stain line representing level of 1938. Upper photograph, 1937.

Lower photograph, 1938.





ANDREWS GLACIER

Showing position of edge of ice on north side of the glacier at the front, next to the lake east of and below the glacier. Points A, B, C, D, and E are identical rocks, giving comparison of relative position of ice in 1937 and 1938. Upper photograph, 1937. Lower photograph, 1938.





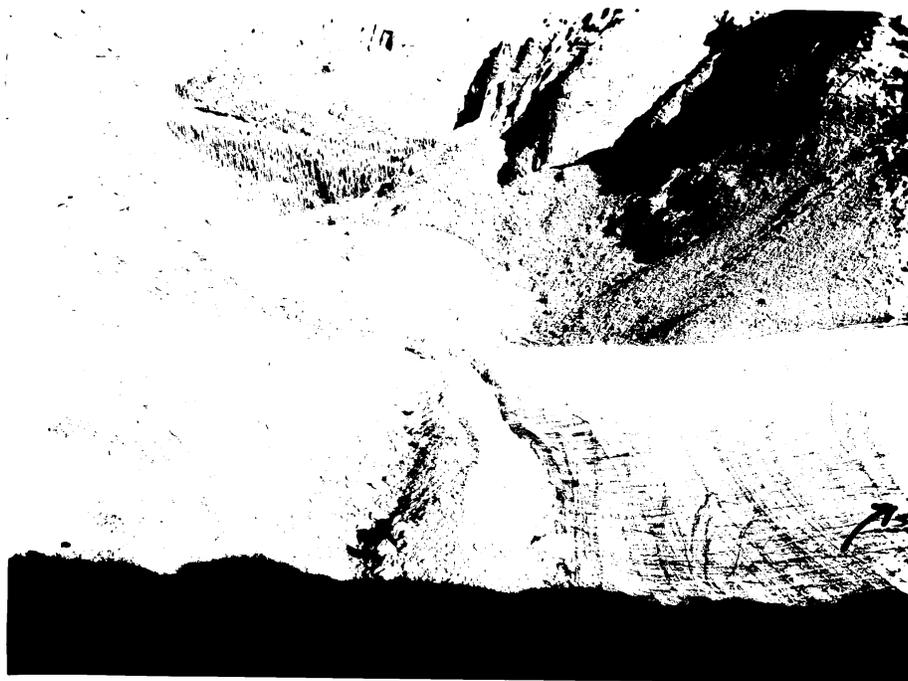
ANDREWS GLACIER

South edge of glacier
as seen from northeast
end of the lake immedi-
ately below and to
the east of glacier.

Points A, B, C, and D
are identical rocks,
giving comparison of
position of periphery
of ice and snow in
field of photograph.

Photograph at left,
September, 1937.
Photograph at right,
September, 1938.





ANDREWS GLACIER

Looking down the glacier from above, showing lateral moraine development on the north edge of the ice sheet. Note the point of snow overlay and exposed accretion bands. Upper photograph, 1937. Lower Photograph, 1938.

